Building Drawing

With an Integrated Approach to Built Environment

FIFTH EDITION

ABOUT THE AUTHORS

M G Shah

M G SHAH

Professor Shah was the Visiting Professor of 'Environmental Sciences' at the University of Pune. Earlier he served as the Principal, College of Engineering at Karad, Aurangabad, Ahmednagar and Pune, as also at Technical Teacher's Training College at Karad.

He also worked as the Director, College Development Council, University of Pune and as Hon. Director (Coordination) 'Science and Technology Park', University of Pune.

His professional and educational experience spanned a period of more than 52 years in which he authored eight books and published many technical papers in reputed journals. Professor Shah expired in December 2000.

C M Kale

C. M KALE

A graduate from University of Pune, Professor Kale worked as Lecturer in Civil Engineering at the College of Engineering, Karad; Government Polytechnic at Karad, Ratnagiri and also Pune. He authored seven books, three of them in Marathi. After his retirement (1981) he worked as a Consulting Engineer at Pune. Professor Kale expired in 1995.

S Y Patki

S Y PATKI

A graduate from the University of Pune, Mr. Patki retired as a Lecturer in Civil Engineering from Government College of Engineering, Pune (1994). His experience of over 38 years, first as a professional in irrigation department and later in Government Polytechnic, Pune and Aurangabad, has given him a deep understanding of the subject "Built Environment".

He has presented papers on Housing; Built Environment—Integrated Approach; Creation of Harmonious Balance with Environment and Ecology; Ecology, Ecosystem and Ecomanagement; Training of Engineering Teachers; Education Technology; Curriculum Development—Implementation; Evaluation, Training and Development of Teacher, at various seminars. He was instrumental in organising a short term course on Built Environment: Integrated Approach at Cusrow Wadia Institute of Technology, Pune. He was also the Convenor for the seminar on "Specialisation in Human Resources Development in Built Environment" during Constro' 94 Exhibition at Pune.

Visited Garden City Shenzhen and Beijing in China in the year 2005 and Bracknell, UK in the year 2008.

Got opportunity to study various aspects of town planning, neighbourhood planning, architecture, transportation, landscape architecture and human behaviour.

BUILDING DRAWING

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"A human being is part of a whole, called by us the 'universe', a part limited in time and space. He experiences himself, his thoughts and feelings, as something separated from the rest - a kind of optical delusion of his consciousness. This delusion is a kind of prison for us, restricting us to our personal desires and to affection for a few persons nearest us. Our task must be to free ourselves from this prison by widening our circles of compassion to embrace all living creatures and the whole of nature in its beauty".

— Albert Einstein

कि नगरांतरी वसिजे तरी नागरची होईजे
— संत ज्ञानेश्वर

*(One who lives in a Nagar (city or village) should behave like a cultured man.
Sant Dnaneshwara)*

Education

Education can change students into enlightened citizens. Creativity for starters, leads to learning, which leads to thinking and knowledge. Similarly, when there is righteousness in the heart, there is beauty in character, which is logically followed by harmony in the home, order in the nation and peace in the world. Simultaneously, you need to import courage in order to think differently, invent, travel towards the unexpired, combat problems and succeed.

Dr A P J Abdul Kalam
(Former President of India)
Times of India 24th June 2010)

We dedicate this textbook with gratitude and cheers
To
All great Thinkers, Philosophers, Ecologists, Architects and Engineers for developing awareness to protect the Earth, green the Earth and heal the Earth, as we have only one Earth for survival.
All professionals for their feedback and guidance through case studies, to create eco-friendly, user friendly, Environment friendly and economical designs for the welfare of the masses.
To fulfill the dream
"Built Environment for 'Gross National Happiness"!

CONTENTS

PREFACE TO THE FIFTH EDITION

BUILT ENVIRONMENT FOR GROSS NATIONAL HAPPINESS

'Built Environment' means man-made environment, taking into consideration the relationship between ecology, environment, town/city, buildings and man. Urban and rural designs creating ideal environment with sustainability is the need of the hour today and for future also.

Total richness due to sun, space, greenery, flowers, nearness of clean water, sky with colourful clouds and breeze is a God-given gift for the real welfare of human beings for sound mind and body. Hence, we must learn to live more closely, in harmony with nature. Nature must be nurtured. For this, urban planners must integrate functional, psychological, climatic and aesthetic aspects of Built Environment to create a harmonious effect which pleases both the eye and the mind.

Increasing population and emergence of large, very densely populated cities, pressure on resources at the local level and its severe scarcity, threat of climatic change, air, water and land pollution has raised importance of 'sustainable cities' and 'eco-friendly construction'. This is another challenge for urban planners.

Need for 'Gross National Happiness' was stressed during 'SARC Conference' in Bhutan (May 2010), earlier it was on 'Gross National Product'. Gross National Happiness (GNH) in other words, it means 'सर्वेऽपि सुखी: न सन्तु'. We all are familiar with this old saying. The word सुख (sukh) is important, सु (su) means good and ख (kh) means space. (खग - पक्षी - Bird) So, 'Good space' is the need for happy and contended life.

Now creation of such good space, i.e., liveable, encouraging, refreshing space for Happiness of all becomes the main objective of Built, i.e., Man-made environment. Built Environment should not exhaust us, it should renew life with enthusiasm and support the regeneration of the body and soul; help to live with dignity, safety, happiness and hope. This is also the real challenge to Urban Planners. Civil Engineering itself is defined as "an art and science of utilisation of natural resources for the welfare of mankind." Physical, psychological and spiritual comfort leads to contentment with inner satisfaction. It brings us nearer to the Nature to gain real insight and to appreciate creativity of supreme Nature.

NEED FOR ECO-FRIENDLY DEVELOPMENT WITH INTEGRADED APPROACH

We need 'Urban Planners and Designers' to accept challenges of eco-friendly development. It needs multidisciplinary contribution, i.e., contribution of Ecologists, Climatologists, Geologists, Hydrologists, Seismologists, Horticulturists, Architects, Engineers, Landscape architects, Building scientists and technologists. All these professionals are known as 'Agents of Transformations' of Natural Environment into 'Eco-friendly Built Environment'.

Economical use of land and other resources, achievements of measurable and non-measurable functions such as visual and audio pleasure, development of feeling for utility and aesthetics as also comfort through the design is the designer's challenge. Global warming, reduction in the forest area, pollution of air and water, garbage and E-waste, inadequate transportation system has given alarming signals to planners. Hence, energy saving, efficiency improving, user's friendly and eco-friendly design needs integrated approach of all.

TOWNSHIPS, PRE-ENGINEERED STEEL STRUCTURES AND COMPUTER TECHNOLOGY

Today big cities are expanding with new townships with high rise buildings. Industries are coming up with pre-engineered steel structures and computer technology is helping all planners, designers not only for planning and designing but construction management also.

Fourth edition of this book was published in the year 2001. During the last ten years, a lot of development took place in many areas related to built environment. Hence, the fifth edition of this book contains case studies related to –

A. (1) Garden City – Shenzhen, China and (2) Neighbourhood Planning for Bracknell, UK.
B. (1) Blue Ridge Township Hinjewadi, Pune. (2) Housing – Nandan Prospera Project of M/s. Shamkant Kotkar Buildcon. Interior Designing – (1) Interior Design (2) Kitchen Grace for 'Clinic for an Orthodontist.
C. Pre-engineered steel structures of (1) Octamec engineering (2) Zamil steel (2) Lloyd Insulations (4) Construction Catalysers.
D. Computer Technology – Software details for planning, designing, construction management from – (1) Newton softwares (2) Ensoft systems (3) Kanix Infotech (4) CalQuan India (5) EDSS (6) Soft Tech Engineers (7) Tekla India (8) CAD Sense Technologies (9) Datapro (10) Auto desk and (11) Neil Automation Technology Ltd.

Chapters 1, 2, 6 deal with new areas, latest thinking and developments related to 'settlements for quality of life, livability index and need for human resources development and research related to eco-friendly construction and materials, effective control of pollution related to garbage, e-waste, grey water and new areas such as solar energy for water heating air conditioning and generation of electricity, development of biodiversity parks, and rain water harvesting etc.

These additions will give new direction to learner for thinking, so as to empower him to act with logic and reason, search for appropriate solution related to the site.

EDUCATIONAL SYSTEM

Expectations from education are, first to kindle the flame, and then to develop essential qualities in planners and designers gradually – qualities such as intuition, intelligence, inventiveness and social vision for the welfare of mankind. Hence, the main expectation from education is to develop social thinkers who will maintain ecological balance and achieve welfare of all concerned by giving economical solutions.

Such thought – provoking educational system needs, firstly, feedback and guidance from the professionals through the case studies and based on it, regular updation of the educational system. Secondly, it should give an opportunity to the students to evolve as thinkers through project work. Creative people are often more sensitive to sight, sound and ideas. 'Why so?' is the question, that arises in their minds while moving through the town, watching landscapes, slums, traffic islands, roads, etc., in short, while observing the townscape. The need is to develop their views about what is excellent, good or bad. Group discussions will help in critical analysis of creations with reference to function, form, aesthetics and economy. Case studies are very useful for 'self-study' in this fast developing technological world of computers.

SELF-EDUCATIONAL SYSTEM FOR SPECIALISED PROFESSIONALS

Nowadays, Human Resource Development is a major challenge in case of creation of Built Environment. Students and professionals now need books with new design approach for different areas. These books should stress on the basic theory to enable the designer to understand the important aspects of design, design criteria, reference tables useful for designing and construction recommendations along with worked examples and working drawings related to latest case studies.

Such books may need regular revision, say after two years or so, depending upon the nature of the subject or they should be published in series with new information and updated in the light of latest or current legislations, new materials and equipment. Young professionals need methodology to check their design against performance tables, adjust and finalise the design for specialist suppliers and installer to implement. Discussion with suppliers is also essential to prepare reliable documentation. Hence, there is a need for information in a concise, readily accessible and usable form with reference to appropriate IS code and expected performance standard.

Teams of senior professionals as editors and few other professionals as co-authors along with contributions from manufactures of equipment and material is essential. This will serve the needs of professionals as well as the students for their project work at a higher level. Most importantly, the format of the book should be appropriate for self-study.

We would like to quote details of two books prepared and published with reference to the points mentioned above.

1. Environmental Physics in Construction – Its Application in Architectural design – Insulation and Condensation, Thermal, Natural Light and Sound by Schild, Casselmann Dahmen Pohlenz, Edited by M Finbow, and Published by GRANADA, London, New York, 1981.
2. Acoustics in the Built Environment Advice for the Design Team by Peter Sacre, Peter Mapp, David Saunders, Edited by Duncan Tempelton, and Published by Architectural Press, 1997.

At present, Technical Education needs books on the following projects –

(1) Mumbai – Pune Express Highway – planning, designing, construction and maintenance.
(2) Kokan Railway – Tunnels – Design Construction and Maintenance
(3) Township – Magarpatta City, Pune
(4) Bandra Sea Link Bridge – Design, Construction and Maintenance.

AGE OF COMPUTER-AIDED DRAWING AND DESIGN

Drawing is a graphical language, to convert requirements into reality. Drawing is a tool to develop the power of imagination. It is also stated that imagination is more important than knowledge, it leads to knowledge and tests the knowledge. 'Attention' and 'Accuracy' are two main qualities of the mind. Faculties of observation and accurate reproductions of what is observed helps in speedy planning, design and construction.

Computer aided drawings and designs, estimates, landscaping, structural design, drawing and project management are great tools to save energy. Artistic skill was a must for architects prior to computers, but today one does not need that much artistic skill. Instead what is essential is artistic aptitude and approach. This new era with computer applications saves time and energy and gives more time to think about the importance of each and every line, dimensions, level and material, to user-friendly environment and architecture and introduce energy saving designs by referring to planning and design handbooks, IS Codes, etc.

Students and teachers should realise the importance of such multidisciplinary subject as each and every line on a drawing is the result of numerous considerations such as function, structure, comfort, economics and aesthetics. This book is revised to give total vision related to Built Environment. Projects for team work related to town planning, architecture, landscape architecture, construction, drawing, etc., will take the students gradually into the world of professionals, facing today's problems and inspire them to think of appropriate alternate solutions. Educational system should develop imagination in the right direction. Built Environment needs different consultants and through this book the students will get an opportunity to choose their elective subjects and also a particular branch for further postgraduate study. Authors have practiced this system successfully in the engineering colleges they have served.

We are really grateful to the authors of various books and articles in different magazines and newspapers, their property supplements for providing valuable views and information relating to the subject during 35 years of our teaching and after retirement. Hence, our indebtedness to certain authors will be evident from the text because of their views with their experience. Over a period of more than 35 years, views and ideas sometimes take root in one's mind in a way that renders it difficult to trace their origins. We, therefore, gratefully acknowledge anyone, whose work we may have drawn in our language without having been aware of doing so and perhaps not mentioning unintentionally. We have made efforts to establish and properly acknowledge the copyright owners of the drawings and plans, various quotations and information published in reports used in this book and wish to apologise for any unintentional omissions in the process. Should any other acknowledgements be necessary, the publishers and authors will be happy to do so when the book is reprinted. Many seminars related to Built Environment and allied subjects have enriched ourselves and our Students Views. Books written by Geoffrey Boradbent, *Design in Architecture* and Ian L McHarg's, *Design with Nature* were a great source of inspiration for us. A separate list of various books is given in the Bibliography. Students and teachers can refer to the books listed therein for additional reading.

Livability Index, 2010 Best cities of India 2010, Published by Confederation of Indian Industries, Gurgaon, Northern region and Institute for Competitiveness is a useful reference book for Urban Planners.

We would like to thank Dr Avinash G Kharat, M E (Civil), Ph D, AITP, Principal 'Sinhagad Academy of Engineering, Pune - 48, having deep study in Built Environment with special emphasis to Vastushastra, Ancient Science of Built Environment - India and Prof. Pratap Raval, B E; M E, Ph D; CENG, FIEI, AITP, Professor of Civil Engineering (Town Planning) with specialisation in "Sustainable Development Planning" from Government College of Engineering, Pune for going through the manuscript and giving us their valuable suggestions.

We are thankful to the former Directors of Technical Education, Maharashtra State, Prof. G S Kadu, Dr B B Chopne, Late Prof. V R Deshpande (Ex. Principal, Cusrow Wadia Institute of Technology, Pune) and Ex. Vice Chancellor Dr. Babasaheb Ambedkar Technological University, Lonare, Dist. Raigad and Prof. P N Vipat, Prof. A V Ekbote, Late Prof. V G Disa, Prof. P P Vitkar, Prof. M V Patankar, Prof. M J Deodhar, Late Prof. A D Agnihotri and Prof. S B Bonde of Government College of Engineering, Pune for their positive and encouraging approach towards this subject.

We are also thankful to Late Shri Anantrao Bhalerao, Editor, Daily Marathwada Newspaper, Aurangabad for his suggestions to authors regarding project work and other educational approaches in American System, after his return from USA.

We are also thankful to M/s. Patsons, Engineers and Interior Designers, Pune and their staff for giving valuable help in drawing work.

The author wishes to acknowledge the support extended to the book by Tata McGraw Hill Education Private Limited for their vision, encouragement right from the first edition in the year 1978 to this fifth edition 2011.

Suggestions for improvement are welcome and every effort will be made to incorporate them in the next edition.

In concluding the preface I would like to sincerely express my deep sense of gratitude towards late Prof. M G Shah and late Prof. C M Kale co-authors, acknowledging and remembering their dynamism and fore sight for Green Architecture in bringing out this 5th edition.

S Y Patki

on behalf of M G Shah, C M Kale, S Y Patki

PREFACE TO THE FIRST EDITION

The basic approach of this book is to make students practice-oriented in their fields of work as future civil engineers, architects, draftsmen, contractors, structural engineers, supervisors or clerks of works. Knowledge of preparing and understanding drawings will prove to be an invaluable aid while performing their jobs efficiently in different capacities.

Building plans are important legal documents, and correct drawings save cost, labour and time in the office as well as on the site. Hence, all concerned have to understand the basics of this graphical language of engineers;

Why to draw?
What to draw?
How to draw? and
How to read what is drawn?

This book, therefore, deals with: (a) the methods of preparation of various types of drawings as per the Indian Standard specifications for "architectural and building drawing"; (b) role of owner, architect, contractor and plan-sanctioning authorities like municipal corporations at all stages of construction, i.e., from planning to completion of work; and (c) architecture—principles of planning, rules and regulations—a must for every draftsman and student before he starts drawing. The questions given for drawing plates will improve the ability of the student to read a plan and develop engineering/architectural imagination.

In short, the text aims to teach through visual instructions.

We are thankful to Prof. V G Disa, and the late Prof. S D Gupte, both of the College of Engineering, Pune, for going through the manuscript and giving us their valuable suggestions. We are grateful to the architects of standing from Pune, viz. Shri V R Sardesai, Shri S G Sule, Shri Chavare, Shri Mohan Keluskar and Shri Gopal Chandorkar, for allowing us to use some of their works and perspective drawings.

This book is written as per the current syllabi, the latest needs of students, from a contractor's point of view, and finally with a desire that every student would like to use his own copy, first for learning, then for guidance and finally as a permanent reference. We are indeed thankful to Prof. G S Kadu, Director of Technical Education, Maharashtra State, Bombay, for giving us permission to write this book and the National Book Trust, India, for granting subsidy.

The authors will feel fulfilled, if the book proves useful to those who intend to study and execute building drawings and also to contractors in their day-to-day work. Suggestions for improvement are welcome and shall be incorporated in the next edition.

M G Shah
C M Kale
S Y Patki

ACKNOWLEDGEMENTS
FOR CASE-STUDIES – FEEDBACK AND GUIDANCE FROM PROFESSIONALS TO EDUCATION

UNIVERSITY AND RESEARCH

"University" by definition, is an institute basically for research. But varsities have been reduced to being institutions churning out graduates and not research scholars. I want young and bright students to take up research work. Teaching and research should go hand in hand. Have a deep understanding of the subject. Enjoy academics and develop some expertise."

Dr Raghunath Shevgaonkar
Vice Chancellor
University of Pune
Times of India – Pune, Education
June 28, 2010

CASE STUDIES – A LINK BETWEEN LEARNER AND THE WORLD OF PROFESSIONALS

Feedback and guidance from professionals, in the form of case studies is essential for fine tuning between industry, i.e., world of professionals and academics. People on the field can tell learners what is happening out there but the teacher can explain details of a case study in a better way as per opinion of the experts.

Case studies are useful not only for self-study and group discussions but in addition it serves the following objectives –

1. To develop an attitude for lifelong learning and empowering oneself professionally by reading more and more, watch carefully, think and discuss to create interesting and imaginative designs by suitable changes.
2. To keep updated by visiting various websites and reading relevant and informative material on line to know technologies of today so as to develop technology for tomorrow.
3. To develop desire to spend more time on the construction site to keep themselves abreast with the latest practice, working of machinery and various stages in construction.
4. To develop multidimensional insight related to many areas in Built Environment and necessity of integrated approach for appropriate solution.
5. To know inclination and attitude of self for selection of elective subjects and then subject for post graduation.
6. 'Brain storming' and 'Reverse thinking' in group discussion will help learners for research with new vision.
7. To encourage people of substance, who can innovate, develop team spirit and lead from the front.
8. To realise the importance of technical magazines, seminars of professional bodies and exhibitions of materials, machinery, etc.
9. To develop the habit of collecting 'Newspaper cuttings, extract' related to various topics.
10. To know – "Research is to see what everybody else has seen, and to think what nobody has thought".
11. In today's times, being confined to the syllabus simply is not enough. To succeed in life, the learner needs to know that little bit extra that keeps him ahead in the mending race.

Today, one should realise that teachers, textbooks, technical magazines, seminars of professional bodies, exhibitions of materials and machines, internet, technical films and visits to sites is a link between learners and the world of professionals. Teachers should spend more and more time on the field to know about latest technologies, which will be useful for updating syllabi. New information and knowledge is essential for 'subject plus teaching' for areas which are not in the present syllabi but essential as knowledge for professional practice.

Case studies help to reduce the gap between education in class room and the world of professionals. Hence, we are very much thankful to the various professionals mentioned below for their case studies related to many areas of Built Environment.

We are thankful to –

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1. Mr Laxman Thite, Architect	Pune
2. Mr Vishwas Kulkarni, Architect	Pune
3. Mr Vikas Bhandari, Architect	Pune
4. Mr Promod Beri, Architect	Pune, Kolhapur
5. Mr Ravi Gadre, Architect	Pune
6. Mr Kiran Kalamadani and Mrs Anjali Kalamdani, Architects	Pune
7. Mr Ram Paradkar, Architect	Pune
8. Mr Amar Manjrekar, Builder	Pune
9. Mr M B Chaudhari, Architect	Pune
10. Mr Subhash Shah, Architect	Pune
11. Mr Raju Mahagoankar, Architect	Pune
12. Mr Arun Kaduskar, Architect	Pune

13. Mr Sunil Bhosale, Architect	Wanowari, Pune
14. Mr R B Nagpal, Architect	Aurangabad, Pune
15. Mr D V Divekar, Chartered Engineer	Pune
16. Mr. Anand Joshi, Environmental Engineer	Pune
17. M/S Shamkant Kotkar	Pune
18. Mr Adil Kapuswala, Architect	Pune
19. Dr OmPrakash G Kulkarni	Nashik
20. Global Green Energy-Pvt. Ltd.	Pune
21. AirObix–Jalshree Corporation	Pune

Structural Designers/Consultants

1. Mr Y S Sane, Structural Consultants	Pune
2. Late R N Bhat, Consulting Ingenieur	Pune
3. Mr V V Ruikar, Consulting Engineers and Structural Designers	Pune
4. Mr C E Godse, Structural Engineer	Pune
5. Mr Dhananjay Dake, Space Structure Construction Catalysers	Pune
6. Mr Kishor P Jain Consulting Structural Engineer	Pune
7. Octamec Engineering	Mumbai
8. Zamil Steel	Pune
9. Lloyd Insulations	Mumbai

Landscape Architect

1. Mrs Shobha Bhopatkar, Architect and Landscape Designer	Pune
2. Mr Jayant Dharap, Landscape Architect and Design Consultant	Pune
3. Mr Pradeep Deverchetti, Landscape Designer	Pune

Interior Designers

1. Mr Ravi Gadre, Interior Designers	Pune
2. Mr Vivek Patki, Engineers, Interior Designers	Pune
3. Mr Snehal Vasani, Architect, Kitchen Grace	Pune

Computer Software Consultants

1. Newton Computers	Pune
2. Ensoft Consultants	Mumbai
3. Kanix Infotech Pvt. Ltd.	Pune
4. CalQuan India	Pune
5. EDSS – Engineering Design Software & Services Pvt. Ltd.	Pune
6. Soft Tech Engineers Pvt Ltd	Pune
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17. Central Building Research Institute (CBRI)	Roorkee, UP
18. Housing and Urban Development Corporation Ltd. (HUDCO)	New Delhi
19. श्री. श्री. अ. दाभोळकर, लिखीत पुस्तक ‘केल्याने होत आहे रे’, मेहता प्रकाशन	
20. Magazines 1. Indian Architect and Builder 2. Inside Outside 3. House Layouts 4. Architecture + Design	
21. M/s. Khole & Jingare Associates, Architects	Pune
22. The World Book Learning Library Volumes, Published by World Book, Inc.	Chicago
23. Confederation of Indian Industry Northern Region	Gurgaon
24. Times of India, Pune-Mirror, Property supplement	
25. Daily News paper Marathi – Sakal, Loksatta, Property Supplement	

SI UNITS

SI units have been used throughout this book, the Indian Standards Institution has recommended the use of SI system in the "Guide to the Use of SI Units (SP 5; 1969)." The All India Council for Technical Education also recommended the SI system at its meeting held in September, 1969.

SI units evolved as a logical follow up of the metric system. The metric system was founded in France around 1789–1799 during the French Revolution. It is a system of weights and measures with decimal relations between units of the same kind. The fundamental units are the centimetre, gram, and second. Hence, it is also known as the CGS system. In 1901, it was thought that the use of metre and kilogram would simplify the electrical units. Further thought led to the rationalisation of the whole structure of metric units leading to the formation of System International d'Unites.

An international organisation of advanced and developing countries, the General Conference of Weights and Measures was formed. At its eleventh conference held in October, 1960, it recommended a unified, systematically constituted and coherent system of fundamental, supplementary and derived units. This system is known as the International System of Units and is abbreviated as 'SI'.

The basic units are as follows:

	Quantity	*Name of Unit*	*Unit Symbol*
1.	Mass	Kilogram	kg
2.	Length	Metre	m
3.	Time	Second	s
4.	Temperature	Kelvin	K
5.	Electric current	Ampere	A
6.	Luminous intensity	Candela	Cd

In our present subject of building drawing, we are concerned mainly with metre. It is also stated in SI system that prefixes like hecta, deca, deci, and centi should be avoided as far as possible.

Hence, dimensioning is preferred in meters (m) and millimeters (mm) in the book. For example, on drawings, a dimension of 3 meters is written as 3.00 m; a dimension of 200 milimeter is written as 200 mm; and an area of 35 sq. meter is written as 35 m^2.

It will be observed that though SI system is recommended for drawing work, site workers still use the FPS system. It is highly essential to use SI system for all purposes. Today, the practice of writing metric and foot units on drawings is followed by architects for easy communication. Hence, some drawings given in the book are with both units.

Hence, in order to know the relationships between these units, following conversion factors should be used whenever required, till there is total switch over to MKS units.

To convert	*Multiple by*
Inches to Centimetres	2.540
Centimetres to Inches	0.393701
Feet to Metres	0.3048
Metres to Feet	3.2808
Miles to Kilometres	1.60934
Kilometres to Miles	0.621371
Sq. Metres to Sq. feet	10.7639
Sq. Feet to Sq. Metres	0.0929030
Acres to hectares	0.404678
Hectares to Acres	2.47101
Gallons to Litres	4.546
Litres to Gallons	0.22
Tons to Kilograms	1016.05
Kilograms to Tons	0.0009842

INTRODUCTION

The book is meant for the students of Civil Engineering, Engineering in General and of Architecture both Degree and Diploma courses. This multidisciplinary subject is dealt through theory and case studies with drawings from well-known professionals. Reading exercises are useful for self-study and group discussion. Individual project work will develop "Thinkers" by creating desire to watch carefully and think logically to find solutions for the welfare of the masses.

Chapter 1: Built Environment - An Integrated Approach

Built Environment with livability is essential for quality of life. Necessity of mutual sustainability of cities and nature needs study of ecology - settlements - buildings and man relationship. Competent design team backed by knowledge of computer and various softwares is required for the integration of functional, psychological, climatic and aesthetic aspects of Built Environment.

Chapter 2: Settlements for Quality of Life

Urban renewal and New Townships are necessary with sustainable development for quality of life. Eco-Housing is the need of the day. Case studies related to townships, housing, predetermined steel structures will show changes in Planning and Construction during the last decade. Project work will be useful to develop thinkers. The role of urban / rural settlement is to make life livable and hygienic along with safety and amenities for masses. Quality of life and livability Index are the main considerations for Townships and Settlements.

Chapter 3: Architecture

This chapter deals with factors related to integrated environmental design through competent design team of related professionals. Architecture is stated as the "Performing Art for the Performance of the User". Principles of architectural design, human sciences, interior design and role of different professionals are dealt, with reference to case studies from professionals. Feedback and guidance through case studies of the professionals will take the reader near the subject "architecture" and "world of professionals".

Chapter 4: Landscape Architecture

The garden is considered as an extension of the house while parks are considered as lungs providing cities with clean air. Landscape architecture creates humanised environment through soft and hard landscaping. Case studies explain various considerations in the landscape design projects. Basic landscaping principles, design procedure in stages and assessment of land will take reader gradually in the world of landscape design.

Chapter 5: Planning, Designing and Construction of Buildings

The chapter deals with the role of owner / promoter and builder / architect and planning, designing and construction considerations. Case studies along with drawings and design concepts from the designer will develop awareness to watch carefully, think about its creation and know advantages of computer aided drawings. Eco-friendly, energy conscious, user-friendly, environment-friendly and economical architecture needs study of climate, human sciences and expected performance standards.

Chapter 6: Computer Technology for Engineers and Architects

Software developers have given details about softwares available and used by engineers and architects, for surveying, planning, designing and construction. CAAD, CAD & CADD have changed the nature of the construction world. Hence, related knowledge and mastery is now essential to all those concerned with this profession.

Chapter 7: Preparation of Submission and Working Drawings

This chapter discusses the graphical language of construction in detail. Each and every line on drawing with its dimension is the result of many considerations. Imagination and accuracy are two important faculties which are developed while preparing drawings from sketching and final working drawings and details. Correct and co-related drawings help in speedy estimation and construction by avoiding wastage of resources. Sketching, orthographic, axonometric and perspective drawings are the basic tools for construction.

Chapter 8: General Information, Reading and Drawing Exercises

This chapter is useful to test oneself about construction and planning considerations. It will develop a habit to collect information useful for the subject and profession. The book is written so as to be useful for self study, to enrich students before entering the world of professionals and to expose students to all faculties of Built Environment.

Appendix I, II, III, IV

Bibliography

Index

BUILT ENVIRONMENT WITH GREEN ARCHITECTURE—A MULTIDISCIPLINARY SUBJECT

Built Environment means man-made environment for livability. It is essential to provide quality of life to all to achieve Gross National Happiness which increases productivity and economy. Nation becomes happy, healthy, and prosperous.

Natural environment comprises of different inter-related systems i.e., land, air, water and life system. Today, pollution, global warming, decrease in natural resources, reduction in forest area has given alarming signal for the entire population of the world.

Hence sustainable urban and rural development with new towns and townships, renewal of settlements for livability is necessary along with Green Buildings to balance urbanisation and environment.

The green building process starts from using sustainable materials for consturction, environmental friendly resources and providing green amenities to ensure a responsible green approach. Sustainable materials are those that are locally available and use the least amount of energy for the manufacture, transport, during construction and for maintenance.

Technical magazines and books are essential to improve Green Design Skills and for sharing research data and ideas to know new approaches.

Thinkers and scientists have expressed their views related to many interconnected areas which will help readers to develop wider vision. There are many new areas which demand attention of teachers and students for in-depth study, presenting papers and research.

1. Earth-Our Home

"Recognising the integral and interdependent nature of the Earth, our home, we proclaim that human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature".

From the 'Text of Rio Declaration'-Principles on General
Rights and Obligations on Environment Protection
United Nations Conference on Environment and Development,
June, 1992

2. Nature

"It is difficult for me to design anything in which nature is not an inherent part. I feel there should be minimum conflict between the natural element of chance and the human element of control. There could be a spontaneity in discipline and discipline in spontaneity. The design should represent something growing spontaneous and natural".

Architect: Shirish Beri
Magazine: Indian Architect and Builder, March, 1999.

Nature's Preservation

"Chandigarh is a rare epitome of modernisation co-existing with nature's preservation. It is here that the trees and plants are as much a part of the construction plans as the buildings and the roads".

Chandigarh, India 'City Serene'
Ref: Brochure: Chandigarh Industrial and Tourism Corporation Limited

3. Built Environment-Man Made Environment

"In Built Environment, there are two types of functions, measurable and nonmeasurable. Attention to measurable functions is necessary due to economy and other factors, but due importance should also be given to nonmeasurable functions, i.e., aesthetics, quality of life etc. To achieve this, the education system should be modified and students should be exposed to all faculties of a built environment".

Recommendations of the
Fourth National Convention of Architectural
Engineers, New Delhi, March 3-4, 1989

4. Environment Consciousness

"Environmentalists and Architects have found that the planning of Visva Bharati University reflected Rabindranath Tagore's concept of a 'built environment' based on highly futuristic ecological architectural elements. The structures have neo-built forms which are environmentally sound, economical and comprise locally available material. The combination of mud huts, thatched cottages, open air classes, burnt clay architecture and concrete structures speak of ecological consciousness essential for quality of life".

Ref: The Times of India, 5th May 1999
Editorial-"Tagore Rediscovered"

5. Civil Engineering

"The Art of directing the great sources of power in Nature for the use and convenience of Man".

Tredgold
Ref: Royal Charter of the Institution of Civil Engineers (1828)

6. Urban Planning-'The Four Functions" (CIAM "Charter of Athens")

The force of this charter lies in giving the first place to the dwellings : the environment of living-the family, under the rule of "24 solar hours".
The second place is given to the 'working' which is daily act of human obligation. The third is the culture of body on one hand and intellectual leisure on the other. When all these goals have received their definitive 'containers' it is possible to give to each of them a respective rightful place and at this moment can interfere with the problem of realising the contacts: that is 'circulation'.

Architect: Le Corbusier
17th December 1959
Ref: For The Establishment of An Immediate
"Statute of the Land", City of Chandigarh

Chandigarh

*Le Corbusier planned the city as a living organism, with the capital complex in the North representing the **head**, the city centre the **heart**, the open spaces the **lungs**, the network of roads as the **circulatory system**, the industrial area the **viscera**, and the cultural and educational belts, **the intellect**.*

The conception of the city has been formulated on the basis of four major functions: living, working, care of the Body and Spirit and circulation.

Chandigarh, India-Architecture
Ref: Brochure-Chandigarh Industrial and Tourism Corporation Limited

The New Landscape in the Third World

Critical issues related to human settlements in the Third World are:

1. Disaggregate the problem of urbanisation by developing growth centres in the hinterland
2. Restructure metropolitan centres
3. Develop appropriate low tech strategies in construction; emulate the high aesthetics of vernacular architecture.

Charles Correa
Architect, Chairman of the National Commission on Urbanisation India.
Author-Book: The New Landscape

7. Architecture

"Architecture is a performing art. It is for the performance of the user"

Architect: James Andrews

Human Scale

An architect should move in nature. I dislike harsh and overpowering buildings. They should be designed for the human scale. A human being is supreme, and a building is not.

Architect: I M Kadri
Ref: Landscape Design, Magazine: Indian Architect and Builder April 1994

"Architecture is a scientific art. Art is evoked at the design stage, but at the time of execution, science must take over. It is only then that one can produce spaces that are rational-and it is only when one designs with ' Shraddha', (faith) and in harmony with nature".

Architect: D K Bubbar
Ref: Magazine: Inside-Outside, Dec-Jan. 1985

Architecture and City Planning

"Architecture does not mean fashionable buildings alone. It also addresses the contents of those buildings in terms of the values they enshrine, nurture or propagate. Similarly, city planning has to be backed by the perception of city assets".

Architect: Achyut Kanvinde
Ref: Times of India, August 27, 1999

Architectural Vocabulary

"Adopt Nature into Architecture"
"The Sky, Hills, Clouds, Trees are all parts of Architectural Vocabulary".

Architect: Shirish Beri
Magazine: Indian Architect and Builder, March 1999

Sustainable Architecture

Today, rapidly depleting natural resources, alarming pollution levels and chaotic infrastructure facilities are forcing architects to re-look at the way they build. 'Sustainable Architecture' is the need of the hour. It is only architecture that dares to integrate and weave itself into the social fabric that can hope to find a context in the present and the future. The urgent approach demanded of today's architects is to design to complement and not contradict the outside environment'.

Sarita Vijayan
Associate Editor
Magazine: Indian Architect and Builder, March 1999

Sustainable Architecture

'The creation of an environment self-sufficient for man's survival"

Architect: Shirish Beri
Magazine: Indian Architect and Builder, March 1999

8. Interior Designing

"It is quite impossible to consider the building one thing and its furnishings another, its setting and environs still another. In the spirit in which buildings are conceived, these are all one thing to be foreseen and provided for in the nature of the structure".

Architect: Frank Lloyd Wright
Quoted in the book *Great Designers of the World*
Author: John L Pellam, Corinne Z Kopen

9. Landscape and Built Form

I always try to blend the landscape of a site in such a way that it goes hand in hand with the built form and adds to the charm of the project.

Landscape Architect: Shobha Bhopatkar
Magazine: Inside-Outside April 1999

10. Computer Technology

"With the computer age upon us, rapid advancement in modern technology, including the internet, e-mail, auto-cad, and fax machines, has enabled designers to successfully complete long distance projects, not only in their state or country, but worldwide, bringing their talents directly to your doorstep".

Donald W Lilly
Book: *Great Designers of the World*
Author: John L Pellam
Corinne Z Kopen

11. Sustainable Development

"Meeting the needs of the present without compromising on the ability of future generations to meet their own".

Bruntland Commissions
Interpretations of Sustainability

12. Education

"I did get inspired to think (from teachers), which is what education is mostly about-inspiration, experimentation and innovation".

Architect: Shirish Beri
Magazine: Indian Architect and Builder, March 1999

Built Environment needs an integrated approach of all professionals. Charts 1, 2 and 3 throw light on the importance of **Building Planning and Drawing** which is considered as an effective tool for the creation of 'Built Environment' to convert requirements into desired reality. Every line and dimension is a result of numerous considerations of planning and design requirements.

With respect to all the present achievements, there is an essential need to change an entire approach towards the present educational system, which is becoming outmoded very fast. Herein lies an opportunity for training by professionals to the new entrants with their aspirations and modern knowledge through latest books, technical magazines, seminars and computer integrated designs. This can also be introduced in human resources development and new aspects of engineering, engineering materials, architecture related to built environment.

IMAGINATION, PROJECT WORK AND REQUIREMENTS OF A PROFESSIONAL WORLD

Project work, submission, presentation and oral examination should be given due consideration as they help in the assessment of your personality. Hard work, creativity backed by knowledge

Chart 1

BUILDING PLANNING AND DRAWING FOR BUILT ENVIRONMENT

To create Built Environment , i.e., man-made environment taking into consideration ecology-environment-man relationship for the welfare of mankind

⇓

Regional, urban and rural planning—architecture and landscape architecture

⇓

Optimum well-designed space, in pollution free surroundings, with acceptable building and plumbing services, for the desired function giving sensation of physical and psychological well being with controllable comfort standards inside and outside the building.

⇓

Skilful applications of human effort to create designs and convert them into drawings for creating sustainable development with physical facilities, design—an art with a purpose[1]

⇓

Building Construction is Engineering in Action[2]

⇓

Action to convert two-dimensional drawings into three-dimensional structures

⇓

Construction management for uni-directional actions of all professionals, for economy, accuracy, quality and timely completion

⇓

Economy of 5 Ms—men, machinery, money, material, maintenance

⇓

Newer building materials, mechanized operations, sophisticated plants and instrumentation, superior construction techniques for less factor of safety in design and less maintenance in future

⇓

Higher level of skills and sincerity of the work force-supervisors and skilled and unskilled persons

⇓

Necessity of human resources development by a thought provoking education system, project work, feedback and guidance from professionals and industries

⇓

People-product-profit[3], profit not only in terms of money but-

- Creation of eco-friendly, users friendly and ergonomically sensitive architecture and built environment
- Economical use of natural resources
- Opportunity to show creative urge of planners, designers and constructors
- Welfare of mankind—satisfaction and joy of achievement of desired social transformation

1. Design-An Art With a Purpose, Architect-Frank Lloyd Wright
2. Building Construction is Engineering in Action-Ref, Author: Vinita Shah, Book: Human Resourecs Development in the Building Industry: A Study in Bombay. Nicmar Publication.
3. People-Product-Profit,—Lee lacocca, USA.

Chart 2

PROFESSIONALS AND CONSULTANTS

1. **Policy Makers at National and State Levels**
2. **Ecology:**
   1. Ecologists
   2. Horticulturists
   3. Conservation Consultants
   4. Foresters
   5. Farmers
3. **Urban Planning:**
   1. Urban Designers
   2. Town Planners
   3. Environment Planners
      - Climatologists
      - Building Scientists
   4. Land Use Planners
      - Geologists
      - Geomorphologists
   5. Economic Planners
   6. Social Planners
   7. Landscape Architects
   8. Architects
   9. Archaeologists
   10. Hydrologists
   11. Legal Consultants
   12. Public Art Consultants
   13. Signage Consultants
   14. Conservationists
   15. Telecommunication Engineers
   16. Electrical Engineers
4. **Architecture:**
   1. Architects
   2. Interior Designers
   3. Civil Engineers
      - Structural
      - Construction
   4. Building Scientists
   5. Legal Consultants
   6. Promoters and Builders
   7. Marketing Consultants
   8. Estate Managers
   9. Maintenance Engineers
   10. Solar Passive Architects
   11. Conservationists
5. **Landscape Architecture:**
   1. Landscape Architects
   2. Horticulturists
   3. Geo-consultants
   4. Lift-Sprinkler-Drip Irrigation Consultants
   5. Landscape Contractors
   6. Electrical Consultants
   7. Fountain Designers
   8. Art Consultants
6. **Publishers**

   Technical Magazines, Journals, Book, etc.

Chart 3

DIFFERENT ROLES OF ARCHITECTS/CIVIL ENGINEERS/BUILDING SCIENTISTS AND SKILLED WORKERS

1. **Role of Architect:**
   1. Architect
   2. Interior Designer
   3. Landscape Architect
   4. Site Planner
   5. Town Planner
   6. Urban Designer
   7. Housing Designer
   8. Arbitrator, Valuer
   9. Conservationist
2. **Role of Civil Engineer:**
   1. Promoter and Builder
   2. Strucural Designer
   3. Foundation Consultant
   4. Waterproofing—Damp-proofing—Termite Proofing Consultant
   5. Project manager—Resident Engineer—Site Engineer—Supervisor
   6. Arbitrator
   7. Valuer
   8. Building Maintainer
   9. Quantity Surveyor
   10. Building Economics Consultant
   11. Environment Consultant
   12. Acoustics and Noise Consultant
   13. Soil-Testing, Material Testing Consultant
   14. Project Management Consultant
   15. Plumbing and Building Services Consultant
       A • Plumbing and Sanitation
       B • Electrical
       C • Air Conditioning
       D • Fire Fighting
   16. Concrete Quality Control Consultant
   17. Restoration of Old Buildings, Monuments and Repair of Old Structures
   18. Lift, Sprinkler, Drip Irrigation Consultant
3. **Role of Building Scientist**
   1. Accoustics Consultant
   2. Electrical Engineer
   3. Airconditioning Consultant
   4. Equirpment Consultant
   5. Solar Energy Consultant
   6. Communication System—Telephone, TV
   7. Computer Controlled Equipment for Lighting, Ventilation, Fire Safety
   8. Information Services
   9. Software Engineer for Planning, Designing, Estimates, Material Accounts, Project Management, etc.
   10. Pest Control
   11. Geopathic Stress Consultant

Chart 3 (Contd)

DIFFERENT ROLES OF ARCHITECTS/CIVIL ENGINEERS/BUILDING SCIENTISTS AND SKILLED WORKERS

4. Skilled Workers:

1. Masons
2. Plasterers
3. Brick Layers
4. Carpenters
5. Plumbers
6. Electrical Wiremen
7. Electricians for various types of equipment
8. Refrigeration-Maintenance and Repairing
9. Painting
10. Surveying
11. Pest Control
12. Bio Gas Plant
13. Welder
14. Tile Layer
15. Furniture Work
16. Concreter
17. Maintenance of Construction Equirpment
18. Glazier

5. Artists and Artisans for Architects and Interior Designers

1. Architectural Glass Work
2. Architectural Mural Work
3. Architectural Facades
4. Architectural Fiber Glass Work
5. Architectural Art for Public Spaces
6. Architectural Ceramics
7. Architectural Mosaic and Wall Relief
9. Architectural Wood Work
10. Architectural Decorative Finish
11. Architectural Stained Glass Work
12. Architectural Plaster of Paris Work

Chart 4

GREEN ARCHITECTURE, ECO-FRIENDLY CONSTRUCTION CONSULTANTS

1. Green Building Projects—
   Co-ordination, Design, Registration, Material selection, Execution, Documentation, LEED certification.
2. Energy Simulation and Analysis for Buildings.
   Orientation studies, Fenestration analysis, Wall and Roof assembly, Optimization, HVAC, Electrical and day lighting analysis, as per Green Building Rating System.
3. High Performance Building Design—
   to save water, electricity, natural resources, cost effective construction-profitable to operate and maintain.
4. Consultants for Pre Engineered Steel Structures.
5. Consultant for Waste Water Treatment.
6. Consultant for Solid Waste Management.
7. Consultant for Solar Energy for Air Conditioning.
8. Consultant for Solar Energy for Heating Water.
9. Consultant for Solar Energy for Generation of Electric Power.
10. Consultant for Rain Water Harvesting.
11. Consultant for Eco-friendly Materials.
12. Consultant for LEED Certification.
13. Consultant for Air Pollution Control.
14. Consultant for Noise Pollution Control.
15. Consultant for Bio-Diversity Park.
16. Consultant for E-Waste Disposal.
17. Consultant for Bio-Gas Technology.
18. Consultant for Pumping Optimization and Energy Conservation.
19. Consultant for Renewable Energy.
20. Consultant for Road, Canal, Pipeline, Railway and Land Survey—Drawing and Estimation.
21. Consultant for Soil Analysis for Landscaping and Selection of Trees and Plants.
22. Consultant for Eco-Housing Assessment Schemes as per
    1. The U.S. Green Building Council (U.S.G.B.C) and LEED
    2. The Indian Green Building Council (I.G.B.C)
    3. Local Municipal Corporations in India.

and real involvement in the subject would help you in giving prompt and precise answers during group discussions and personal interviews.

Here, an in depth analysis of every subject during your education and thereafter would provide the necessary feedback for your career.

Your presence of mind, the depth of your knowledge, communication skills and ability to put up your views and argue logically are tested at the time of interview, oral and during group discussion or project presentation.

Imagination

"Imagination is more important than knowledge, for knowledge is limited, whereas imagination embraces the entire world, stimulating the process, giving birth to Evolution.'"

Albert Einstein

Student

1. Listen to and ask "Questions".
2. Read and reread "History" you can never know "Enough".
3. Know that there are no "Solutions", only "Approaches". Work hard to understand the problem, what it means, simplify and try to solve it, then try again.

Author: Andy Pressman
Book: *Architecture 101—A Guide to the Design Studio*

Aesthetic Sensibility

According to Architect **Arthur Erickson**, a student needs to have nourished an aesthetic sensibility. If he does not have it, he cannot develop it. It cannot be learnt, but if it is there, he can nourish, refine, and expand it infinitely. Architecture is a visual art.

During the thinking process at a certain moment, there is a sharp and sudden realisation of a truth—a solution, there is a new idea to tackle the problem. The eye, mind and hand together empowered by the imagination, tackle all problems in planning and designing.

An appropriate idea is the result of imagination in the right direction. The word "Idea" has been derived from the Greek Word Idein which means 'to see'.

Drawing is a tool to develop the power of imagination. Attention and accuracy are two main qualities of the mind. Imagination leads to knowledge and tests the knowledge.

Intuition, intelligence, information, inventiveness are all faculties interrelated to each other. This God given gift is developed with individual efforts in the right direction. Attention and accuracy for reproduction are two qualities of our brain, the same are developed during work by hand or by the computer, when your eyes, brain and hands work together. Imagination is the root cause for all inventions and designs.

Students and teachers should look towards the project work given in different chapters from a totally different angle, to prepare an entry in tne professional world with a theoretical background and well developed ability along with a creative vision for social engineering. Welfare of all clients is the challenging task for all professionals in a developing country. It is stated that architects and engineers and all professionals should strive hard to reduce unhappiness of masses than spending energy on increasing happiness of a few. This vision is essential for all professionals in developing countries.

Project Work

Project work includes different subjects related to Built Environment. A choice of topics may help in choosing elective subjects and promote specialised study in subjects of individual liking.

Professional World

Professional world requires knowledgeable persons who have enriched themselves through technical journals, seminars, case studies, group discussions and who have developed a skill in paper presentation. Development of a real professional personality with proficiency is the aim of technical education.

Educational technology in foreign countries have given importance to individual project work right from primary education.

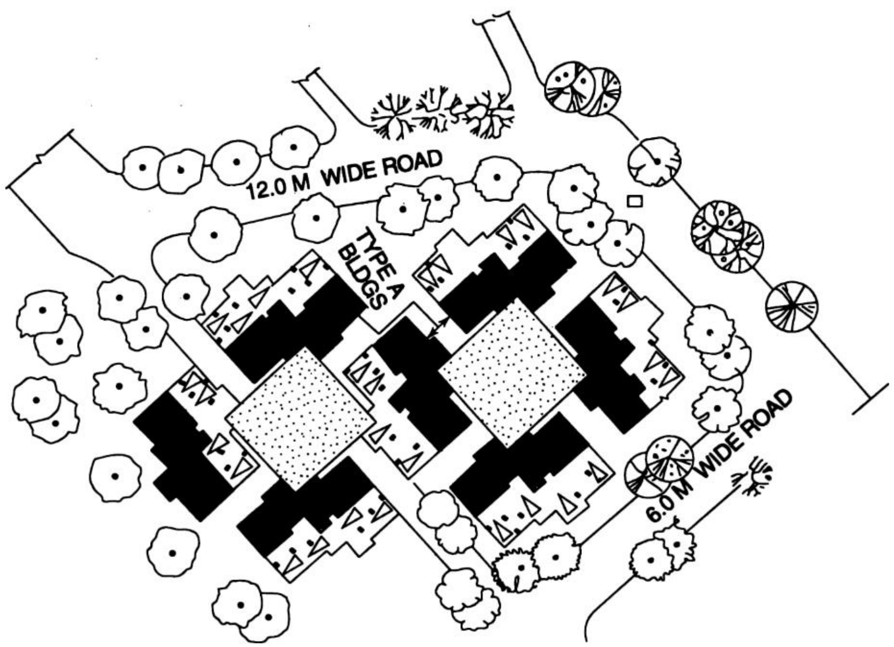
Group discussion in a small group on information collected for a particular project helps in developing communication skills.

Quotations

We have given quotations from learned and famous architects, thinkers and authors from all parts of the world. Students and fresh teachers may not get the opportunity to read so many books during the initial years. These quotations are the essence of thinking and the experience of their own and other related subjects of authors. Quotations throw light on the related subject and real expectations from the inter-related areas. We were inspired by books which threw light on other inter-related subjects as well. Students and teachers are advised to read these books as and when possible and to write papers in their journals and magazines on related subjects with reference to quotations, whenever possible.

1

BUILT ENVIRONMENT AN INTEGRATED APPROACH



Topics covered in this chapter

Earth

"Environment Revolution, today a global movement-concern to protect the earth, has replaced the intention to destroy it. So there is a new task to understand the way the world works; regulate behaviour in response to this knowledge, restore the earth, green the earth, heal the earth".

Landscape Architect : Ian L McHarg
Book : *Design with Nature*

Nature

Natural Environment comprises different interrelated systems -

1. *The lithosphere or land system* — *(Geology, Land forms and Soils)*
2. *The atmosphere or air system* — *(Weather, Climate and Air Quality)*
3. *The hydrosphere or water system* — *(Seas, Surface Fresh Water and Ground Water and Ice)*
4. *The biosphere or life system* — *(Plant and Animal Organisms)*

Editor : David Chapman
Book : *Creating Neighbourhoods and Places in Built Environment (E & FN Spoon)*

SETTLEMENTS AND NATURE

"Settlements have increasingly adverse impacts on nature. We need to pay more attention to urban planning and design, reduced resource usage and recycling so that more aesthetically pleasing cities can co-exist with nature for mutual sustainability".

Book Edited by: David Chapman
Book: *Creating Neighbourhoods and Places in Built Environment (E & FN Spon)*

1.1 NATURAL ENVIRONMENT AND BUILT ENVIRONMENT

1. Natural Environment

It is the nature with sunshine and rain, mountains, hills, valleys and cliffs, rivers and lakes, oceans, rocks, soil and forests with trees, shrubs, bushes, grasses and flowers. History reveals that the natural environment has undergone large changes without the presence of human beings-changes in climate, earthquake, etc.

2. Environment for Living

It is related to the surroundings and conditions affecting life and human behaviour. Rational approach in planning of urban/rural settlements should take into consideration the impact of man's action on his environment on one hand and the influence of the environment on man on the other hand.

3. Climate

It is the atmosphere around us that produces varying effects of temperature, precipitation in the form of rain, snow, and hail, humidity, winds, cloudiness and sunshine. Weather can be defined as short-term variations in the atmosphere.

Climatology refers to the study of the climate of an area. The climate depends upon the latitude and seasons of the year, nearness of land and sea, altitude and topography, and affects solar radiation, temperature, rain and direction of wind.

The study of climate is essential to know its effect on human activities and on soil, vegetation and water resources which are essential for life.

Physical Geography and Human Geography are important subjects.

Physical Geography - Major emphasis is given to study the celestial bodies like the sun and other planets and the physical features, e.g., mountains, plateaus, rivers, soil, etc.

Human Geography - It deals with the interaction between the natural environment and the man, man's different lifestyles and his adjustments in different environment. According to 'Ratzel', Human Geography is the synthetic study of relationship between human societies and the Earth's surface.

"Ellsworth Huntington", an American Geographer studied extensively the importance of role of climate in the advancement of civilisation and defined Human Geography as "the study of relationships of geographical environment to human activities and qualities".

4. Topography

It relates to the shape and the natural features of the land - mountains, hills, valleys, cliffs, plains, streams, rivers, lakes and seas. The study of topography helps in deciding locations of human settlements, transportation systems, and placing of various types of buildings with reference to natural surroundings, water resources, flood levels, availability of materials of construction, climate and suitability of land for agriculture, horticulture, sylviculture, floriculture and safety and security.

5. Geology and Geo-Technology

Geology deals with the study of our planet, earth and the types of rocks and soil in it. Study of geological map and investigation on site gives knowledge and data for the designing of different types of structures.

Geo-technology is a branch of engineering which is related to the study of soils in order to design and construct buildings' foundations economically with due structural safety.

6. Vegetation

Vegetation in the form of forests with hardwood and softwood trees, pastures with grasses and other vegetation is a part of natural ecology. It interacts with other living organisms - insects, birds and other animals for their survival. For many years, landscapes have been altered by human activities creating discomfort and danger for the survival of other living organisms.

Forests help in absorbing carbon dioxide from the atmosphere, recycling nutrients such as nitrogen and purifying water. Forests and pastures can be created and maintained.

1.1.1 Built Environment

History shows a constant struggle of man in imagining and creating an ideal environment in the form of shelter and settlement. Shelter is the basic need of man along with food and water, along with shelter, man has always shown tendencies to make settlement in the form of a group or community. Shelter in the form of a hut provides protection from the sun, rain and wind, and also safety and privacy for family life. Settlements in the form of villages or towns play an important role in providing essential infrastructure in the form of housing along with roads and lanes, water supply and drainage system, and other essential services. Hence, a settlement like a **Village** or **Town** is a big psychological shelter to man while a **house** or **home** is an individual shelter for stress free living.

Insects, birds and animals, small plants and trees and human beings are considered as living things on earth. Insects, birds and animals live by making adjustments with the climate, surroundings and without harming the natural environment. Plants and trees along with colourful flowers and fruits are a God given gift of nature for all. As the natural environment with varying climate is not suitable to the life style of man, man is always trying for suitable transformation in the natural surroundings. This transformed environment is known as "*Man-made* " or "*Built Environment*".

History throws light on the culture and life style of different civilisations, different types of buildings and various considerations in the planning of settlements. Built Environments were planned not only to shelter people but also to provide ground for their various activities and protect their *possessions* from supernatural powers, and to create a humanised safe space. Another feature of planning to be remembered in relation to settlement is the framework or system of settings of placing different types of buildings into discreet and distinguishable place along with roads, open spaces and chowks so as to create living environment.

The location of the town, *proximity* to a water source, hills, type of land – plain, sloping, hilly, desert and climate, have given an opportunity in developing different types of layouts, construction techniques and life styles. Through history we have learnt of different cultures, such as Greek, Roman, Egyptian, Aryan and Arabic in different parts of the world. It is interesting to study the habits, manners, and customs related to different cultures through literature and old ruins of forts, temples, palaces and other monuments. These man-made environments show basic consideration related to modify the world in some purposeful way. In the beginning, such modifications had caused negligible encroachment on nature and land and minimum pollution of air and water, as population was less when compared to the availability of land. Only 40 million people occupied the earth in the period of Egyptian Civilisation, i.e., 2700 BC – 2300 BC (construction of pyramids). The Earth's population is projected to rise from its current level of about 6.5 billion to reach some 10 billion by 2025 (*Ref. Concise Atlas - DK - 2009*).

There is an alarming change due to enormous growth in population, uncontrollable urbanisation and industrialisation, creating danger of pollution to air, water, land and human beings. This has changed the face of the earth by encroachment upon forests through *buildings* and expansion of cities using natural resources. We have changed the composition of the earth's hydrosphere and atmosphere through the use of fossil fuels. This alarming situation is created by man by destroying his surroundings including hills, rivers and valleys and also by throwing waste material into seas and oceans for the reclamation of land. Initially, man was living closer to nature, while enjoying his work in the agricultural field or near the river or sea shore, in different seasons. Gradually, man has moved away from nature. Living in a concrete jungle, moving through over crowded streets, towns and a polluted world has affected his normal behaviour causing stress and leading to various health problems.

One should note that there is a close relationship between the environment and behaviour of man. If one of the purposes of the culture is to help people to interact efficiently, then an ideal Built Environment helps in that process. Today, the whole of mankind is facing some serious problems. The present age is known as the age of shrinking space, shrinking time and towering expectations.

Built Environment is a subject encompassing many professions, which aims at creating awareness amongst all, to look carefully at the things around them. These constitute houses, roads, footpaths, shops and their sign boards. Traffic islands, trees, their colours, shapes, sizes, their functional utility and aesthetic feeling, everything that creates an impact on the mind, which may be pleasing or otherwise. This is essential, in order to develop "thinkers" in planners at all levels, - designers, architects, civil engineers, engineers of all other branches, policy makers, administrators and also the users. Hence, the subject, Built Environment should get top priority in education.

1.2 ECOLOGY-ENVIRONMENT – SETTLEMENTS – BUILDINGS AND MAN RELATIONSHIP

"Interdependence is a higher value than independence. Effective Interdependence can only be built on a foundation of true independence"

Author: Stephen R Covey
Book: *The Seven Habits of Highly Effective People*

We can compare the relationship between Ecology, Environment, Urban and Rural Settlements, Buildings and Man with the relationship expected in our family, and from our family members for success and welfare. No family is now free from challenges from its own members or from the outside world. Globalisation has created a new environment and new problems. Success and welfare of the family now depend upon effective communication, goals set for achievement for individuals and search for creative and meaningful ways for achieving these goals through desired relationships by realising the value of interdependence amongst all members.

Industrialisation during last 100 years has divided nations into developed, developing and underdeveloped nations. A process of economic polarisation of the world has divided population into the affluent 'haves' and the poor 'have-nots'. Democratic countries with large population having sections with different income groups are facing number of problems related to slums, shortage of fuel, food, water, job, opportunities and housing.

In addition to this, an alarming situation has been created by the numerous problems associated with environmental degradation. Unrestrained population growth, rainforest destruction, high rates of natural energy consumption are the major factors responsible for such degradation. Now awareness about the problems associated with the environment is increasing. Discussions on global warming, pollution of air and water, acid rain and the danger of a depleting ozone layer is a sign of such awareness.

There is a need for analysis and feasible economical solutions with reference to ecology – environment – settlements – buildings – man relationship. Climatic region, latitude and longitude, nearness of the sea, height above mean sea level, etc., are the factors related to the climate of a place. Natural vegetation is useful for controlling some harmful elements related to the climate. Tropical climates with fixed seasons need well planned towns with infrastructure for comfortable living and working conditions and natural greenery in the form of urban forests to refresh man.

1.2.1 Ecology - Ecosphere - Sustainable Development

Ecology

"The term 'ecology' is derived from the Greek roots 'oikos' meaning 'House' combined with the root 'logy' meaning the 'science' or 'the study of'. Thus, literally ecology is the study of the earth's 'households'.

Author: Eugene P Odum
Book: *Ecology*

The word 'ecology' first appeared in the English language in the year 1873. Today, ecology is considered as the structure and function of nature. Its study is considered essential for an awareness of the totality or pattern of relationship between organisms and the environment. The following details will throw light on various aspects, so that the importance of this subject is realised.

Ecology is a part of the science of biology. It is the scientific study of how living organisms like plants and animals relate to each other and to their environment. This study consists of an ecological analysis of life on earth, stressing on the role of living things and their mutual dependence. An animal is any living being such as fish, bird, insect or human being. An animal can also mean any creature other than a human being. A plant is also a living thing, but it is unable to move about by itself.

All living organisms require food, nonpolluted air and water for their survival. They are in competition with one another for the matter and energy they require in order to survive. Out of all living organisms, Man being intellectual has gradually become the most dominant species on earth. His behaviour has ignored the fundamental nature of his relationship with other forms of life and their right of living for his own aspirations and survival. Many of the ecological difficulties arise from the growing pressure and expansion of human activities.

Let us try to understand how nature works. It works on the basis of an intricate and interdependent system consisting of checks and balances. Elements of the ecosystem jointly act as producers, consumers and decomposers. The oxygen carbon-dioxide cycle, photosynthesis process, nitrogen cycle, the evaporation distillation-transportation – condensation – precipitation process, i.e., the hydrologic cycle, are all parts of the ecosystem. Changes in microclimates as well as increased pollution are responsible for ecological changes.

Thus, while creating a desirable environment, we should be careful about:

1. Land use – topographical changes in watersheds, soil erosion, quarrying for materials, flooding, deforestation, and change in natural drainage system.
2. Pollution of air, water and noise.
3. Excessive use of water for irrigation causing water logging and salt effloresces, reduction of the water table level due to excessive pumping.
4. Energy crisis – use of fossil fuels such as oil, petroleum, gas and coal.
5. Nuclear reactors creating heat and radioactive wastes.
6. Treatment of industrial wastes, global warming, acid rains, ozone depletion.
7. Effect on aquatic life due to industrial waste polluting river water, untreated sewage and sullage water.
8. Conservation principles to be adopted in the use of natural resources.

The important fact to be remembered is that the ecosystem is inter-connected throughout the globe. Any change anywhere causes a chain of reactions, causing an immediate or long term effect. With pick and shovel, mistakes were not too serious but with enormous blasting, *bulldozing* and nuclear energy there is and has been danger to our earth (vide Chernobyl disaster of April 1986 in Ukraine, Russia in a nuclear power station). Ecological and environmental damages go hand-in-hand.

It is found that nothing is non-essential in nature. Any imbalance of one or other element of nature is immediately and automatically corrected; in achieving this, nature may act cruelly. Hence, we should strive to live in harmony with nature, as ecological consequences are often unpredictable. With this background, it would be interesting to know more about Ecosphere.

Ecosphere

The ecosphere in which humanity survives is divided into seven spheres of the planet earth with their impact on its ecology. *Ref. The 'Hindu', dt. 22.12.95,Nature and Resources, Vol. 28 No.1, 1992*.

1. **The Fire sphere or solar sphere (Teja)**

This sphere originated with the sun about 4.6 billion years ago (4.6×10^9). The sun is the base of life sphere. It controls the earth's atmosphere and hydrosphere. It is basically responsible for sunshine, evaporation in the hydrosphere, weather, clouds and rains. Apart from enlightening the souls of human beings, it governs our inner soul. It sustains us through the entire process of life and governs it fully.

2. **Lithosphere or earth sphere (Prithvi)**

This sphere is about 4 billion (4×10^9) years old, and it came into full existence after the sun. The formation of cracks and faults in the lithosphere due to movement of tectonic plates has been accepted as "Continental Drift Theory", (1950) . This has created land mass, hills and valleys, mountains and rivers with the natural beauty and greenery, forestry and scenery, as also eco-poetry.

3. **Life sphere or biosphere**

With the formation of the sun and earth, volcanoes and their throwing of hot gases in the troposphere, a new stage was set in the process of life formation, for the creation of the atmosphere and rainfall. The life sprouted wherever there was an environmental chance. It covered the entire planet's core – in crevices, on plains, on sea-bed and mountains, on the poles and the equator. It all started about 3.5 billion (3.5×10^9) years ago because of fire sphere (sun) and lithosphere (earth). But it could not have protected itself and continued to grow and expand without cryosphere, atmosphere and hydrosphere.

4. **Cryosphere**

'Cryosphere' has been derived from the Greek word *cryo*, which means cold or frost. Geologically, pre-cambrian era started from the formation of the basic gas called earth about 4.6 billion years ago (as a part of the sun) up to 570 million years ago. Ice was formed in the late pre-cambrian era about 2 billion (2×10^9) years ago, known as the great ice age. It protected the outer cover of the earth, and shielded it from elements, through space.

The cryosphere is an integral part of the global climate system with important linkages and feedbacks generated through its influence as surface energy and moisturefluxes, clouds, precipitation, hydrology, atmospheric and oceanic circulation.

5. **Atmosphere (Vayu)**

The atmosphere was created by hot gases from volcanoes in outer space. They were thrown up above the crust of the earth, millions of years ago. They came out along with hot magma (molten rock materials beneath the earth's surface). When magma solidifies, it is called lava. The atmosphere is prevented from escaping by the pull of the earth's gravity. Were it not for gravity, "one man might hurt another by a puff of his breath into the depths of space, beyond recall for all eternity", according to Ruggiero Boscovich (1711–1781).

It is due to the gravity that we are firm-footed on this earth. It is due to this modern pure atmosphere before AD 1900 that we began to enjoy modernised life and nature. The atmosphere nearly disappears at above 550 km of the earth's surface. At above 300 km, the atmospheric pressure is about 0.1×10^{-9} of the atmospheric pressure at sea level.

It is the tropospheric atmosphere up to an average of 12 km above the earth's surface which all human beings are concerned with. Architects and civil engineers are basically concerned with the first 500 meters of the atmosphere.

6. **Hydrosphere (Aap)**

The hydrosphere encompasses about 70% of the earth's surface by which it appears as a blue planet as viewed from satellites. It encompasses oceans, seas, rivers, groundwater, streams, lakes, marshy lands and water vapour in the atmosphere. It is formed due to the ejection of steam from the bowels of the volcanoes. This steam then condenses into rain water, cools our planet, evolving new life systems and forestry. It thus impacts blue and green colours to the grey earth. This process has been going on for millions of years forming cool water in varied atmospheric and geographical zones.

The atmosphere and hydrosphere produced forests and various life forms with abundant species on the earth and in water. Nature produced primary and complementary colours. Nature and natural selection were basically responsible for evolution of species by mutation and genetic recombination. Micro and macro organisms were evolved in this process. It is a Hindu belief that man originated from the evolution process which in microprocess started with fish (water) which evolved into a tortoise (amphibian) and then into a boar (earth) and so on to the present human form. In Hindu mythology, they are known as ten incarnations of God. Incarnation is "avatar" – Matsyavatar (fish), Koormavatavar (tortoise), Varahavatar (boar), and so on in the evolutionary process.

Thus, atmosphere and hydrosphere have introduced the idea of colours, architecture (space), and painting; sculpture (Gods) and even civil engineering (Materials). This is beautifully explained in the famous book *The Dynamics of Architectural Form* by Rudolf Arnheim (University of California Press, 1977). He firmly believes in nature and enhancement of nature by human beings to suit his purpose of vision and happiness. His architecture is nothing but binding of space and nature for human setting. He believes in the "dynamics of surrounding space." He loves symmetry and asymmetry. He enjoys the contrast between vertical and horizontal. In the interplay of spaces, he utilises the contrast of solids and hollows. He accepts order and disorder in nature but maintains, "The components of disorderly arrangement must be orderly within themselves and the lack of controlled relations between them would disrupt nothing, frustrate nobody". He firmly believes in the adaptability of man and his integration in natural surroundings.

This leads us to the minds of human beings as a whole which is designated as Noosphere.

7. **Noosphere (Noo-Mind), Humansphere, Anthrosphere or Technosphere**

It refers to the spiritual and physical sphere of the earth and covers a height of about two metres only. It was Le Corbusier who made a typical human being as a module for "Building and Bridges". Every structure was designed with components of the human being as submodules. This man and structure was to fit in the natural surroundings. This was a new dimension of architecture and civil engineering in tune with the nature and its natural surroundings.

Thus, Noosphere is the sphere of the mind in the form of human beings.

It originated about 2 million (2×10^6) years ago in "Homo Habilis" (extensive open tropical grasslands). These native species developed into "Homo Sapiens" (Man, the wise), and then into "Man, the doubly wise" who appeared on this earth about 50,000 years ago.

Man is now a large scale Bio-Geo-Ecological force. He is now sharing this lithosphere, cryosphere, biosphere, atmosphere and hydrosphere with every other species. Hence, it is necessary to study ecosphere in detail to integrate it with nature, human beings and all modern sciences, involving new and old culture.

Sustainable Development

Sustainability

"Meeting the needs of the present without compromising the ability of future generations to meet their own".

Bruntland Commission's interpretations of sustainability,
World Commission on Environment and Development – "Our Common Future"

Hence today, experts are thinking of total development with reference to sustainability. It is related to environmental problems, population growth, urbanisation, deforestation, use of natural resources and disproportionate consumption of resources in developed and underdeveloped countries. All environmental issues are related to population growth, energy consumption, global warming and pollution. The concept of sustainable development stresses the need for ecological determinism, so as to achieve qualitative growth within the limits of the ecosystem's carrying capacity. Hence, sustainable development is an integral part of our sustainable health, life and enjoyment.

Feedback from a Professional to Technical Education Prof. Y S Sane, a structural designer, has expressed his views about sustainability, construction industry and appropriate technology along with structural drawings (Figs. 3.36 to 3.44).

"On the threshold of the 21st century, the construction industry needs to look back and forth without loss of any more time. The review of what has happened in the past is necessary to understand the changes that have taken place in general and about materials and methods in particular. The full globalisation of our problems and perspective is going to take place in a short period, whether we like it or not. There are political and social forces still trying and dreaming to reverse the clock of time and development. But the pressure due to economic, social and political forces exerted by the national and international necessities are not going to be demolished or avoided. At the most, it can be marginally reduced or delayed but without any significance.

Therefore, under these circumstances, we have to look forward for the scenario of the construction industry in this century. While creating the necessary infrastructure to usher in this century and to march, it has to be competent, viable and keeping pace with the rest of the world, particularly with developing countries and those already developed. It may be categorically borne in our minds that we will never succeed in achieving the desired ends unless we are careful in accomplishing every development in a sustainable manner. "Sustainable development" will be the 'catch word' of the time to come and we will have to adopt this 'acid test' for all proposals to advance the techniques, methods and choice of materials for the development of the construction industry which is perceived in this century.

From time immemorial to the beginning of this century, construction methods were mainly manual and labour intensive. Depending upon the purpose or function, the methods were adopted right from very crude to very refined manner. The time consumed or the speed with which the construction work was completed is incomprehensible even on this date. Where economical resources were scarce, bare minimum quality and durability was accomplished and where the question of economic resources or time required did not matter, unduly heavy, robust over durable monument like creations were constructed. No doubt, some of them have added to our historical and cultural heritage, even many of them are of world fame. It is not the scope of this writing to go into the aesthetics of the construction work. The choice of materials, methods of construction, architectural planning and ornamentation of the edifices, etc., are not to be discussed here.

In this century, the required speed, complexity of physical circumstances, geography, climatic conditions, etc., and the ever-increasing cost of human labour have compelled improvisation in the methods of construction with machine tools, and other equipments.

These changes have not only helped to mitigate the compulsions of the situation but have also resulted in an improvement in the quality of work and a rise in the workmanship standards also. This phenomenon has caused the replacement of human labour with machines, in order to improve efficiency and ensure consistency. This phenomenon has even resulted in the creation of techniques and tools, plants and equipment for replacing human labour as it could not give consistency in quality and quantity.

However, it is desirable, to invent and improve, in the near future, the techniques, tools, plant and equipment, etc., such that we do not cause unemployment in our ever growing enormous population till it is properly controlled. Our appropriate technology will have to be labour intensive at least for some more time in the future.

From the main resources of the construction industry namely men, money and material, unless we pay attention to the scenario of material resources for the future, the thought about sustainable development would not be complete. We have been drawing material resources from the earth for the last few centuries without any thought for the limitations of these resources. The depletion of petroleum products like crude oil, natural gas and coal have already warned us that resources are not unlimited. Whether man has taken adequate notice of this unpalatable truth to the required extent or not is debatable. However, efforts are being made for tapping alternative sources of energy like atomic, wind, tidal, solar and other forms which are regenerative in nature.

It is surprising to note that the attention being paid to the depletion of materials for generation of energy in various forms is comparatively much more than for the limitation on other natural resources like ores for metals like iron, copper, aluminium, ingredients required for production of cement and other ceramic products required by the industry in general and the construction industry in particular. It will not be enough only to go for appropriate technology to maximise the use of locally available materials or develop alternatives to the established items in the industry, but it would also be necessary to consider how best the materials can be recycled. In the changing scenario of the construction industry, the range of durability is going to vary, and the long life envisaged in recycling construction materials will need more attention. Creation of nonbiodegradable waste in large quantities should not remain a major hurdle for the coming future".

Sustainable Development – Seven Dimensions of Sustainability As per the Hutchinson Dictionary of Science (1995) "Sustainable" means capable of being continued indefinitely. The sustainable yield of a forest is equivalent to the amount that grows back. It is used in environmental science to signify a "balanced structure".

Following are the seven dimensions of sustainability which are essential for integrated development planning.

1. *Climatic Sustainability*

It involves cleaning of polluted atmosphere due to population pollution, i.e., popollution expansion of cities to mega and jumbo levels, heavy use of vehicles and industrial explosion, with effluents of gases from chimneys. Thus, popollution, transport – two-wheelers, three-wheelers, cars and taxis, trucks, aeroplanes and also industries are basically responsible for polluting greenhouse gases like CO_x , SO_x, NO_x, CFC (chloro-fluoro-carbon), CFM (chloro-fluro-methane), etc. These create a variety of diseases affecting our chest and heart. Millions of working man hours are lost and thousands of deaths have been the result of these gaseous respiratory pollutants in slums and industrial areas choking up cities all over the world. Smog (smoke + fog), Saze (smoke + haze) are some of the products of pollution. Depletion of the ozone layer and an increase in skin cancer and other types of cancer are the results of climatic pollution in modern industrial societies. Hence, reducing and controlling air pollution is a necessary requirement for climatic sustainability.

Architecture and civil engineering have to play a major role in climatic sustainability. A good healthy sustainable climate due to proper design of towns, roads, airports, railways and buildings, with parks and gardens, differed and sprinkled in mega towns is an essential part in improving quality of life.

2. *Cultural Sustainability*

We must integrate old culture with modernisation and evolve models which must grow from within. The village model must be integrated with farm systems involving cultural continuity. Rural shift of population to urban areas must stop. Rubanisation as such spoils village culture and city culture simultaneously. Hence, solutions must be found and implemented for eco-development with local ecosystem (culture specific and sites specific solutions).This is termed as "Appropriate Technology" (AT), i.e., technology appropriate to local environmental situations.

What is cultural sustainability for New York may not be true for New Delhi. What is true for New Delhi is not applicable to Pune; and what is true for Pune is definitely not true for any village. India requires a village model of "Ralegana Siddhi in Aghmendagar District, Maharashtra, which was evolved by experiment and with academic help from the University of Pune and from the state government with Padmashree Anna Hazare leading this "Sustainable Appropriate Technology Movement". This is termed "Sui-Generic", i.e., Unique for indigenous agricultural environment.

Yet what is true for Ralegana Siddhi is not true for villages affected by earthquake as in Latur and Osmanabad districts of Maharashtra (India) where more than 100 villages were destroyed by earthquake in 1993. The building codes and structural codes for construction of residences, farm houses and factories along with schools, hospitals and mini, midi, or maxi dams are to be made different from other villages or agricultural areas. Even in the same state, architects and civil engineers have to adopt a different module for such earthquake affected areas with appropriate technology in materials of construction and mode of approach.

3. *Ecological Sustainability*

We have in this Cosmos only one ship to travel in the Cosmic Ocean or Cosmic space. It is the "spaceship earth", our mother earth, now termed as "Gaia" by new age writers and thinkers. This new idea treats the planet as a single unit or a giant single organism or cell. Our life and Quality of Life are purely interlinked with the environment. Hence, we must maintain the physical environment and living things including trees and plants around us. The "Gaia" hypothesis was first introduced by the British Scientist James Lovelock in Earthwatch, in a article "Gaia takes Flight" in Sept. /Oct. 1992.

Total Quality Management (TQM) of the earth demands that the system management of the earth must be such that "What we take away from mother earth must be replenished back to her", so that there is ecological sustainability and quality of life is ensured. If the quality of life is downgraded due to indiscriminate and senseless use of the earth's resources, happiness is naturally destroyed. Then what is the real aim of Life? Happiness or misery?

Hence, it is necessary to use resources frugally and intelligently without harming the life supporting systems. As such, consumption of fossil fuels like coal, oil, petrol, natural gas etc., should be limited. Otherwise, in another 100 years, nothing will be left for the future generation. Even wasteful use of water is to be avoided, it being a depletable resource.

All harmful resources and products are to be controlled and limited. They should be replaced with renewable resources or recycled products. If the quantity of pollution and waste products is reduced, energy is automatically saved. Resources must be conserved and fruitfully altered, e.g., timber or wood is now being replaced by plyboards, fiber board, plywood, hardboard, sunmica, formica, kitply, etc. "6000 metric tonnes of plastic furniture saves 14000 cum m. of wood available from 320 sq. km. of forest." This is an example of avoiding damage to a life supporting system.

Architects and civil engineers have to promote self restraint in material consumption of fossil fuels and replace them by recyclable resources for integral development.

Coordination is an integral part of ecological sustainability, but legal and administrative guidelines are necessary for its enforcement.

4. *Economic Sustainability*

What is the use of all theories and discussions, if there is no economic sustainability in all private and public investments? There should be efficient allocation, use and management of resources. Economics must be insulated from politics. Alternate materials must be viable, strong, efficient, load bearing and qualitative. QR, i.e., Qualitative Restrictions are a must for any structural project. Many RCC buildings in Mumbai, Hyderabad, Bangalore and other mega towns have failed due to uneconomic, unsuitable and unsustainable quality of materials and construction. Roads, railways, waterways and airways, all infrastructural work must be economically and qualitatively sustainable. Economics is the heart of a nation or family welfare. Structural failures lead to loss of life and loss of money with loss of credibility of the individual or an enterprise or a nation as a whole which does not cater for Total Quality Management and Execution (TQM and TQE) of a project or its components.

The cost of environmental degradation to the percentage of GDP (Gross Domestic Product) is given in Table 1.1

Table 1.1

Country	% of GDP
1. India	4.5
2. China	2.6
3. Eastern Europe	5.0
4. Industrialised Highly Developed Countries (HDCs)	1 to 2

Source: Economic Times, 14.2.97

5. *Health Sustainability*

Health is wealth. A nation's health now basically depends upon the health of blue collard and white collard workers (factory and office workers). The health of these industrial and / office going workers is important from the point of view of loss of man hours, production loss and the consequent loss of money in domestic consumption or foreign export. Loss of time cannot be replenished and the wheel of time cannot be reversed. The goals of medicine should not be only to prolong life, but to improve its quality. Prevention is better than cure. Malnutrition is a silent killer of children and old people who live below the poverty line. In India, this affects about 40% of the population. Boys and girls who are undernourished cannot be very productive after they grow up. Thus, further labour force is reduced qualitatively and quantitatively.

Air and water pollution also adversely affects the worker force in factories and other service areas, as also in agriculture. In short, primary (agriculture), secondary (industrial) and tertiary (services) – all three sectors are affected by environmental pollution.

Residential and public buildings, transport, infrastructure and town and country planning form the basis of not only Health Sustainability but also of Human Development Index (HDI) covering all aspects of development.

6. *Social Sustainability*

If a society is treated as an organism, living and vibrant, its sustainability depends upon the interaction among different groups and individuals, and between rural and urban areas. It also depends upon building of a modern civilisation which has reasonable equity or equality in assets and in income distribution. This reduces the gap between the "Haves" and "Have Nots". It gives a reasonable standard of living to all groups. An income proportion of 1: 10 to 15 among lower income groups in proportion to higher has been universally recognised as a reasonable income ratio for social sustainability. It caters to the basic needs of lower income groups covering food, clothes, shelter and entertainment, if good and free education is provided by the government or nongovernment organisations (NGOs) to their children and proper health insurance schemes are introduced. If all sections of the society are happy, the Nation as a whole is happy.

Architects and civil engineers contribute to town planning, country planning, residential and public constructions including factories, schools, hospitals, parks, railway stations, bus stands, etc., as also water supply and sanitation facilities including traffic decongestion, arrangement like cycle roads and segregation of slow and fast moving traffic. All these items are used by the society as a whole. They develop brotherhood and lead to integration of the entire society.

The entire approach of social sustainability leads to spatial sustainability.

7. *Spatial Sustainability*

This means ability to achieve a balanced rural urban configuration and qualitative territorial distribution of human settlements areawise. This helps to reduce popullation and slum formation in metropolitan areas without affecting existing ecosystems. Otherwise, excessive concentration of population with low infrastructural facilities destroys the available space and spatial environment.

There is enough scope for agriculture, horticulture, arboriculture, sylviculture, floriculture, sericulture, aquaculture, pisciculture, etc., in spatial sustainability to bring farmers into the modern culture of farming with the time age old and modern systems merger of techniques. This can be done through training in agricultural colleges and universities, provision of technological packages, banking, cooperative and farm credits and cooperative access to different markets.

This spatial agro reforms with introduction of agro forestry and agro dairies will lead to the development of process industries and biomass industries in rural areas, creating rural agricultural and non-agricultural employment, reducing the rush towards cities. It is India's 70% rural population which will then act to establish Biosphere Natural Reserves and also protect Biodiversity for the benefit of 30% urban population. Agrofarming, agroforestry and agroindustries are the base of national climatic conservation, fossil fuel conservation and replenishment as also protection and continuation of Biodiversity. India has great biodiversity. Its living resources contain 45000 species of plants, 95000 varieties of animals, 370 mammals, 1200 birds, 180 amphibians, 400 reptiles, and 1700 species of fish and 60000 varieties of insects. They need protection from deforestation and urgent afforestation to cover 33% of the land area.

Intergenerational Equity The present day 'sustainable development' has to take care of our resources which are dwindling with overpopulation of human beings and animals with their requirements of day to day survival and industrial expansion. Hence, the concept of sustainable development leads us to the concept of intergenerational equity.

In the language of Economics, needs are equal to well-being or welfare. Thus, sustainable development is that which secures an increase in the welfare or well-being of the current generation, provided that the welfare of well being of the future generations does not decrease. This is known as intergenerational equity.

We have to protect the environment. We must conserve fossile fuels, forests and energy, so that the present civilisation survives. The rise and fall of civilisations have been a historical geographic process. But those civilisations were like an oasis in the vast expanse of this world. Unless we take care, this new world wide civilisation with infotech superhighway (cyberspace) may also be destroyed by scientific and technological processes. "Conserve the resources and create ever lasting new ones" should be our slogan. The spaceship earth is our environment which covers everything in our surroundings that affects our day-to-day lives. As per the noted American biologist and prolific environmentalist Rachel Carson, of *"Silent Spring", "No organism in biological history has survived for long, if its environment became in some way unfit."* India itself is losing its forest at the rate of about. 1.4 million hectares per year. Apart from forest being damaged, the forest land is first converted into agricultural land and then to non-agricultural use-conversion into industrial and residential complexes and construction of roads, railways and airways. The same is true for all developing and developed nations.

"Saving the earth" requires environmental planning and management in which civil engineering, architecture, town and country planning has a major role to play. Utilisation of space and materials judiciously and selectively will be the future life sustaining force. All eco-system will have to be carefully planned for comfortable survival.

"The Earth Charter", a document to enunciate human responsibility towards life-sustaining resources of our planet, has been approved by the jury of "The International Saint Francis Prize for the Environment" as a basic prayer of all creatures.

The preamble of the chapter reads:

"We, the people of the earth, declare that the primary goal of human efforts to put an end to the present destruction of the Earth's ecosystems is to guide and inspire future human development in order to create new life-style that will guarantee to the whole human population, social justice and harmonious relations among Nations and Peoples and respect for the life-giving capacities of our Mother Earth".

It contains clauses whose signatories are twelve jury members, one of whom is Dr M S Swaminathan, former Director, Centre for Research on Sustainable Agriculture and Rural Development, Chennai.

Structural Economic Changes As per Prof. P Khanna, Director, National Environmental Engineering Research Institute, Nagpur (1991), *"Structural Change involves large scale technological substitution towards environmentally benign technologies such as Clean technologies of industrial production that conserve resources, generate less pollution, provide direct economic benefits and stimulate the growth of industry as well as the national economy – Recycle and Reuse Waste".*

The construction industry has to play a big role in the sustainable development process through the full usage of renewable, and environment-friendly modern building materials. The industry should also encompass and save energy with labour intensive projects, designs and execution.

1.2.2 Environment

The word 'environment' is used with relation to a variety of human functions and needs physical, cultural, economic, political, psychological, collective, perceptional and with many other functions. Each function is a system by itself or is a part of the other system.

Different views expressed below will throw more light on this term" Environment".

1. **Environment**

   Environment can be seen as a series of relationships between things and things, things and people, and people and people. Four elements are being organised-Communication, Time, Space and Meaning.

   Essays edited by: Anthony King
   Book: *Buildings and Society.*

2. **Environing and Environment**

   "Environing means to surround, so an environment is not only a physical milieu but one which actively and significantly surrounds, so that the environed thing in some way is aware of or affected by its environment."

   Landscape Architect: Bill Hillier
   Book: *Space is the Machine.*

3. **Technosphere and Biosphere**

   In the words of Barbara Ward, "We live in the biosphere of inheritance and technosphere of our creation. The problems have arisen due to discontinuities of both. House is the outward and visible sign of an inward spiritual grace. Technosphere should not destroy Biosphere."

In other words, it is stated that we live in two worlds. Within the envelop of our skin is a biological entity which is tuned finely to survival in natural environments. Around us are the buildings of inert material.

4. **Environmental Education**

"The environment includes a complex of natural, built and social components in the life of humanity."

"Environmental Education should develop understanding of the complex relation between socio-economic development and the improvement of environment".

"It should aim basically to succeed in making individuals and communities understand the complex nature of the natural and the built environment resulting from the interaction of the biological, physical, social, economic and cultural aspects and acquire the knowledge, values, attitudes and practical skills to participate in a responsible way in solving environmental problems and in the management of the quality of the environment."

The First Intergovernmental Conference
on Environmental Education -
organised by UNESCO and UNEP Tbilisi, 1977.

Man's progress from 'primitive man' to the technological man' his needs of material and energy, his greed for more and more and his activities as a moulder have resulted in changing the environment into two interlinked components the natural environment and the man-made (psycho-social) environment.

Our planet 'Earth' is an interdependent system. It will be seen that during the course of the socio-cultural, historical and political progress of mankind, the geographical dimensions of the globe have come under different national jurisdictions. But one should note that there are parts of the globe that fall outside national jurisdictions; which are known as global commons. The open oceans and the Antarctica are mankind's commonly shared properties.

There are human activities generating from any nation having a bearing directly or indirectly upon the global warming, sea-level rise, depletion of the stratospheric ozone layer and large scale deforestation, which are planetary or global concerns.

Natural environment today exists at the mercy of man. The Universe consists of systems. It is essential for man's own existence to be aware of the laws of various systems, function, productivity and tolerating capacity of the environment, both living and non living. One should study to know adequate steps to restore and maintain the stability of the environment.

We should realise that "Environment" is defined not only as one's surroundings, but it also covers all conditions affecting life and human behaviour. Hence, our aim should be creation of an agreeable environment that would ensure a fuller, richer and happier life for every individual. Such a creation requires the study of two interrelated components, i.e., a) various factors considered under' Environment' and b) "Man" his physical and psychological requirements. Today's rational approach to the planning of towns, townships, housing schemes and various types of buildings takes into consideration, among other things, the impact of man's action on his environment, on the one hand, and the influence of the environment, on the other.

Hence, creation of a planned environment requires the capacity and ability of a planner to think in terms of the "wholeness of the environment". In planning of towns, housing schemes, individual buildings first priority is given to the environmental approach of creating a desirable environment and this is then followed by a suitable structural design.

Environmental action should take into consideration:

1. Health of all
2. Safe water for all
3. Food for all
4. Fuel for all
5. Control of pollution -air, water, land
6. Control of noise
7. Treatment of solid wastes
8. Control of radioactive wastes
9. Safety for occupational hazards, physical, mechanical, chemical, biological, radiation, psychological hazards
10. Accident prevention and occupational safety
11. Safe work environment for pleasure, achieving production targets
12. Living in harmony with Nature-plants, greenery, flow of water, fountains, to make one's environment a place of joy, love, beauty, harmony for eternal bliss.

1.2.3 Settlements, Town Planning - Regional Planning for Welfare

Settlements

"And today, the needs of mankind have multiplied to such an extent that it is virtually impossible to satisfy them without having recourse to comprehensive planning of towns and the countryside … need is agreeable environment that would ensure a fuller, richer and happier life."

Authors: V Modak, V N Ambedkar
Book: *Town and Country Planning and Housing*

On the background of various thoughts expressed under ecology, environment and man relationship, you will be aware about the physical and psychological requirements of town. Town planning can be considered as the first step in shaping the natural environment, i.e., to create environmental filter number one. Cities are the visual setting for the people. Hence, town planning is required to plan streets and the spaces around the buildings, city skylines, roads, footpaths, trees alongside the streets, traffic islands, gardens, sympathetic soft landscaping to soften hard layouts, and for the creation of a cohesive, pleasant and cheerful townscape.

Town planning is not a bookish theoretical subject. Its results are seen all around us. Not only planning but maintenance by the individuals, and gram panchayat / municipality / corporation is important to create and maintain livability and 'social behaviour'.

With the development of settlements for a few hundred persons in villages, lakhs of persons in towns and crores in metropolitan centers, to find and achieve means and ways to change present cities for a better environment is the modern challenge . It should be a dream design for a world in which there are few historical, political or social constraints, a world in which town planners, architects and landscape architects would be masters of urban form and appearance.

It is stated that, नवांगं नगरः प्राहूः। — which means,"There are nine essential amenities which constitute a town,"e.g., buildings of different types, markets, roads, temples, water supply, drainage, protection, entertainment and educational facilities. One of the ऋचा in ऋग्वेद is विश्वं पुष्ठ ग्रामे अस्मिन् अनातुरम्।" which means,

"Whatever is best in the universe that should get place in the town-best designs, gardens, well-planned chowks and roads, temples so that citizens will be proud of their town or city."

Every town has got its own culture, personality and warmth; hence town planning can be considered as a process which helps in creating and maintaining 'living environment' by ensuring some kind of unity and harmony between nature and architecture. History shows that a town emerges, develops, and improves just as a society develops. Tourism and commerce have brought distant places nearer to each other. This has given an opportunity to study the culture, values and qualitative aspects of city life and urban landscapes, scientific and technological achievements in designing, transportation systems, airports, harbours, flyovers and bridges. Now, town planners, architects, landscape architects and engineers from different countries have opportunity to show their creativity in their own and other countries as well. Different aspects in town planning like sports stadia, cultural centres, parks, churches and temples, commercial and residential complexes, educational centres, hotels and recreation centres for tourism have given inspiration to show their creativity.

Hence, expectations from towns are also constantly expanding along with the scientific, technological and cultural developments.

Different towns with varied climates, extreme cold to tropical climate-with variety of topographical features are examples of urban planning ideas. One will agree that physical planning for functional use has now become a scientific and multifaceted art. The main considerations are economic, climatic, hygienic, technological and artistic in nature. Today, computer application is helping urban designers to bridge the gap between two dimensional town planning and three dimensional spatial orders. Designers can visually experience ground realties instead of imagination. Hence, conventional planning tools such as master plans and three dimensional scale models are found to be insufficient. Computer processes large amount of statistical data and provides three dimensional visualisation along with experimentation and variation as and when required.

The main issue of urbanism is management of cities. Cities which were some years back found to be comfortable and livable, have now become unsuitable for living due to over-crowding and unbridled expansion. These congested cities are facing various problems such as transport, schools, hospitals, water and electricity. Roads and footpaths are used by hawkers and shopkeepers. A rising index of crime, aggressive driving, insufficient street lights, etc., are some of the reasons for the decrease in safety and security in cities. Accidents have become a common feature on roads due to the increase in number of vehicles. Walking on footpaths and cycling on roads is becoming increasingly difficult.

Regional Planning for Welfare

Every citizen is concerned about the present and the future conditions, future developments and also the safety and security of the town. There is a growing realisation on the importance of the development of neighbouring areas. These areas are connected with the life of the town through their supply of agricultural products, and also have labour, economic trade and cultural ties with the main town. Hence, a detailed study of the interdependence of the town and its surrounding, rural and urban settlements is essential for its prosperity. Such prosperity and welfare ultimately depends upon planning of the town and regional planning, with a periodical assessment of the real achievements.

Regional planning is concerned with spatial planning, multidimensional and multi-objective planning of the region with urban and rural settlements.

A particular region consists of few towns and villages. One will find that there is a total difference between the life in a town and a village or in an urban and rural environment. Towns are developed under different town planning and development schemes. The role of private developers is also important in developing towns. This has caused an imbalance and created problems. People rush towards cities for survival, education and better economic environment. Modern society in a city has changed rapidly and become more complex technologically and socially. Changes are responsible for the degradation of life. Increasing pressure due to overcrowding on all types of services are creating problems. Towns are expanding in all directions with encroachment of land and illegal constructions. Making over-populated towns livable with essential amenities like fresh air, quick and comfortable transport system, healthy environment and job opportunities are some of the points demanding attention from experts, and municipal corporators. On the other hand, we need rural development which will transfer every village into a healthy mini town, amongst natural greenery and unpolluted environment with provision for essential amenities. One will not leave a village if there are educational facilities with employment opportunities. This is a must for real agricultural development in our country, and is termed as Integrated Rural Development.

Main considerations for the regional plans can be summarised as:

1. To reduce congestion in towns.
2. To stimulate investment in under-developed regions so as to create greater balance between different regions.
3. To develop varieties of industries in under-developed areas for creating more employment.
4. To introduce effective communication systems.
5. To create new developed areas for settlements.
6. To create regional level development plans as intermediates between the national and local development plan so that better co-ordination in different schemes becomes possible.
7. To introduce economic and physical land use planning, taking into consideration agricultural, industrial and other developments.
8. To collect data related to population, employment, resources, housing, industry, commerce, transport, mineral resources, recreation, utility services, etc., of that region.
9. To have knowledge of different human activities in the region.
10. To get acquainted with the problems in different regions – unemployment, depopulation, overpopulation and congestion with proper solutions.
11. To study the population, covering different income groups, their education, housing, etc.
12. To conduct environmental study, to ensure control over pollution of air and river water, afforestation, protection of river catchments area, flood control and control over land erosion.
13. To locate and encourage industries suitable to the environment.

1.2.4 Buildings – From Shelter to Architecture - Landscape Architecture

Architecture

"When the architect sets pencil to paper, he is doing more than designing a building. He is describing his society to itself and to the future"

Author: Eugene Raskin
Book: *Architecture and People*

In the beginning of human civilisation, man had constructed his habitat through an instinctive process.

The first construction activity was the building of huts with bamboos and leaves. This was undertaken when ancient man decided to abandon his natural shelter – caves and live on river banks. Huts built by him not only protected him from the sun, wind and rain, but also gave him security. It also gave him enough time to carry out search for new materials of construction, such as boulders, bricks, mud, lime, mortar and wood.

The man started taking delight not only in the art of construction but in other arts as well, such as painting, sculpture, music, dance and poetry. He got inspiration from nature in the form of shapes and colours of leaves and flowers, and their effects on the eyes and on the mind. All arts were developed by different artists from time to time with such inspirations from nature. Decoration of walls, paintings, murals, etc., shows a sense of beauty and spontaneous creative expression of a joyful life.

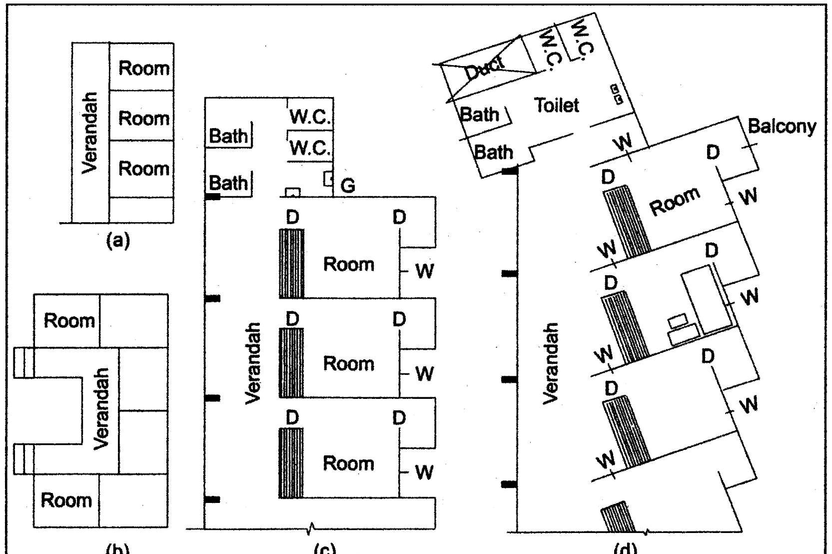
Man was soon constructing different types of huts with walls, roofs, floors, doors, windows, etc. However, he was not satisfied with his hut. He started thinking in terms of improving its "utility". He also began considering the "feeling" that the structure evoked in the mind of the observer. He realised that certain proportions of doors, windows, height and width of walls, certain colour combinations and textures, etc., were aesthetically more appealing. He also observed from nature or otherwise, the various forms, such as cubes, cones, spheres, cylinders or pyramids seen in light and shade created varied impressions on the mind of the observer. Due to these observations, constructional forms changed gradually as art introduced itself into construction with new ideas of utility, and form and feeling for aesthetics, which gave birth to a new art and science known as Architecture. Architecture is defined as the art and science for designing and constructing functionally graceful structures, to serve the user well and satisfy his varying and complex needs.

At this stage, one should know that Architecture is of two kinds, i.e., (i) Vernacular or Traditional, and (ii) Designed.

Vernacular or traditional architecture is the origin of the Built Environment. It is based on the use of a "Model" with variations and differs from primitive design in the extent of variations. It has a close link with the culture in which it is created. The main purpose was to create a place to meet, to share food and to have private territories for a family. Figure 1.1 (a) and (b) are examples of vernacular or traditional architecture. They show typical plans suitable for shops, schools, health centres and offices. It should be noted that vernacular architecture does contain an element of design but it conforms closely to the traditional way of design. One will agree that there is minimum of originality in it. At many places particularly in villages, such type of buildings are constructed even today, with the help of local masons and carpenters without guidance from civil engineers or architects. Figure 1.1 (c) shows the typical plan for a hostel, an example with some modifications in the vernacular design.

Designed architecture is the result of a conscious effort to create something new. It contains an element of tradition but each design is original. Function, form and feeling for utility and aesthetics are the three considerations in designed architecture. Figure 1.1(d) is an example of designed architecture. It is the plan for a hostel. The building has columns outside the plinth line; hence more effective area is available in the passage. The tilting of the rooms has given the balconies privacy and a good view, an elegant elevation, cross ventilation and additional area in the passage to keep a bicycle or chair. Hence, more functional utility is achieved as compared to plan (c). One should realise that there is a difference between building and architecture. Architecture is an art, and as such it is some way an expression of the man or men who design it. This varies from architect to architect. An architectural construction is the final out come of the creative nature of a creative personality.

Looking at the history of designed architecture we can broadly classify it into (i) Classical (ii) Modern (iii) Postmodern architecture.



(a) and (b) Vernacular or traditional architecture. A typical plan used for many buildings, shops, schools, health centres, offices.
(c) Plan for hostel based on vernacular architecture (d) Designed architecture

Figure 1.1 *Vernacular and Designed Architecture*

Classical Architecture The whole medieval period was dominated by different styles in architecture, namely Greek, Roman, Byzantine, Gothic and the British colonial style. Style came into existence when man wanted to cover bigger areas for different functional use. The main construction problem was how to put a roof on such big areas.

In India, there are a number of old cave temples showing "Post and Lintel" constructions and halls with carvings. The Egyptians constructed huge pyramids, i.e., tombs for their kings and different temples in which they used blocks of stones for posts and lintels. The Greeks used stone constructions with columns and beams based on the principles of timber construction. The Greeks developed a style of proportions known as "Order of Architecture". An order of architecture is a systematic proportioning of the base, column and entablature related to the diameter of the column. It is said that these orders were based on the proportions of human body. Doric order was deliberately based on man, Corinthian on a maiden and the Ionic on a stout lady whose girth was the average between the above two. The above orders, gave detailed dimensions with reference to the diameter "D" of the column at the floor level. They embodied perfection in design. This was essential, as the construction in a stone masonry required many years for completion. Vaults and domes were built during the Byzantine and Gothic period. In addition to the principles of construction used by the Greeks and Egyptians, the Romans used arches for vaults and domes. They utilised pozzolana sand, mortar, plaster and concrete. This architecture during the Roman period was known as Romanesque. During this period, temples having *Goupuram* and columns with capitals (plain or fluted) were constructed in India. During the Gothic period in architecture (AD 1100 – 1500), churches were constructed with pointed arches, with ribs supporting the masonry by buttresses. These structures led to the development of the idea of the 'framed structure". Grandeur and monumentality became the dominant features of this style. The Victoria Terminus station at Boribunder, Bombay (now Mumbai or CST Terminus, i.e., Chhatraptati Shivaji Terminus), the Bombay Municipal Corporation building, Rajabhai Tower at the University of Mumbai are some of the best colonial examples of this style.

With the revival of ancient art, literature and learning during the renaissance period of AD 1500 – 1700 , the old style of architecture was revived. Dome construction became popular for many buildings. The period from AD 1750 onwards is known as the period of modern architecture.

Modern Architecture The movement of modern architecture started in the year 1920 after the industrial revolution in Europe. New materials like cement concrete, steel and glass brought changes in construction methods. Framed structures of steel or RCC brought changes in construction methods. Framed structures of steel or RCC (reinforced cement concrete), instead of load bearing ones, became the prominent feature of modern architecture. Use of materials in their natural state – exposed brick work, finished concrete, varied judicious use of steel and glass became popular. The plastic quality of concrete helped in constructing huge structures. Functionalism, geometric order, proportions and simplicity were the key factors as compared to the previous style.

For a number of years architecture was mainly practiced either in places of worship such as churches and temples or in palaces. But the industrial revolution brought about a change in the traditional style of living and also in the existing structural system. Wealth also changed hands bringing into existence a new elite class with new tastes. Buildings were now required for factories, stations, schools, and offices. Residential accommodation was needed for workers as well as mill owners. Man required different types of buildings for his activities – houses, bungalows and flats for living, schools and colleges for education, health centres and hospitals for health, railway and bus stations for transportations, aerodromes for air transport, clubs and theatres for entertainment and banks, shops, office buildings and factories for work. He realised the futility of meaningless ornamentation of buildings and the traditional styles and orders of architecture. Then came the First World War. With the economic pressure brought about by it, the need and importance for functional planning was felt. The use of reinforced cement concrete (RCC) was made for the first time in construction. This triggered the rapid development of modern architecture. Functional structures with RCC columns, beams, slabs, *chajjas*, and canopies were found to be economical owing to the increased speed of construction and proper utilisation of space according to functional requirements. Architects got more freedom to plan buildings suitable for various purposes and environments. Use of plywood, glass, different types and shades of colours, dry distempers, oil–bound distempers, plastic emulsion paints, oil paints, etc., helped architects to make new structures more elegant.

Postmodern Architecture Modern architecture started losing its popularity in the 1970s. One of the reasons was that the language and grammar of modern architecture became universal. Similar types of hotels, shopping complexes, and office buildings were constructed in different parts of the world without any consideration for the local lifestyle or local culture. When a certain style changes, it becomes the base for a new style. Similarly, modernism became the base for post modernism. Architects now started the use of traditional language of architecture, old elements and symbols, arches, curves, decorated columns and gabled roofs, etc., in compositions.

Important points related to postmodern architecture are:

1. Contextualism – A design is the outcome of the context in which it is placed.
2. Planning and designing suitable to the landscape and neighbourhood.
3. Form, colour, style, scale and detail revival of the past styles and ornmentation. Availability of different colours for external finish, materials, for cladding, marble, granite, and glass.
4. An architect's new role of interior designer got scope in furniture, lighting, floor patterns, false ceiling work with plaster of paris, plywood or other suitable materials with lighting fixtures.
5. Air conditioning system, acoustics, fire safety, lifts, escalators, computerised controlled equipment, solar system for heating water, etc., has changed the planning system. Help of different consultants is taken right from the initial stage. This is known as the integrated approach in planning and designing.

Thus new materials, technology, thoughts and creativity brought changes in architecture. One thing is however, important. Man, the user, constructing buildings suitable to his psychological needs should not be cut-off from nature and there should be minimum use of natural resources and search for new forms of energy is essential. Nature has got immense power to encourage, refresh and motivate man,. There is a need for harmonious unity between buildings and surroundings. With the help of new ideas in landscape architecture with new materials, technology and information about new achievements in the field of architecture, landscape architecture and interior designing, there is no end to the number of good environmental designs that can be achieved. Any construction is incomplete without landscaping.

Landscape Architecture

"Good landscaping is above all, sensitive to the specified requirements of the programme as well as unmentioned ones and captures the spirit of the built form or the environment it is supposed to support/surround".

Landscape Architect : Jayant Dharap, Pune

Landscape architecture covers that position of the landscape which is developed or shaped by man beyond buildings. A landscape architect is one who completes the scenic picture, bringing liveliness through well-planned arrangement of trees and flowers around the building and through indoor plants inside the building. He brightens the picture with fountains, stones and rocks, colourful flowering creepers, grassy earth mounds, rock cascades for water flow, a pool of water with fishes or turtles, long low steps and comfortable benches, side walls with motifs or textures of different varieties of selected stones, winding walkways, etc. This covers the entire campus or layouts of a housing society or an individual bungalow. It involves the development of roads and other utilities comprising nature, designed primarily as space for human living. Thus, landscape is supposed to form an inseparable part of the environment.

The three consultants responsible for preserving and beautifying the environment are the ecologist, horticulturist and the landscape architect. Planed urban landscaping, i.e., urban forest is intended to give a picturesque appearance to towns, provide shade and comfort during summer, prevent incidence of dust, act as wind breakers, serve as visual barrier when needed and create an agreeable and cheerful environment. With a decrease in the availability of land, the landscape architect is now concerned with landscape design which involves selection of textures, materials, and different components to give a definite character to the designed area. It also includes landscaping on terrace.

Although architecture for a building is considered to be three-dimensional, it is in fact, four-dimensional, with time itself as the fourth dimension, as designs keep changing. Landscape architecture, however, is a two-dimensional consideration (viz. length and width). But with the height available up to sky varied and unlimited in dimension, it becomes a three dimensional aspect in retrospect. As such, with variations such as a building surrounded by ample space or a building having marginal distance and compound, each case becomes a challenge to the landscape designer who is in fact, a complementary competitor to the architects.

According to **Le Corbusier,** "*The site has a natural centre of gravity determined by its size, shape and the pattern of buildings, trees, hills and other landscape features around it"*. There are six basic types of land forms:

1. Level, gently sloping or rolling hills
2. Sloping sites backed by steeper slopes or by hills
3. Valley or gorge sites
4. Bowl-shaped sites
5. Fan-shaped sites
6. Rigid or hill top sites

In all cases, whatever may be the type of landforms and surroundings, sight, sound, skin and smell senses help us to create an overall integral opinion about the building. A building is first observed always in silhouette in conjunction with the silhouette of environmental surroundings such as hills, trees and other landscape features along with or including other structures/buildings. It is necessary to decide the weight of the building mass at a particular location point to bring the system in equilibrium. One should also remember at this stage the consideration of its character, which implies its success of creating an impact on the mind about the functional design and harmony within its surroundings. It should be impossible to imagine the site without a particular characteristic of the building. Landscaping helps us to achieve this impression.

1.2.5 Man

"Man, seeks the path of benign planetary enzyme, aspires to be the world's physician. Heal the earth and thyself … I hope that in the 21st century the largest accomplishment of art will be to restore the earth."

Landscape Architect : Ian L McHarg
Book : *Design with Nature*

Expectation from the 'Built Form' are stated by *Sthapati* with reference to physical and psychological requirements of man. He has mentioned that there are five arts related to the satisfaction and happiness of man, viz. Music, Painting, Dance, Sculpture and Architecture. Three basic principles related to these arts are :

1. Sukhadarshanam (सुखदर्शनम्), i.e., visual pleasure in built form such as in painting, dance, sculpture, architecture and visual and audible pleasure in music.

2. Ramyam (रम्यम्), i.e., impact created on the mind by the art with unforgettable quality or achievement of the design.
3. Bhogodyam (भोगोद्यम्), i.e., consideration for the decisions regarding the utility in search of perfection.

All artists / designers should try to achieve these principles.

According to architect D K Bubbar, (Inside Outside, Dec.–Jan. 1985) "Ancient architecture in India succeeded because it was synthesis of all the arts centered around a basic philosophy. It took into consideration, man's relationship with the space around him. In Sanskrit, there are many words for space, but architecturally, Akash (आकाश) or Kha (ख) is the most relevant. Everything that has form, is evolved out of and is a result of this Akash or Kha, i.e., space.

Space is manifested on three levels - Maha-Akash*, the universal space,* Griha-Akash, *the space contained by walls and a roof, and* Ghat-Akash, *the space contained in vessel or body.*

When these three levels of space are proportionately apportioned, both with each other and with the materials used, then the resulting designs, be they interiors, buildings or city plans, make for congenial environments. Congenial environments, in their turn, lead to happiness or Sukha *(literally good space -* Su(सु)*-good,* Kha (ख)*- Space). Conversely, disproportionate allocation of space leads to unhappiness, Dukha (दुःख)* (du (दुः)-bad, kha(ख)-space)." The authors fully agree with above view of the eminent architect.

A major aim of physical planning is that of human welfare and a physical management resolution towards it, by ordering the use of space and its development. This will create appropriate environment for man, his needs, comfort and welfare. Two charts, i.e., (i) Built Environment - Man - Building-Environment Relationship and (ii) Architecture and Human Sciences will throw light on many aspects related to the study of man. (Charts 1.1 and 1.2).

Chart 1.1

BUILT ENVIRONMENT
MAN–BUILDING–ENVIRONMENT RELATIONSHIP

Man : Needs of man	Hunger and thirst, activity, respiration, rest, elimination, space with visual and acoustical privacy for different activities, security, prestige, return on investment	
Building : Building technology	**Resources –** Money, materials, men, machinery **Structures –** Load bearing, framed, composite, steel **Services –** Environmental, water, drainage, electricity, gas, communication, furnishing **Enclosed space –** Visible surfaces to satisfy sensory needs seeing, hearing, heat and cold, smell, kinaesthetic equilibrium. Feeling for utility and aesthetics	Man shapes his environment but he is also shaped by it.
Environment	**Cultural –** Social, political, economic, technological, historical, aesthetic and religious **Physical –** Site, climate, topographical, rules and regulations for construction	

Built environment design needs all the relevant factors to play their appropriate part remembering architecture as an art and science for the performance of man in the best possible way.

Chart 1.2

ARCHITECTURE AND HUMAN SCIENCES

The following human sciences are found useful while planning and designing buildings. Planners and designers should study them in detail since these provide useful information.

1. *Anatomy*: Systematic description of the body. Ten major systems – skeletal, muscular, Integumentary (skin), circulatory, respiratory, alimentary, urinary, nervous, endocrine (glandular) and reproductive.
2. *Anthropometrics*: Direct measurement of the human head and body – statistical analysis of those dimensions.
3. *Ecology (human)*: Study of man as an organism in relation to his physical environment, effects of geographical location, climate, food supply, shelter, interaction with other species for growth, size and development of physical characteristics.
4. *Ergonomics*: Study of variations in illumination levels, noise levels, temperature, air movement, etc., on human performance in terms of comfort, output, efficiency, etc., as a basis for design. It is the "scientific study of man in his working environment" with special reference to anatomical, physiological and psychological factors.
   It is the science of designing jobs, equipment and work places to fit the worker. Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can cause long term disability.
5. *Physiology*: Systematic and structural analysis of the ways in which different parts of a living organism are adapted to each other, and of their interactions and functions.
6. *Social Psychology*: Observation of people in groups and of their effects on each other in terms of output, efficiency, well-being, etc.
7. *Psychology*: Study of the behaviour of man; study and correlation of his abilities especially those contributing to intelligence, measurement of personality traits, effects of heredity and/or environment on personality, function of the nervous system, physiology and psychology of perception.
8. *Sociology*: The study of society in terms of all that happens to human beings by virtue of their reactions to each other with reference to the social structure, social function and social change.
   Other human sciences which may be useful are :
   Anthropology - Physical, Social, Structural;
   Archaeology, Demography, Ethnography, Ethnology, Ethology, Linguistics, Parapsychology, Pathology, Psychiatry, Psychoanalysis.

Environment is for man, his needs, comfort and welfare. Its study will develop an interest in other allied subjects such as Human Sciences with an aim of poverty eradication.

Man-made and natural elements together comprise the territorial habitat within which man lives, works, raises his family and seeks his physical, spiritual and intellectual welfare. History shows rich varieties in culture and human achievements. Growing population creates many problems, demands on the natural resources being one aspect. The land area (of the country) being fixed, the space is strictly limited. Heavy population migration for survival, to the metropolis and urban areas, have not only led to the problem of slums and squatter settlements but have also created unhygienic living conditions.

Population increase beyond the capacity of social and physical resources to accommodate human beings is the greatest challenge concerning the society today. Rural environment needs more infrastructure and employment facilities which will attract many people to stay there.

In today's world, there is reduced space due to growth in population, urbanisation and industrialisation. The expectations of the common man in our country are increasing rapidly due to worldwide information through various media. Shrinking space, shrinking time and towering expectations of man, demand a totally new approach related to Built Environment. New considerations for land ceiling, land prices, infrastructural needs, speedy construction techniques, use of heavy machinery for construction activities, resource planning, conservation, national policy for housing, change in the policy of town planning on the basis of today's problems in towns related to parking areas, more areas for shops and markets and open spaces are some areas which demand attention today.

1.3 BUILT ENVIRONMENT WITH LIVABILITY

Urban areas or Rural settlements are considered as environmental filter number one. Desired micro-climatic controls are to be achieved through town planning with different zones, roads, green belts, parks and gardens, open spaces and water bodies. An urban forest is created by selecting suitable types of trees to reduce temperature, noise, pollution and dust to provide a colourful green environment around the buildings, in the streets and open spaces. Huge water bodies, natural or artificial in the form of lakes are created to control temperature and to create a psychologically pleasing and cooling effect.

All types of settlements, viz. a colony, small town, a large city or even a metropolitan town, i.e., all urban and rural settlements should fulfill these needs by providing proper structural systems of services in harmony with nature.

Buildings are considered as environmental filter number two. Planning, designing, construction and maintenance should be done with reference to the following points so as to create controllable comfort inside the building to achieve "livability".

Structural controls are achieved through :

1. Study of climate
2. Orientation of the building
3. Thermal Insulation - thickness and material of walls and roof, i.e., "fabric"
4. Shading devices
5. Controlling day light and provision of artificial light
6. Noise control
7. Ventilation and air flow
8. Moisture control - dampness control
9. Water proofing, and
10. Termite proofing.

Mechanical and structural controls as per necessity - the use of mechanical systems for :

1. Ventilation
2. Air-conditioning
3. Acoustics
4. Noise controls
5. Various types of building services - for communication, vertical transportation, telephone and information, safety services against fire and theft.

Today, different functional requirements vary for different types of buildings. They need comfort not only in general but controllable comfort through instruments for creating desirable conditions for production in industries / factories controlling temperature, humidity, dust, noise, light, odour, etc.

We are in need of an environment which would create livability and functional utility inside and outside the building. Natural greenery helps for such transformation in creating a pleasing environment.

The creation of the right physical environment with "livability" is the main objective of town planning, architecture and landscape architecture. The expectations of the common man in our country are increasing rapidly due to worldwide information through the media. **In a democratic country, the common man looks towards Built Environment as a device to modify the climate, natural as well as social, cultural and aesthetic, to provide the highest and most decent quality of life.**

Town planning provides a suitable background and base for architecture. It acts not only as an environmental filter but also to establish a social identity, indicate status and develop culture.

Building as a 'Container' of 'Activities' The shape of the building and number of storeys depend upon the size of the plot, rules for marginal distances and floor area index (*Ref*. Fig. 5.30). Building is planned for some activities - Residential, Commercial or otherwise. Activities, their logical sequences and related space are to be accommodated skillfully on different floors. In case of all small plots, the size and shape of the building is restricted while in case of public buildings such as schools or hospitals, modification in the shape to fulfil functional needs is possible due to the large size of the plot. Hence, one should look towards the building as 'container' of activities for the present as well as for the future needs also. Today, due to the advancement in technology, man thinks about a building not only as a shelter but as a container of activities along with needs for future expansion.

Maximum utilisation of permissible FAR, i.e., floor area ratio, provision of the latest amenities with architectural style, and fetching the highest market price is the demand of the developer and promoter. Design consideration includes factors related to human sciences, physiology, psychology and sociology. Hence, the building as a whole is considered as a device for modifying the climate, natural (environment filter number two), as well as social, cultural and aesthetic.

Hence, architecture is considered as a building activity which offers a stimulating climate in physical, social, cultural and aesthetic forms that is essential to provide the highest and decent quality of life with an appropriate environment design. Environment-friendly architecture and user-friendly architecture has given a new approach in planning of buildings. Architecture is also considered as the aesthetic conversion of requirements into reality. It is the transition of an idea from a two-dimensional form of drawing to a three dimensional form of construction.

Today, architecture has a very comprehensive meaning. It is not only for palaces and temples, for status and prestige, but concerns itself with every strata of society and with every type of building, e.g., milk booth, bus shelter, public toilet and the individual place. It deals with 'space', and space as a specific volume is intended for a specific form of human activity. To be architectural, space must be man-made, technically efficient and aesthetically satisfying for the desired function.

Landscaping is a way towards healthier green surroundings. Greenbelts of trees, lawns, gardens, parks, nurseries, golf courses and fountains sooth the senses, relax taut nerves, take away tensions and provide refreshing breaks. This is the need of a well-planned town. Waterscapes provide a unique environment incorporating man-made lakes, ponds and streams. A fantasy land with a fairy tale atmosphere is a new demand in the world of entertainment.

1.4 INTEGRATED APPROACH IN DESIGN

1.4.1 Need for a Competent Design Team

It is stated that the main message of Built Environment is the integration of the functional, psychological, climatic and aesthetic aspects to create a harmonious effect which pleases both the eye and the mind, kindles and develops the desire to protect and live more closely in harmony with nature.

Planning, designing, construction and maintenance thus need an integrated approach not only of specialists and consultants but all planners at different levels. (*Refer to Charts 2 and 3*).

All essential consultants for a particular project should come together right from the planning stage so as to guide the concerned parties during planning, designing and construction, keeping in mind the environmental aspect. These specialists should have a clear understanding of building methods, materials, environment and performance as well as standards expected of them. Joint discussions and decisions are essential between design and project teams, to finalise each and every detail in the sets of drawings to avoid any delay on the site; otherwise project planning, scheduling, controlling and monitoring has no value.

R A Reynolds in his book *Computing for Architects* has suggested distribution of work amongst different agencies as mentioned below. It is on the basis of fees paid to various consultants.

Role of various agencies in planning of buildings :

1. Architect	35%
2. Quantity surveyor	23%
3. Structural engineer	18%
4. Service engineer	12%
5. Management consultant	4%
6. Landscape architect	2%
7. Specialist designer	2%
8. Various other consultants	4%
(such as environmentalist, interior designer, etc.)	
Total	100%

The total role of the architect, landscape architect and interior designer is about 40% which suggests that about 60% of the role is to be played by the civil engineer in various capacities. This capacity development needs special training during the educational stage in respect of various branches and sub-branches. Nowadays computers are used for all types of work mentioned previously. This helps us to collect and store information and think about different alternatives so as to finally choose suitable data for economical, efficient and energy saving designs.

Another agency in the building industry comprises the owners / promoters and builders. They may be owners of the land or persons interested in investing money in building construction. They may be technical or nontechnical persons. All concerned should know the importance of an integrated approach, the role of different agencies and technological developments in their respective fields.

1.5 INTEGRATED DESIGN AND BUILDING DRAWING - COMPUTER AIDED DESIGNS AND DRAWINGS

"Imagination is more important than knowledge. For knowledge is limited whereas imagination embraces the entire world, stimulating the process, giving rise to 'Evolution'.

– Albert Einstein

One essential quality of an architect or engineer is the power of imagination. While planning and designing, the imagination of the designer is at test. During the thinking process at a certain moment, there is a sharp and sudden realisation of a truth - a solution. There is a new idea to tackle the problem. The eye, mind and hand together empowered by the imagination tackle all problems in planning and design. An appropriate idea is the result of imagination in the right direction.

"Draw what you see and see what you draw" is the principle of drawing. We may add, "imagine what is to be constructed and draw the same on the drawing board by orthographic or pictorial details. Then compare what you have constructed and what you have drawn".

A student connected with architecture or engineering should look towards the subjects of drawing, planning and designing with a different angle. He has to treat it as an important subject, a tool to develop the power of imagination. Drawings with desired details, dimensions, levels and notes will save time during estimation and supervision and explaining to masons, carpenters, fitters, etc. Attention and accuracy are two main qualities of the mind. Faculties of observation and accurate reproduction of what is observed help in speedy construction which is effected by correctly reading the drawings. It is also essential to develop a skill for instant sketching, orthographic or pictorial, views for explanation. This knowledge is useful for computer aided design and drawings (*Refer to Chapter 6*).

1.6 NATIONAL BUILDING CODE OF INDIA - 2005

National Building Code of India was published in the year 2005 on behalf of Bureau of Indian standards. This is a valuable code giving information related to planning, design, construction of buildings and related areas. It also contains list of standards for reference hence gives guidance during teaching. The main emphasis is given for 'Integrated Approach'. It is stated that the aim of the 'Integrated Approach' is to get the maximum benefit from the building and its services in terms of quality, timely completion and cost-effectiveness. In the team, the inputs from each of the professional disciplines have to be so optimised that the total systems efficiency becomes the maximum. Knowledge, experience of qualified professionals is useful right from the conceptualisation through construction and completion stages of a building project and indeed during the entire life cycle. Cost optimisation has to be achieved through proper selection of materials, techniques, equipment installations, etc.

Different sections in the above code are as under -

1. Integrated approach
2. Development control rules and general building requirements
3. Fire and life safety
4. Building materials
5. Structural design
6. Constructional practices and safety

7. Building services
   - Lighting and ventilation
   - Electrical and allied installations
   - Air conditioning, heating and mechanical ventilation
   - Accoustics, sound insulation and noise control
   - Installations of lifts and escalators
8. Plumbing services
   - Water supply, drainage and sanitation (including solid waste management)
   - Gas supply
9. Landscaping, signs and outdoor display structures

Case Study

Township
An Eco-Friendly Environment – Vasant Nagri
Architect – M/s. Sanjay Puri, Mumbai

Around the year 1992, considerations for Eco-friendly, Environment-friendly planning and construction were new parameters. Idea of self sufficient township with the convenience of town life and advantages of the country life for stress-free living, creating a more enjoyable and sustainable place to live, work and shop and socialise was the need.

Vasant Nagri was the answer. Architect Sanjay Puri showed various considerations related to planning eco-friendly township; study of wind direction while planning layout with roads, sectors for various functions, large landscaped areas and architecture to give identity to each sector. 4000 flat owners got pleasant view of a garden or the colourful trees along the road. Sewage treatment plant provided treated water for the maintenance of the gardens.

Various ways to tackle the natural environment for comfortable human living and behaviour and creation of stimulating environment are worth studying.

Architect Sanjay Puri has explained the total planning step-by-step which is a good example for fresh learners to study various details. Future is demanding new townships with so many amenities.

1.7 INTEGRATED TOWNSHIPS–NEED OF THE FUTURE

1. Land is the basic raw material for townships.
2. Integrated townships should include everything that is needed for the stress free lifestyle. It should be planned not only for residential usage but mixed reality usage – walk to work, shopping complexes, schools, gyms, hospitals, facilities for leisure and entertainment, etc.
3. It should offer a good standard of living in apartments, row houses, bungalows at affordable price.
4. Such townships should reduce pressure on infrastructure of the main city.
5. Separate management authority for day to day maintenance is essential.
6. Renting and leasing of residences should be made easy with good rental return hence such commercial office should be the part of the township as in foreign countries.
7. Smaller cities should also be encouraged for growth with such essential infrastructure and good connectivity with the nearby city.
8. Long term policy for townships, public-private relationship, accountability for quality and environmental protection and planners with new vision is the need.
9. Along with infrastructural development we need sufficient Urban Planning Schools for post graduation for Architects; Landscape Architects for Environmental Art and Design, and for Civil Engineers to work as City Managers, Estate Managers for newly planned towns and management of townships.
10. Maintenance of townships need skilled and semiskilled workers—electrical work, plumbing work, garden work, civil works. There is lot of job opportunity in this field for new development and maintenance in townships.

According to the study, India will require 20–25 new cities in the next 30 years. These will logically be situated near the largest 20 metropolitan cities.

PROJECT	V A S A N T N A G R I
LOCATION	VASAI, MUMBAI.
AREA	TOTAL AREA 25,00,000 SQ.FT COMPLETED PHASES INCLUDE FOUR SECTORS WITH 1100 FLATS A SHOPPING CENTRE, A RECREATIONAL CLUB AND A TEMPLE. AREA OF COMPLETED PHASE I AND II 7,00,000 SQ.FT
CLIENT	SHETH DEVELOPERS LTD.
ARCHITECT	M/S SANJAY PURI ARCHITECT.
RCC CONSULTANT	M/S MESACON
INFRASTRUCTURE CON.	M/S ECON PVT. LTD.
CONTRACTOR	VARIOUS FOR THE VARIOUS BLDGS. AND INFRASTRUCTURE
COST	FOR COMPLETED PHASE I AND II - 28.0 CRORES.
DATE OF COMMENCEMENT	SEPTEMBER 1992.
COMPLETION OF PHASE I AND II	OCTOBER 1997.
BRIEF EXPLANATION	VASANAT NAGRI IS A SELF SUFFICIENT TOWNSHIP PROJECT SPREAD OVER 54.0 ACRES OF LAND. THE TOWNSHIP IS DESIGNED TO INCLUDE 4000 FLATS, A PRIMARY AND SECONDARY SCHOOL, A HOSPITAL, 2 SHOPPING CENTRES, A COMMUNITY CENTRE AND TEMPLE, A LARGE RECREATIONAL CLUB WITH SPORT FACILITIES.

VASANT NAGRI

AN ECOFRIENDLY ENVIRONMENT

Figure 1.2 *Vasant Nagri Township – Details of Project*

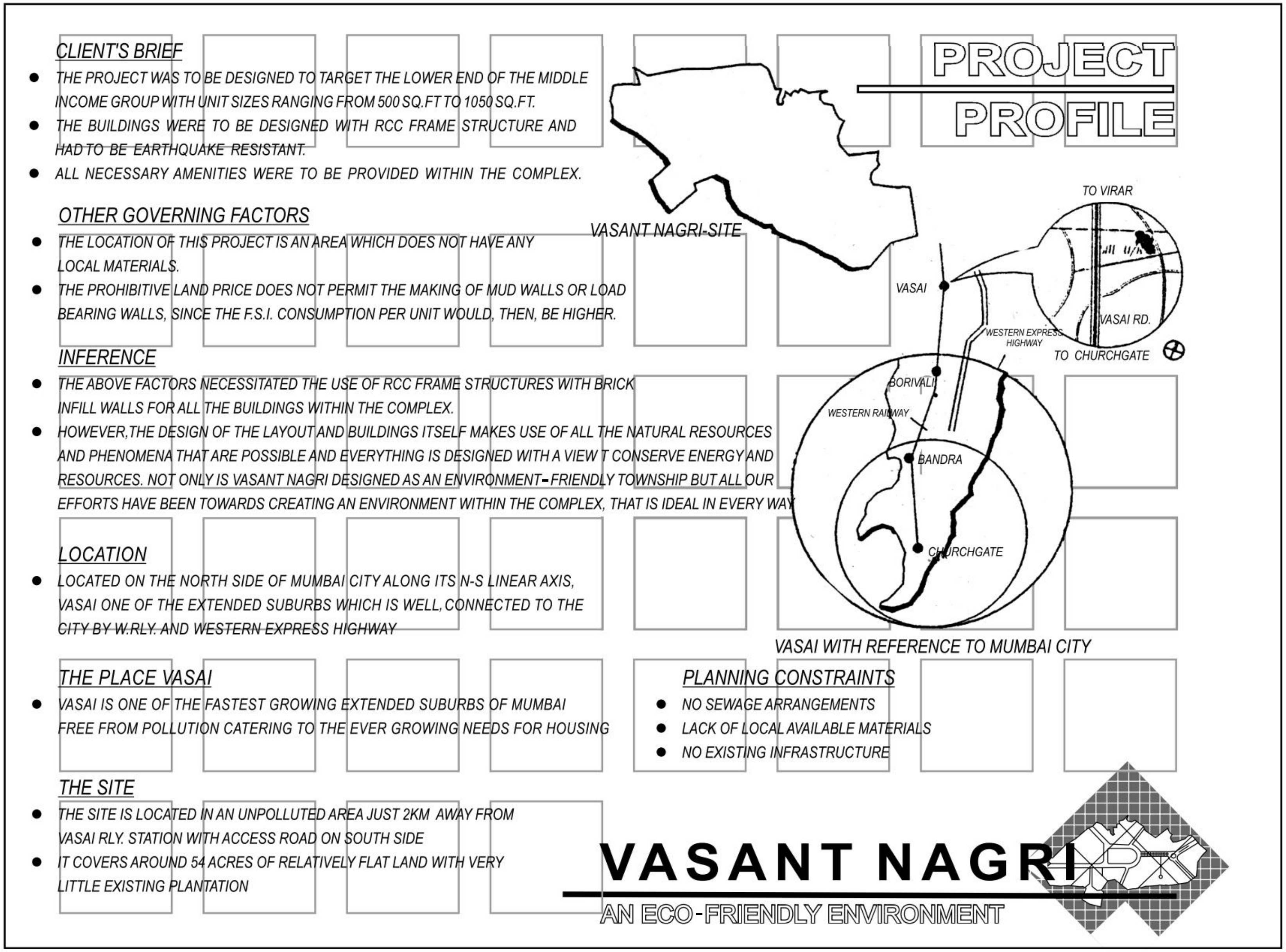
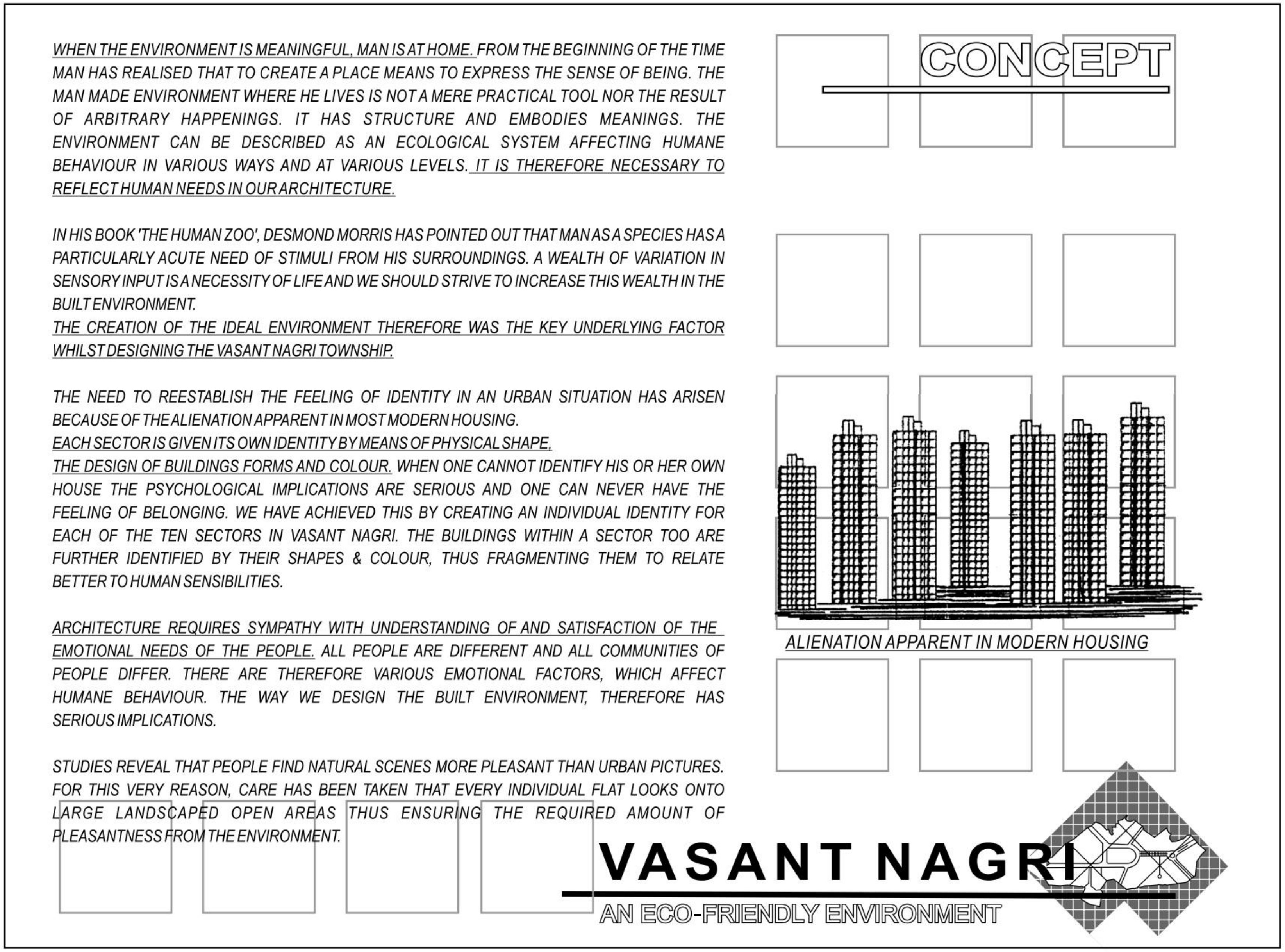


Figure 1.3 *Vasant Nagri Township – Project Profile*



WHEN THE ENVIRONMENT IS MEANINGFUL, MAN IS AT HOME. FROM THE BEGINNING OF THE TIME MAN HAS REALISED THAT TO CREATE A PLACE MEANS TO EXPRESS THE SENSE OF BEING. THE MAN MADE ENVIRONMENT WHERE HE LIVES IS NOT A MERE PRACTICAL TOOL NOR THE RESULT OF ARBITRARY HAPPENINGS. IT HAS STRUCTURE AND EMBODIES MEANINGS. THE ENVIRONMENT CAN BE DESCRIBED AS AN ECOLOGICAL SYSTEM AFFECTING HUMANE BEHAVIOUR IN VARIOUS WAYS AND AT VARIOUS LEVELS. IT IS THEREFORE NECESSARY TO REFLECT HUMAN NEEDS IN OUR ARCHITECTURE.

IN HIS BOOK 'THE HUMAN ZOO', DESMOND MORRIS HAS POINTED OUT THAT MAN AS A SPECIES HAS A PARTICULARLY ACUTE NEED OF STIMULI FROM HIS SURROUNDINGS. A WEALTH OF VARIATION IN SENSORY INPUT IS A NECESSITY OF LIFE AND WE SHOULD STRIVE TO INCREASE THIS WEALTH IN THE BUILT ENVIRONMENT.
THE CREATION OF THE IDEAL ENVIRONMENT THEREFORE WAS THE KEY UNDERLYING FACTOR WHILST DESIGNING THE VASANT NAGRI TOWNSHIP.

THE NEED TO REESTABLISH THE FEELING OF IDENTITY IN AN URBAN SITUATION HAS ARISEN BECAUSE OF THE ALIENATION APPARENT IN MOST MODERN HOUSING.
EACH SECTOR IS GIVEN ITS OWN IDENTITY BY MEANS OF PHYSICAL SHAPE,
THE DESIGN OF BUILDINGS FORMS AND COLOUR. WHEN ONE CANNOT IDENTIFY HIS OR HER OWN HOUSE THE PSYCHOLOGICAL IMPLICATIONS ARE SERIOUS AND ONE CAN NEVER HAVE THE FEELING OF BELONGING. WE HAVE ACHIEVED THIS BY CREATING AN INDIVIDUAL IDENTITY FOR EACH OF THE TEN SECTORS IN VASANT NAGRI. THE BUILDINGS WITHIN A SECTOR TOO ARE FURTHER IDENTIFIED BY THEIR SHAPES & COLOUR, THUS FRAGMENTING THEM TO RELATE BETTER TO HUMAN SENSIBILITIES.

ARCHITECTURE REQUIRES SYMPATHY WITH UNDERSTANDING OF AND SATISFACTION OF THE EMOTIONAL NEEDS OF THE PEOPLE. ALL PEOPLE ARE DIFFERENT AND ALL COMMUNITIES OF PEOPLE DIFFER. THERE ARE THEREFORE VARIOUS EMOTIONAL FACTORS, WHICH AFFECT HUMANE BEHAVIOUR. THE WAY WE DESIGN THE BUILT ENVIRONMENT, THEREFORE HAS SERIOUS IMPLICATIONS.

STUDIES REVEAL THAT PEOPLE FIND NATURAL SCENES MORE PLEASANT THAN URBAN PICTURES. FOR THIS VERY REASON, CARE HAS BEEN TAKEN THAT EVERY INDIVIDUAL FLAT LOOKS ONTO LARGE LANDSCAPED OPEN AREAS THUS ENSURING THE REQUIRED AMOUNT OF PLEASANTNESS FROM THE ENVIRONMENT.

CONCEPT

ALIENATION APPARENT IN MODERN HOUSING

VASANT NAGRI

AN ECO-FRIENDLY ENVIRONMENT

Figure 1.4 *Vasant Nagri Township – Concept*

CONCEPT

THE RELATIONSHIP OF COMPLEXITY AND UNITY IS ANOTHER IMPORTANT FACTOR IN DETERMINING THE QUALITY OF ARCHITECTURAL SPACE. IF COMPLEXITY IS FAR EXCEEDED BY UNITY, THE RESULT IS A DULL AND MONOTONOUS ENVIRONMENT & IF THE OTHER WAY AROUND, TOO CHAOTIC ENVIRON MAY BE. THUS UNNECESSARY REPETITION IS CAREFULLY AVOIDED THROUGHOUT THE SCHEME. SIGNAGE, LANDSCAPE AND ROAD DETAILS REMAIN CONSISTENT THROUGHOUT THE ENTIRE SCHEME AND THESE UNIFY THE VARIOUS SECTORS OF THE TOWNSHIP.

CITIES ARE NO LONGER PERCEIVED AS RELIGIOUS, COMMERCIAL OR UNIVERSITY CENTRES BUT AS FORMED URBAN LOCALITIES IN WHICH SUCH DIMENSIONS AS IMAGE, SYMBOL, PERSPECTIVE STRUCTURE AND ABOVE ALL EMOTIONAL VALUES ARE BROUGHT TOGETHER IN THE COMPLEX WEB OF TOTAL PERCEPTUAL EXPERIENCE.

THE CITY OF CHANDIGARH IS AN EXAMPLE OF THE ABSTRACTION AND FRAGMENTATION OF URBAN SPACE DETERMINED BY A TECHNOLOGY SHARED BY THE LIMITED ELITE BUT INCOMPREHENSIBLE TO ITS VAST MAJORITY. IN EVERY RESPECT, CHANDIGARH PRESENTS A CONTRAST TO THE ENVIRONMENTAL CHARACTER OF OUR TRADITIONAL INDIAN CITY.

THE BASIC PLAN OF TOWN AND GRID STRUCTURE EVOKE A STRONG SENSE OF ORDER. EVEN THOUGH CHANDIGARH REFLECTS A SENSE OF ORDER, CLEANLINESS, PEACE AND BETTER LIVING CONDITIONS, IT IS DULL IN ITS UNIFORMITY.

VISUAL HIERARCHY

ANOTHER FACTOR, THAT AFFECTS HUMAN EMOTIONS IS POTENCY. POTENCY CAN BE DESCRIBED AS THE AMOUNT OF PHYSIOLOGICAL EFFORT IT WILL TAKE FOR THE INDIVIDUAL TO TERMS WITH THE STIMULUS PERCEIVED. THUS A TYPICAL HIGH RISE BUILDING MERELY THROUGH ITS VISUAL CHARACTERISTIC MAKES IT DIFFICULT FOR PEOPLE TO ESTABLISH CONTROL OVER THEIR ENVIRONMENT.
WE HAVE THEREFORE DESIGNED THE ENTIRE INITIAL PHASE IN ONLY G+3 WITH LATTER PART IN ST + 7 STOREY STRUCTURES. THIS ALLOWS A VISUAL HIERARCHY.

OUR COUNTRY HAS ITS OWN DIVERSE CULTURES AND BEHAVIOURAL PATTERNS OF ITS PEOPLE WHICH ARE DISTINCTLY DIFFERENT FROM THOSE IN THE WEST. A STUDY OF THESE FACTORS IS EXTREMELY IMPORTANT BEFORE A LARGE PROJECT IS PLANNED.

IN VASANT NAGRI, WE HAVE SUCCESSFULLY CREATED A MOVEMENT PATTERN WHICH IS DISTINCTLY DIFFERENT AND YET FUNCTIONAL AND PROVIDES A VARIETY OF EXPERIENCES WHILST MOVING THROUGH THE SITE. ENVIRONMENTAL FACTORS AND HUMAN BEHAVIOUR PATTERNS HAVE BEEN STUDIED AND WE HAVE TRIED TO REFLECT THEM IN THE DESIGN AND LAYOUT OF VASANT NAGRI

VASANT NAGRI

AN ECO-FRIENDLY ENVIRONMENT

Figure 1.5 *Vasant Nagri Township – Concept*

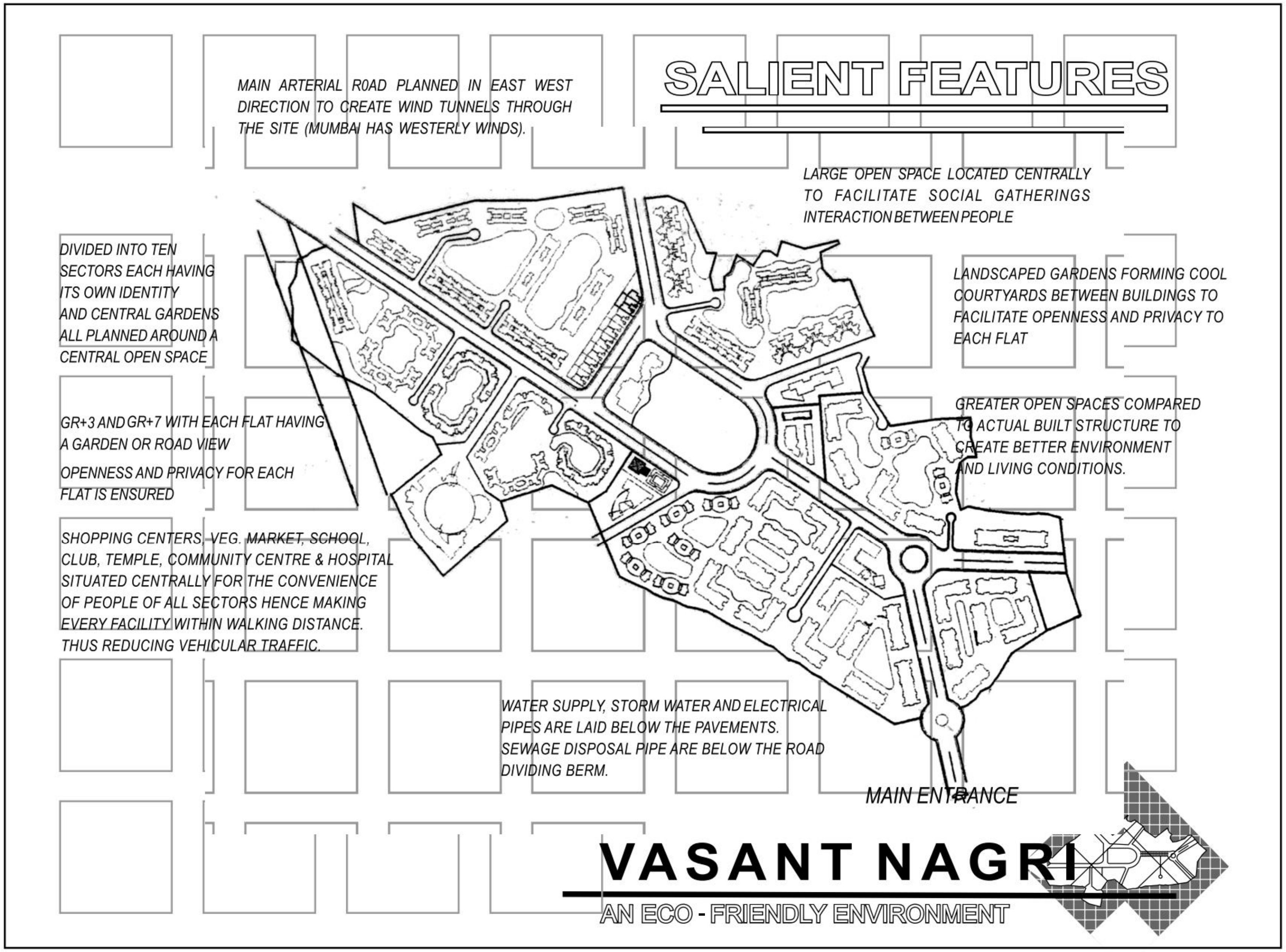


Figure 1.6 *Vasant Nagri Township – Salient Features*

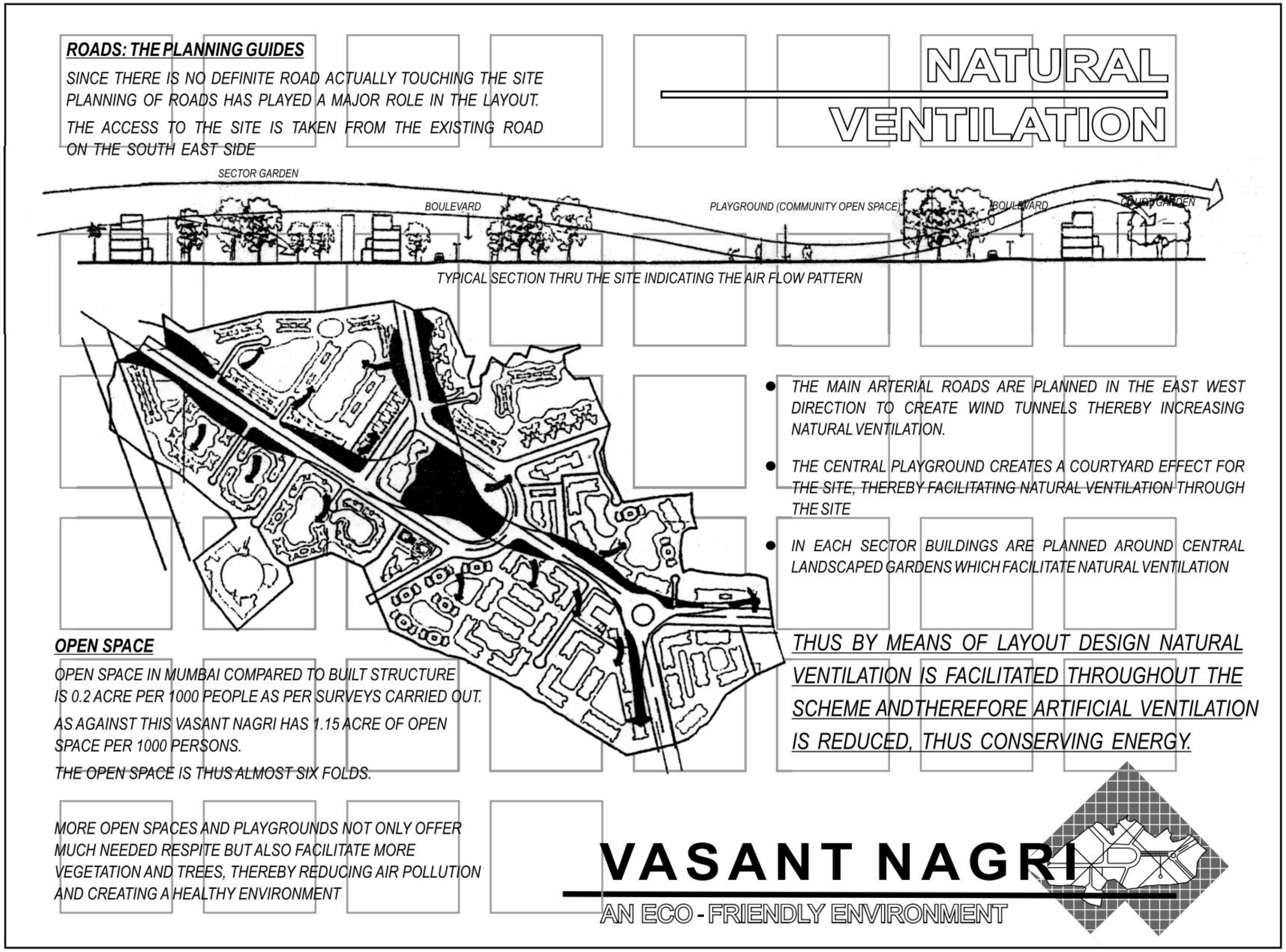


Figure 1.7 *Vasant Nagri Township – Planning of Roads and Natural Ventilation*

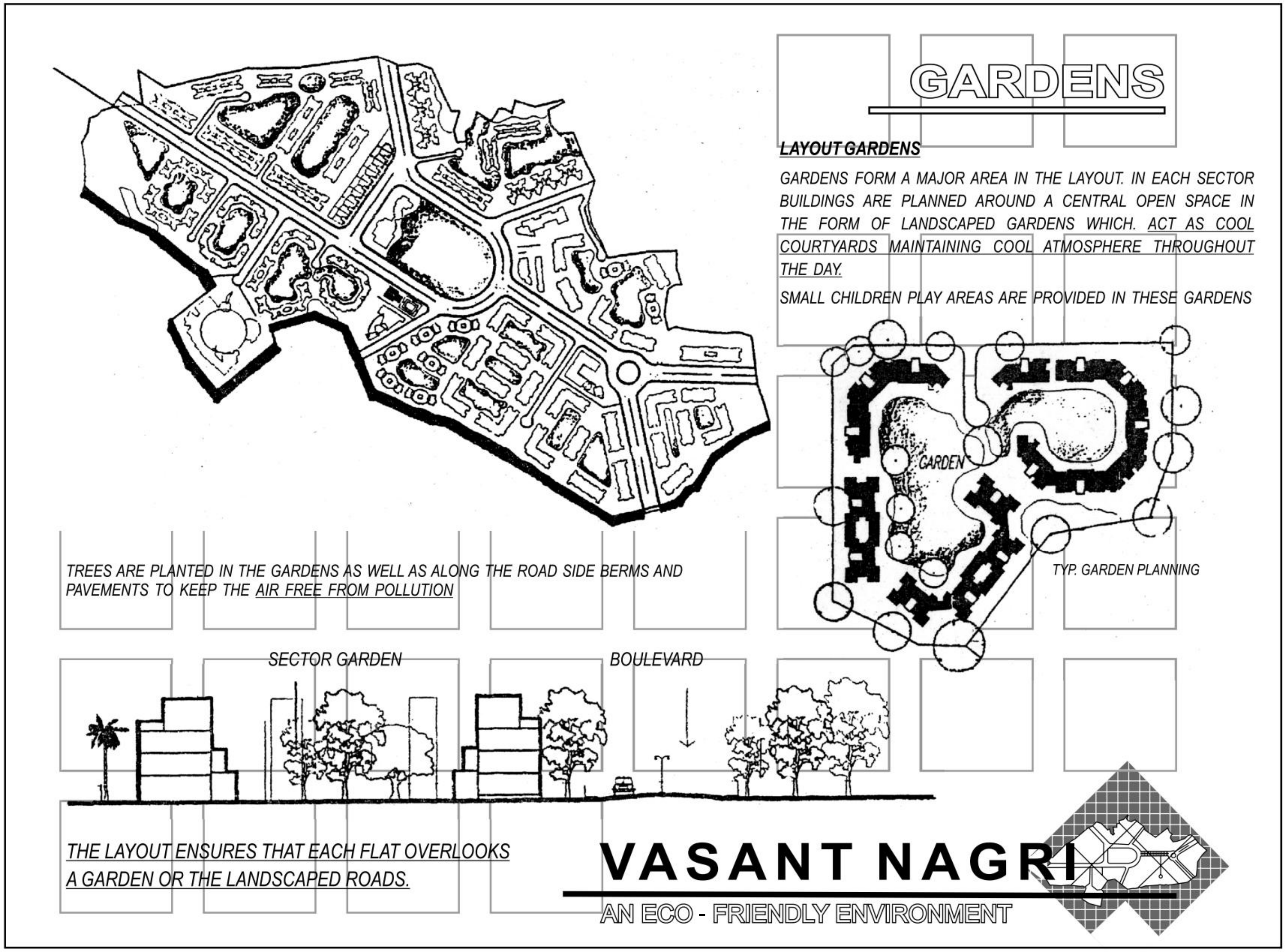


Figure 1.8 *Vasant Nagri Township – Gardens – Layout Considerations*

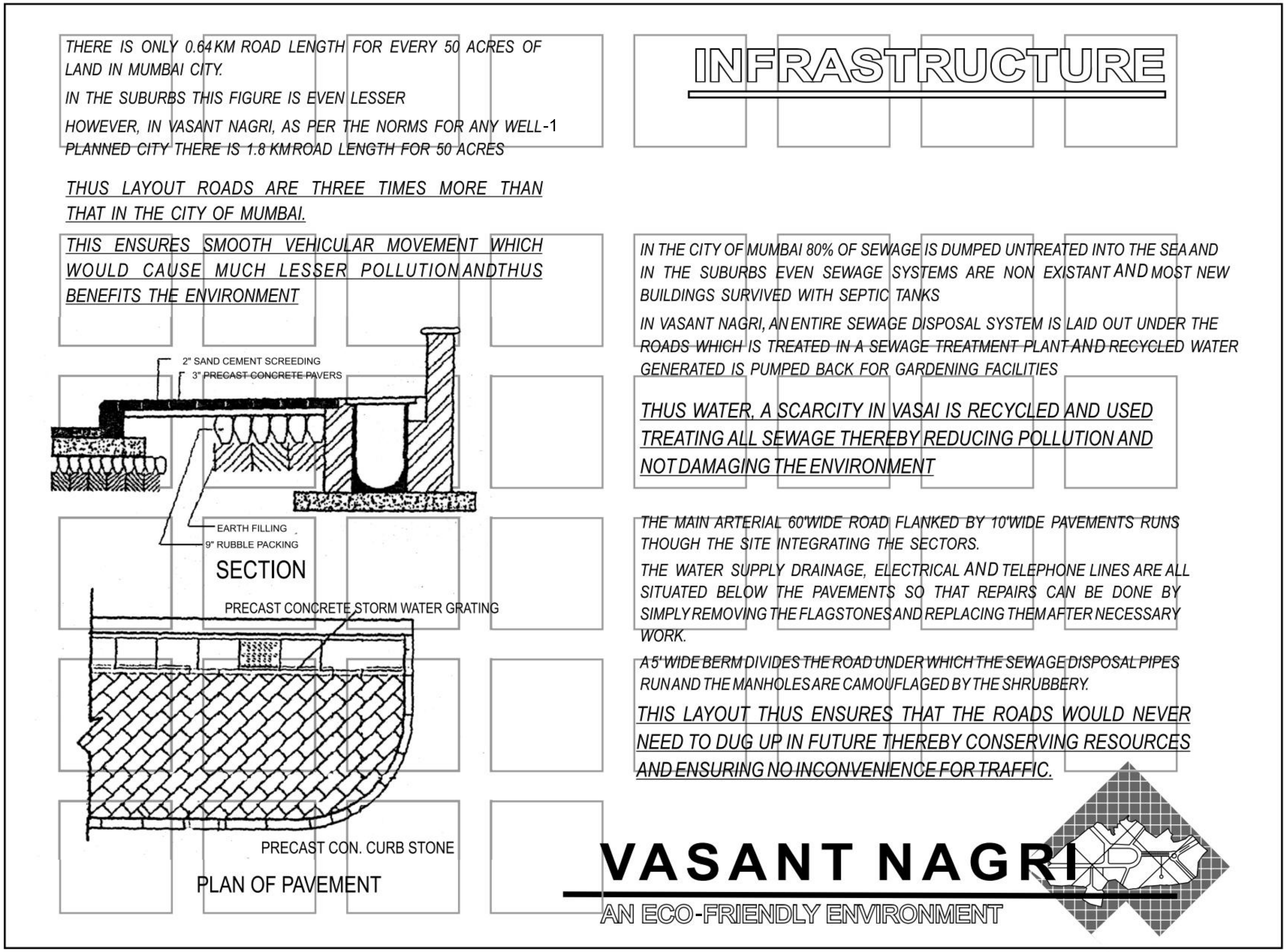


Figure 1.9 *Vasant Nagri Township – Details of Infrastructure*

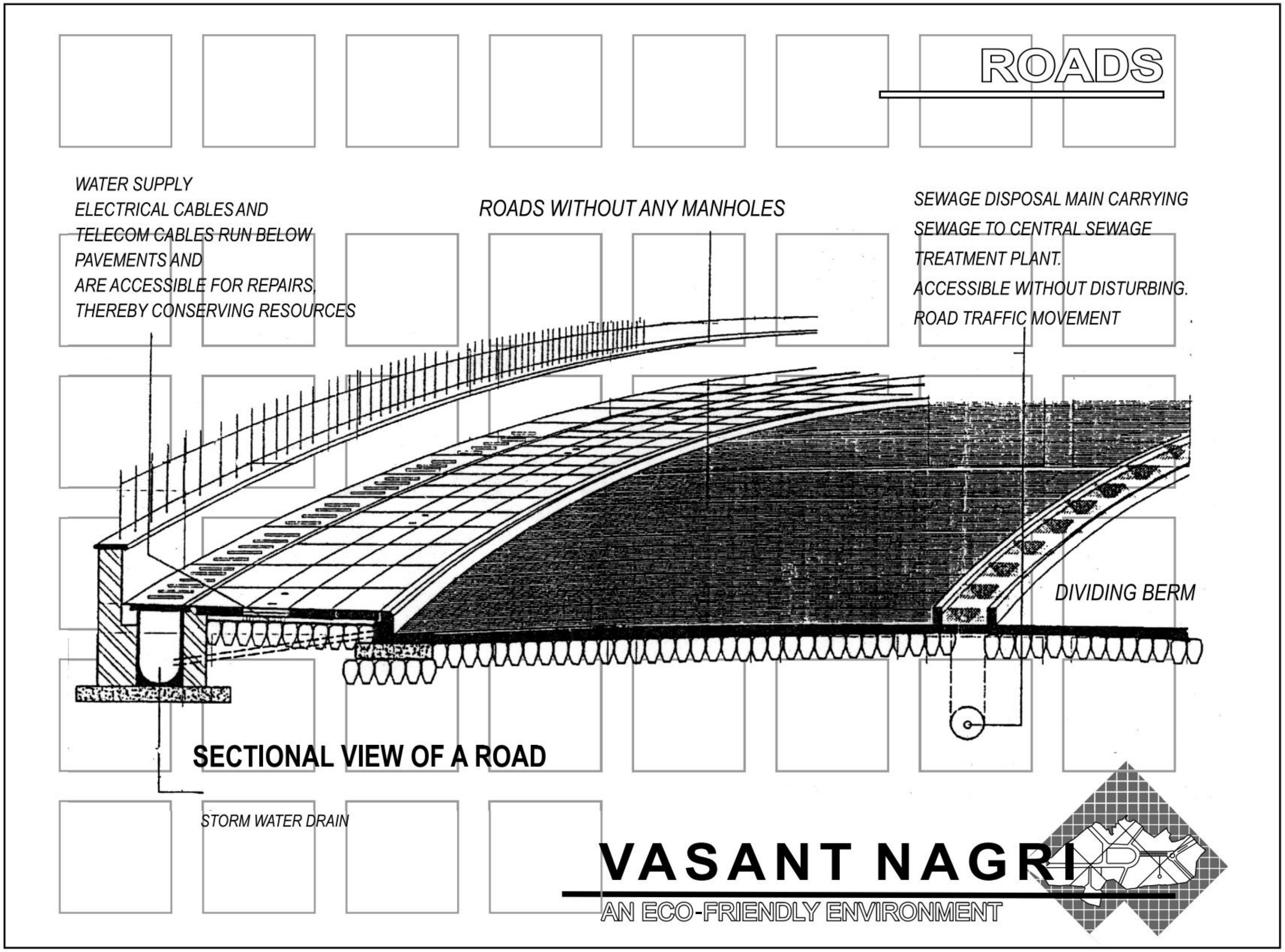


Figure 1.10 *Vasant Nagri Township – Details of Roads – Considerations*

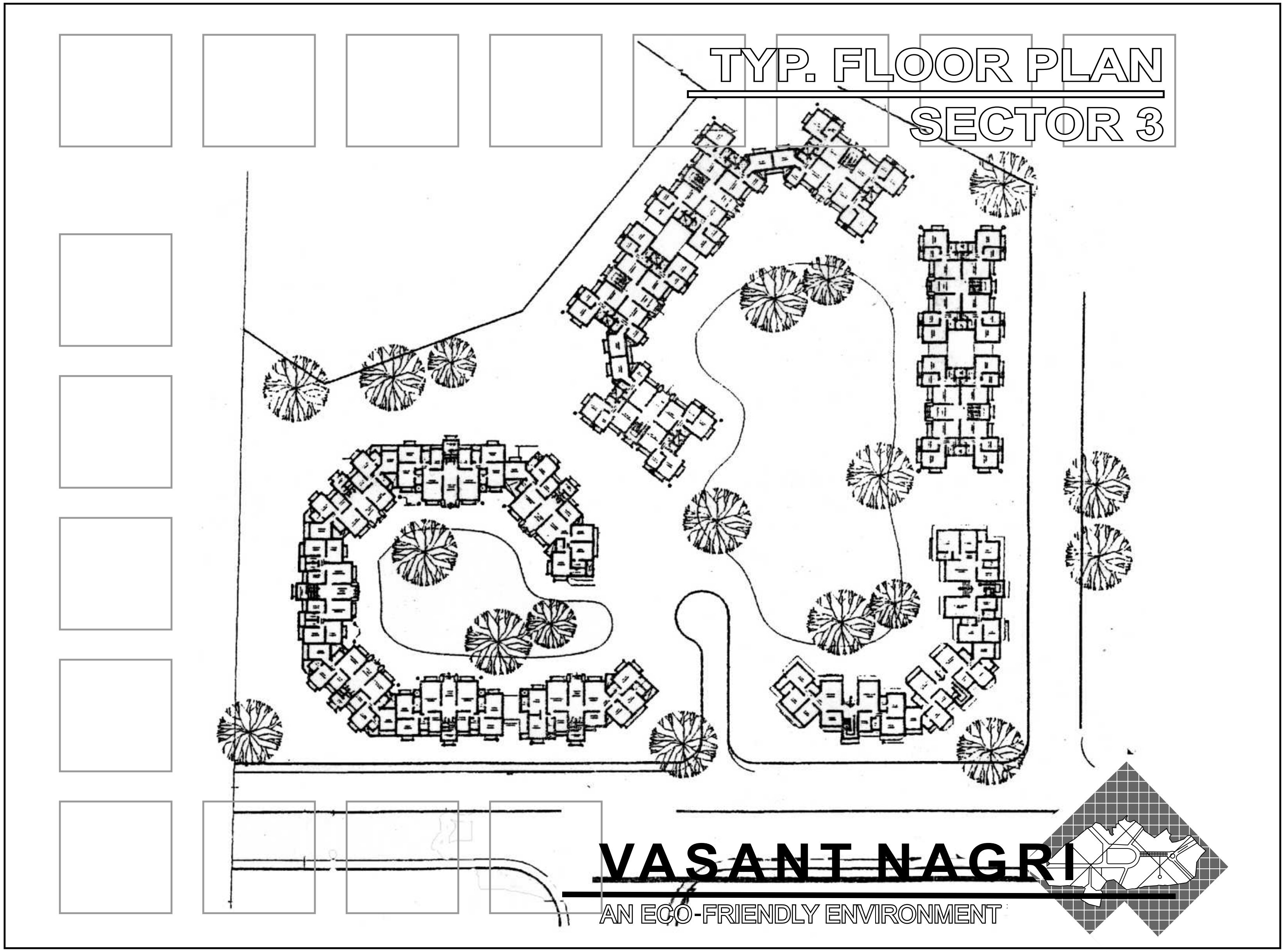


Figure 1.11 *Vasant Nagri Township – Typical Floor Plan*

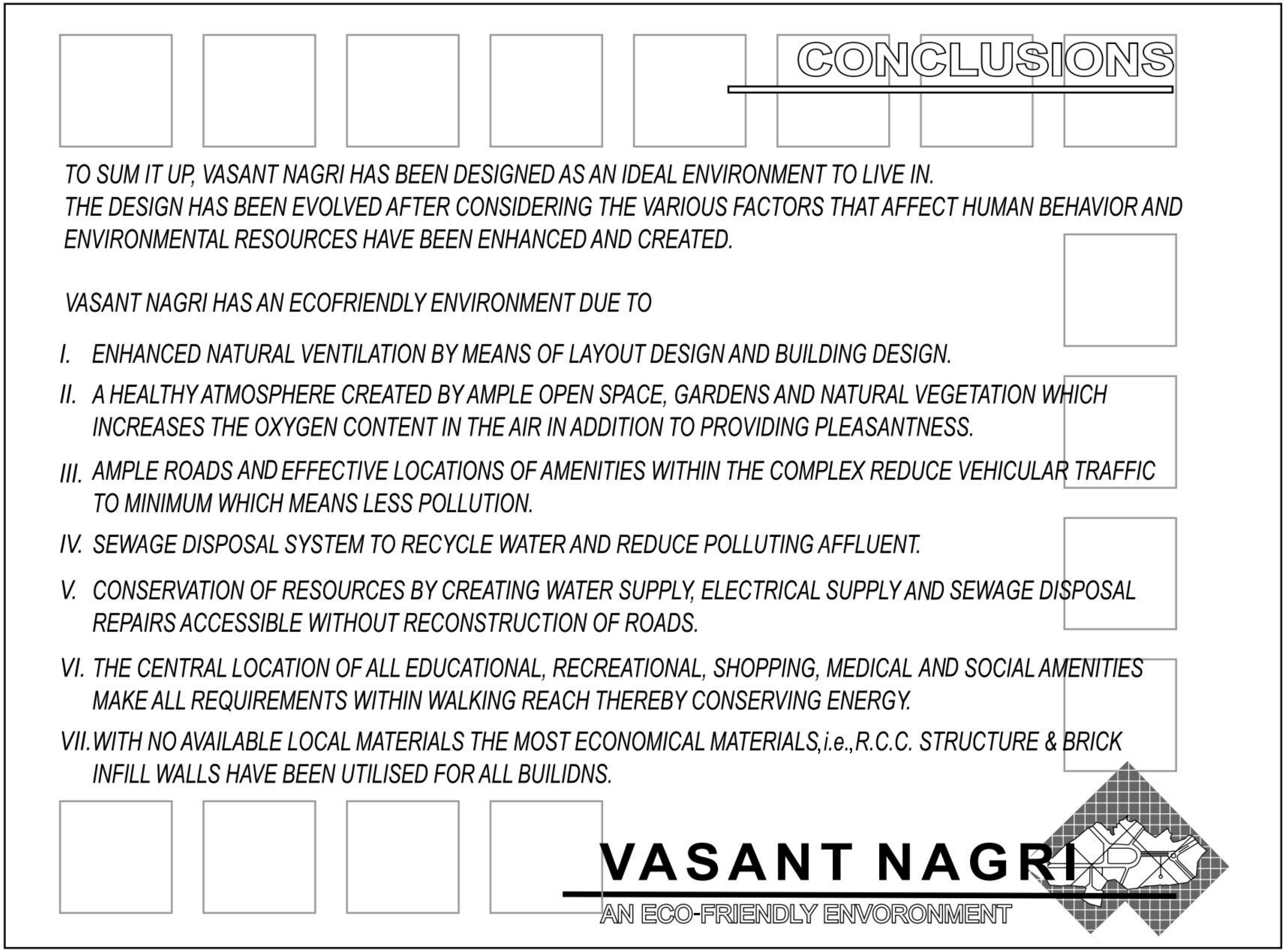
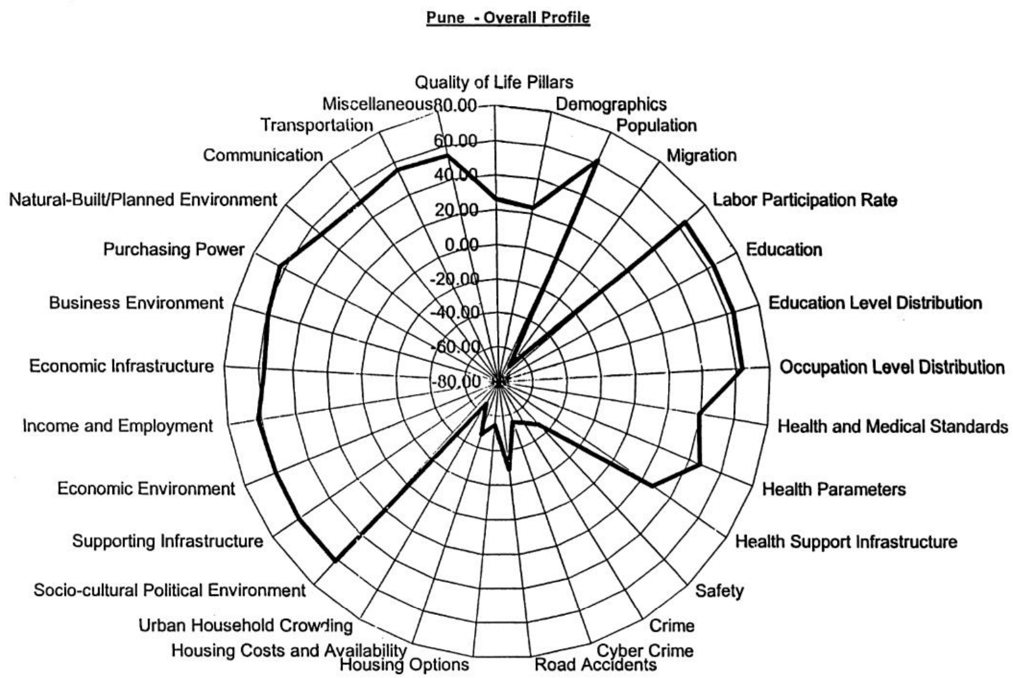


Figure 1.12 *Vasant Nagri Township – Conclusions*

2 SETTLEMENTS FOR QUALITY OF LIFE



My Dream City

I have visited hundreds of cities across the world, but not one of them comes close to my ideal. So what is the profile of my dream city? It should have a population of not more than five million, generate its own power through green sources, be a vibrant economy where everyone has access to clean energy and clean water, use biofuel and insist on rain water harvesting, and is full of parks and trees. In short, it should be the flag-bearer of eco-friendly habitats, which aim at complete carbon neutrality.

Dr A P J Abdul Kalam
Former President of India
Times of India, Pune, Sept. 19, 2010

Sustainability

"Fundamental questions about the future of our cities, should settlements be dense or sparse, nucleated or dispersed, monocentric or polycentric, or a mix of all types have been raised by the issue of sustainability"

Author : Bill Hillier
Book : *Space is the Machine (Cambridge University Press)*

Topics covered in this chapter

2.1 Need for Urban Renewal and New Townships
2.2 Remaking Sustainable Cities for Livability
2.3 Urban Planning – Designing - Landscaping
2.4 Challenges in Sustainable Development
2.5 Eco-Housing Assessment Schemes
2.6 Town and Townscape
2.7 Case Studies
2.8 Project Work

Quality of Life

"The quality of life experienced by citizens living in a city is tied to their ability to access infrastructure – transportation, communication, water and sanitation; food, clean air, affordable housing, meaningful employment, and green space and parks".

Livability

"Livability is "Quality of life" as experienced by the residents within a city or region. It is often viewed as enhancing the economic, social, cultural and environmental well being of current or future residents".

Ref: Report – Livability Index 2010
The Best cities in India
Confederation of Indian Industries,
Northern Region

2.1 NEED FOR URBAN RENEWAL AND NEW TOWNSHIPS

Creation of livable space for quality of life is the main objective of "Built, i.e., man-made environment". Livability is related to enriching, refreshing, stimulating, green and colourful surroundings, which keep mind and body, fit for efficiency. Living in slums is totally unhygienic and undesirable. Hence, all will realise that we need "Built Environment for Gross National Happiness"! Stress-free living is the need for such happiness. Growth of self, society and nation is related to the quality of life, happy and contented life.

Comparison to judge "Good, Better, Best and Excellent" is a born human instinct. It is an assessment essential to know present ranking which is essential for further improvement in the related field. Television and tourism shows cities in the world. Common man compares the same with what he sees and experiences in our cities. It is food for brain for planners and designers which give rise to many questions such as –

1. Why are our villages, cities lagging on 'livability' standards?
2. Is there any way to change this scenario?
3. What will happen; in coming years, if degradation of environment is not controlled?
4. Is there any system to know to 'common man' where 'his city' stands related to the quality of life?
5. What are the parameters for comparison of different cities to know their livability index?
6. Why not to judge all small and large settlements and suggest ways for improvement so that flow towards cities from villages will be controlled?
7. Why not to make country life more attractive with jobs, agricultural tourism, facilities for education and comfortable transport?
8. Do we need human resources development consultants such as Ecologists, Climatologists, Urban Planners and Designers, and specialists for Geo-technique, Physical and Human Geography, Horticulture with study related to urban renewal?
9. What is the role of common man to improve degradation of city?

Cities are considered as engines of economic growth. We should accept the challenge by preparing "Development Plans" with "New Townships" and action plans for "Urban Renewal". We need public, private partnership to show "We can build better cities today"!

Findings of surveys related to Livability Index, Best Cities in India and the World, Cleanliness and Sanitation standards will throw light and show guide lines to prepare action plans for sustainable development.

1. ***Planning and Building Sustainable Cities – Report of 'TERI'* :** Important consideration related to planning of cities is "Economic and social development should not be at the cost of public health and environment". Basic five urban services that ought to be in a city are, i) water, ii) electricity, iii) transport, iv) waste management, and v) and energy-efficient buildings. Sixth additional urban service essential and control these five services is 'Governance'! We must build better sustainable cities today as they act as engines of economic growth. For such cities, it is essential to strengthen and empower local bodies to improve governance and encourage public private partnership to provide urban services.

Ref. Report of 'TERI' – The Energy and Resource Institute.
Times of India – Pune April 15, 2009

2. ***Livability Index 2010, The Best Cities in India*:** Survey was conducted by the Institute of Competitiveness and Confederation of Indian Industry, Northern Region to find the Best Cities in India. Livability index mapping of 37 cities of India was done with reference to –

1. Population density	3. Transportation	5. Migration
2. Job opportunity	4. Healthcare	6. Accidents

"It is mentioned that the study uses hard data collected from reliable sources to eliminate the possibility of personal bias or a sampling error observing the reality".

The model for survey was based on the world renowned diamond model of Prof Michael Porter, from Harvard University who states that 'Overall Liability Index' depends upon eight pillars –

1. Demographics	5. Housing options
2. Education	6. Socio-cultural, Political Environment
3. Health and Medical Standards	7. Economic Environment
4. Safety	8. Natural, Built /Planned Environment

Thirty seven cities in India were judged and ranked on these main considerations and 20 sub-pillars. First eight cities as per rank for overall Livability Index are –

1. Delhi	3. Chennai	5. Kolkata	7. Ahmedabad
2. Mumbai	4. Bengaluru	6. Hyderabad	8. Pune

Ref: 1. Report of CII – Confederation of Indian Industries.
2. Times of India – Pune March, 10, 2010

3. ***Survey for Cities Offering the Best Quality of Life in the World*:** Survey was conducted by the Global Consultancy Services "Mercer" to find cities offering the World's best quality of living. 100 cities were assessed on local living conditions and analysed according to 39 factors in 10 categories. These includes

1. Political stability	3. Waste disposal	5. Restaurants
2. Banking services	4. Standards of International Schools	6. Theatres
7. Record of Natural disasters		

As per findings of the survey, cities were ranked as –

1. Vienna 2. Zurich 3. Geneva

Düsseldorf, Frankfurt,. Munich and Bern were included in the first top ten.

London (39), Aberdeen (53), Birmingham (55), Glasgow (57), Belfast (63), New York (49), and Dubai, Abu Dhabi, Taipei in Taiwan and Bussan in South Korea were included in the top 100.

4. ***Survey of Cities in the World for Eco – Credentials*:** This survey was also done by "Mercer" for Eco-Credentials. The parameters for judgement were –

1. Water availability
2. Waste removal
3. Quality of sewage systems
4. Air Pollution
5. Traffic Congestion

As per ranking – Calgary, Honolulu and Ottawa were first, second and third; while Scotland and Northern Ireland also did well with Aberdeen, Belfast and Glasgow in the top 50.

Ref. Times of India, Pune Mirror
May 27, 2010

5. ***Survey on the Basis of Cleanliness and Sanitation Standards*:** Survey of different cities in India was done on behalf of the Union Urban Development Ministry of India for cleanliness and sanitation standards with reference to –

(i) Open related parameters

(a) Open defecation, (b) Use of toilets by all, (c) Elimination of Manual scavenging (d) Total human excreta, black waste and grey waste – treatment and disposal (e) Treated waste water – Recycled and Reused, (f) Solid Waste matter-Collection, Treatment and Disposal (g) Impact of City waste on surroundings.

(ii) Process related parameters

(a) Systems to check open defecation (b) Effective working of sewerage systems (c) Seepage / sludge-cleaning, transportation and disposal after treatment, (d) Maintenance and functioning of underground and surface drainage systems (e) Solid waste – collection, treatment as per rules.

(iii) Outcome related parameters

(a) Improved quality of drinking water in city compared to base line. (b) Improved water quality in water bodies in and around the city, (c) Reduction in water-borne disease incidence amongst city population compared to base line.

(iv) As per survey – Chandigarh, Mysore, Surat, Tiruchirapalli, Jamshedpur, Mangalore and Rajkot were in the top ten list.

It is stated in the report that 'Sanitation is linked to human dignity and well-being hence demands top priority'. 443 cities and towns with a population of more than one lakh were recently rated on parameters mentioned above. Cities were also classified as red, black, blue and green to denote increasing level of achievements of good environmental and health outcomes.

1. A green rating indicates a healthy city.
2. A blue indicates a city recovering but still diseased.
3. A black indicates a city that needs considerable improvement.
4. A red indicates a city on the brink of public health and environmental emergency, requiring immediate remedial action.

As per survey no city in the country could qualify in the 'Green' category. In 'Blue' category four cities were ranked. They were, (a) Chandigarh, (b) Mysore, (c) Surat and (d) New Delhi. Pune and Pimpri – Chinchwad fall in the black category while 229 cities are in the black category, the remaining 190 fall in the red category.

Ref. Times of India – Pune August 13, 2010

2.2 REMAKING SUSTAINABLE CITIES FOR LIVABILITY

Seventy Third and Seventy Fourth Amendment Act, 1992 of the Constitution is considered to be the beginning of a new era in the history of Panchayati Raj Institutions and Urban local government in the country. It bestows power on the people to plan for themselves and participate in the decision making process. The spatial and environmental planning in the planning system has also been envisaged by this act of various levels right from Nagar Panchayat to a Metropolitan area.

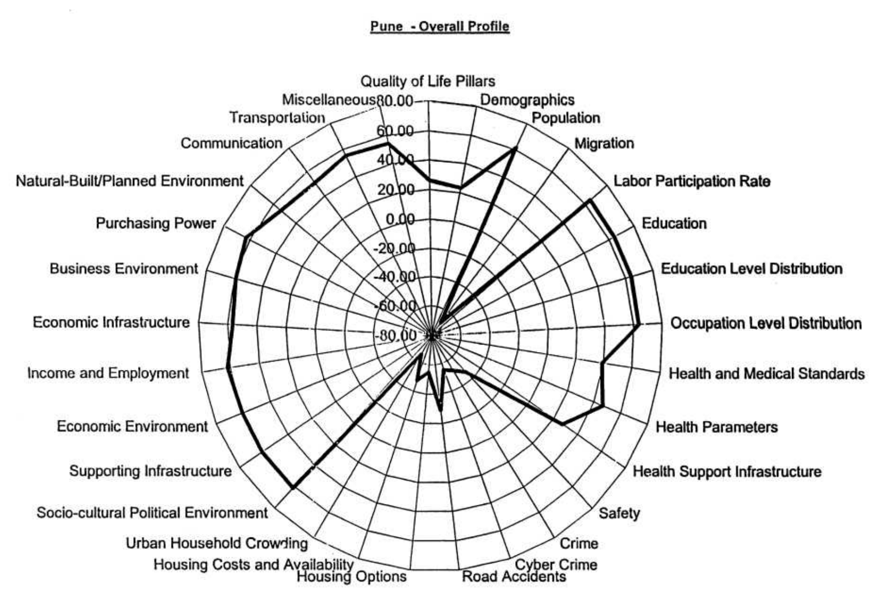
Rural and Urban bodies, i.e., panchayats and the municipalities are now empowered to prepare plans for development. District Planning and Development Committee (DPDC) in every district is authorised to consolidate the plan prepared by the panchayats and municipalities and prepare a draft development plan for the district as a whole. Each municipality is expected to prepare a plan for its area and undertake the task of urban planning, including town planning regulate land uses and construction of buildings, and phasing of the programme for economic and social development. This committee at the district level (DPDC) is supposed to interact with the municipal bodies and the panchayats in addition to planning and resolving conflicts.

Now we need

1. Development Plan for each and every town – having:
   (a) Nagar Panchayat
   (b) Municipal Councils and
   (c) Municipal Corporation
2. Survey to find quality of life related to present conditions of:
   (a) Livability (b) Infrastructure (c) Healthcare
   (d) Horticulture (e) Tourism

Local bodies, grampachayats, municipalities, municipal corporations, nongovernment organisations, students of architecture, town planning and civil engineering will get opportunity to do project work related to towns, and its improvement for livability. Such projects need guidance from urban planners and designers. Initially we need data for planning. Various parameters for such survey are given for guidance.

Pune – Overall Profile



Pune – Overall Profile shows cities liveability quality with the help of measurable pillars. This acts as guide lines while preparing development plans to decide priority for essential projects related to infrastructure, reservation of land and planning in stages.

Cities large and small should act as national assets and engines of economic growth. What we need is surveys to prepare such overall profile for all large and small cities so as to provide data for preparing development plans.

Development plan showing 1. Agricultural Zone 2. Green Zone 3. Hill Top and Hill Slope Zone 4. Residential Zone 5. Industrial Zone 6. No Development Zone 7. Green belt Zone 8. Economically weak section zone is the need.

Urban planners with such vision is the real need to guide municipalities and Grampanchayats.

1. LIVABILITY

1. Total population – Population density in different wards/areas. Congested and noncongested areas, floor area ratio,
2. Job opportunity – Business, Industries, Agricultural, etc.
3. Education Facilities – standard of education, details of educational institutes, hostels, international schools.
4. Housing – present conditions, slums, old constructions and redevelopment schemes, new housing projects, availability of land and other infrastructure, facility for loan for housing.
5. Migration, reasons, rate of migration.
6. Safety and security.
7. Crime rate – types, systems to control crime.
8. Record of natural disaster and plan for disaster management, flood, fire, earthquake, accidents, storms, etc.
9. Political stability – Historical survey.
10. Banking facility.
11. Entertainment – sports/resorts/restaurants / hotels/ gardens, museums, / spas/ water sports/ libraries, /shopping malls/golf course/ river/ lakes/water sports.
12. Cultural centres – Music/drama//dance/ shops for book and gift articles.
13. Facilities for conferences / exhibitions / cultural shows / marriage halls / family get together functions.
14. Use of river, sea shore, lakes, hills for tourists and citizens.
15. Newspapers giving information to tourists; events, places, timings, etc.
16. Facilities to establish business centres for outsiders.
17. Rules and regulations for foreigners living in the cities.
18. Hostel facilities for working women.
19. Historical, cultural, religious, commercial importance of the city – facilities for tourists/ visitors/business community.
20. Gardens / botanical gardens / nurseries/picnic spots and resorts.

2. INFRASTRUCTURE

1. Transportation – Different modes – air/rail/sea/river/road.
2. Roads – ring roads, flyovers, bridges, traffic control.
3. Record of accidents – spots and measure to reduce accidents.
4. Availability of land/infrastructure for expansion of settlement with new townships/ housing complexes, regional plan.
5. Town map with details for tourists – Locations of tourists' spots/malls, cultural/business centres, phone numbers / websites.
6. Transport within city – buses/trams/taxies/ ferryboats/ metros/ monorails/timings/languages for instructions/display boards/ ticket facilities for tourists / brochures/facilities for tourist's families/same ticket for different modes.
7. Study of traffic / congestion areas/signals/one way/two way rules.
8. Facilities for pedestrian – wide and clean footpath for safe comfortable walking, continuous, non slippery footpaths and walkways. Provision of side walkways, stairways, underground crossings, ramps, hawker free footpaths with pedestrian railings, zebra crossings, signals for traffic control.
9. Uninterrupted supply of electricity.
10. Area reserved for exhibitions/circus shows/festivals with essential infrastructure.
11. Solar energy for generation of electricity for street / garden / open area/lighting.

3. HEALTHCARE

1. **Water supply –**
   i. Source of supply, quantity of water – per head per day, pressure,.
   ii. Treatment for water – methods to control wastage in distribution.
   iii. Quality – testing procedure after treatment / interval of testing.
   iv. Plan for distribution of water – pipe dia. / locations/ maintenance schedule.
   v. Wells and bore wells – quality of water, encouragement to use water for gardening / cleaning, etc., safety measures for open wells.
2. **Sewage –**
   i. Plan for sewerage system with all details.
   ii. Treatment and disposal of treated sewage.
   iii. Garbage-collection of wet and dry garbage, treatment, disposal, conversion system for manure, biogas plants, generation of electric power.
   iv. Storm water – collection, disposal, system for maintenance.
   v. Toilets for public, on roads, market, sport areas, etc.
   vi. Toilets in schools, colleges, hostels.
   vii. Maintenance of sewerage system and sewage treatment works.
3. **Noise** – Survey related to control pollution due to noise, during festivals, in business, market areas, around hospitals, educational institutions.
4. **Air pollution** – Laws related to air pollution, methods to control air pollution due to dust particles, industrials wastes.
5. **Hospitals** – Locations of hospitals in the city, hours required to reach a hospital and distance to the nearest health professionals. Facilities for medical tourism, ambulance services, facilities in the ambulance.
6. **Cremation facilities in the town** – Necessity of calm, quite and green environment.
7. **Cleanliness and sanitation standards –**
   i. No open defecation.
   ii. Toilets for urban poor/slum dwellers, Individual and community sanitation facilities, mobile toilet units during festivals.
   iii. Adequate public sanitation facilities – paid/free, locations.
   iv. Collection points to collect waste (a) news papers, (b) empty bottles, (c) plastic waste, (d) shoes, (e) old garments, and (f) plastic wastes.
   v. Care of the health of sanitation workers and providing protection equipment / medical help.

vi. Waste disposal systems for, (a) hospitals, (b) hotels and restaurants, (c) hostels, (d) institutes, and (e) industries; treatment and disposal.
vii. Control of water born diseases.
viii. Special care for floating population during festivals/sports/religious functions.
ix. Solar energy for heating water, /generation of electricity.
x. Rain water harvesting systems.

4. HORTICULTURE – GARDENS/NURSERIES.

i. Analysis of top soil – suitability for landscaping.
ii. List of trees / plants / flowers/ vegetables, etc., related to climate, soil, availability of water.
iii. Development of botanical gardens / gardens/nurseries/sale of equipments for gardening.
iv. Terrace gardens for flowers and vegetables.
v. Conversion of dry and wet waste into compost.
vi. Exhibitions of flowers / vegetables, guidance for gardening.
vii. Export of flowers, fruits and plants.

5. TOURISM

i. Hotels – classification as per standards of tourism.
ii. Sight seeing tours – safety, tour programs
iii. Reservation facilities for journey/sight seeing tours/ entertainment programmes/ exhibitions.
iv. Standard for cleanliness / quality of food, water.
v. Health check of hotel staff / cooks.
vi. Facilities in travel coach, air conditioning/safety for luggage/ first aid-medical/ toilets for long travels / sleeper coach/ communication, etc.
vii. Market for gift articles / photographic services.
viii. Cultural programmes in theatres / publicity/parking, advance reservations / air conditioning / safety

2.3 URBAN PLANNING – DESIGNING - LANDSCAPING

Now before studying various considerations, expectations from urban planning, designing it is essential to know some important landmarks and achievements in Town planning in a chronological order.

2.3.1 Town Planning

1898 – An improvement trust was formed for widening of narrow lanes and roads, provision of drainage facilities, etc., for Bombay and other towns. It was dissolved in 1933 as it was found incompetent to control the hap hazardous growth of cities.

1915 – Enactment of the Bombay Town Planning Act. This act empowered the municipal councils to acquire the lands within their respective municipal councils, irrespective of the ownerships so as to develop them systematically along with the provisions of basic amenities and redistribute such developed plots among the respective owners after recovering settlement charges from them. The aim was to achieve planned development of towns on a self supporting basis, i.e., without putting the entire cost involved in development on municipal councils. Part of the municipal areas was covered by these town planning schemes. The act was not obligatory. It remained advisory. Hence, only few towns were developed where local authorities were interested. Disintegrated development was the loophole in this act.

1954 – The Bombay Town Planning Act of 1915 was replaced by the Town Planning Act of 1954, which made it obligatory for every municipal council to prepare a comprehensive development plan for the entire town instead of partial plans prepared previously. It provided an opportunity to develop from whole to the part which was essential for the integrated development of a town. The loophole in this act was that it treated a town as a separate unit, neglecting its close, physical, economical, social and political ties with the rural areas around it. The outcome was haphazard growth outside the municipal limits.

1966 – The Maharashtra Regional and Town Planning Act, 1966 came into existence for a comprehensive regional planning to develop towns and their surroundings. Regional planning is based on the fact that fairly well developed cities cannot be considered in isolation of the region around them, as they depend very much upon each other. Therefore, the aim is integrated development. Regional planning aims at balancing of population and industry, realisation of transport services and routes, as also proper distribution of services and facilities so as to avoid congestion.

Township development programmes are also undertaken by authorities sponsored by the state government such as CIDCO (City and Industrial Development Corporation) MIDC (Maharashtra Industrial Development Corporation) and other MHADA, etc.

2.3.2 Urban and Rural Built Environment – Planning - Designing

Creation of the right type of urban / rural environment for the welfare of all is a challenge for all planners, designers and developers. Here we should remember that the physical environment of nature is the main component part of urban / rural space, and "Built Environment" take shape in this natural setting. It will also be seen that built from varies according to the conditions of the natural setting.

Space is real; it affects our senses long before words. We are also aware that seeing comes before words; we look and recognise the object. Space is studied with various dimensions such as absolute and relational space, space and mass, physical and social space, mental and real space, abstract and differential space, space and time, space and place, etc. Students dealing with the design of urban space should study these dimensions in detail, apart from cyberspace.

Urban / rural space includes other objects such as bridges, fountains, groups of trees and the facades of buildings. Hence, author Ali Madanipour has said that space could be seen as an abstract substitute for the world around us which is the general understanding of our built and natural environment.

In the creation of urban space, three related aspects are mainly considered, i.e., physical, social and symbolic, which are incorporated in street plans or layouts, architectural style of buildings, their design and land use. Hence, it is essential to keep in mind urban space as the objective and think of creation of physical space with its social and psychological dimensions. This includes space at all possible scales and to transform global into micro space for all activities.

Urban/rural form can be considered as the geometry of this space. Morphology deals with the 'science of form, structure and 'Urban Morphology' is stated as the systematic study of the form, shape, plan, structure and functions of the built fabric of towns and cities and of the origin and the way in which this fabric has evolved over time as mentioned by author Clark (1985).

Following views will throw more light on urban designs and urban space:

1. ***Shaping Human Settlements***

"The dependence of one life process on another, the interconnected development of living and physical process of the earth, climate, water, plants and animals, these are the elements of the self perpetuating biosphere that sustains life on earth and which gives rise to the physical landscape."

Landscape Architect: Michael Hough
Book: *Cities and Natural Process*

2. ***Urban Space***

"I have used the term "urban space" not merely to refer to the spaces between buildings, i.e., voids… I have used the term in a broad sense, to encompass all the buildings, objects and spaces in an urban environment as well as the people, events and relationships within them".

Author: Ali Madanipour
Book: *Design of Urban Space*

3. ***Urban Design***

"Urban design, like its sister architecture, is a people's use of accumulated knowledge to control and adopt the environment for social, economic, political and religious requirements."

Author : Cliff Moughtin
Book : *Urban Design, Street and Square*

4. ***Design of City***

"The task of the city builder is to understand and express, in built form, the needs and aspirations of the client group. How does the city builder design to best serve the communities needs? How can the designer ensure that the end product is culturally acceptable? These and other similar questions are important issues for those in city designing professions".

Author: Cliff Moughtin
Book: *Urban Design, Street and Square*

5. ***Urban Design***

"Urban Design… the multidisciplinary activity of shaping and managing urban environments, interested in both; the process of this shaping and the spaces it helps shape".

Author: Ali Madanipour
Book: *Design of Urban Space*

6. ***Evaluation of Design***

"How a city looks and how its spaces are organised forms a material base upon which a range of possible sensations and social practices can be thought about, evaluated and achieved. "

Author: Harve D.
Book: *The Conditions of Post Modernity*

Urban Design is considered as a part of the process of the production of space, which includes an economical, political as well as cultural process with visual and verbal means of communication. Our understanding of space concentrates only as shape if it is limited to visual understanding. What is necessary is spatial understanding which is a three dimensional understanding of space. One should imagine to enter this space instead of just seeing it. Our aim should not be restricted to only appearances but in creating and understanding spaces that we can use for different purposes. Improvement of functional and aesthetic quality of the built environment for its users should be a designer's aim. This is related to spatial management. It becomes art and science. Landscape Architect Michael Hough in his book *Cities and Natural Process* has stated that, "*Urban Design can be described as that art and science dedicated to enhancing the quality of the physical environment in cities, to providing , civilising and enriching places for people who live in them*".

Whatever has been written and said about urban planning design and landscape is equally true for rural design, planning and landscape also. Here the scale is different, cost of the land is less, size of the plot is bigger and with the closeness of nature, achievement is comparatively easy.

What is essential is, understanding of total approach in planning, designing and landscaping. Tool to develop this approach and three dimensional vision is to study various township projects. New towns and designed towns such as Chandigarh, New Ahmedabad, New Bhopal, their plans, roads, gardens, sectors, the plantation, open areas is a real food for thinking. New projects such as Lavasa City, Magarpatta City (430 acres), Nanded City – Pune (700 acres), Garden Wonderland Marvel – Zephyr, Kharadi, Pune, Amanora Park Town, Hadapsar – Kharadi by pass, Pune (400 acres) are also useful to study their layout plans with planning of garden and their specifications.

Views and Expectations about Town

1. *"Town Planning is the art and the science of ordering the land uses and siting the buildings and communication routes so as to secure the maximum level of economy, convenience and beauty".*

Keeble (1969)

2. *"A town or city is a system constituted by people, space and built structures, etc., and therefore has to be viewed as an interconnecting phenomenon of people, space and structures."*

Prof. G M Mandalia,
Department of Architecture and Town Planning,
University of Roorkee.

3. *"A town, like a flower, or a tree, or an animal should at each stage of its growth, possess unity, symmetry and completeness"*

Ebenezer Howard

4. *"Every human being has the right to live in security, safety and with human dignity. If we are to look at the past, it is apparent that architecture, urban design and planning have not kept abreast with the massive strides taken by the development of information technology and the electronic media."*

Architect: Lal Balsuriya
President of Sri Lanka Institute of Architect

5. *"Civics as an art, has to do, not with imagining an impossible no place where all is well, but making the best of each and every place, especially in the city in which we live".*

Biologist and City Planner: Patric Gedees
Book: *Cities and Natural Process*

6. *"It is much easier to work towards a society that minimizes unhappiness rather than one that maximises happiness"*

Karl Popper
Philosopher

2.4 CHALLENGES IN SUSTAINABLE DEVELOPMENT

2.4.1

It is clear! No matter how big the earth is, it will suffer, world population present and future will suffer if due care is not taken to save the earth, heal the earth and green the earth. It is predicted that, we would need 1.4 planets to support the life style to which we have become accustomed or we could start to save the earth by making small changes to our lives. (Times of India, Pune, Dec. 13, 2009.) It is mentioned in the book, *Cities and Natural Process* by Michael Hough that "*When we consider a World population projected to be ten billion* (1000 crores) *by the year AD 2025*, *4.5 billion people in developing countries are estimated to be living in urban areas by the end of the century*, *and the massive impacts of human activities on world ecosystems*, *then it is clear that the links between nature, cities and sustainability have profound implications for survival*." This will affect our culture in future as according to A B Grove and R W Cresswell (Book : *City Landscape*) "*Our cities are very much an expression of our culture. If our cities are experiencing difficulties, the hypothesis is that our culture itself is in trouble. That is a serious matter*."

For this, the reasons are well-known; the most important is, the most vulnerable part of the Earth's ecological system is the atmosphere because it is so thin. It is affected by – Ozone damage, Green House effect and Acid Rain.

Ozone Damage

Damage to the ozone layer in the earth's atmosphere is caused by groups of chemicals called chloroflurocarbons (CFCS) and Chloroflurомethene (CFM). The ozone layer screens out the damaging ultra violet radiation from the Sun. The damage to the Ozone results in more ultra violet radiation getting through to the earth's surface. CFCs are used in different equipments, either as refrigerants, fire extinguisher systems, aerosols or as foaming agents for plastics insulants. It is found that CFCs while passing through the ozone layer break down to their basic constituents' one of which is chlorine. This chlorine helps in destroying ozone atoms. One atom of chlorine in CFC destroys one lakh atoms of ozone. There is a need of alternative materials and banning of CFCs. CFM is released by chemical fertiliser factories and supersonic planes (SST – Super Sonic Transport).

Greenhouse Effect and Acid Rain

Study of the earth's carbon cycle throws light on the importance of rainforests. They help in taking carbon dioxide out of the atmosphere, and producing oxygen. Protection of rain forests is essential. Global warming is related to the destruction of forests. Carbon enters the atmosphere as carbon dioxide, which is produced when fossil fuels, i.e., fuels containing carbon are burnt. Coal, wood, natural gas, petrol and oil produce CO_2 after burning. This CO_2 combines with other gases such as methane, sulphur oxides, nitrous oxides and CFCs to create green house effect which helps to arise in global average temperature. Trees and plants help in reducing CO_2. Hence, it is necessary to control the use of fossil fuels, along with planting of trees and plants on a mass scale. "Go Green" is the need. Acid rains results with an increase in the pollutants, particularly sulpher dioxide from coal-fired power stations and nitrous oxides from vehicle exhausts. They dissolve in the rain to form dilute sulphuric and nitric acids and destroy trees, hence, mass transportation system instead of individual vehicles is the need.

Experts tell us how the environment is reacting to the increasing amount of CO_2 in the air. They throw light on natural disasters and climate changes, tremendous loss of ice from glaciers and thunder storms. Nature is indeed showing signs of more dangerous calamities, which may turn things upside down irreversibly. Wild fire, flame throwing tornadoes and volcano can produce a cloud of gas and rocks that can reach temperatures above 1000° F/537° C, people can easily move out of the way of most lava flows, they cannot escape a pyroclastic flow. Extreme category hurricanes world side rises from 20% in the 1970s to 35% in 1990.

Carbon Credit

Carbon Credit is the value assigned to reduction of green house gases. For e.g., one carbon credit equals one tonne of CO_2. It is measured in Certified Emission Reduction (CER). One CER is priced at 15–16 Euros, i.e., around ₹ 1000/-.

Environment Protection to Restore the Balance

Scientists and thinkers are striving to find new ways to restore the balance who are aware of all problems related to the environment. In 2000, Al Gore, former Vice President of the USA proposed to make the next 10 years an environment decade.

Goals suggested were –

1. Protection of forests.
2. Control of air contamination.
3. Control of water contamination.
4. Developing awareness about environmental problems and values.
5. Effort to control global warming with the co-operation of all nations.
6. Change in the lifestyle, to make it environment friendly, like car pooling, sharing books, switching to CFL lights and most important realisation related to three R's – Reduce, Recycle and Reuse.

Case Study

Feedback from Professional to Education

The total environmental solution by 'Global Green'

Global Green Energy and Sustainability Solutions Pvt Ltd (GGESS) based in Pune is the Indian arm of Global Engineering Systems FZC, UAE a globally present company with references in over 15 countries. The company offers end to end solutions in Sustainability and Environmental Engineering to industries, builders, developers, municipal corporations, consultants, contractors, special economic zones, hotels, townships, malls, commercial complexes, etc. The company has full-fledged offices in Mumbai and Chennai and in overseas locations such as UAE, Oman, Djibouti, etc.

Company offers solutions to

1. Sewage and Effluent Treatment / Recycling Systems
2. Reverse Osmosis Desalination
3. Gray water Treatment / Recycling
4. Energy and Water Conservation
5. Renewable Energy Sources – Wind, Solar, Biogas
6. Solid Refuse Management
7. Green Building
8. Clean Development Mechanism
9. CSR Consultancy
10. Sustainable Assessment and Report
11. LED Lights

GGESS has already made its mark as a social enterprise which focuses on adding value to the society. The group has earned a name for its ability to leverage the humane face of technology. The activities of the company are all aimed at helping members of the society, lead a healthy and clean lifestyle thereby reducing their carbon footprint. All the technologies and solutions offered by the company are centered around protecting our Mother Earth and her resources, flora and fauna so that our children and grandchildren get to enjoy a life of good health and harmony.

GGESS is the Indian Licensee of AnoxKaldnes, Norway / Sweden who are the inventors and patent holders of the revolutionary Moving Bed Biofilm Reactor (MBBR) technology. The technology is used extensively in biological treatment of sewage, grey water, industrial effluent, etc., and the company boasts of a reference base of over 600 large scale installations and over 20,000 small installations spread across 60 countries.

Waste Management Solutions

Sewage and Industrial Effluent Treatment Plants: GGESS holds the prestigious license for the world renowned MBBR™ Process invented and patented by AnoxKaldnes, A Swedish-Norwegian conglomerate with several intellectual properties in the field of waste water treatment technology. GGESS also promotes the innovative concept of Grey Water Treatment and Recycling, a sure-shot way to water conservation.

Biogas Plants: At GGESS, we have the technology to efficiently convert organic waste into biogas and energy; yet another profitable and environment friendly measure that goes a long way towards conserving the planet. GGESS is also a front runner in designing and implementing Integrated Solid Waste Management Programs.

Reverse Osmosis: GGESS today has carved a niche for itself as a manufacturer of highly reliable membrane-based filtration Plants. The energy efficient Reverse Osmosis Desalination Plants assembled by the company under technical collaboration with some of the pioneers in the field has helped many of our clientele realize low life cycle costs and low operating costs thereof.

Energy and Water Management Solutions

Energy and Water Conservation: It has been established beyond doubt that every establishment, irrespective of its largeness has the potential to save considerable energy, often up to 30%. At GGESS, our Water Saving Devices saves water up to 40% - a cost effective solution that offers pay back in a reasonably short period of time. Light pipe is another day light source, which can increase the productivity by 6 to 16%. GGESS is also experimenting with solar thermal and solar photovolatics and it will not be long before these energy savers benefit organisations and mankind as a whole.

Rainwater Harvesting: At GGESS, we provide the necessary infrastructure and equipment to enable this highly efficient method of water conservation that also makes for good economic sense. Our domestic systems enable conservation of around 50% of normal water usage while the commercial systems enable water savings of up to 85%.

Renewable Energy: Nonconventional energy or renewable energy is yet another area of expertise at GGESS. Our Micro Wind Turbines are manufactured to international standards and certified by expert bodies to double up as the most ideal source of energy.

Under-floor Air conditioning: One of the latest concepts to have evolved at GGESS, the Under-floor Air conditioning saves as much as 25% energy over conventional air conditioning, and will soon be the greenest choice for cooling solutions.

LED: LED lights are highly energy-efficient and guaranteed. We are doing street lights, highways; commercial and residential complexes too.

With all the services we provide Green Building certification consultancy by GRIHA / IGBC / LEED ratings, where you are saving lakhs of rupees. GGESS is also providing Corporate Social Responsibility (CSR) consultancy and environmental cell team to builders, industries and corporates which involves major leading companies of India.

Address
204 Winners Court,
Lulla Nagar Junction,
Pune – 411040
Website
www.environment.ae
Email ID
india@environment.ae

2.4.2 Eco-Friendly Development, Construction, Green Architecture

Towns, Townships – Environmental Filters Number One

Towns, Townships act as Environmental Filters Number One Hence, renewal of towns, planning of townships should achieve microclimatic control for comfort by studying local climate, topography, nature of soil, suitable vegetation, and surroundings. In new towns and townships, this information is useful while preparing layout plan with different zones, such as residential, commercial and industrial zone.

Orientation of roads, areas for green belts, bio-diversity parks, gardens, open spaces along with provision of natural or artificial water bodies and ponds are the other considerations while planning layout plan.

Transportation centres, schools, colleges, sports stadia, auditoria, marriage halls, markets, malls should be located with due consideration for parking, colourful tree plantation, garden, flowerbeds, etc., in open areas, walkways, footpaths with safety and with measures to control noise.

2.4.3 Case Study – Tata Motors (Telco Pimpri, Pune)

Green Revolution in Industry

Telco factory at Pimpri, Pune is a well–known successful example for the creation of a harmonious balance with the environment and ecology. Mass tree plantation along with provision of water bodies has created a cooler environment with a drop of about 4° C temperature, dust and noise control and proper ventilation by the planting of colourful plants and trees. The whole 364 hectares of land looks more like a park than an industrial site with more than 13000 workers living and enjoying working in pleasant and natural surroundings.

A chain of six water bodies, i.e., two lakes and four ponds has created favourable conditions for both water as well as aerobeal; birds. This area has thus developed into an excellent bird sanctuary with more than 150 different species of birds. More than three lakh trees act as air refreshers in that area. Plants are excellent pollution detectors. Injury caused by air pollution is visible in plants long before its effects are felt by animals and human beings. Trees also act as dust traps and noise barriers. They also act as soil preservers. The original land was barren and with hard strata.

(Ref. Extract from Paper presented by S Y Patki)

2.4.4 Green Environment

Stress-free Botanical Environment

Green art, Green health, Green environment is getting more and more importance in landscaping related to small or large housing projects or townships. There is a very real reason for 'Green

Colour'. It is stated that – "In the light spectrum green lies in the middle. It is known for its pleasant effect on the eyes, when green light strikes the retina, the eye's lenses need no readjustment to focus, and so causes no stress. Put together with other colours, green is known to draw out their most positive effects, the most soothing combinations of which are seen in nature". Importance of botanical gardens is stated by Bijan Dehgan, Environmental Horticulture Professor, University of Florida, that "*There is more comfort in a botanical garden. The spectrum of colour and planned arrangements distinguish it from untouched habitats like hills and forests. It's like looking at a beautiful picture, truly art,"* It is Green Art"! (Times Property – October 25, 2008)

Green is a colour that has gentle and positive meanings internationally. It symbolises hope, wealth, growth, relaxation and space; it ties to nature, associated with rebirth, fertility and regeneration. It has great power for healing and calming. Colour therapy acknowledges green as "the healing colour". Open green space in a private or public garden or in a landscape area creates restorative pleasing environment, walking though parks and botanical gardens calm nerves and calm moods. They create quiet places for meditation and reflection by releasing negative energy. It also decreases stress level. In landscaping, what is most important is greenery, lawns, the beauty of lush green plants and the sound of running water for stress relief. The idea of Green Architecture is explained by Architect Shirish Beri in the following words :

"*Going green in architecture is all about simplicity….. where care is taken in selecting the right material that have the minimum applied and embodied energy, as also minimal side effects on the environment. Durability is another concern to reduce maintenance both costs and pressure on resources …… and design to achieve multiplicity of space usage at different times*." (Ref. Times Property – 26.9.2009)

Buildings – Environmental Filter Number Two

Building should be planned and designed so as to act as Environmental filter number two. The basic consideration is "Orientation" with reference to North. Study of sun-path, direction of wind, existing trees, plants, maximum and minimum temperature and direction of rain will be useful in placing various rooms related to their functions and expected internal circulation. Window locations related to the view, ventilation, air flow and required day lighting will help in finalising plan. Consideration for thermal insulation and sun shading devices, taking maximum advantage of sunlight and natural ventilation are interconnected factors, which show skill of the planner.

At this stage, it is essential to know the functional performance of building materials and components in service so as to select appropriate materials. A building consists of (a) The outer shell – the wall, roof which is affected by the external environment, and (b) type of services provided for the internal environment.

The outer shell is to be designed for thermal insulation, prevention of dampness, structural soundness, durability and fire protection. The internal environment and services should fulfill the requirements of control of temperature and humidity, ventilation, lighting and acoustical requirements.

Durability of the building fabric and components is related to its continuing ability to meet its functional requirements in service. Durability and weather tightness give longer life to the building, choice of material is related to its strength, characteristics, thermal conductivity, specific heat, density, strength to weight ratio, water absorption, and chemical resistance. The harmful effect of moisture in materials and components is one of the qualities responsible for the degradation of service performance with time.

The design considerations of the building are related to the dimensional stability, chemical resistance, corrosion resistance, abrasion and impact resistance. The decision regarding the selection of material depends on its properties, climate, nature of foundation and maintenance. Control of temperature and humidity in the town; township will help for a longer life of the building.

Design of Mechanical Controls for Additional Comforts

The functional design for the building may demand provision for mechanical ventilation, air conditioning, acoustics, noise control, different types of building services and safety services. These provisions need basic capital expenditure along with maintenance charges. It was found that with due reduction in temperature, humidity and with proper selection, the expenditure on the above mentioned controls is reduced substantially.

Expectations from the Green Buildings

"A Green Building should create delight when entered, serenity and health when occupied and regret when departed."

Book – *Natural Capitalism*
(Ref. Times Property 7.11.2009)

1. A Green home, when compared to a nongreen home is more energy-efficient, utilises less or optimum level of water and other natural resources, has green areas, intended for plentiful sunlight and cross-ventilation, all of which could save money and ensure better health. Green home is eco-friendly in the sense it puts less waste into the environment.
2. A Green home can save almost 40–50% of the operating costs and that way recover the higher initial cost, 15–20% higher cost, in two or three years.
3. It utilises alternative energy sources like sun, wind, geothermal and biomass energy. Some homes, apartments offer insulated roofs and walls that considerably lessen the heat ingress in some cases up to 60% thereby resulting in significant lower air conditioning loads. Variable frequency drive (VFD) system automatically adjusts motor speed of the cooling system according to the ambient temperature.
4. Solar heating to warm homes. The solar panels have no moving parts and can collect power without adding any fuel or replacing worn out parts.
   The solar water heaters are to be provided with non-electrical buster (gas back up), thus saving 40% of the load requirement of individual flat.
5. Installing skylights in order to optimise natural sunlight.
6. Using sensors for outdoor lights, outside entrance, door and in the stair which will operate when there is a movement.
7. Low flow showerheads which significantly reduce the household water consumption.
8. Vermiculture, a way of composting using earthworms, to speed up the process in compost pit.
9. Rain water harvesting. The process of accumulating and storing rainwater, to be used for gardening, raising water table level by regenerating of bore wells.
10. Window tinting reflects the rays of the sun, reducing heat loss in winter and heat gain in summer.
    Double sealing in windows reduces street noise by as much as 40 decibles, air conditioning costs comes downs by as much as 20%.
11. Gray water collection treatment and reuse facilities.
12. Segregating, storing and effective disposal of solid waste. Provision of Garbage chute where bio-degradable waste will be treated and used as manure.
13. Using low wattage bulbs BEE star rated electrical equipment. Light Emitting Diode or LED are energy-efficient consuming about 90% less power than incandescent bulbs. Longevity is yet another benefit. They are made from nontoxic materials unlike fluorescent lighting, which uses mercury. LEDs are also recyclable.
14. Sewage treatment plant (STP) in township.
15. Water is to be used in a self-sustainable manner through reducing, recycling and reusing strategies. It saves potable water to an extent of 30 – 50%.
16. Eco-friendly materials: Ready mixed concrete with flyash, recycled steel, flyash bricks, low energy consuming pre-cast slabs are in use. Recycled aluminium, low volatile organic compound paints are also gaining grounds. The power back up generators are CNG powered and the machines create less noise pollution. Use of flyash to reduce thermal cracks.

17. Building planning and designing should give more weightage to orientation, placement onsite, selection and use of material and finishes.
18. Well-insulated, airtight façade with good solar control will create comfortable environment for living.
19. Indoor and outdoor plants and trees
    (a) Indoor plants brighten the rooms, stair, provide a cheerful sight for those grey and often dreary winter days.
    (b) A 50 meter belt of forests with trees of different heights reduce the noise effect by 20–30 decibles.
    (c) A hectare of vegetation collects in its foliage 20–30 tons of dust.
    (d) One full grown Banyan tree is equivalent to five air conditioners for 20 hours.
    (e) Casauarina, tamarind trees absorbs 10 decibles noise and neem nine decibles of noise.
    (f) Select indigenous and drought resistant species.
    (g) Develop your own nursery so that plants at 1–2 meter height will be available for plantation.
    (h) The nonconcretisation of pavements and other surface leads to rain water absorption preventing flooding situation and raising the ground water table, garden gets ample natural water, keeps temperature cool.
    (i) Planting Modinga grandisora (Shevga) on barren land can be beneficial. It is found that roots of this tree absorbs toxic metals and excess sodium present in soil. (Times of India, Pune 27 May, 2009)

2.5 ECO-HOUSING ASSESSMENT SCHEMES

2.5.1 Indian Green Building Council (IGBC)

The standards for the eco-housing are developed by The Science and Technology Park a Government of India Institution jointly with International Institute for Energy Conservation (IIEC) in association with "The Energy Research Institute (TERI)" with technical assistance from the United States Agency for International Development (USAID).

"Indian Green Building Council (IGBC)" lays down certain broad criteria on rating green buildings for residential sector. Homes which are sustainable over the life cycle of the building can be constructed. The rating programme is a tool which enables the designer to apply green concepts and criteria, so as to reduce the environmental impacts which are measurable.

The programme covers methodologies to cover diverse climatic zones and changing life styles.

Many new green building materials, equipment and technologies are being introduced in the market. IGBC highlights new developments on its website on a continuous basis at *www.igbc.in.*

New Eco-Housing is compulsory and is legalised by 1st April, 2010.

The Eco-Housing assessment scheme started by Pune Municipal Corporation gives certification to the projects based on the ratings.

The Criterion for the ratings is based on measures like

1. Site planning
2. Environment Architecture
3. Efficient building materials
4. Installing solar water heaters
5. Segregation and disposal of waste
6. Water conservation
7. Construction safety measures
8. Energy-efficient lighting

Each green initiative adopted by the developer will receive some points. Out of 1000, a minimum of 500 points are required to qualify for a one star rating. The main advantage is that Pune Municipal Corporation is offering 10–15 per cent concession on the premium charges for developers depending upon the ratings. Buyer gets 10–15 per cent rebate on property tax. (Ref. Times of India Nov. 14, 2009)

2.5.2 The US Green Building Council (USGBC) and LEED

USGBC was formed in the year 1993 to establish the present day LEED, i.e., the Lendership in Energy and Environmental Design Program or the LEED Green Building Rating System. This was found useful to educate architects, engineers, contractors, interior designers, product manufacturers and clients to know the value of green design, to show how buildings influence the environment and to develop the strategise ways in which new buildings could be evaluated prior to construction and 'define' and measure 'green' buildings.

Guidlines to establish 'Green Building' benchmarks are given under six categories.

1. Sustainable sites	14 points.
2. Water efficiency	5 points
3. Energy and atmosphere	17 points
4. Materials and resources	13 points
5. Indoor environment quality	15 points
6. Innovation and design process	5 points
Total	69 points

Construction projects are classified as –

1. Platinum Project – 52 to 69 points
2. Gold Project – 39 to 51 points
3. Silver Project – 33 to 38 points
4. Other Project – 26 to 32 points

LEED is merely a rating system that depends on existing standards by ASHRAE, which designers are supposed to folllow.

LEED for New Construction Project v2.2 gives details for project checklist which is found as an excellent outline of all the elements for the designers of a sustainable building.

Ref: BOOK – Emerald Architecture
Case Studies in Green Building
Mc Graw Hill.

2.5.3 Go Green !

"90% of the opportunity to make a building green lies in the first 10% of its design process. Builders have to integrate engineers and experts on different topics into the earliest stages of the conceptual process, to develop an approach in terms of layout, lighting and other aspects, trying to find the best possible solution for a task."

Magazine–Inside Outside, March 2009

Human Resources Development for Green Buildings

Green Architecture today minimises negative environmental impacts of building, promotes the efficient use of natural resources, and protects the health and well-being of its occupants.

In case of any building, if designed correctly the building would use the right amount of energy for its operations. Design is necessary in response and sympathy to the climate of its locations.

Charts showing—details for twelve months for 1 to 4,

1. Sky conditions – Cloudy, mixed and clear
2. Temperature – Maximum, minimum and average
3. Heating and cooling days
4. Direction and details of rainfall – Maximum, minimum and its duration.
5. Existing plantation on the site and in the surrounding area and
6. Geo-technical details of the site is the need.

Built Environment is the subject where we need experts related to planning, designing, construction management for various areas. In Eco-friendly construction we need, still more experts / consultants for 1) Renewable energy, 2) Bio-diversity, 3) Solid waste management, 4) Consultant for eco-friendly materials, 5) Soil consultant for top soil on the site and guidance for the plantation, 6) Solar energy for heating water, generation of electricity and economical back up system, layout, total cost and maintenance cost in future, 7) Rain water harvesting, layout, estimate, 8) Gray water treatment, planning, construction, maintenance, 9) Experts for Eco-Housing assessment scheme/ LEED certification, 10) Electrical energy consultants – selection of fixtures, for total economy, and 11) Eco-Friendly Architecture.

Following areas requires constant study, research so as to find solutions which will be useful for economical planning, designing, construction with less maintenance. Human Resources Development is essential in the following areas:

1. Air Pollution

Air Pollution Watch is done with reference to the points as mentioned below.

1. Smog, that combination of fog and smoke, is a familiar form of air pollution which contributes to global warming.
2. Carbon dioxide is associated with vehicles, aeroplanes, power plants, and human activities where fossil fuel like petrol and natural gas is burned; such activities pump enough carbon dioxide into the atmosphere.
3. Countries are working to bring down smog, and smoke for people's health. Individually one can reduce the carbon footprint by driving and flying less and recycling.
4. Governments are taking measures to limit emissions of carbon dioxide and other greenhouse gases. One is the Kyoto Protocol, an agreement between countries to cut back carbon dioxide emissions.
5. Another way out is to put taxes on carbon emissions or raise taxes on petrol so that consumption will go down and cause less pollution.

PM 10 – The respiratory suspended particulate matter

Particulate matter consists of very small liquid and solid particles floating in the air. The particles, small enough to be inhaled into the deepest parts of the lung, are less than 10 microns in diameter (about 1/7th thickness of human hair). These are known as PM 10.

As per report of the Indian Institute of Tropical Meteorology (IITM), PM 2.5 which represents particles less than 2.5 micrometers and ozone (gaseous pollutant) are the most dangerous pollutants.

Control of Air Pollution

1. Unpaved margins – Construction of roads should be done from edge to edge so that thee is no space for dust and vehicles must convert to compressed natural gas (CNG). "Vehicles plying on pucca roads blow 6,456 tonnes of dust every year while the dust raised by vehicles plying on Kuccha roads is 1,299 tonnes every year", as per ESR Report.

   "Small and medium industries are responsible for 303 tonne PM 10 emission every year. Fossil fuels used in slums contribute to the air quality. About 93,000 commercial properties which include hotels, malls and hospitals emit 204 tonne PM 10 every year".
2. Increase in the frequency of the public transport buses and reduction in the personal vehicles is necessary.
3. A curb on adulteration of fuel, strict checking of vehicular pollution and a control over use of generators is essential.
4. Control on use of diesel generators in housing societies, malls and industrial units. It is found that they emit 379.61 tonne, PM 10 every year.
5. The Chest Research Foundations study during Diwali celebrations shows 25% people in the city suffer because of air pollution due to crackers.
6. Though there is rise in population and number of vehicles, roads have not been developed in proportion of pollution.

2. Noise Pollution

Noise pollution affects those living along roads.

1. Long term exposure could lead to hearing loss.
2. Exposure to moderately high, i.e., above 70 decibels, during a single eight hour period causes a statistical rise in blood pressure.
3. High noise levels have the most significant impact on animal life.

Now the State Govt. had issued a circular to MMRDA, MSRDC and PWD on December, 3, 2008, asking them to implement noise abatement measures to reduce noise from roads. The noise barriers are a must on roads where distance between traffic and buildings is less than 30 metres.

The Mumbai Metropolitan Regional Development Authority (MMRDA) for the first time ever, will install acoustic noise barriers on a road at Bandra – Kurla complex. Till now, the barriers were only installed on flyovers (Cost ₹ 8.68 cores). The project is expected to lower noise levels on these roads upto 55 decibels and will not let them exceed 70 decibels. Without the barriers, noise levels can go to 100 decibels sometimes.

Times of India, Pune Mirror,
Jan.12, 2010

3. Bio-Diversity Parks To Control Air Pollution

Air pollution is a threat to health and well-being. The United Nations recommends at least 12 sq. m. of green area per person for adequate environment for physical and mental health. The Bio-Diversity Park (BDP) plan includes planting 1000–2000 trees (generic forest species) per hectare and allowing the land to rejuvenate. An average family of five will require 60 sq. m. of green area to breath and survive. On this basis we can calculate area for the BDPs for city/ village, so as to provide clean air for citizens. Major advantages of the B D Parks are stated as under –

1. ***Environmental Boon***: Parks are on the job, 24 hours a day, serving environmental functions like cleaning the air and returning oxygen to the atmosphere, and providing habitat to wildlife. It creates desirable environment for birds, flowers and plants.
2. ***Recreational Opportunities***: Contact with nature helps citizens of different ages and children for social and recreational opportunities, such as, jogging tracks, cycling tracks to build their health. It offers a safe alternative to playing in the streets and parking lots.
3. ***Protection of the Land***: It is necessary to understand relation between soil, water and forest. BDP protects water resources, soil formation. Diverse varieties of trees, growing to different heights increase "time of concentration". It is due to obstructions created by leaves, branches at various levels to travel of raindrop. Old branches lying in the forest also obstructs path of water. Humus which is generated from dry leaves and decomposed organic matter releases water very slowly. Forests also arrest soil erosion. Therefore, streams in the area having a forest cover have water for a larger period. Hence, forest,

Bio-Diversity Park is necessary for conservation of both water and soil. BDP maintains eco systems.

4. ***Stores for Various Products*:** Useful for various pharmaceutical drugs, seeds for flowering plants, ornamental plants, different types of trees with flowers, fruits are available in large quantities and preserves eco-system.
5. ***Long term Investment for Sustainable Development*:** The B D Park helps for conservation of lands and increases the value of the property. These parks add to the aesthetic quality of neighbourhoods.

Obstacles for B D P

Though there are many advantages of the Bio-Diversity Parks in and around the town still the problem is related to the acquisition of land. Cost for acquisition and total time required for the same. In the development plan, area should be reserved for B D P and 60 m strips on either side of a river should be marked as a non development area. Tree plantation on both banks will make picturesque scene with colourful flowers.

4. Rain Water Harvesting (RWH)

Rain water harvesting is a self-sustainable and eco-friendly way of water conservation. It definitely acts as a tool to win over water scarcity and also helps in reducing burden from municipal water supply arrangement. Water is the basic need. In developing cities, it is found that the existing infrastructure cannot match the pace of development and increasing demand of water.

Rain water harvesting means arresting rain water during monsoon, storing it in artificial reservoirs / tanks or natural reservoirs, i.e., aquifers and using it later whenever required. Rainwater is the purest form of water. It gets contaminated during its travel either in the atmosphere or on the ground. The harvested rain water can be used for flushing, washing, gardening, irrigation – drip / sprinkler.

In rural areas, R W H is used for recharging of the ground water table by various methods such as percolation tanks, providing terracing on the slopes of the hill, contour bunding, contour trenching, boulder check dams and infiltration pits to facilitate percolation.

In urban areas, rainfall which occurs on the roof / terrace is to be catched with the help of rain water drop pipes. It is collected to a centralised location by means of pipes. Such collected water is then used for gardening purpose, or it is directly used for recharging a bore well / well by using filtration device to remove suspended particles /turbidity. Due to bore well / well recharging, groundwater source get replenished as well as improves the quality of ground water. It can be reused or recycled back for day to day activities by means of suitable plumbing.

According to experts, Pune receives a total rainfall of around 700 mm throughout the year. An apartment block or bungalow with 1000 sq. ft. terrace can save around 60000 – 70000 litres of water every year. Hardware costs for installing a rainwater harvesting system is between ₹ 10/12 per sq. ft. of terrace area. Approximate cost of the storage tank is ₹ 5 to 6 per litre of the tank capacity. (Ref. Times of India, Pune June 4, 2010).

Collection of rainwater that falls on the ground is called surface rain water harvesting. This water is polluted as it comes in contact with the ground, so it should be recharged into the ground by means of filtering recharge pits which are filled up with gravels to speed up percolation.

Pavements: In urban areas, people adopt paving facility around the building leaving no scope for water to percolate. To meet both the requirements one can use porous pavements made with higher % of coarse aggregate. It can also have a geo-textile layer at bottom for diverting the water to a particular location. Pre-cast tiles with holes in center set sand bedding will also allow good percolation.

Sea Water Ingress: In coastal cities, it is observed that the bore wells which initially had sweet water turn saline after some period which is on account of ingress of sea water into the soil. The sea water can also affect building foundations. Charging these wells with rain water will assure good quality of ground water.

It is essential to collect data related to rainfall, soil analysis, water table level, water demand as per intended use and building plan before finalising RWH details. It is also necessary to do back wash of filter media around the wells for efficient functioning. Design should not cause excessive rise or fall in water table causing dampening or uneven settlements.

5. Recycling of Waste Water

Installation of water recycling system is now mandatory for all new major housing schemes. The state government notification said, "*Installation of system for recycling of waste water from bathrooms and kitchen sinks is mandatory in building layouts having net plot area, excluding area under development plan reservations, or development plan road, of 4000 sq. m. and above. The recycling system shall be installed as per the norms and specifications decided by the municipal commissioner from time to time. The treated water may be used for gardening and all other purposes other than drinking*."

Water recycling systems will help save drinking water a priceless commodity. This scheme is useful for small houses as well as new residential schemes.

According to the new rule –

(a) Waste water (grey water) refers to water discharged anywhere in the house except in toilets and urinals.

(b) Waste water can be collected in settling tanks, which ideally should be large enough to hold twice the expected daily flow plus 40% above that to allow for sludge accumulation.

(c) Iodine or Chlorine can be used to disinfect water. Also various types of filters need to be used.

(d) Water produced in toilets and urinals is termed as black water. As per the provisions, it would be mandatory to provide independent sewer lines to carry gray water and black water. Laying dual pipelines – one for potable and other for recycled water – would be necessary. This dual pipeline should be marked differently for easy identification.

Maintenance

As per the law, the owner of the building or the housing society shall ensure that the system is properly maintained and that the recycled water shall be used for nonpotable purposes only. There would also be a provision for a monetary fine if the owner / housing society fails to provide or properly maintain the recycling system; the executable amount has not been fixed yet.

Recycling of backwash water

The Pune Municipal Corporation plans to set up a small water treatment plant at its Parvati Water Works to recycle around 40 MLD of backwash water which normally goes down to drain. Five to seven % water of the total capacity of the treatment and filtration plan is backwash water. It contains suspended materials and other chemicals which are left behind after water purification by the treatment plant.

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Packaged Sewage Treatment and Recycle Plant
Website: www.airobix.net

About AirObix® STRP

Domestic Sewage / Wastewater generated from domestic water uses such as toilets, lavatories, occasional septages (sludges) from localised septic tanks, homogenised wastewater from canteen / kitchen / restaurant and its floor washing.

Wastewater quality

	Inlet	Outlet
BOD_5 at 20 °C*	250 – 400 mg/l	<15 mg/l
COD	600 – 800 mg/l	<50 mg/l
pH	7.5 - 8.5	7 – 8 (Neutral)
Total Oil and Grease	50 mg/l	<5 mg/l
Total Suspended Solids	200 – 450 mg/l	<10 mg/l
Odour	Foul/septic	Odourless
Appearance	Yellow Grey	Clear

** BOD_3 is used under Indian statutes.*

Possible end application

On the basis of above parameters, treated wastewater can be recycled typically for the following applications.

Garden and lawns irrigation	Nonbathing recreational water replenishment
Pavements and floor washing	Groundwater recharging
Vehicle washing	Toilet flushing

Where can we use AirObix® STRP

- Housing colonies and townships
- Commercial complexes / shopping malls
- Construction site labour camps
- 24x7 activities - call centers / ITES offices
- Hotels and Resorts
- Hospitals
- Industries with large workforce
- Sports grounds, Golf courses
- Passenger liner and cargo ships

Treatment Process

System Description

The wastewater emanating from toilets and other domestic usages such as kitchen washes (can be called as sewage collectively) from various generation points are collected though drainage line in a Buffer Tank. On the upstream of Buffer Tank, screen is provided for removal of stringy, fibrous, plastic and such extraneous material from the sewage. A Scum Trap is provided to separate the scum, fats, oil and grease which will otherwise hinder further process. The sewage collected in the Buffer Tank is constantly pumped to the AirObix® STRP with the help of nonclog Raw Sewage Pump. The auto level controller system is provided to avoid overflow of AirObix® STRP or annunciate Buffer Tank high level.

AirObix® STRP is a packaged system designed for sequential biodegradation, clarification and storage of treated wastewater for further pumping. AirObix® STRP is factory-fitted pre-piped, pre-wired system that fits directly onto the concrete base pad, slab or the basement floor once delivered at site.

Process

AirObix® STRP employs activated sludge process utilising highly active biomass of aerobic microorganisms. These are easy to develop and maintain with no foul odour at all. Using high pressure blowers, the oxygen in air is diffused into bio-reactor contents for a series of biochemical reactions to take place. Depending on input, organic matter the cell multiplication of the micro-organism takes place, which is extremely high. The organic matter undergoes bio-oxidation and the reactor overflows continuously into the subsequent secondary settler unit. The micro-organisms which are heavier than water settle in this unit in form of concentrated sludge. This sludge is not the raw putrescible solids that are found in raw sewage, but the active biomass of useful micro-organisms. These micro-organisms are returned to the bio-reactor to take part in bio-degradation of incoming wastewater continuously.

Due to exponential growth of micro-organisms, the wasting of some of its fraction is necessary for maintaining a steady state metabolism and therefore, fraction of total biomass is discarded periodically in sludge form.

This watery sludge is needed to be dewatered and converted into a thick manageable mass. AirObix® STRP incorporates a compact gravity-fed sludge dewatering system consisting of special bag filters to filter out water from the sludge within a short span of one day. This system works continuously and cleanly not requiring additional manpower for desludging operation.

The purified wastewater overflown continuously from the settler system is collected into in-built treated water tank. This water is pumped out as per the required frequency of end application and is passed through an on-line Multigrade Filter (MGF) as a polishing treatment to biologically treated water. This removes tramp suspended solids giving water the clear sparkling look.

Although the biological process removes most of the pathogens (diseases-causing micro-organisms) it still needs to be subjected systematic disinfection. This is achieved on-line chlorination system. Finally the water is given a second level of disinfection through a UV disinfection system.

AirObix® STRP treatment process is semi-automated through auto-controlled sequence comprising of safety interlocks for rugged and trouble-free operation of the equipment. The system can also be conveniently changed over to manual mode. The fault-response and troubleshooting is controlled through audio-visual annunciation and is simplified to ensure safe operations.

AirObix® STRP is a total solution for recycle wastewater and is packaged aesthetically into skid mounted systems. Operation & Maintenance of AirObix® STRP can be taken up on annual basis by the company.

Standard Models

Model	20AB	40AB	60AB	80AB	100AB	140AB	180AB	200AB
Capacity, lit/day	up to 34000	up to 50000	up to 72000	up to 90000	up to 118000	up to 154000	up to 198000	up to 240000
Population served, per day	130 - 225	250 - 325	400 - 480	525 - 600	670 - 775	925 - 1025	1200 - 1320	1325 - 1600

	Conventional STP	AirObix® STRP (Jalshree Corporation)
Configuration	Multiple units – mostly in civil construction. Separate Pump room necessary.	Single skid mounted system built in corrosion protected steel. Only underground Buffer Tank is built in civil.
Space requirement	Large area requirement hence location problem. Area required for 100 m^3/d plant is 80 m^2.	Small footprint – less than 40% of the conventional. Can be fitted in the basements, side margins or on the terraces. Area required for 100 m^3/d plant is 25 m^2.
Relocation	Permanent fitment. Relocation not possible.	Portable – can be relocated quickly on a truck trailer.
Planning and execution	Planning and execution lengthy, typically 12 weeks, needing major site detailing. Needs dealing with multiple agencies at site.	Short delivery period, typically 10 weeks, being the factory-built equipment.
Quality and aesthetics	Moderate QC on quality and limitation on aesthetics due to onsite construction.	Meticulous quality control being factory-built. High level of external aesthetics.
Sludge dewatering and odours	Either provision of huge sludge beds generating odours and requiring cleanups, which are messy. Alternatively need to put energy guzzler Filter Press.	In-built compact gravity fed bag sludge dewatering system with no odours or disposal mess. Simply remove, clean and reuse.
Energy and controls	Demands simple 24x7 energy input. Higher energy requirement to handle lean flows. Generally comes without automation.	Optimised oxygenation, level operated sewage transfers, equipment safety interlocks.
O&M	Elaborate O&M requiring variety of skills. Rigorous labour input for housekeeping and maintenance.	Simpler to operate and maintain. Only 1½ to 2 hrs of daily labour input.
Payback	Slow or no returns due to low recyclability of treated water. Practical chance of cost recovery.	Due to high quality output of usable water AirObix® STRP has a low life-cost. AirObix® STRP pays back within 12 – 50 months depending on size. Cost saving due to space is 0.5X price of AirObix® STRP. At premium properties it can be 2X.
Estimated Cost	₹ X (for 100 m3/d) as installed cost	₹ 1.25X approx. Larger models nearly at par with Conventional.

6. Sewage Treatment

Sewage generated from Class I cities and Class II towns (As per 2008 estimates) are 38,254 MLD but they can treat only 11,789 MLD, only 30% of the generation. There are 498 Class I cities those with 1 lakh population.

The state government in 2008 made it mandatory for large constructions – like malls, hotels and even residential complexes to have on site treatment of sewage water. The new rules for waste treatment make it necessary for every new construction with more than 60 units or 240 residents to have a treatment plant. Any project with an area of over 2000 sq. m. was also brought under the ambit of the rules.

Now action plan is expected from Municipal authorities to fill up the gap between treated and untreated sewage in a minimum time frame. Rivers which are a source of drinking water, are most polluted, hence, sewage treatment and reutilisation of treated sewage need higher priority. It is also mentioned that operation and maintenance of treatment plants and sewage pumping stations needs to be checked for the quality of treated sewage as per general standards prescribed under the environmental protection Rules for discharge into streams.

The Central Pollution Control Board (CPCB) report shows that Maharashtra has the largest number of rivers of polluted river stretches in the country. It has identified 26 rivers in Maharashtra with 28 polluted stretches. Mula and Mutha in Pune, Kalu and Bhatsa in Thane and Mithi River in Mumbai are the prominent ones. The CPCB has marked 150 polluted river stretches in India, which includes almost all the major rivers.

Times of India, Pune, September, 5, 2010.

Refer – Case Studies
1. The total environmental solution by ‘Global Green’ and
2. ‘Airobix’ – Packaged Sewage Treatment and Recycle Plant

7. Eco-Friendly Bio-Gas Technology

Garbage segregation into dry and wet, collection and treatment is a problem. It is now tackled by Garbage processing plants with a capacity of 5–10 metric tonne in the city. It not only converts wet waste into electricity but also powers street lights. Pune Municipal Corporation has planned to process 100% garbage for generation of electricity. According to the Environment Status Report 2009–2010 daily garbage generation in Pune is 1300 – 1400 metric tonne. Garbage collection, transportation and disposal were facing severe problems because of huge quantity, human dependant activity and objection for open dumping. Garbage attracts insects and rodents and rainwater trapped in the bins becomes ideal breeding grounds for malaria causing mosquitoes.

For apartments and co-operative societies the wet waste from kitchen is used for vermicomposting pit, to get manure to be used for gardening. Vermicomposting pit contents cow dung, brickbats and coconut coir and wet waste. The tank is covered with gunny bags and watered regularly.

8. E-Waste

The electronic waste guidelines (April 2005) define e-waste as the waste generated from used electronic devices and household appliances which are not fit for their original intended use. E-waste is classified as hazardous because it contains many toxic ingredients and heavy metals like lead, cadmium, mercury with potential to pollute the environment and damage one’s health when processed recycled or disposed of.

(a) Television and computer monitors contain lead; other electronics are made with mercury, cadmium and chromium, which are hazardous.
(b) CDs, DVDs and VHS tapes can be recycled.
(c) All batteries of any type may be considered hazardous waste, need to be disposed at a hazardous waste facility.
(d) Throwing e-waste into landfills allows toxins to seep in groundwater.
(e) Incinerators emit toxic air pollutants, including dioxins.
(f) E-waste generated in 2009 – Mumbai 11,017 tonnes, Pune 2,584 tonnes, Maharashtra, 20,270 tonnes.
(g) Delhi, Bangalore and Kolkata have started management of electronic waste through a collective effort for environmental friendly recycling to reduce pollution. Other cities are planning on the same lines. There is an increased awareness, research and development activity related to e-waste management.

Taloja near Mumbai, Ranjangaon – Pune District and Butibori near Nagpur are three locations selected by Govt. of Maharashtra for the disposal of E-waste.

9. Housing for Slum Dwellers

The target of achieving a slum free India in five years is outlined by the government. The nature of the problem is as follows: “*Despite the country’s robust economic growth, around 93.06 million people will live in slums in cities by next year, an increase of around 23% since 2001, forced by a lack of space and means*”. There has been a growth of 17.8 million across the country in the last decade. “*Among the states, Maharashtra tops the chart where around 1.815 crore will be living in slums in 2011, followed by Uttar Pradesh* (1.087), *Tamil Nadu* (86.44 lakh), *West Bengal* (85.46 lakh) *and Andhra Pradesh* (81.88 lakh).”

“*It is essential to find exact population in slums in each and every small or big settlement while collecting data and preparing development plan. Affordable housing with essential commodities is a challenge for planners*.”

Ref. Times of India, Pune, September, 5, 2010

10. Solar Energy for Air Conditioning

Electric power is the major running cost in commercial buildings where almost 60% energy is used for air conditioning purpose. Getting power through conventional means leads to pollution. One kilowatt of power gives off 800 grams of carbon. “*Solar thermal is the answer to sustainably addressing the growing need for power. Innovative technology using solar energy for air conditioning*.”

(Mamata Energy from Ahmedabad)
ACREY India 2010
HVAC Industry, Times Feb. 27, 2010.

Dr. OmPrakash G Kulkarni from Nashik got patent for designing world’s first Solar Centralized Air Conditioning system using heat from solar energy. This latest technology will be useful for air conditioning of hospitals, auditoriums, solar thermal-based cold storages for agricultural applications and chilling with heating for pasteurisation of milk and other products.

Details of research given by Dr. OmPrakash G Kulkarni will be useful for students, teachers and professionals to know technical know how about this research, design considerations, comparison between conventional method of air conditioning and advantages of use of solar energy.

Case Study

Solar Thermal Energy For Central Air Conditioning Using Scheffler Parabolic Concentrators

Name of the Inventor	Dr. OmPrakash G Kulkarni, Mentor, Advisor and Consulting Engineer in Instrumentation, Automation, Energy Management, Renewable Energy and IPR. E-mail: *kulkarnismo@gmail.com* Mob: +91 9422245346

1. Solar Energy

Solar Energy is most clean, free and forever, which can be termed as future energy to save our mother Earth and Nature. It has energy in two forms. 1) Solar Thermal – which can be used for heating and cooling 2) Solar Light – which can be used for generation of Electric energy known as PhotoVoltaic.

2. HVAC System

HVAC is an acronym for heating, ventilation and air conditioning. This system is used for climate control, to maintain comfortable atmosphere by heating / ventilation / air conditioning. It is based on principles of thrmo-dynamics, fluid mechanics and heat transfer, HVAC system regulates room temperature, humidity and fresh air flow ensuring that such elements remain within their acceptable ranges. Effective control of such factors minimises health related risks.

1. A high humid atmosphere impairs the body's ability to regulate body temperature as it prevents the evaporation of sweat.
2. High humidity also decreases physical strength which usually leads to fatigue.
3. An unhealthy surrounding can also affect people's thinking abilities. Hypothermia, heat stroke and hyperpyrexia, among others are some of the illness that may also occur.

3. Conventional system for Air Conditioning

At present conventional system of air conditioning is based on vapour compressions technique. This require need of a compressor which is highly electrical energy prone device. It also call for specially qualified staff and expensive maintenance leading heavy recurring costs. The huge demand of electrical energy call for sustainable load on generation end as transmission and distribution losses are almost 43% or above.

The refrigerant used PFCs or HFCs are termed as Ozone Depleting Substance (ODS).

Spreading of infection is a serious problem in central (Air Handling Unit) AHU used in Hospitals which is termed as "Hospital Infection Control Problem".

4. Newly developed Solar Air Conditioning System

This is a unique technology in which the solar thermal energy is converted into cooling. The solar heat is used as thermal compressor in place of electro-mechanical compressor. The refrigerant used is totally eco friendly. The 13.6 Sq. m. size Scheffler parabolic concentrators are used as source of energy to collect the solar energy by generating steam. The stagnated temperature at the focal point is above 930°C

The working principle is as follows.

1. Any liquid which evaporate below zero degree centigrade can function as refrigerant. In this system Ammonia + Water + a proprietary chemical is used as refrigerant. The mixture is heated using thermic fluid to make it a vapour at temperature of 180°C and pressure of 16 bar.
2. This mixture is throttled and subjected to cooling at 70°C. At this stage the water gets condensed and only ammonia vapour passes to next stage. The water from stage 3 is used for this cooling.
3. This ammonia vapour is again throttled and cooled to a temperature of 29°C. Cool water from cooling tower is used for cooling which goes to Stage 2 as mentioned above. At this stage the ammonia vapour gets liquefied and is ready to be used as refrigerant.
4. Here the liquid ammonia is used to chill the close loop circulated water (received back at 12 to 14 °C from AHU or FCU through an insulated receiver tank) to a temperature of 6 to 7 °C.
5. This chilled water is sent to a specially insulated tank of capacity to hold stock for about 1 hr. requirement. From this tank, the chilled water is pumped to AHU or FCU where the cool air is generated and water gets warmed up to a temp. 12 to 14 °C which returns for next cycle of chilling as mentioned in stage 4.
6. At Stage 5, the liquid Ammonia again gets converted to vapor. This vapor is at around 7°C which is passed through a heat exchanger to cool drinking water at around 18°C. Thus, the temp. of the vapour rises and the heat input from Solar is reduced consequently in creasing the Coefficient Of Performance (COP) of the system.
7. This vapour is then absorbed in water. This mixture is again sent for heating to repeat the next cycle. Hence, this technology is called Vapor Absorption Technology and the cooling unit is called Vapour Absorption Machine/ Chiller i.e., VAM or VAC.
8. Various methods of heating through Solar can be used, i.e., by generating steam, hot water, heated thermic fluid, direct heating of the refrigerant etc. But using steam or hot water is more economical.
9. The above system is called single effect and there technology in which LiBr+H_2O mixture is used for chilling the water. This is normally operated in double-effect or triple-effect mode. Hence, the solar input is reduced resulting into increase in COP of the system.
10. The Coefficient of Performance - COP - is the ratio between useful energy acquired and energy applied and can be expressed as:
    - COP = Hu / Ha Where :
    - COP = Coefficient of performance
    - Hu = Useful energy acquired (Btu)
    - Ha = Energy applied (Btu)
11. This system involves use of number of Parabolic Solar Concentrators of 13.6 sq. mt. size. All the concentrators are ganged with a wire rope brought on a winch, driven by a small DC Motor controlled by an intelligent central tracking system. The motor is powered by battery which is charged using Solar Photovoltaic Panels. Thus, the tracking is grid autonomous. The entire operation is monitored, controlled and governed by micro controller-based intelligent device using specially developed 4GL RDBMS software. The special Data logger keeps the record of entire performance. The special Laser technique is used during erection for highest accuracy.
12. The system is provided with three stage protection control to avoid any malfunctioning and accident.
13. Schematic Block Diagram shows details of the air conditioning unit. Plate 2.2 Students, teachers from civil, mechanical and other branches are advised to study this case study and contact Dr. OmPrakash G. Kulkarni, who has got patent for this research, for further developments.

Case Study

Solar Energy for Generation of Electricity by 'SunCube'

The SunCube is a concentrating photovoltaic system which magnifies sunlight and directs it onto solar cells and is set up as a 300 watt module, with 30 + percent efficiency which is almost double the efficiency of standard PV. SunCube technology is used in Australia and other developed countries since 2006. One SunCube, 1 m long, 1 m wide and 38 cm in depth and it contains nine subcells of 33.3 sq. cm. size. Top surface consists of Fresnel lens while bottom consists of Photovoltaics cell (PV cell). SunCube moves in the direction of sun with the help of separate motors. Sunrays catched by the fresnel lens are transferred to PV cell and gets converted into electrical power. Life of SunCube is 25 years.

Ref. Sakal Property supplement
27/11/2010
Ref. Green and Gold Energy
www.greenandgoldenenergy.com.au

11. New Construction Techniques and Materials

(a) Construction Industry is becoming more and more professional. It's orientation is towards the science of construction and hence, more sustainable in the long run.
(b) Stock Requirement Planning (SRP) techniques for quality control to maintain uniform quality at every stage is found to be beneficial.
(c) Systems to measure individual performance, accountability regarding deadlines, predicting timelines, are employed.
(d) Aluminium Formwork System saves cost, time and improves the quality of construction. For repetition of building layouts and for above-the-plinth work, MiVAN aluminium shuttering technology is faster. This formwork is cost-effective as the panels can be re-used up to 250 times and erected using unskilled labour. A conventional cycle for a high-rise slab is 30 days, with MiVAN it is 10–12 days. It eliminates clay bricks, encourages fly ash. Stronger structures, super flat walls and a smooth silken finish is the result.
(e) There are technologies like dry wall / foam concrete walls which are yet to come to India on a large scale. Gypsum is used as a plasterboard in drywall solutions.
(f) Using slip forms for making the central structure around the lifts and the staircases, which allows for continuously moving and self-escalating forms. It is possible to achieve work of three to four floors in a short span of time.
(g) Windows designed to withstand wind pressures at higher levels, Hydro-pneumatic water pumps to control the water pressure to avoid danger of bursting at ground floor level and Eco-friendly elastomatic paints that seal in the pores and eliminate chances of leakage are used.
(h) Waterproofing is done with the help of a catalytic reaction to concrete that seals the pores, capillaries and shrinkage cracks.
(i) Use of earth moving machines saves time.
(j) Use of flyash, crushed stone aggregate instead of river sand is in practice.
(k) Double glazed windows for insulation keeps the premises cooler.
(l) Project consultants are recommending project specific technology for efficient and optimum structural systems.

Students and teachers will know technical details about latest technology during their site visits. Information mentioned above is collected from the technical brochures, site visits and discussion with site engineers.

12. Environmental Art and Design

Environmental art and design develops feelings to appreciate nature and encourages harmonious co-existence between man and his surroundings, i.e., settlement.

This settlement environment can be divided into – (1) Urban, (2) Rural, (3) Courtyard, and (4) Room environment and so on.

James C Snyder has mentioned in Architectural Research 1984 that, "*Environmental Art, as a kind of art, is more enormous than the Architectural Art, more expansive than planning and more emotional than Engineering. This is a type of practical and effective art which has long attracted the tradition*".

Urban Eco-system

The natural beauty of plants and trees enlivens landscape. Every site, every town has 'local colour' due to geography, climate, variety of plants, trees. Introducing the forests into urban area, and locating cities in the forest creates urban greenbelt landscapes. It acts as the lung of a city, gives base for preserving biological diversity, essential for sustainable development. It creates cozy living space with fresh air.

Christopher Benninger, Architect and City Planner, Pune has expressed his views on Gardens that, "*Each city has its own special qualities of water, hills, foliage and even scent! It has its colours and its far landscapes yearning to be beckoned into our souls. Lucky cities have their sea fronts, their rivers, their mountains, or their ancient trees. If you know no God and you feel lost, worship these inanimate things, and you will find solace in your heart*." (Times of India, Pune Mirror, Sept. 26, 2010)

Urban greening helps in enriching the skyline of cities. Concrete buildings with high and low profiles needs contrast of soft and mild landscape, colourful picturesque scenery for which creepers and green grass is the choice for landscaping. It is said that landscape becomes the integration of natural beauty, life beauty, architectural beauty, painting beauty and literature beauty. The landscape composition changes with time. Sky, mountains, buildings, lakes, trees and plants presents different scenery in different seasons during one year and throughout the day also. Green plants can purify air, and reduce noise hence they are regarded as 'Green filters'. Evaporation of water from the surface of plants can control over-temperature, increase the humidity of air. Plant can block the cold wind of winter and can reduce the erosion of soil.

Roads, squares, open areas in town, traffic islands, footpaths, walkways, areas around natural and artificial lakes, hills and hill slopes, fountains and steps around fountains and traffic islands, building entrances, the atrium, i.e., transition between the inside and outside of the building, entrance gates and fences, bridges and flyovers, pavilions to be used for relaxation and sightseeing on hills, near water surface or on ground, corridors which guides visitors to walk on, protects from sun and rain; are areas in a town where Environmental Art and Design gives artistic touch.

Development of nurseries, constant maintenance of gardens, plantation of flowering plants as per season, exhibitions of plants and flowers develops love for nature and maintains environment full of vitality and beauty.

Botanical gardens calm nerves and calm moods also. As society grows more urban, space gets tighter, and even luxury homes get smaller. They get just a small terrace or sit out, this deprivation has created an interest in gardens and gardening. Aesthetically, landscaped terraces gives pleasure. In landscaped area of city, housing society or township the beauty of lush green plants, and the sound of running water, fountains, artificial lakes, water pool, water fall, water drop, stream and gully creates soothing effect. Walking through parks and botanical gardens watching greenery or colourful nature through the year is just like enjoying holidays without all the planning and cost.

Environmental designer thinks of whole town, different sectors, streets, open areas, lakes, hills and creates pleasing environment with greenery, water, flowers, trees and connects man with 'Nature' for eternal bliss.

2.6 TOWN AND TOWNSCAPE

Advanced Remote Sensing Technology

"Advanced Remote Sensing Technology for surveying is a well-established technology, which was used for planning Ahmedabad city. Maps explain the water, industry, traffic, transportation and other related infrastructural needs. It is a faster technology as compared to the traditional ground survey methods and even aerial photography, to get comprehensive pictures from different angles. The monsoon period is avoided for remote sensing survey."

Comment by : Dr S Prabhakaran
Additional Secretary, Department of Space
Ref. : Times of India, April 29, 1998

Ground survey, aerial survey and advanced remote sensing technology for surveying are the methods for collecting data and finalising plans for urban / rural design. With these, advanced expectations related to achievement in urban / rural environment are now within the reach of the planners.

2.6.1 Road Alignments in Townscape

Roads are routes. They are ways for vehicles to travel. Roads along with buildings are considered as the 'outside environment'. A journey along a roadway shows buildings, interesting landscapes, good views and also dull views. Roads may pass through cuttings or on elevated surfaces, i.e., environments showing the sky and wide views. Trees and views seen through trees, greenery of fields, colourful plantations, view from a bridge are all considered parts of the route design. Speed requirements, facilities along with surroundings need top most priority. Design of the road is done by different professional disciplines. City planners, highway designers, service engineers and quantity surveyors should have some common goal related to the end product. Well-planned, safe, suitable for the type of user, easy to maintain and economical routes should be the aim which means all members of the design team should have an understanding of the other disciplines involved.

Road alignments can be considered under different categories as under :

1. Flowing alignment is to be designed for vehicles with high speed, to enjoy landscape. Horizontal, vertical and transition curves for the desired speed are an essential requirement.
2. The hill road alignment should be made suitable to the character of the highland areas to enjoy the landscape. Change in direction and elevation of the alignment is a characteristic feature.
3. The country side or rural alignment is adjusted to the local contours and to enjoy surroundings of agricultural fields and farms.

There is a need to integrate all road alignments into the environment than providing purely technical / geometrical designs. Materials for the road, accommodation of various services, surface treatment for the roads and footpaths with reference to the durability, colour and texture, control on type, size and location of advertisements in urban, rural areas and along the roads, etc., need codes for safety and visual pleasure of architecture and the surrounding landscape. The townscape consists of different types of alignments within a town and its surrounding areas for safe movement of vehicles and commuters through the built environment.

A Lively Space to Sit, Talk and Watch

Aundh-ITI Road Pune, (Ref.–Times of India–Urban Issues/Times Properly Oct. 23, 2010)
Photo - Courtsy Mr. Priyam Patki

This newly transformed lively urban space is a pleasant surprise and gift to the citizens to sit, talk and watch.

What we need is a pedestrian friendly footpath, a continuous, convenient and comfortable footpath to walk. Seating created around existing trees not only protects trees but creates meeting place for senior citizens and pedestrians to sit and chat. It's really is a good beginning. What is needed in addition is colourful plants on the background and constant maintenance to keep place clean and pleasant.

Credit of such lively, thoughtful transformation goes to Architect Prasanna Desai and design team Ar. Mahesh Thakor, Ar. Tejas Joshi and Ar. Akhil Gupta, Residents of Aundh Vikas Mandal, local corporator Mr. Dattaji Gaikwad and Pune Municipal Corporation.

Cityscape needs such colourful transformation with colourful designs with comfortable seating places and plants and flowers to watch. Challenge for designers!

Pedestrian Friendly Footpaths and Walkways

In towns, consideration should be given to pedestrians of all age group. The following observations will throw light why the roads and footpaths are becoming unfriendly for pedestrian and search for solutions. It is stated by Ivan Illich in his book Energy and Equity, that "*People move well on their feet, people on their feet are more or less equal. An improvement on this native degree of mobility by new transport technology should be expected to safeguard these values.*"

1. Today, roads are laid out, designed and built, all with an automobile or two-wheeler in mind. Not enough consideration is given to other users like pedestrians, cyclists and public transport.
2. The vehicular growth rate every year is increasing. Cars and two-wheelers begin to jostle for more road space and use up public space for parking, the city becomes less walkable.
3. Only a walkable city with well-designed integrated pedestrian infrastructure and with good public transport can combat growing pollution and congestion and make the city liveable.
4. Footpaths must give pedestrians a continuous, convenient and comfortable walkway. They must be adequately wide, continually navigable with no or minimal breaks and free of obstructions.
5. Pedestrians walk is extremely unsafe with hostile conditions and in constant conflict with motorised traffic and pedestrians are easy victims to crashes and accidents.
6. People trip over potholes, slip on sludge, or are grievously hurt bumping into numerous obstacles strewn along the footpaths.
7. There is continuous erosion of space for walkers even though every journey begins and ends with a walking trip.
8. City lacks proper footpaths, zebra markings, pedestrian railings and signals and discipline.
9. Walkers are ignored as is evident from the state of footpaths being narrowed to provide more space for carriage ways.
10. We need environmental guideline for walkways and pedestrian plan and make their implementation mandatory.
11. Penalty for encroachment on pedestrian space is necessary.

2.6.2 Sustainable Cities with High Rise Housing

"Remaking sustainable cities, not brand new cities"

Antony Wood
Of the CTBUH

The council on Tall Buildings and Urban Habitat (CTBUH), Chicago offers solutions for sustainable livings and designing of viable tall buildings for the past 40 years. It was established in the year 1969, by the architects and engineers who were designing the world's tallest buildings at that time. Some of the views as per their observations are as under -

1. Now cities cannot just continue to grow horizontally. It is completely unsustainable method of development. Cities have to grow vertically and denser. A small space must be able to house many people. With ever expanding suburbs horizontally, the energy and carbon implications are too great.
2. In Singapore, where 80% live in government built high rise buildings and the other 20% live in privately built high rise. So finally 100% of Singapore lives in high rise housing - well-constructed, sustainable with proper drainage and water system.
3. The most important thing is infrastructure. It needs integrated approach as all tall buildings are linked to common infrastructure.
4. A noncar based mass transit system - elevated rail, subway rail or whatever needs to be put in place. What is required is radical government policies, with a bigger vision. Central body to monitor and continue work irrespective of governments coming and going.

Times of India, Pune
December 5, 2009

Mumbai in AD 2010

"For Mumbai to progress into the 21st century, we need imaginative laws as much as we need imaginative planning and architecture - high rises set amidst lagoons and groves use of land to the bare minimum, say only 25%. The key word would be environment."

Architect : Hafeez Contractor
Ref. : Times of India, 15th August, 1998

In his article mentioned above, the architect has emphasised the following points:

1. Instead of spending crores in the repair and maintenance of dilapidated buildings, they should be razed to the ground to create large areas for fresh development with imagination.
2. All future developments must be vertical. Giant buildings should function as neighbourhood districts.
3. High speed elevators and sky tunnels will be essential, rather than buses and trains.
4. Slums and illegal constructions will not get a place in the new scenario.
5. Land should be reclaimed to develop bands of forested area all along the western shoreline of Mumbai.
6. Sea water should be allowed to enter the present island by breaking and lengthening the coastline and widening of nallahs by excavating their sides to convert them into salubrious lagoons.
7. Swampy creeks should be developed into beautiful water bodies attracting a wide variety of birds and animal life.
8. If today, we can realise even 20% of our dreams, we will improve our quality of life immensely.

2.6.3 Feedback and Guidance from Professionals

Increasing Techno sauviness in contemporary buildings – Need for Architectural Engineering Education in India.

Computerisation, networking, sophisticated usage requirements, stringent building and eco-friendly approach byelaw are making the contemporary building process more and more techno savvy.

As an example, let us look at the planning of a sophisticated laboratory. The various consultants required for the project are – structural, construction management, electrical, interiors, plumbing and drainage, gas piping, fire fighting, heating / ventilation and air conditioning, building maintenance systems, networking, wind / solar energy, rainwater harvesting, gray water recovery, waste management, parametric modeling and virtual pre-coordination.

Traditionally, the architect has been the team leader, the lead consultant for any building project. He is supposed to co-ordinate the activity of various consultants and sees the project to a technically fulfilling completion.

As said earlier, various factors are turning the building process more and more techno savvy. In such a scenario, an architect who is trained more in utility and aesthetics aspect of the built form may not be able to justice to the other aspects.

Here an associate, a sort of right hand, a well-trained architectural engineer will be of immense help to him, as he is trained with enough knowledge of Architecture to support the main architect and also knowledge of various technologies that go to make a building. Being trained holistically, he will help the main architect to find the right balance between aesthetics and technology.

Architectural Engineering was introduced in the USA as early as 1890 in the University of Illinois. Right now 15 Universities in USA and two Universities in UK offer Architectural Engineering as a full time graduate course.

In 1985, an attempt was made in India, by University of Calicut, by starting a degree course in Architectural Engineering, making students appear for Institute of Engineer's exam. Problems of non-acceptance of graduates by Council of Architecture and various statutory authorities resulted in closing down of the course.

Institute of Engineers, however, still continues with its Architectural Engineering division, supported by Civil Engineers Practicing as Architects. However, its long term continuance is bleak.

Today, the bureaucratic hurdles are stalling the process of introduction of graduate course in India, the dire need of making available Architectural Engineers for a smoother building process can be achieved by some different approaches. A one year / two years, full time/ part time post graduate degree / diploma in Architectural Engineering can be introduced by various educational institutes.

To summarise, techno savvyness in contemporary building has necessitated the promotion of training of Architectural Engineers who will help an Architect in holistic co-ordination in conception, design and construction of a built form.

Pramod Beri
Architect, Pune - Kolhapur

Note-Refer chapter 3, for more details on Architectural Engineering

2.6.4 Role of Project Management Consultant

Built Environment is land value changer. It transforms barren land into 'Real Estate' such as self sufficient township, high rise buildings with offices, restaurants, malls, residential units as per the demand. It creates job opportunity for the development of individual, society and nation.

Today planning, designing, construction needs services of 'Project Management Consultant' up to occupation and then 'Building Maintenance Engineer' for maintenance services.

Role of Project Management Consultant demands knowledge based solutions for the total integrated development. New age real estate companies need not invest heavily into purchasing land and related risks but are in a position to approach a land owner with good real estate proposal, arrange the finance, build and operate it with the help of Project Management Consultant.

Basic services of Project Management Consultant (PMC) are related to -

1. Study of proposal
2. Infrastructural development
3. Architectural and Structural services
4. Approval from different authorities
5. Services of various consultants
   (a) Fire fighting and safety
   (b) HVAC and dust control
   (c) Effluent treatment and water treatment plant
   (d) Electrical consultant
   (e) Power system protection design
   (f) Control Automation and Instrumentation
   (g) Procurement Assistance
   (h) Interior designing
   (i) Landscaping
   (j) Solar Energy Consultant
   (k) Construction Management Services
   (l) Documentation
   (m) Post Contract Services

Eco-friendly construction may require additional services for 'Green Certification' or from 'Eco-Housing Assessment Scheme'.

"*The basic consideration is the totality, not to treat the buildings as functional assemblies of engineering cubicals but as lively spaces created for the performance of the user*."

- Project Management Consultant controls various works with the help of construction managers. Mr Anand Joshi of S N Joshi Consultants Pvt. Ltd., Pune who works as Project Management Consultant has given details for the work of 'Construction Manager' who works on site under P M C.

1. *Scope of Work*

(a) Collecting and understanding scope of the project from the Assoc VP (PMC) / Functional Head (Project Execution)
(b) Study and verify the contract documents
(c) Study and verify the drawings
(d) Study and verify the planning schedule
(e) Study and verify the equipment logistics plan
(f) Study and verify the quality plan
(g) Study and verify the various checklists
(h) Familiarise with the MIS as per the ISO requirements

2. *Construction*

(a) Establish site offices, QC lab
(b) Establish infrastructure for office and construction
(c) Responsible for overall control of construction activity at the site
(d) Collect and Review weekly, fortnightly and monthly periodical report for the entire site and ensure timely submission to the concern authorities
(e) Maintain QC Lab and timely testing of construction material regularly
(f) Project Execution as per the design, drawings and specifications given
(g) Complete accountability for quality and timely completion of the project as per the schedule
(h) Co-ordinate with Client, Architects, Consultants, Contractors during the project execution
(i) Monitor the working of the contractors for adequacy of manpower and workmanship
(j) Attend all meetings on site, prepare minutes of meetings and keep the Head (Project Execution) informed about the project execution
(k) Monitor and Control the incoming material and the quality, quantity of the same
(l) Responsible for recovery from the clients during the progress of the project
(m) Obtain necessary certificates from various consultants at specified stages of the project for records
(n) Tracking and updating project schedules and reporting to the Functional Head (Planning) for revisions in the project schedule, if any
(o) Handle clients and attend to their queries
(p) To follow and enforce company policy decisions in respect of safety, field tests, dress code, punctuality, site discipline
(q) Maintain neatness and tidiness at site along with good and prompt housekeeping
(r) Maintain the accounts and overall administration of the resources at the site
(s) Verify measurements and certify the bills of contractors
(t) Review and approve reconciliation of materials given by the Lead Engineers

3. *Post Construction*

(a) Preparing snag list and get all rectification jobs executed
(b) Settlement of final bills of all contractors
(c) Issue virtual completion certificate to the concern agencies

4. *Handing Over*

(a) Preparation of handover manual comprising of the following:
- As Built drawings
- Photographic records
- Asset list and reconciliation statement
- Facility management manual

(b) Submit the entire project document to the Functional Head (Project Execution)

5. *Process Improvement*

(a) Critically review all the standard processes used for the construction on site and suggest improvements
(b) Give inputs to the R & D Department in the corporate on any information related new processes and technology

6. *Other Activities*

(a) Allocate work to all direct reportees and evaluate their performance
(b) Conduct performance appraisal of direct reportees
(c) Identify training needs and communicate with HRD team
(d) Review and monitor staff productivity to ensure optimum performance
(e) Motivating, retention and career growth of the team
(f) Resolve all people issues within the team

2.6.5 Role of Urban Planners - Need for Urban Planning Schools

Government has realised that infrastructural development is a key to India's planned and predicted growth. Along with infrastructural development, we need sufficient Urban Planning Schools for post graduations for Architects, Landscape Architects for Environmental Art and Design, and for Civil Engineers to become 'City Manager', for newly planned towns and management of townships. Universities abroad offer a wide range of courses on 'Urban Planning' which cover all aspects in this field. There are separate courses for 'Real Estate Developers' and 'Builders'. We need Urban Planners who are aware of our socio-cultural fabric of our urban space. Our own Urban Planners who are educated in foreign universities will be useful for training fresh urban planners.

In the year 2010, when emphasis was given on 'Green Cities', 'Green Architecture', 'Affordable Housing' and 'Eco-assessment Scheme', expectations from Architects, Engineers and Landscape Architects have got new dimensions.

Feedback from Professor Pratap Raval, College of Engineering, Pune will throw more light on the necessity of specialised course for Urban Planners and their challenges.

Urban Planning for Quality of Life

"*The end of human race will be that it will eventually die of civilisation*". These rather radical words of Ralph Waldo Emerson should be enough to caution us. Ever since man has begun his journey towards civilisation, we have been showing greater greed. We tend to forget the environmental and social issues and the limited resources that Mother Earth provides us with. Urban planning is just one of the issues in this multifaceted problem.

Over the years, the quality of life in cities all over India has deteriorated. Urbanisation has brought with it complexities in life. In order to ensure a better and safer world to our future generations we need to address these complexities. Urban India is faced with congestions, cramming of residential layouts in unauthorised and unplanned areas, and crumbling or inadequate infrastructure delivery systems, resulting in degradation of sanitary and environmental condition. Urban planning is multidimensional including effective land usage, architecture, design, sanitation and drinking water just to mention a few. Urban planning is designed to regulate the use of land and other physical resources in the public interest and can make tremendous difference in the quality of life and well being of the people living in cities.

In a city, the pieces of land are essential to the well-being of the whole. How these pieces are put together and their relation to one another is what is particular about the design of a city. It is for this reason that a city is often described as a machine - the little parts adding up to create the grand design. Urban planning can be defined as the design and regulation of the uses of space that focus on the physical form, economic functions, and social impacts of the urban environment and on the location of different activities within it. Urban planning impacts societies on a number of fronts: housing requirements for all social segments of existing and migrant population, micro-economic activities of people, social harmony and cohesion sustained economic development of cities, aesthetic and environmental concerns. In essence, planning plays a significant role in contributing to people's overall quality of life.

European Sustainable Development and Health Series : 3 described the Urban Planning is the process which includes land use planning, town and country planning, physical planning, urban and regional planning, territorial planning and space management systems.

The urban planning system provides the means to encourage good design, not just in conservation areas and other attractive places, but everywhere. Securing good design is central to good urban planning. The appearance of proposed development and its relationship to its surroundings are relevant to the consideration of an urban planning application to urban local authorities in Europe.

Urban Planning Systems generally comprises three functions:

1. Long term strategic planning provides an integrated vision for future based on an overall evaluation of strengths, weakness, opportunities and threats.
2. Plan making is 'providing frameworks through the development strategies and plan at different geographical scales' the plan includes wide spectrum of content : strategies, policies, projects, structures, facts, figures, land use, settlement patterns, housing, statutory measures, retail, tourism, slum issues, transport schemes, environmental action, measure to achieve social equity, economic decisions and investments.
3. Development Control includes "legal or administrative procedures operating at the local level to control the location and form of development and the changes within buildings.

Urban planning in India functions through mechanisms called Urban Local Bodies or ULBs. These Urban Local Bodies are classified into four major categories:

1. District Planning Committee
2. Metropolitan Planning Committee
3. Municipal Corporations
4. Municipalities (Municipal Councils)
5. Notified Area Committees

In Indian context, development Plan is spatial unite for Urban Planning and the 'development plan' provides an essential framework for guiding and controlling development. The development plan may comprise one or more types of plan depending on geographical location. Among other things, the development plan:

1. Provides a vision for the area
2. Identifies the main objectives to realise that vision
3. Defines the local context of people and places
4. Sets out the overall design policy framework (and other considerations) against which the local authority will assess development proposals
5. Provides the policy foundation for supplementary planning guidance

Today, there is new emphasis on decentralisation, transparency and accountability to achieve sustainable urban development embracing the concern for quality of life; equity between people; intergenerational equity; social and ethical dimensions of human welfare and carrying capacity of natural environment.

Information related to 'Town and Country Planning Courses' will be useful for further studies. The details for the same are —

1. College of Engineering, Pune www.coep.org.in
2. School of Planning and Architecture, New Delhi, www.spa.ernet.in
3. School of Planning and Architecture, J.N.T.U., Hyderabad www.jntu.ac.in
4. Guru Ramdas School of Planning, GNDU, Amritsar www.gnduonline.org
5. CEPT University, Ahmedabad, www.cept.ac.in
6. School of Architecture and Planning, Anna University, Chennai, www.annauniv.edu/sap
7. Indian Institute of Development Studies, Mysore, www.uni-mysore.ac.in
8. School of Planning and Architecture, Bhopal.
9. Sardar Vallabhbhai National Institute of Technology, Surat, www.svnit.ac.in
10. Visvesvaraya National Institute of Technology, Nagpur, www.vnitnagpur.ac.in.
11. Indian Institute of Technology, Kharagpur
12. Indian Institute of Technology, Roorkee.

2.7 CASE STUDIES

2.7.1 Garden City Shenzhen – China

Garden city, Shenzhen, in China is a good example of Built Environment with an integrated approach of all planners, ecologists, urban designers, architects, landscape architects and horticulturists. Shenzhen is not only famous for its planning, architecture and infrastructure but also known as a well-maintained town with gardens and greenery, a calm, quiet and cheerful environment alongwith different transport systems with air conditioned buses and metro railway.

1. China is first in population and the third largest country in the World [(1) Canada (2) Russia (3) China]. It was ruled by different dynasties for 700 years.
2. Cultural Revolution began in the year 1919; China became independent on 1st October, 1949. Credit of the speedy development after 1976 goes to well known leader Deng Zao Ping.
3. Shenzhen is a new city planned and developed between the years 1980 to 1995 to compete with Hong Kong.
4. One can reach Shenzhen from Mumbai to Singapore in four hours, then from Singapore to Shenzhen in four hours or from Mumbai to Hong Kong by air in eight hours and then by train / road/ fairy boat within one hour. Shenzhen is nearly in line with cities – Allahabad, Dacca and Kolkata.
5. Shenzhen is the name of the river that meets the sea between Hong Kong and Shenzhen. Shenzhen, the fisherman's village was declared as 'SEZ' – Special Economic Zone to develop new town as International Tourist Centre and Garden city. It is claimed that the prospect of the development of tourism in Shenzhen is much wider and Shenzhen will become the tourist attraction with both national feature and modern characteristics.
6. Shenzhen is rich with greenery and hills, water reservoirs, and with nearness to sea on south side its average temperature is 23.7°C with mid subtropical maritime climate.
7. **Layout of Roads**–Main roads are with 8 / 10/ 12 lanes with wide footpaths and trees on both sides which add to the beauty of the road and multistoried buildings with attractive designs. Signage, and bus stops with information boards in English and Chinese language help tourists. Scooters, Motorcycles and bicycles are not permitted on these roads. Air conditioned buses, taxies and metro are the main modes of transport with 80 km/h speed. Town Map showing bus routes and numbers, web site details for tourist spots, hotels, gardens etc is useful for the tourists.
8. **Tourist Attractions:**
   - **(a) Window of the World**–4,80,000 sq. m. theme park with 130 scenic spots, 108 m. tall Eiffel tower, Niagara Falls, Taj Mahal and other wonders of the world are created amidst well-developed layout plan with trees and flowers. Open air theater to accommodate audience of 10,000 for entertainment programme is another attraction. Well-planned and maintained spot is full of greenery, pathways, and roadways for full entertainment in a day.

     http://www.szwwco.com
   - **(b) "Splendid China" and "China Folk Cultural Villages"**–This is another tourist spot created to know history of China in a period of 5000 years, culture, art, ancient architecture and Chinese folk art and dance. More than 50 million visitors all over the world have visited this cultural village. An investment of over 100 million RMB was done.

     http:/www.cn5000.com.in
   - **(c) Shenzhen Sea World**–It is a beautiful scenic spot to enjoy water sports, exhibition of boats, ships, marine life, dolphin show, etc.

     http://www.szxms.com.cn
   - **(d). Shenzhen International Garden and Flower Expo Park**–66 hectares area is developed with the help of 25 countries and 67 domestic cities in China for creating 100 scenic spots with the help of fountains, sculptures, trees and flowers. The biggest 1000 kva solar power system is a special feature.

     http://www.shenzhengarden.com
   - **(e) Shenzhen – Garden City**–Small and big gardens with lakes for fishing, lotus flowers and facility for boating are created and maintained in a systematic manner. Fairy Lake, Botanical Garden preserves over 6500 species of plants. It is a picturesque and unforgettable garden with green hills and a boat club.

     http://www.szbg.org.
9. **Residential Complexes**–Well-planned and constructed complexes are maintained through different agencies. Complexes consist of different six to twenty four storied buildings with all essential amenities lifts, air conditioning, gardens, swimming pools, gyms with latest equipment along with equipment for kid's play area, security, shops, play areas with calm and quite environment with trees, flowers, water ponds in unbuilt area has created pleasing, cheerful surroundings for living and has achieved 'Livability".

Conclusion

Four months stay (Oct. 28th to Feb. 25, 2005) in Shenzhen Garden City was calm and quite living experience in the residential complex and city has shown various factors which have contributed to give one quality, i.e., 'Livability'. Encouraging, motivating, peaceful, colourful, pleasant environment which is highly essential in a stressful life. Not only creation by architects and builders but equally important factor is the behaviour of residents. Happy and contented residents are the gift of such creation. Play areas, gyms, swimming pools, outdoor sitting, colourful plants with day to day careful maintenance have added charm to keep mind and body fit. It was a pleasure to move in a city in air conditioned buses, walk on wide and clean footpath and watch architectural creations. Discipline in traffic has reduced total noise factor in a city of about 80 lacs of population. Nearness of sea shore, hills with greenery, ample water and malls flooded with people, hotels and restaurants have made this city really a place of attraction in China.

S Y Patki

Ref. 1. Brochures related to various tourists places.
2. Shenzhen Daily, News Paper

2.7.2 Neighbourhood Planning – Bracknell UK

1. *History of Bracknell*

Lion Kelly's directory of 1847 referred to Bracknell as a small village situated on the main road to the West of England consisting of a long narrow street. By 1891, the population of Bracknell was 2220 with Priest wood being the most populated area.

In 1948, the Ministry of Town and Country Planning chose Bracknell as the location for a new town to which Londoners, made homeless by the war would move. The first neighbourhoods were developed in the 1950s and today, the population of the once modest market village is around 60,000.

Several large mansions such as East Hampstead park, South Hill Park and Lily Hill Park proved important to the history of what is now modern Bracknell. These grand houses brought trade, employment and famous visitors to the village.

In the 1850s, water in the town was obtained from pumps and wells.

2. *The Railway Line*

Bracknell forest was the quiet rural area lying south of the Great Bath Road, linking London to Bristol. London was a great market for goods and frustration of inadequate road transport in the early nineteenth century led to the plan for an ambitious railway line to link the seaport at Bristol to London.

The railways brought commuters and middle class entrepreneurs with their wealth and demand for schools, churches, and other public amenities leading to the opening of the whole area for development. The branch line was electrified in 1939, when electric trains replaced the old steam locomotives.

3. *The Brick Industry*

The geology of the region was a principal factor in the importance of the brick making industry in the borough. In the Bracknell area, there were brickworks at Binifield, Warfield and Wokingham.

4. *The Concept of the New Town Movement*

The idea of the British New Town Movement was first proposed by the Victorian Ebenezer Howard, whose book, *Garden Cities of Tomorrow* provided inspiration for post-war planners. The vast destruction inflicted by the Second World War created a need especially in London for both houses and jobs. In 1944, the Greater London Plan recommended the establishment of 10 satellite towns to meet the housing shortage. In 1945, the New Towns Committee created government sponsored corporations financed by the Exchequer. They were given the power to acquire land within a defined, designated area to establish new towns. The New Towns Act, 1946 provided the Government with the power to implement these plans.

The New Towns were not intended on either industrial estates or dormitory suburbs. The principle was that they would become self contained communities combining the convenience of town life with the advantages of the country. Local industry, shops, housing and cultural facilities would be provided to meet the needs of the local inhabitants.

5. *Industry and the New Town*

Bullbrook and Easthampstead became the nucleus for the Eastern and Western Industrial areas. Firms wishing to come to the New Town had to obtain the vital documents; the Industrial Development Certificate and a Building License. To encourage existing employees to move to the new town with their firm, tours around the town and new housing developments were organised at weekends for visitors and were highly successful. A limiting factor on the growth of industry was the building of the new housing to accommodate employees. There was fierce competition between firms to increase their housing allocation from the Bracknell Development Corporation as those organisations guaranteeing housing to employees could attract more suitable candidates. The extension of the new town in 1963 led to the opening of the Southern Industrial area.

6. *New Town Development Corporation*

The New Town for 25,000 people was intended to occupy over 1000 hectares of land in and around ‘Old Bracknell’ in the area now covered by Priesthood, Easthampstead, Bullbrook and Hormon’s water. The existing town centre and industrial areas were to be retained with new industry brought to provide jobs.

A Development Corporation of eight members was set up to steer the construction of the new Town. The start up money was loaned by the Government, to be paid back by renting out houses, factories and shops. The corporation started with a strong preference for houses, rather than flats and for traditional building methods and materials. Plans for the New Town generated much hostility. Compulsory purchase orders, which forced people to sell property and land for housing, were the cause of much resentment as they offered very low rate of compensation. In addition, many were angry because the corporation was not allowed to house existing Bracknell residents in the New Town.

The representation and redevelopment of Bracknell Town centre is an ongoing objective which seeks to revitalise the heart of Bracknell, creating a more enjoyable and sustainable place to live, work, shop and socialise.

Observations

It was a pleasure for me to stay in Bracknell town for a period of three months.

1. It is a calm and quite town, full of greenery.
2. Well-planned areas with roads for cars, pathways and footpaths for pedestrians.
3. Different types of houses, single, double-storeyed and three-storeyed apartment blocks.
4. Typical house consist of front open space and back yard, with all amenities.
5. School, Library, Community Centre, shops for different areas are located at convenient locations.
6. Bus transport system is very efficient.
7. Town Centre provides all essential amenities. Well-designed centers create pleasing experience while moving and purchasing.
8. Gardens, Play areas, Gym buildings, Community canteen with Theatre have been provided with ample opportunities to keep oneself fit, mentally and physically.

S Y Patki

Reference

1. Core strategy Development Plan Document –February 2008, Bracknell Forest Borough Council Local Development Frame Work.
2. Brochures related to sight seeing spots published by Council.

2.7.3 Self-Sufficient Township

Townships with affordable housing and amenities is the need of the future. List of amenities is given below. Learner should add in this list after reading brochures and after visiting construction sites - completed townships. Time saver standard handbook gives details, dimensions, various considerations for the requirement of these amenities for preparing detailed drawings.

1. Housing	• 2/3/4 bedroom flats, duplex units • Grand landscaped entrance with security control, signage, watchman’s cabin, separate entry and exist gates
2. Entertainment	• Mini theater, open area theater • Club house with modern amenities with a crèche • Library
3. Sports	• Swimming pool with attached kids pool / water slide / fun pool / open showers • Basket ball court, cricket pitch, football ground, tennis court, table tennis, pool table • Skating area, Indoor games hall • Mini golf area • Well-equipped gymnasium • Jogging track, pet’s walkway • Children’s play area with sand pit, activity zone, floor chess / Snake and Ladder, other play equipments • Toddler’s play area • Cycling track

4. Healthcare
- Health spa / Steam and Massage rooms
- Meditation hall / Aerobics / Yoga hall
- Accupressure path
- Medical center

5. Social Get-together
- Senior citizen's sitting area / covered and semi-covered sit-outs
- Laughter club area
- Multipurpose hall

6. Education Facilities
- Nursery / Primary / Secondary schools

7. Amenities
- Inverter back up facility
- Piped Gas for cooking LPG system
- Intercom facility
- Toilets for servant's, drivers, visitors
- Parking area for visitors
- Advanced fire fighting system
- Well-planned internal roads with road side avenue plantation - Footpaths, walkways - concrete / paving block finish
- CCTV monitoring for common area / peripheral surveillance
- Sewage treatment plant with grey water circulation system
- Rain Water harvesting
- Bore wells / wells
- Lifts with generator back up
- Car washing unit
- Battery car transport system
- Solar system for hot water / generation of electricity for street lighting
- Shopping arcade

8. Garden / Nursery
- Eco-friendly plantation
- Drip / Sprinkler systems for garden/lawn
- Nursery for trees/flowering plants / ornamental plants
- Storage space for garden equipments
- Fountains
- Garbage - Dry and wet, processing units, storage for manure
- Grey water circulation system
- Bio-gas conversion unit
- Medicinal plants, fruit trees

CASE STUDY - TOWNSHIP, HOUSING, INTERIOR DESIGN

1. Blue Ridge @ Hinjewadi, Pune
Flagship - Infrastructure (P) Ltd.
Paranjape Schemes
An ISO 9001:2000 Company
E-mail-contact@blueridge.in
www.blueridge.in

: Integrated International Township - Residential Housing and Commercial space with leisure facilities and amenities in 138 acres.
Study layout plan, read text – A piece of land of 138 acres, its shape, location of North and river. It is transformed into a well-thought out plan for housing and commercial use with many many amenities.
Think of different stages in planning, rules for township, total development, essential infrastructure, amenities and landscaping. Visit to the site will enrich learner while watching transformation of two-dimensional working drawings into three-dimensional structures ready for occupation.

2. Nandan Prospera -
A Housing Scheme at Baner - Pune
(M/s. Shamkant Kotkar Buildcon)
E-mail-info@nandanbuildcon.com
www.nandanbuildcon.com

: A project with prestigious CRISIL 5 - STAR REAL ESTATE RATING for excellence in construction.
Study various details relating to planning, amenities and construction.
Four buildings connected at eighth floor level, view overlooking beautiful landscape, sky. Visit to the project will give ample food for thinking - Planning to construction and then for Environmental Design Evaluation.

3. Interior Design - Clinic for an Orthodontist
Vivek Patki
E-mail-vpatsons@vsnl.com

: 'CREATION' ! Conversion of 522 sq. ft 48m^2 apartment into a functional and aesthetic clinic for an Orthodontist. Text, drawings and photographs will explain the total procedure behind the challenges in the creation.

4. Interior Design -
Design of Kitchen
Kitchen Grace
www.kitchengrace.com

: Workable, eye-catching, strong, durable surfaces, pleasing colours and features that maximises space - in addition it should be relaxing.
Kitchen grace gives details about kitchen work triangle and so many considerations.

Blue Ridge Township at Hinjewadi, Pune

Paranjape Schemes (Constructions) Limited,
An ISO 9001:2000 Company
Architects: ECADI Fairwood
Anirudha Vaidya and Associates.
R C C Consultants: J + W Consultants, Formerly Y S Sane Associates.
Legal Advisor: Sudhakar Kale, Trilegal, Mumbai

1. Be a World Citizen – People lived amidst the pure delight of lush natural surroundings, though without the comfort of modern facilities. In today's urban life, we have all the modern comforts. But unfortunately, nature finds no place in today's crowded cities.

At the golden middle of these two extremes, lies a well-balanced lifestyle of a modern township 'Blue Ridge'. With the amenities of tomorrow and environs of the yore, it is the place that raises your lifestyle to global standards and makes you a true world citizen.

2. About 'Blue Ridge Township' – 138 acres of sheer Excellence – this Integrated International Township blends the best in Residential Housing and Commercial Space. Strategically located in Hinjewadi the IT Hub of Pune, Blue Ridge offers Leisure Facilities and Amenities which are a class apart.

- 10 min. off the Pune – Mumbai expressway.
- Proposed road from the site to main Hinjewadi road – 5 min.
- Proposed road to Baner (6 lane super highway) – 3 min.
- Ample power for over 1000 hectares of development expected from MSEDCL.
- Rajiv Gandhi InfoTech Park – A renowned IT hub and other big IT giants.
- About 5500 jobs will be created in the next few years.
- 36 new educational institutes coming up.
- Hotels: Taj Gateway, JW Marriot, Smart Inn, Le Royale, Hotel Lemon Tree, St. Laurn, Sayaji.
- New fire station being set up – The best in India.

Ultra Modern Features

- The range of 1,2,3,4 and 5 BHK apartments and duplexes set in 25 storey high towers, are ready to create an unparalleled living experience.
- Blue Ridge is not only designed to suit your present day needs, but will also stay at pace with your changing and growing need over time.
- A well-maintained township.
- Provision for maintenance of landscape, roads, public area lighting systems, etc.
- Provision for maintaining, optimising and maintaining all utilities like water treatment plant, waste and sewage treatment plant, irrigation systems, electrical substations, etc.
- Ample provision for multiple service providers for phone, television, internet, etc., will get residents the connectivity without digging up the roads.
- Maintenance by professional – facilities management agency.

Salient Features

- Aluminium form work technology by Mivan for superior finish.
- Well-built concrete roads with landscaped sidewalks.
- Extensively landscaped podiums.
- Ecologically balanced treatment on the river front.
- Marina with due regard to safety and security.
- Captive water treatment plant.
- Recycling of treated sewage water for irrigation.
- No sewage dumping into river.
- Recycling and reuse of waste.
- Captive 220/22 KVA power substation.
- Designed to suit your present day needs, changing and growing needs over time.

Phase I

- SEZ Administrative office – Banks – Cafeteria – Specialty Restaurant
- Six buildings with a total built up of 1.3 million sq. ft.
- Floor plates ranging from 13000 – 45000 sq. ft. with an 80% efficiency and flat slab construction with no beams.
- Six high speed elevators per building, the latest from Kone.
- Two level basement parking.
- A walk down to the office will let the vision take the shape.
- Inspiring office environs.

Sports – Leisure

- Kayaking – Beach Volley ball – Squash – Skating – Cycling, Badminton, Soccer, Golf, Swimming.
- Spa, Club house, Boat Club with Marina – Yoga / Meditation Hall, Music, Gym, Pet zoo, Fishing, Sunset Point.
- Shopping Mall, Multiplex, Entertainment Zone, Restaurant, Vegetable Market, Gaming Zone, Amphitheatre.
- Blue Ridge Public School – ICSE Board Curriculum.
- Blue Nest – Day care center for your little ones.
- Unpolluted, fresh, cool, environs along the beautiful water lagoons and huge green trees, Coconut Grove – Fruit Orchard, Landscaped Gardens with Water bodies , Road side trees, Urban forest, Butterfly Garden.
- Blue Ridge – The World of leisure, luxury, sports, entertainment, lifestyle in commune with nature and eternal bliss.
- Experience the complete world.

Blue Ridge Township — Case Study

Mivan Technology for 25 storey high towers —

MIVAN Information

The basic element of Mivan Form Work consists of panels made from extruded aluminum section welded to 4 mm aluminum sheet. The panels are light in weight with excellent stiffness factor thereby yielding to minimum deflection / self-bulging under wet concrete pressure and concrete vibrators. The panels are manufactured in standard sizes to suit the requirement of specific type of construction, be it residential or commercial or any other structure. Installation and erection Mivan Form work is a simple PIN & WEDGE type, that pass through holes in the outside ribs of adjacent panels. The main advantage of this type of shuttering is fast progress and high quality concrete with accurate tolerance, verticality and excellent finish. This eliminates the application of internal and external plastering. The other important aspect is that the masonry activity is tremendously minimised thereby reducing the completion time and labour. High quality concrete finish is produced within the accurate tolerance limits related to verticality, line, level and plumb. No further plastering is required. The shuttering panels and accessories can easily be erected by regular nonskilled labours, after a nominal training given to them.

Advantages

1. Project duration is reduced, as the structure is erected speedily. The total erection process is manual and labour oriented. No machineries are required.
2. It gives consistency in dimensions.
3. Ensures perfect right angle joints between wall and slab.
4. It gives high tolerance of finish concrete surface.
5. It is possible to achieve minimum four days per floor to a maximum of 10 days constructions work cycle.
6. It is possible to accurately programme construction sequence due to repetitive and stereotype nature of the assembly process.
7. This enables unskilled labour to work with the formwork and reducing the requirement of skilled labour.
8. The panels fit precisely, simply and secured with each other, thereby minimising cement slurry oozing between gaps as compared to conventional shuttering.
9. No bracing is required.
10. The only tool being used during erection is the regular hammer, eliminating the use of nails and other accessories as used in conventional shuttering system.
11. Making, remaking is eliminated, thereby reducing wooden material, time and labour. Mivan shuttering is also cost-effective in stereotype designed buildings.
12. Mivan shuttering can be deshuttered after 36 hrs as the system has provisions for props to be left behind.
13. Mivan form work eliminates the necessity of scaffolding as compared to the buildings constructed by conventional system and is very efficient in the construction of multi-storeyed buildings. The formwork can be used by unskilled labour more than 300 times without loss of quality.

Methodology For Mivan Shuttering

1. The reinforcement for the vertical structural members to be placed in position.
2. Start Mivan shuttering at first floor level (or as designed).
3. At the Mivan originating level, insert the kicker nut bolt by drilling the holes to the external vertical face of the beam / column by + - 5 mm accuracy in line and level before concreting of slab.
4. Mark the base line on slab through total station in both directions.
5. Erect the internal walls and columns. The electrical junction boxes and conduits should be placed in position simultaneously during the erection of the vertical panels.
6. Fix the deck slab.
7. Tie the reinforcement for the slab and beams,
8. Any electrical and plumbing cut-outs should be placed in the respective predetermined locations. All conduiting for electrical works shall be fixed after the reinforcement work is completed.
9. Re-check and confirm the verticality, plumb, line and level of the slab and walls
10. Cast the slab.

DESIGN OBJECTIVES

- To derive a master plan considering site conditions, weather conditions and environmental aspects.
- To integrate as well as also segregate to desired levels various requirements and activities.
- Environmental and Energy aspects to be given priority while arriving at the design solution.
- The overall design should cater to the aspirations of the buyers, majority in this case could be young IT Professionals.
- Vastu shashtra points to be catered to the maximum without compromising design quality.
- Individual housing units to be designed to accommodate the needs of the users to the utmost level.
- Requirements of the present building rules and proposed rules & policies to be studied and design has to fit in such rules.
- Considering the location, the scheme is to be properly conceived as it would give an impact from the busy Mumbai-Bangalore bye-pass and especially the high-rise character of the scheme would make a very strong presence.

NANDAN PROSPERA- A HOUSING SCHEME AT BANER

NANDAN ASSOCIATES (Mr.Shamkant Kotkar) TRADITIONAL VALUES,MODERN VISION

VK:a
architecture

5 Agarkar Bhavan
L B Shastri Road
Navi Peth
Pune 411030

t: +91 20 24335668
f: +91 20 24331203

e: mail@vkarch.com
w: www.vkarch.com

Figure 2.1 *Nandan Prospera – Design Objectives*

CLINIC FOR AN ORTHODONTIST

Architect – Vivek Patki – Patsons, Carpet area 522 sq. ft (48 m^2).

Clinic

The brief was to convert a 522 sq. ft (48 m^2) apartment into a functional and aesthetic clinic for an orthodontist – by no means a mean task. What made it happen was the creative handling of the nine working areas, converting every negative constraint to advantage, and utilising the available space to fulfill the precise and well-researched requirements of the client, Dr Jayesh Rahalkar.

After detailed sittings where I tried to get a feel of his requirements, a plan was prepared.

Structural Constraints

The toilet positions were already fixed, though the internal walls had not been constructed. Also, there was a column and seven feet headway below the beam which needed to be tackled imaginatively. There were only three windows – two from the Westside and one from the duct. Most of these negatives, however, were finally turned to our advantage.

Reception Area

Double doors were provided at the entrance – the main door with the name plate opens on walls, while the inward opening door is of glass, for transparency. The reception was placed facing the entrance passage, with a door for the staff to go into the consultation room, while a separate door would be used by patients coming to visit the doctor. The idea behind this was to give an impression that staff, technicians, assistants, etc., were going into another room and not infringing on the doctor's time when the patient was waiting.

The doctor had said that he wanted an aquarium in the waiting room. I decided to make it a focal point, by enclosing it within an unusual, angular wooden structure. Niches in the wall facing the receptionist were used to house a mock series of steps for displaying artifacts and an idol of Dhanvantari. A television with speakers was hung in the seating area with sufficient headway for entering the passage. A glass brick wall between the reception and the working area looks dramatic and adds to the light effect. Everywhere we have tried to use mirror and glass to reiterate the concept of transparency.

A low partition was created at the right of the reception to make room for a passage that would lead to the second door used by the staff, with place for their raincoats, umbrellas, lockers and a shoe rack. This passage also leads to the toilet. The bathroom was converted into a small pantry cum changing room for the doctor.

Consulting and Examination Area

The doctor's table is designed in a semicircular shape so that the patient can be close to the doctor. The look here is warm with wooden wall panelling. The AC in a wooden cabinet was fitted in the wall so as not to obstruct natural light coming in the lone window. Colourful chairs lend cheer and a column with glass ledges displaying artifacts completes the look. A low partition successfully hides the dental chair behind it.

At the other end of this room is the basic treatment planning table, a glass tracing table with adjustable illumination. The X-ray panel near the doctor's chair has been designed so that it can be seen by the doctor during the clinical procedure.

Crossing over to the examination side is the dental chair where the ambience is more functional with white lights dominating. The flooring is in pleasant white granite. A unique sliding trolley fits neatly into the ledge on the side when not in use, and another trolley is provided for the light cure machine. Drawers line one wall, and a mirror running through the length of the wall with lines etched on it, gives depth and dimension. A granite platform with sink, foot operated taps and a soft board showing the appointments of the day are additional features provided for practical purposes.

All the services are concealed to make movement around the chair free and easy, so that the doctor can work with two assistants and the patient conveniently.

Ample storage is provided, since the doctor needed to store all study models of teeth made by him for a period of eight years according to the law. The working area is also used by Dr Rahalkar's wife, an ayurvedic and health consultant for her practice.

The kitchen has been converted into the laboratory and sterilisation area. Double folded shutters were made for ease in operation. The compressor connected to the dental chairs is also fitted here as required.

Since the colour of the chair of the dental unit was pre-decided – a sea green – the rest of the clinic needed to have a colour scheme to complement it. Patches of yellow, red and blue were added to the white and sea green to brighten things up.

Concealed wiring with safety devices is provided for lighting as well as gadgets. Balanced lighting with warm halogens at the reception and neon-diffused light inside the false ceiling is used.

Conclusion

Optimum use of space with minimum passage area, niches converted into complete working units, use of glass and mirrors all over to create the illusion of space, and give a cozy, nonclinical look and a cool colour scheme, have all helped in creating a comfortable, extremely functional clinic in just 522 sq. ft.

References: Inside Outside magazine September 2001.
Design of Small Spaces

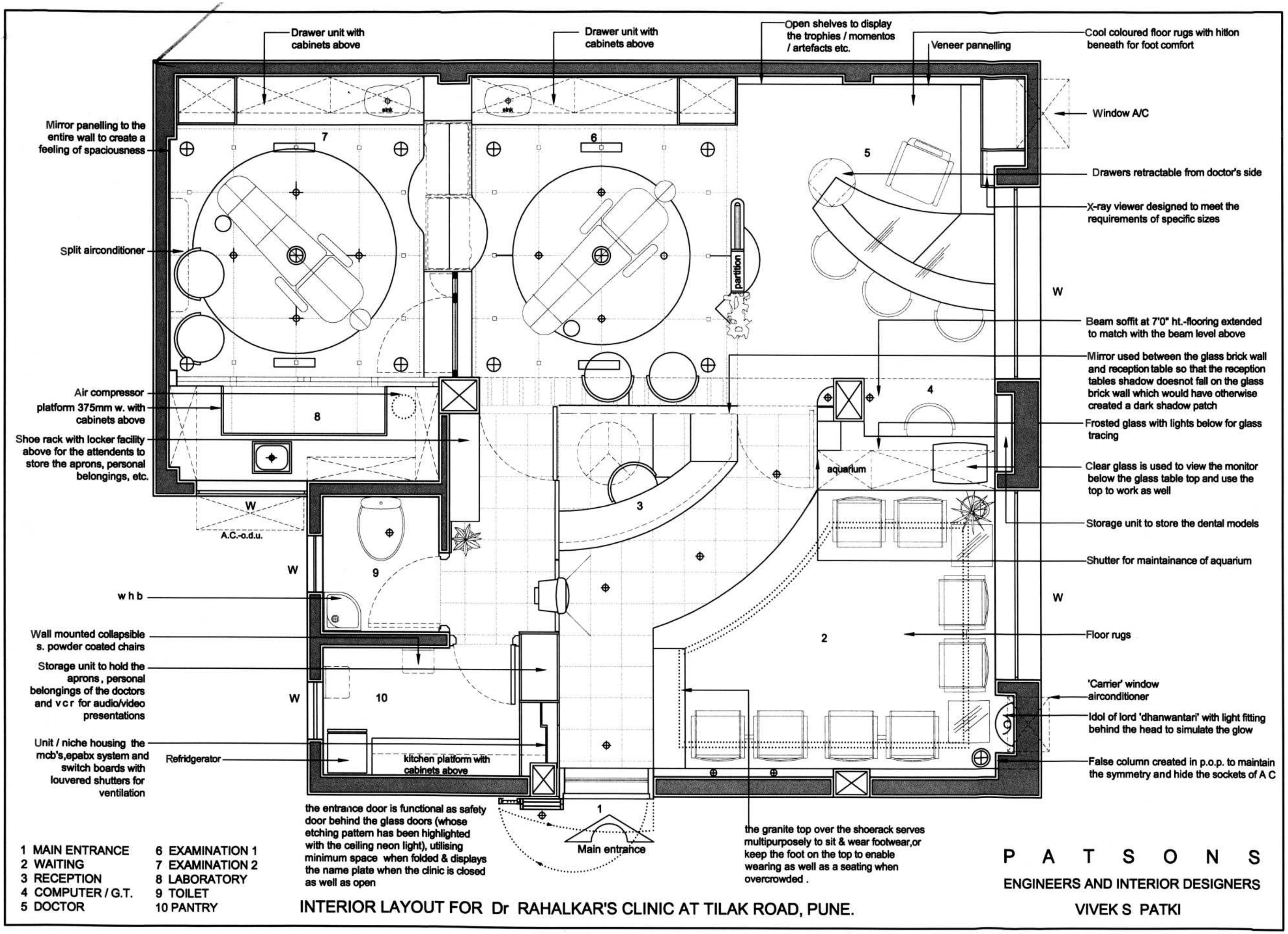

Figure 2.2 *Clinic for an Orthodontist – Interior Layout*

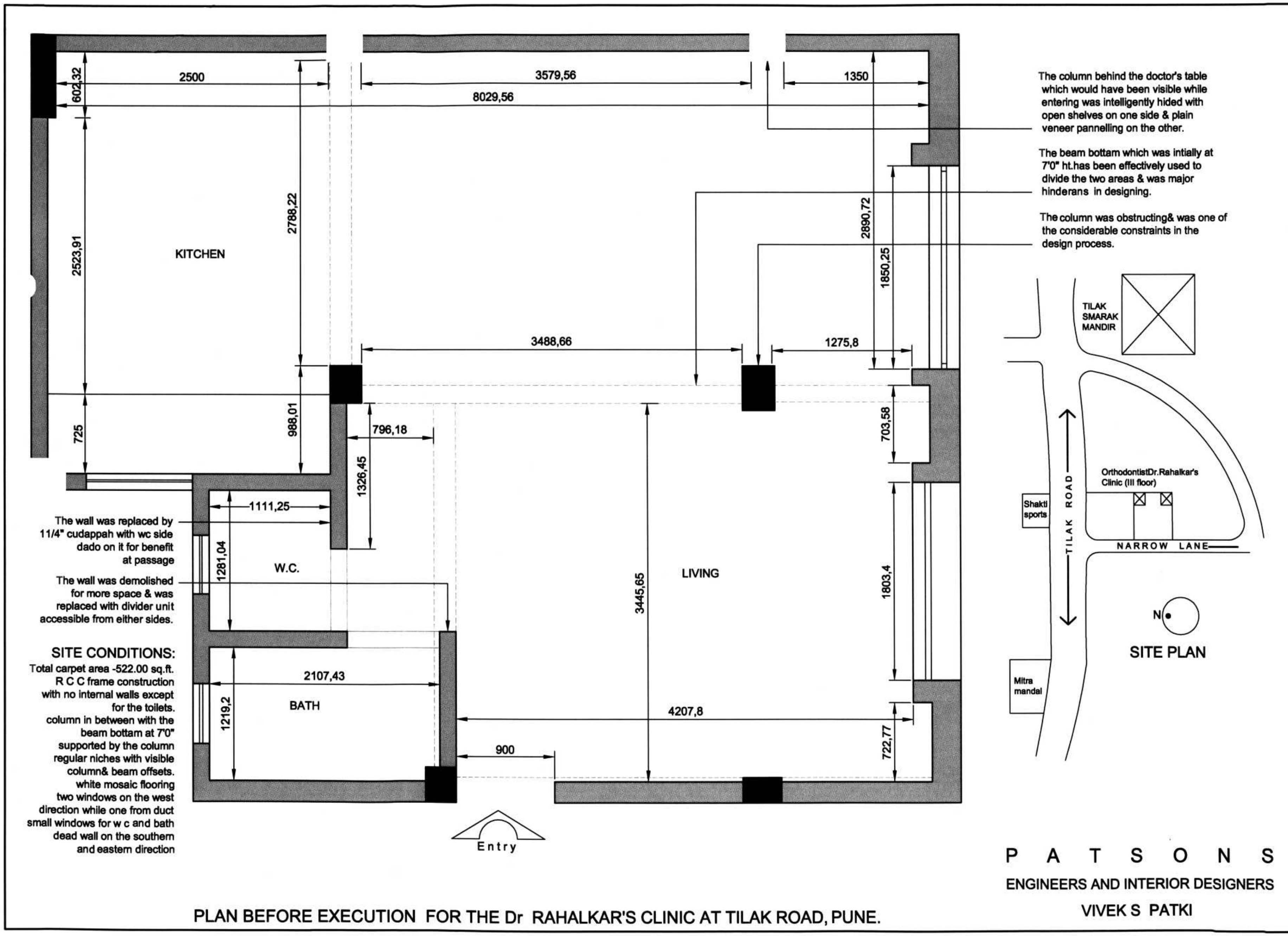

Figure 2.3 *Clinic for an Orthodontist – Plan before Execution*

ering - Innovating Engineering Building	**:**	Octamec offers a variety of green building options that help mitigate energy consumption: (a) Recyclability of materia (b) Insulation panels, (c) Cool roofs with special paint colours and solar reflectivity character of the roof, (d) Energ conservation systems for Air-conditioning with evaporative condensers, (e) Rain water harvesting system, and (f) Win driven turbo for natural ventilation.
-engineered Buildings	**:**	Pre-engineered Buildings (PEB) are suitable for an unlimited range of buildings, commercial or industrial with spee economy, quality and flexibility. PEB is suitable for faster infrastructure growth in terms of buildings used for warehous factories, cement plant, steel mill, labour camps, power plants, etc.
ns (India) Ltd. - Pre-engineered Insulated	**:**	Pre-engineered Insulated steel buildings is a combination of Pre-engineered steel components and Pre-fab Polymethar / Rockwool Panels for construction of office and residential buildings. A complete energy efficient building is offered c turnkey basis including design, supply and erection.
atalysers - A new age Architectural	:	Construction Catalysers has been an active body in providing its expertise to solve complex design problems associate with building structures. These structures by the virtue of their physical optimism are economical, incredibly light, eas to transport, fast to install and aesthetically marvelous. Their ability to integrate function, form, strength and econom is excellent.

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new to be discovered in PHYSICS now, all ore and more PRECISE measurement."

know."

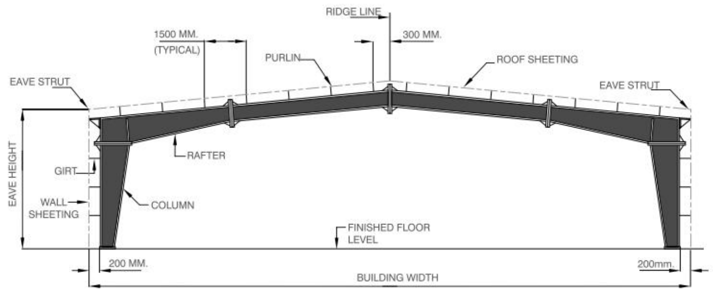
sure it, You canout improve it"
— By – Lord Kelvin.

PRE-ENGINEERED BUILDINGS

- The extreme standardisation with maximum flexibility gives PRE-ENGINEERED BUILDINGS edge over othe building system.
- PRE-ENGINEERED BUILDING manufacturers mostly use customised softwares for the design and detailing of th structure.
- There would be absolutely no cutting or welding at site. The erector would only use spanners to connect the variou elements together.

PRIMARY FRAME TYPES

Octamec Building Systems, caters to customer requirements of building type, space efficiency, building utility and designing flexibility.



Frame Cross Section

Octamec Pre-engineered Steel Buildings are designed by our architects solely with customer requirements in mind and within the parameters of the pre-engineered structures.

Our basic architectural measures include:

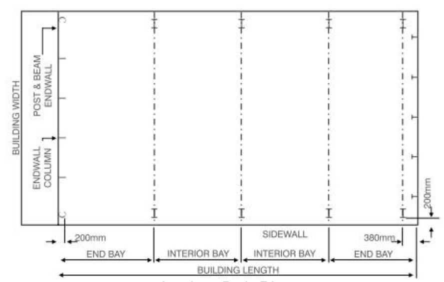
Building Width is the distance from the outside of eave strut of one sidewall to the outside of eave strut of the facing sidewall. Building Length is the distance between the outside flanges of endwall columns in facing endwall.

The End Bay Length forms the distance from the outside of the outer flange of endwall columns to the center line of the first interior frame columns.

The Interior Bay Length is measured as the distance between the center lines of two adjacent interior main frame column which usually range from 6m, 7.5m and 9m to 15m.

The Building Height forms the eave height, which is the length from the foot of the main frame column base plate to the top outer point of the eave strut and can measure up to a height of 30m. In the case of columns that are recessed or elevated from finished floor, the eave height is the distance from finished floor to top of the eave strut.

The Roof Slope, of which any practical ones can be constructed by our architects, is the angle which the roof forms with respect to the horizontal and are commonly 0.5/10 and 1/10.



Anchor Bolt Plan

Octamec has minimum roof live design load of 0.57kN/m2 and design wind speed of 110km/hr which are applicable in keeping with American codes. Further as per project requirements buildings can also be designed as per IS/AISC/MBMA standards.

TIPS

Building length:

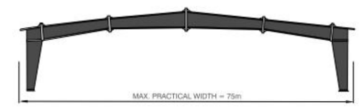
It is advisable to keep all bay lengths equal. If this is not possible, maintain all interior bays equal and the end bays equal but shorter than the interior bays.

Building Width:

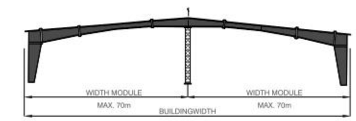
Since the roof purlins are at 1500mm c/c spacing make the building width a multiple of 3M.

FRAME TYPES

Octamec Buildings are built using various frame options. The figures below depict the most commonly used in the industry.

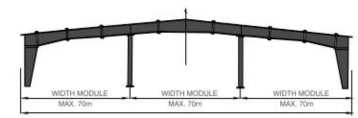


OCTAMEC CLEAR SPAN (OCS)



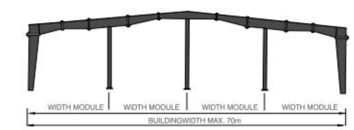
OCTAMEC MULTISPAN "1" (OMS-1)

(1 Interior Column)



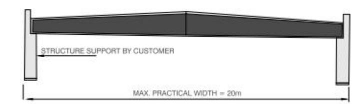
OCTAMEC MULTISPAN "2" (OMS-2)

(2 Interior Columns)

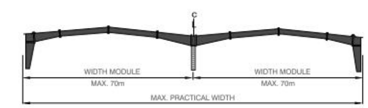


OCTAMEC MULTISPAN "3" (OMS-3)

(3 Interior Columns)

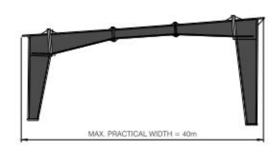


OCTAMEC ROOF SYSTEM (ORS)

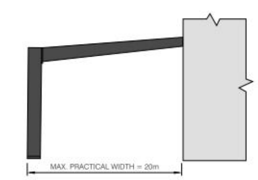


OCTAMEC MULTIGABLE "1" (OMG-1)

(1 Interior Column)



OCTAMEC MONO SLOPE

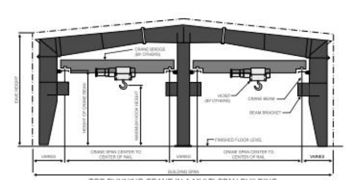


OCTAMEC LEAN - TO (OLT)

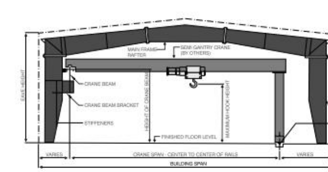
CRANES

Octamec buildings are designed to support any type of crane system. Overhead travelling cranes up to 20MT can be supported on brackets and higher tonnages can be supported on an independent support mechanism.

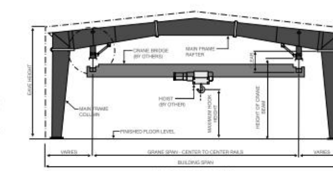
Crane supports for overhead travelling cranes include beams, brackets and bracings.



TOP RUNNING CRANE IN A MULTI-SPAN BUILDING



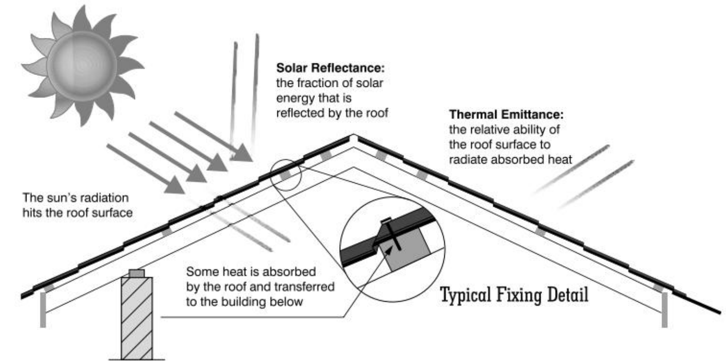
SEMI - GANTRY CRANE



UNDERHUNG CRANE

Figure 2.4 *Frame Types and Cranes*

OCTAGREEN



OctaGreen is Octamec's very own initiative towards creating a cleaner and greener environment. Our commitment towards saving our continuously depleting natural resources has led to us offering our clients a variety of green building options that help mitigate energy consumption. Incorporating Octamec's OctaGreen products within a building can help you earn credits towards green building certifications.

Recyclability

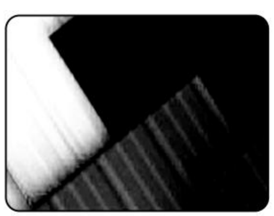
Octamec Building systems structural members, wall & roof panels are made of steel. The Green Building resource guide has given steel as a building material the highest 5 star icon rating owing mainly to its annual average recycling rate of 70%. Unlike other conventional building materials, steel components are completely recyclable once disassembled.

Octamec Buildings are designed and fabricated in-house using cutting edge technology, customized softwares and an advance enterprise planning system which leads to the optimal use of construction materials. Therefore, you can be assured that there will be virtually no wastage when you build an Octamec Building.

Insulated Panels

Octamec Buildings insulation systems offer superior and uniform insulation compared to the more traditional construction methods. This leads to a reduction in energy usage offering energy savings of 12% – 14%.

The insulated panels are completely recyclable after dismantling and can also be reused to create the framework for a new building project



Cool Roofs

Octamec's paint colours on our roof profiles help mitigate heat generaled by the Sun's rays. This can be very effective in regions like India where temperatures tend to cross 30°C frequently. Most of Octamec's roof colours meet the reflectivity levels required by LEED to mitigate heat from the sun's rays. This leads to savings for our clients on the energy front as they will require less energy to cool their buildings.

Solar Reflectivity

Octamec Building's roofs reflect almost all of the sun's heat back into the sky instead of absorbing the heat into the building. The "Coolness" of the roof is measured by two properties, solar reflectance and thermal emittance. Both these numbers are measured from O to 1, a lower value indicates higher absorbance.

The Solar Reflectance Index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a Standard black (reflectance 0.05, emittance 0.90) is O and a Standard white (reflectance 0.80, emittance 0.90) is 100. The table below indicates the parameters required to meet LEED certification.

Energy Conservation Systems

Octamec Building Systems helps incorporate Air Conditioning Systems with evaporative condensers which help save as much as 40 percent on condensing energy. By reducing peak electrical demand at design conditions, they can allow unit electrical service to be downsized for lower installation costs and electrical demand charges. A chemical-free water treatment option eliminates the use of harsh chemicals, reduces water consumption costs and lowers water treatment costs.

Rainwater Harvesting

Our unique gutter and downspout system can be used for rainwater harvesting and will help gain credits towards green building certifications. According to the LEED - NC green building rating system if reduction of potable water consumption by 50% is achieved than one can claim points towards certification.

Natural Ventilation

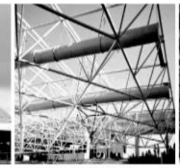
Our wind driven turbo and ridge vents ensure natural ventilation at absolutely no operational costs. As they run entirely on wind energy there is no energy consumption and therefore entails tax benefits as it is an energy conserving device. The vents are leak proof and can withstand winds upto 140 km/hr.

Figure 2.5 *Octagreen*

octamec
SPACE FRAMES
INNOVATING IMAGINING


ITPO, Bangalore


Kudalasangama, Karnataka


Al Wahada Stadium, Abu Dhabi

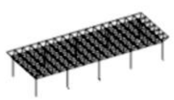

Reliance Group, Silvassa

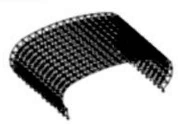
Why Octamec Space Frames?

- Octamec Space Frames are **ideal for long column-free** like sports facilities, exhibition centers, passenger terminals, malls, assembly areas, and production facilities, etc.
- With Octamec Space Frames, there is virtually **no limit to the shapes and spans** that are possible.
- Octamec Space Frames have a **built-in reserve strength** enabling the structure to take local overloading.
- Even when badly damaged they **do not collapse rapidly**. This property is of great importance in cases of fire, earthquake, explosion or terrorist attack.
- Due to the inherent stiffness of space frames, their **deflection is considerably less**.
- Octamec Space Frames possess great rigidity and stiffness hence **resist large concentrated and unsymmetrical loading**.
- With Octamec Space Frames, **long cantilevers are made possible**, increasing roof area even with smaller ground area for columns.
- Octamec Space Frames redefine industry standards of **aesthetic** requirements.
- Octamec Space Frames are the true new medium for **architectural expression** meeting the challenges for lightweight and aesthetic forms required of these facilities.
- The light and strong space structures are efficient and, most importantly, beautiful. **Octamec Space Frames** provide an architecturally pleasing appearance. In layer structures, lights, air-conditioning ducts and other facilities can be kept inside the roof elements thus giving a clean appearance.
- Octamec's computer automated-software now achieves very **rapid design and detailing**.

Typical Space Frame Orientations

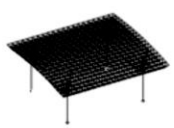
FLAT DOUBLE LAYER

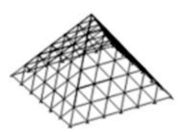




CUBO DOUBLE LAYER

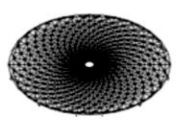
BARREL VAULT

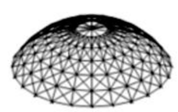




PYRAMID

LAMELLA DOME





SCHWEDLER DOME

SPACE CURVE SYSTEM

The Space-Curve system has been developed through advance engineering analysis, where the optimal design features of Self Supporting Roofing and Space Frames have been combined to achieve a building that has virtually no limit to the span you can attain. In addition, it couples to become the most economical system for spans in excess of 40 Meters.

We use proprietary tubular and nodular elements for the primary and secondary frames in place of hot rolled, Welded Plate or cold-formed sections. Long-Bay Spacings can be accommodated economically due to the modular built up nature of the purlins, allowing for transverse movements between columns. Zero roof puncturing creates a leakproof building with no maintenance hassles. Finally this system has a great saving in the amount of steel consumed during the life cycle of a project and therefore has become the most favored system for projects of various applications of Industrial Process Plants and Storage for Coal, Cement, Limestone, Fertilisers, Petroleum, and any other commodities.

Figure 2.6 *Octamec Space Frames*

Pre-Engineered Buildings (PEB) were introduced into the steel building industry to facilitate fast design, delivery and erection of simple low rise structures like canopies, warehouses, etc. PEB can be constructed in much less than the normal time for other structure. Over the years, the basic essence of speed still remains. However, the concept of PEB has been scaled to structures beyond the norms of canopies or simple small warehouses. PEB has its reach on literally all type of structures. In the due course, the list has been appended to include heavy industrial structures, super and hyper markets, shopping centres, theatres, shopping malls; the list goes on. So, what is that makes PEB so adaptable and easy?

PEB is a structural concept whereby all the components of a building are designed, detailed and fabricated to suit the specific requirement of design and serviceability, yet very much standardised to facilitate ease in design, detailing, fabrication and erection. There would be absolutely no cutting or welding at site. The erector would only use spanners to connect the various elements together. Unlike the perception that PEB buildings are off the shelf, in reality, each and every component is proportioned to meet the design criteria. Nothing is "off the shelf", the various elements of the building are precisely Pre-engineered to the requirement of the particular project.

Components of a PEB building

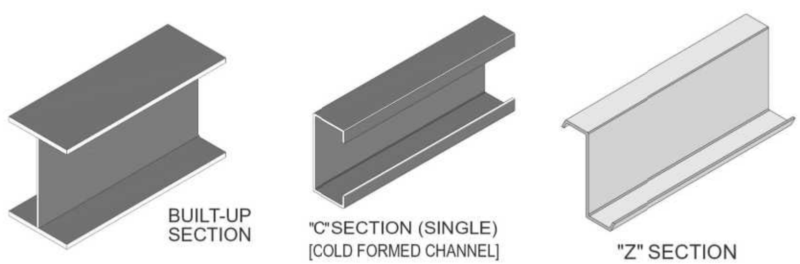


Figure 2.7 *Components of a PEB building*

PEB buildings are made up of three major components. They are:

1. ***Primary Framing*:** Primary Framing consists of columns and rafters with tapered web and variable flanges. These are manufactured by welding together cut plates to form I-sections. The tapered sections are welded at factory /bolted at site at splices to form the desired frame profile. These frames in PEB are normally moment resisting frames with fixed or pinned bases as mandated by the design.

2. ***Secondary Framing members*:** Secondary framing members are purlins and girts made of cold formed sheets. Normally, secondary framing members are in Z or C shapes. Purlins which are used to support roof sheeting and the girts at longitudinal walls are normally designed as continuous members. However, the girts at transverse or short walls are normally designed as simply supported beams. The spacing of secondary framing members are primarily dictated by the capacity of the cladding to span in between the purlins/girts.

3. ***Cladding*:** Cladding comes in a variety of profiles which are customised to suit structural and aesthetic requirements.

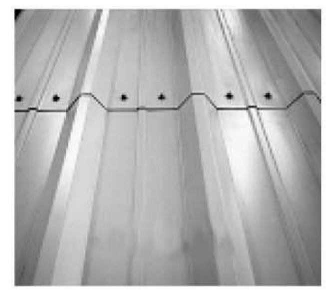


Figure 2.8 *Cladding*

Structural Profiles in PEB:

Figure 2.9 shows some of the typical frames used in PEB. The various profiles for the primary members are chosen based on the requirement in terms of the building usage, loads, economy, etc. The chosen profiles are spaced at distances varying from 6 to 10 m in order to form the length of the building. Quite often in buildings a combination of all the profiles indicated are used. This gives a lot of flexibility for the building configuration.

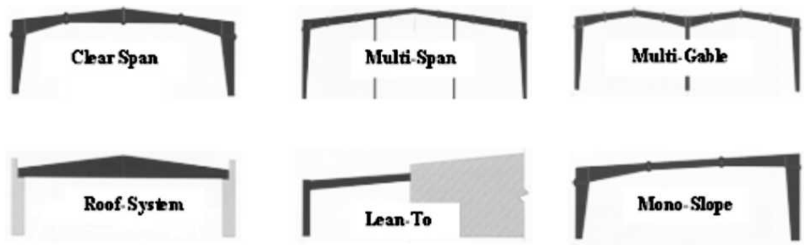


Figure 2.9 *Typical Frame Profiles*

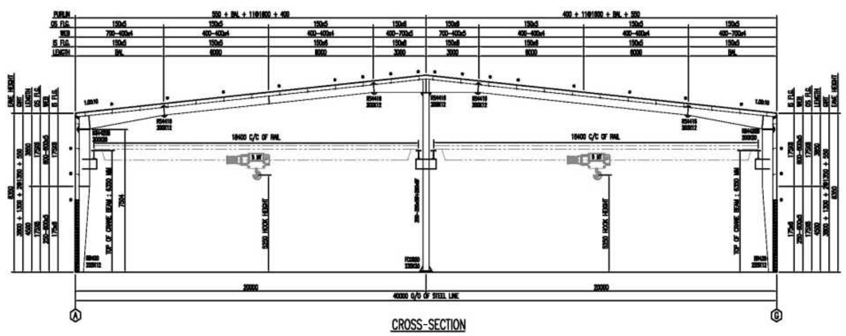


Figure 2.10 *Typical Cross-section Sheet*

Design Loads and Codes

A PEB can be designed as per the code dictated by the consultant or the end user. As the PEB concept originated from the US, the default codes used are American. However, the buildings in India are mostly designed using IS codes of practice. (refer to Figure 2.10 typical Cross Section Sheet.)

Design and Detailing Process

PEB manufacturers mostly use customised softwares for the design and detailing of the structure. Softwares that are tailor made to suit the PEB concept offers fast and economical design and detailing. PEB manufacturers also use pre-designed templates for design calculations. Design templates are used to present the information in a very consistent manner from project to project. For example, a typical design cross section representation sheet is shown in Figure 2.10. All design packages from Zamil would have the same representation of cross-section. This allows predictability and easy access to information for clients and consultants verifying the design. Some manufacturers even use pre-calculated capacity tables for different elements like Purlins and panels.

In PEB, the connections are standardised to a great extent as mentioned earlier. Figure 2.11 shows the capacity chart for a typical mezzanine beam connection. It may be observed that for the connection MZE-001, the connection capacity is 129 kN when 4 mm thick web is used. (refer to ***Figure 2.11 Mezzanine Beam Connection)***

So, for a mezzanine beam, if the reaction is less than 129 kN, the designer would specify the connection code of "MZE-001" in the design summary.

Mezzanine Beam Connections

All Bots: A 325 N

Beams: $F_y = 34.5 kN/cm^2$; $F_u = 44.8 kN/cm^2$

Angles: A572 Grade 50 ∠75x75x6 (UNO); $F_y = 34.5 kN/cm^2$, $F_u = 44.8 kN/cm^2$

Type	Bolt	End Connection Capacity, kN		Type	Bolt	End Connection Capacity, kN	
	Diameter (mm)	Beam Web Thk. : 4 mm	Beam Web Thk : 5 mm.		Diameter (mm)	Beam Web Thk. : 4 mm	Beam Web Thk : 5 mm.
MZE-001	20	129.0	161.3	MZE-003	20	172.0	215.0

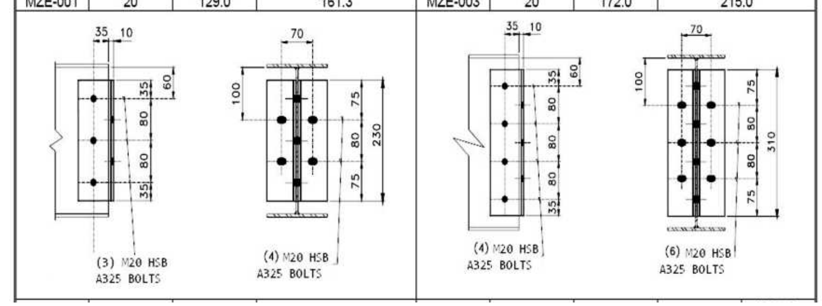


Figure 2.11 *Mezzanine Beam Connections*

The detailer and the concerned in the design/detailing flow would know how the connection is to be detailed and represented. connection patterns are standardised. Figure 2.12 shows a knee connection. On the contrary, for rigid connections, where the pattern of variations could be quite extensive, instead of standardising the connection completely, the connection would be designated as K4-84-24-AB by the structural engineer.

Figure 2.12: Knee Connection Detail

The connection would be designated as K4-84-24-AB by the structural engineer. He would not be required to give any specific connection drawing in the calculations. From the code, the detailer would know very well this is an indication for a rigid knee connection where the knee web thickness is 4 mm, there are 8 bolts in the outside pattern, 4 bolts in the inside pattern, the diameter of the bolts are 24 mm and there are stiffeners A and B as shown in the drawings above. Understandably depending on the forces the pattern, sizes, pitch and the gauges of the bolt would vary. This approach of standardisation and customisation offers speed and efficiency to the system.

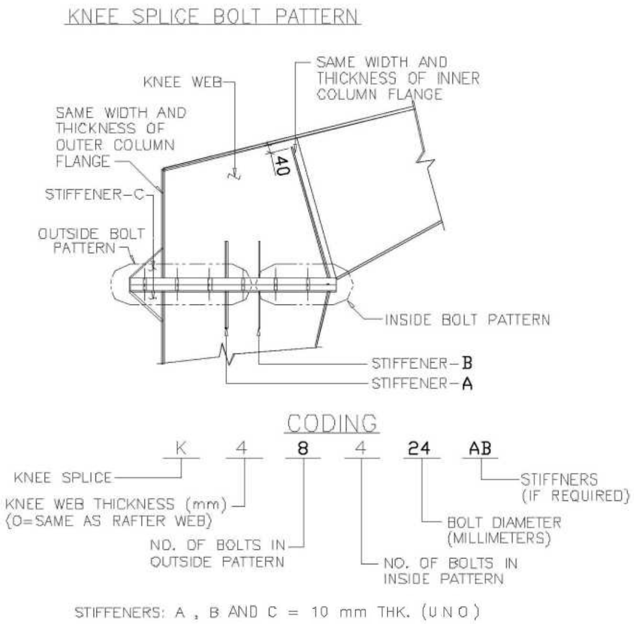


Figure 2.12 *Knee Splice Bolt Pattern and Coding*

Manufacturing of PEB

The manufacturing process of PEB buildings under factory conditions provides efficiency and high quality. Automated welding lines and painting lines are used by major manufacturers like Zamil. Use of machines that utilise CNC ensures very little error margin. In the end, the finished product is subjected to quality tests to ensure error free output.

Advantages of PEB

PEB offers many advantages to the client. The major ones are listed below.

1. ***Speed*****:** The use of PEB will reduce total construction time of the project by at least 30 to 40%.
2. ***Economy*****:** Considerable saving in design, manufacturing, transportation and erection cost is realised due to the systematic approach and optimised design.
3. ***Exceptional Quality*****:** Factory controlled manufacturing process gives finished product with excellent quality.
4. ***Flexibility*****:** PEB allows the usage of variety of features to improve the aesthetics of the building.
5. ***Sole responsibility*****:** The complete building design, fabrication and supply is by a single party. There is a single point of contact and responsibility.

Conclusion

This paper was intended for a brief introduction into the PEB system. The extreme standardisation with maximum flexibility gives PEB edge over other building systems. It may be concluded that PEB are suitable for an unlimited range of buildings, whether it be commercial or industrial structures. In addition to the enhanced aesthetics and faster operational-ability, PEB offers many significant advantages to clients.

PEB In India

Pre-Engineered Buildings (PEB) are extensively used in industrial and commercial projects world wide. In India, the concept of PEB was introduced around the early 1990's. As we all know, there are many PEB manufacturers in India now. Currently the market potential of PEB's is around 4 lakhs tonnes per annum. The current pre-engineered steel building manufacturing capacity available in India is 5 to 6 lakhs tonnes per annum. The industry is growing at a rate of 10 to 15 %.

ZAMIL STEEL

Zamil Steel is Pioneer in Pre-engineered building manufacturing, Apart from five PEB plants worldwide, it has a state of art manufacturing facility in India also which is located in Pune, Maharashtra. Pune facility is operational since Feb 2008 and producing high end pre-engineered Building.

PEB is one that suits for faster infrastructure growth in terms of buildings used for Warehouse, Factories, Cement Plant, Steel Mill, Labour camps, Power Plants, etc.

More about Zamil Steel's product offerings and technical support please contact our Marketing team at the following address:

Zamil Steel Buildings India Pvt. Ltd. Al Monte Software Park, Office no-101, S.no-8, 1st Floor, KHARADI, PUNE-411014, Maharashtra.

Tel : + 91 20 3055 3000 // Fax: + 91 20 3055 3242

E-mail- *zsindiamarketing@zamilsteel.com*

Website: WWW.ZAMILSTEEL.COM

PRE-ENGINEERED INSULATED STEEL BUILDINGS LLOYD INSULATIONS (INDIA) LIMITED

Pre-engineered Insulated Steel Buildings

Pre-engineered and Prefabricated structurers on which prefab Polyurethane / Rockool Panel are mounted, provide and excellent solution for today's requirement of Thermal Insulated Building for construction of office and residential buildings. Lloyd PEB Building systems comprises of steel columns, Rafter, Purlins, Prefabricated Rockwool or Polyurethane Foam Panels on roof and wall, complete with all other interior services and HVAC system. Combination with Glass Facades or brick wall is also possible. A complete energy-efficient building is offered on turnkey basis including design, Supply and erection.

Importance of Thermal Insulation in Buildings**:** India is a tropical country with ambient during summer ranging from 35–45° C and sometimes even 50° C at some places. Similarly, winter temperature goes down to 4–10° C and sometimes even minus temperature at some of the places. Coupled with these extreme ambient temperatures where humidity during summer time is ranging from 60–90% and sometimes even higher.

This combination of high temperature and humidity makes conditions which is unbearable for work in office and living at houses. During summer there is continuous heat transfer from environment to inside of buildings directly through the roof and also partly through walls. During the winter the cold passage is mostly through the walls during night. There is a necessity to retard and obstruct transfer of heat and cold from environments to inside of buildings. This terminology to retard flow of heat or cold is termed as thermal insulation. Thermal Insulation in a building is provided on the roof and walls both from inside or outside the building. In addition, air conditioning requires insulation provided on the chiller water pipelines and on HVAC duct work. These areas need to be insulated primarily to minimise loss of cooling generated by expenditure of energy and to stop condensation formation which otherwise would make the building environment wet and messy.

LLOYD INSULATIONS (INDIA) LIMITED
The Total Solutions Company
386, Veer Savarkar Marg, Prabhadevi,
Mumbai – 400 025, Maharashtra, India.
E-mail: lloydinsul@vsnl.com

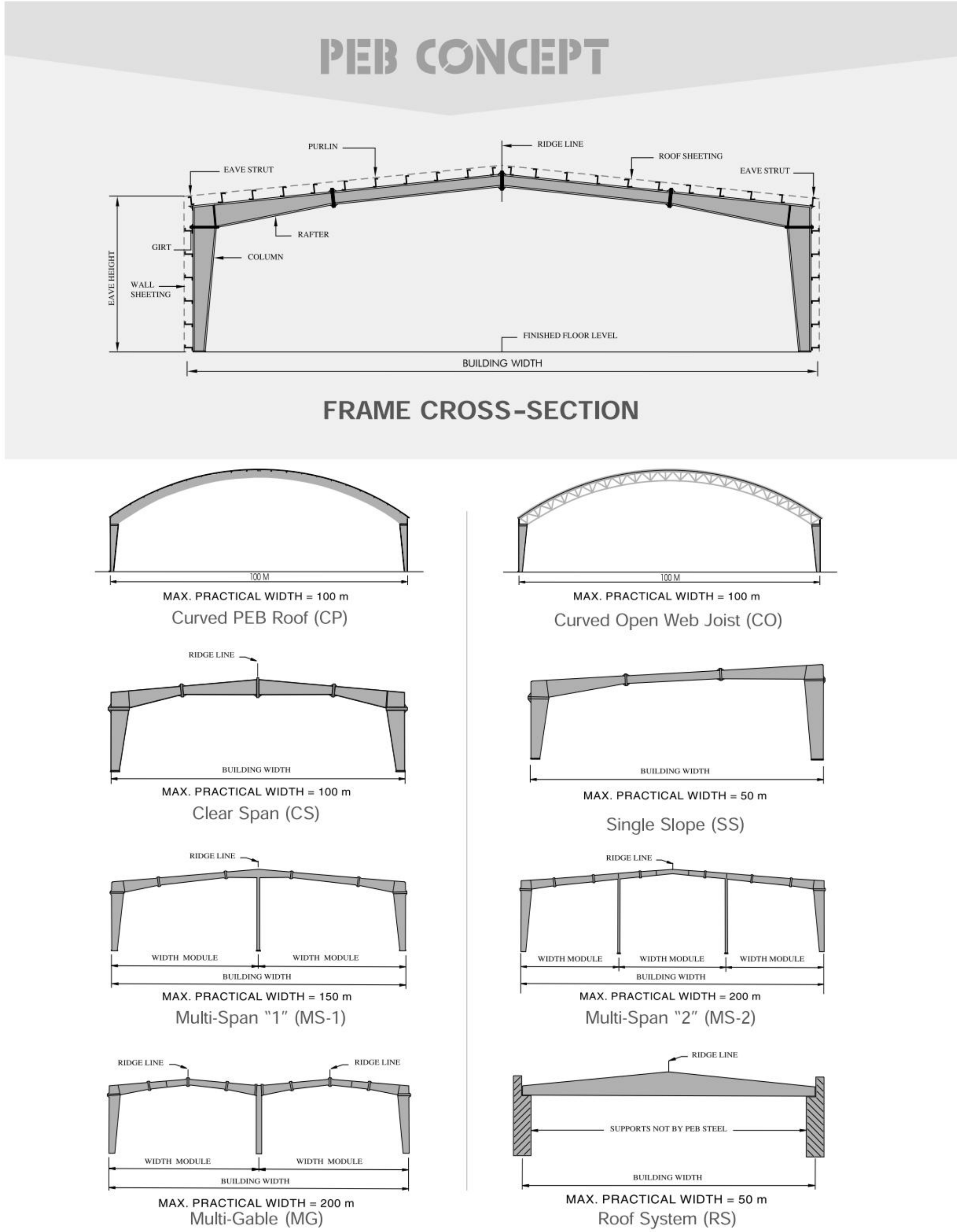


Figure 2.13 *PEB Concept and Frame Cross-section*

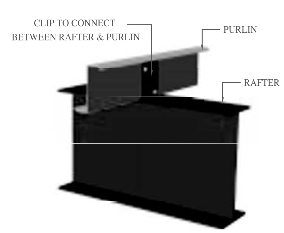
LATEST INTERNATIONAL CODES

***PEB Steel Lloyd** recruits only the most talented and experienced designers and engineers in the **steel buildings i**ndustry who apply LATEST National & International **Codes of design** and fabrication such as :*

AISC 2005 Design Code · *MBMA 2002* Tolerances code · *IBC 2006* Building code · *AISI 2001* Purlin code · *ANS 2006* Welding code

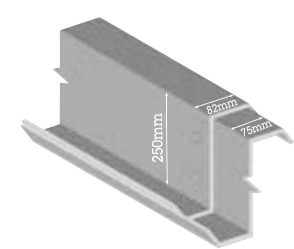
IS: 801 (Code of Practice for use of Cold Formed light gauge steel structural members in general building construction) & IS:811 (Cold Formed light gauge structural steel sections)

Deflection		Structural Member	Deflection Limitation	Load Combination
	1	Main frame rafters	Span/ 180	Dead+Live
vertical Deflection	2	Roof purlins	Span/ 180	Dead+Live
	3	Mezzanine beams and joists	Span/ 240	Dead+Live
	4	Top running crane (TRC) beams	Span/ 600	Dead+Live
	5	Underhung crane (UHC) beams	Span/ 500	Dead+Live
Lateral (*) Deflection	1	Main frame columns	Eave height/ 90	Dead+wind (10 yr. wind)
	2	Main frames supporting top running cranes (TRC) or underhung cranes (UHC)	Runway ht./100	Crane Lateral (D+CR) Or (0.6D+W) using 10 yr. wind
	3	Wall girts	Span/ 120	Wind only (10 yr. wind)
	4	Endwall wind columns	Span/ 120	Wind only (10 yr. wind)
	5	Portal frames (2)	Eave height/ 90	Wind only (10 yr. wind)



Connection Clip
(AS PER AISI 2001)

Special Ridge Vent
(FOR MAX VENTILATION)



Z 250 Purlin
PERFECT Z LAPPING

Figure 2.14 *PEB Steel Lloyd – Latest International Codes*

2.8 PROJECT WORK AND ITS PRESENTATION

Educational Technology in many foreign countries has given importance to individual project work right from primary education. Such project work is found to be essential for involvement of the learner in education. Today, even the best teacher cannot give information related to certain topics because of very rapid changes in technology. They have also got to complete their subjects within the limited time of the term. However, the students are curious about many areas related to their subjects and profession, areas such as different machines, instruments, construction techniques, manufacturing processes of different materials, work done by different professionals, etc.

Project work and its presentation is considered as an individual activity of the learner. It is an activity with creativity, which allows the students to develop skills such as collection of information, gaining related knowledge, to meet persons in the field, visit projects, prepare charts, slides, photographs, video films, models and to speak before students and teachers by employing techniques of effective public speaking. This also requires skill to work and co-operate with others.

Expectations from education in general and technical education are to first kindle the flame in the mind of the student about the subject and the profession and then allow them to develop gradually as planners, designers and managers. Creative people are sensitive to sight, sound and ideas. Built environment is a multidisciplinary subject which needs creative thinkers. Intuition, intelligence, imagination, creative thinking, desire to collect and analyse information, deep thinking and diligent research are inter-related faculties of our brain. Imagination is stated as the root cause for all inventions and designs. Each and every student, thus, gets an opportunity to develop gradually, step-by-step, to become a resourceful person able to interact with others with an improved skill in communication. Presentation of a project allows a student to express himself/herself effectively in a variety of ways, through various presentation techniques and to systematically improve, his/her ability and confidence. The student's project work usually becomes a topic of discussion in the interview and hence it should be considered as a technique which gives a student the required confidence for a smooth entry into the professional world.

Projects related to various areas in built environment such as urban planning, problems seen in the city regarding transportation systems, parking, pollution, slums, water supply and drainage, fire hazards, departmental procedures, architecture, role of promoter and builder, landscape architecture, construction, computer work, etc., are given at the end of the concerned chapters. A student may select other related areas as per his observations. If required, the student may subdivide the topic as per the availability of time. Help of the teacher in selecting the topic and its scope should be taken. Presentation time may be 30 minutes. Think how much knowledge each student will get by listening to sixty presentations on different topics by sixty students of the class in each term. All such volumes of the projects will be a treasure for future students. Students should think that, project and its presentation is like a mirror which reflects their personality, even the submission work of each and every subject should be considered in terms as mirror of individual personality and group personality.

2.8.1 Project Work - Different Steps

The following are the steps usually followed in project work:

1. Selection of a particular area in a subject as per personal interest and background knowledge. Initial study, collection of information through textbooks, journals, technical magazines, IS Codes, etc.
2. Discussions with the teacher / field persons as per proposed schedule, finalisation of work, sticking to the schedule.
3. Development as per planning schedule, collection of accurate details and references of books - author, publisher, page numbers, drawings, photographs, etc.
4. Preparation of the text along with charts, audio-visual aids, etc.

Presentation of the Project

1. Presentation includes (a) introduction within minimum time, (b) a main body which needs more time, and (c) conclusion in minimum time and with effective and appropriate sentences to be remembered by the audience.
2. You may use flip charts, line graphs, drawings, slides or overhead projector, film strips, video tapes, tape recorders, computers, etc., as per necessity. A rehearsal for presentation along with the above aids is essential to complete the presentation effectively within the scheduled time.
3. Your voice, body language for communication, which means posture, facial expressions, eye contact to keep the attention of the audience and gestures with hands, head and arms are the tools for effective presentation. Voice - volume refers to how loudly you speak, whether the speed is too fast or slow, while pitch refers to how high or low your voice sounds. Clarity and pronunciation are also important considerations.
4. Do rehearsals in front of the mirror or in front of few friends, check time limit, and keep stage fright under control. Be relaxed before a presentation. Then take a deep breath and walk with confidence to your place in front of the students and others. Watch carefully the presentations done by other students and note down the plus and minus points. Be polite while answering questions raised at the end of the presentations, keep your answers brief, say 'don't know', if you are not aware of the answer, and finish with grace. Note the finer points for further improvement.

It is better to arrange lectures of experts, for students, to know and develop skills in effective presentation. This will help them to convey the information clearly and to hold the interest of the audience throughout the presentation. There are many things to observe and learn from students and teachers for effective presentation. You will realise the long-term benefits of skills which are developed through project work.

Individual project work will develop 'thinkers' by creating a desire to watch carefully and think logically to find solutions through users-friendly and efficiency improving and energy conscious designs.

PROJECT WORK

1. Study of different maps - Collect maps of different towns in India - Delhi, Bhopal, Chandigadh, Chennai (Madras), Ahmedabad, Hyderabad, Pune, Bangalore, Calcutta, Jaipur, Mumbai, etc. Display maps in the classroom / drawing hall to study details shown in the maps and street patterns.

   Collect information about transportation systems, water, drainage, electrical services, slum problems and proposals for improvement in the total environment. Classify them and then think of requirements for

   (a) towns near rivers
   (b) towns near sea shores
   (c) towns with religious festivals
   (d) towns for tourist, etc.
2. Study working of town planning department in a state. Interview a town planner, and study town planning scheme proposal, data and maps.

3. Collect information about the development of the land, sizes of the plot, built-up areas, tenements per hectare, open areas, marginal distances between buildings, F A R rules for layouts of the plot, width of roads, tree plantations and procedure for the acquisition of land.
4. Hold an interview with a town planning officer of a city corporation proposals for new developments, problems, study of development schemes and considerations for town planning policy.
5. Conduct a detailed study of the problems in your own town and other towns - slum improvement and eradication schemes, transportation systems, pollution of air and water, noise levels, maintenance of buildings, and parks and gardens.
6. Study in detail surroundings of bus stands, railway stations, markets, cinema houses and marriage halls with reference to traffic problems, garbage disposal, parking, street lighting, advertisements, sign boards, traffic islands, safety on roads, tree plantation and problems in summer and rainy seasons. Prepare a suitable scheme to improve the comfort, convenience and visual pleasure of a particular area.
7. Refer to the lectures of town planning officers, landscape architects, transportation engineers / consultants, environment consultants, etc., for topics related to the development of towns, their existing problems and proposed developments.
8. Collect information and write essays on :
   (a) Sustainable development
   (b) Conservation
   (c) Schemes for slum improvement
   (d) Traffic control systems in India and other countries
   (e) Road transport and railway transport schemes for city transport and their comparison
9. Collect details related to the procedure of purchase of land from a city survey office, land records, property register, agreement for sale deed. Write a note on total procedure.
10. Write an essay on the transformation of a village into a mini town - its existing problems, possible transformation in housing, shopping and market area, area around schools and bus stations, green belts, developments around temples, etc. Collect maps and photographs of such places.
11. Collect newspaper cuttings related to the achievement in development of towns, problems related to pollution, improvement in slums, e.g., clean city project of Surat town in Gujarat and Osho Garden in Pune.
12. Flood and Fire are two problems related to the cities
    (a) Collect information about history of floods, flood damage, and methods to control floods, slums near river banks, reduction in the section of the river by encroachment, flood alarming systems, etc. These are few points related to flood control. Study and prepare reports for your city.
    (b) Fire hazards due to various reasons results in loss of property and life. Study fire safety systems in theatres, assembly halls, shopping centres, etc. Collect design consideration details for fire safety.
13. It is stated, "To understand cities is to understand people, their behaviour and problems". Collect information by interviews with people about various problems. Some of them are:
    (a) Transportation systems
    (b) Hawkers occupying footpaths and roads
    (c) Garbage disposal system
    (d) Noise levels
    (e) Parking problems
14. Ring road planning, underground market as in Delhi, underground road crossings, flyovers as in Mumbai are some of the ways for planning transportation systems. Prepare reports by collecting information about design requirements, problems if any, and suggestions related to planning and design.
15. It is said, "*Urban Grid is the means by which the town becomes a mechanism for generating contact with less energy and more pleasure*." Collect information about cities where the urban grid system is found suitable.
16. Hills and rivers add to the charm of the city. They need attention of town planners, landscape architects and engineers for aesthetic development. Think of such developments in some nearby towns.
17. Collect data at least for two years for your city or any city for
    (a) Sunrise and sun setting time
    (b) Temperature, maximum and minimum
    (c) Humidity
    (d) Rainfall
    (e) Wind direction and velocity
18. "Through configurations, buildings, like organisms, both contain and transmit information." Visit bus stops, railway stations, hospital buildings, airports, cinema and marriage halls. Study various signs and information boards which guide travelers / visitors. Collect data about them.
19. Open spaces are often described as the "lungs of the city". Visit different open spaces in your city and open spaces left in housing societies. Collect photographs of the present condition. Think of suitable development scheme and prepare a project report.
20. Collect details for the project 'Metro Transportation Project' (MTP) for elevated railway at Chennai. Discuss the suitability of ring railways for mass transportation.
21. Study Urban Planning of Chandigarh. Reference Books. 1. *Documenting Chandgarh - The Indian Architecture of - Pierre Jeanneret / Edwin Maxwell Fry / Jane Beverly Drew*, (Volume 1) Concept and text by Kiran Joshi and 2. Seminar Volume - "Celebrating Chandigarh" 50 years of the idea. Study details of planning, visit the city - write your report about what was proposed, what is achieved and what is useful for planning new cities, and for extension of existing cities with reference to interviews of users.

    Study details for sectors, roads, areas of special architectural interest, city centre, industrial area, the lake, landscaping, policy regarding 'No Personal statue to be erected' and truthfulness of building materials, planning, designing, construction quality and maintenance of different types of buildings, roads, parks, open areas, etc.
22. Study problems related to the new cities. New Ahmedabad (Gandhinagar), New Bhopal, New Delhi - with reference to study of plans and interviews of the users in the context of the following views.

The "Statute of Land" is the description of what is proposed and has to be proposed in the future and the engagement of the authority that such realities will never be destroyed by inattentive resolutions or decisions.
The "Statute of the Land" has also to include the date of the creation of the city as it has also to foresee some possibilities of evolution or change which are hidden in the future.
One has the "Statute of Land". It is like a seed. What can be grown from the seed? It is in the hands of the Administrators".

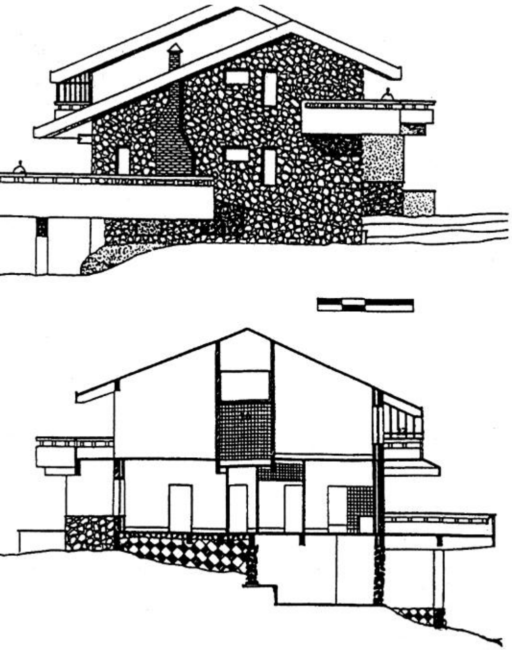
Town Planner and Architect - Le Corbusier
Ref. Note - 'For the Establishment of an immediate
"Statute of Land" - City of Chandigarh. 17th December, 1959.

23. Refer case study of 'Vasant Nagri Township'. Prepare your report after visiting township - achievements, suggestions from users and maintenance programme.
24. "Human needs and the city - Happiness and security both can be achieved by satisfying -
    (a) Physiological needs - survival, health, comfort, shelter, etc.
    (b) Safety / Security needs - protection from man-made and natural hazards, anti-social behaviour, etc.
    (c) Affiliation needs - identity, communal organization, recognition, etc.
    (d) Self-actualisation needs - self fulfillment, capacity for choice, freedom, etc.
    (e) Cognitive needs - creativity, growth, expression of love, hostility, etc.
    (f) Aesthetic needs - beauty, pleasure, etc."

    Prof. Pavan Kumar
    Asst. Professor, Dept. of Architecture
    Birla Institute of Technology, Mesra, Ranchi

    Think of planning strategies and policy guidelines for cities to fulfil 'Human needs' mentioned above, published in the publication "Cities for all" on World Habitat Day 1999 by Building Materials and Technology Promotion Council, New Delhi.
25. Read report Livability index Best Cities of India, published by CII - Confederation of Indian Industries.
26. Visit Blue Ridge Project, Hinjewadi, Pune and Nandan Prospera, Baner, Pune and prepare your reports related to planning, construction, landscaping and total environment.
27. Visit 'Pre engineered steel structure' for any industry during erection. Study drawings.
28. Collect information for 1. Gypsum 2. Dry wall construction technique.
29. Wastewater Management (Ref - Times of India, Pune 24.5.2011.

    Wastewater treatment includes physical, chemical, and biological processes to remove physical, chemical and biological contaminants. Students and teachers are advised to contact following consultants to study various treatments.
    1. Anuj Enterprises, Pune – E mail: *anujenterprises@rediff mail.com*
    2. Suyog Engineering Pvt. Ltd. Pune E mail: *suyogeng@dataone.in*
    3. ERA HYDRO BIOTECH ENERGY PRIVATE LIMITED, PUNE
       Web: *www.erahydrobiotech.com*
       Email: *Contact@hydrobiotech.com*
    4. Western Aqua Treat Solutions Pvt. Ltd. Pune
       Web: *www. westernenviro.com*
       E mail: *info@westernenviro.com*
    5. Panse Consultants, Environmental Engineering Services, Pune
       Web: *www.microfine.systems.com*
       E mail: *microfinesystems@rediff mail.com*



rchitecture is a perceptual one, that man experiences architecture ust vision, and that the achievement of human satisfaction should im".

Author: Geoffrey Broadbent

: *Design in Architecture—Architecture and the Human Sciences, John Wiley and Sons, London*

lding by how beautiful it is in isolation, but instead by how much lar place has become by its addition."

Architect: Cesar Pelli

ce' can create either a sense of delight or a sense of depression

Topics covered i chapte

Art and Science of Planning and Construction of Sound, Economical and Elegant Buildings for Residential and Nonresidential Purpose to Create the Desired Environment Inside and Outside the Building

PRINCIPLES

VITRUVIUS—Roman architect 400 BC II — * Utilitas (Usefulness) * Firmitas (Strength) * Venustas (Beauty)

FRANK LLOYD WRIGHT—American Architect— * Function * Form * Feeling

LE CORBUSIER—French Architect— * Building is an efficient machine * Functionalism

CTION UTILITY

ople and Their Requirements
posal — Site — Finance
PROGRAMME
neral Scope of the Proposed Building
NT
gulation and Bye-Laws of the
nctioning Authority
ablishing Areas for Different Units
nction—Number of Persons
rniture Requirements
ominess
xibility
nitation — Lighting — Cleanliness
Ventilation
nitary Convenience—Air-Conditioning
ace for Equipment for Air-Conditioning,
ntral Heating, Acoustics, and Machinery,
.
ND LINE PLAN
ouping
culation
entation — Aspect and Prospect
vacy
egance

FORM

- STRUCTURE
- STRUCTURAL DESIGN
  Main considerations, protection from Sun, Rain, Wind and Earthquake.
- CLIMATE, Its Effect and Design Considerations
- MATERIALS OF CONSTRUCTION
- METHOD OF CONSTRUCTION
- CONSTRUCTION NOTES AND SPECIFICATIONS
- ECONOMY IN STRUCTURAL DESIGN

FEELING FOR AESTHETICS AND UTILITY

- OUR EYE AND NATURE
- ARCHITECTURAL COMPOSITION
  — Unity
  — Mass Composition
  — Contrast
  — Proportion
  — Scale
  — Accentuation and Rhythm
  — Materials for the Exterior
  — Expression
- CHARACTER OF THE BUILDING
- INTERIOR DESIGN
- COLOUR
- INDOOR PLANTS
- LANDSCAPE ARCHITECTURE

"Architecture is a performing art, it is for the performance of the user".

enities and controllable comfort standards. It can also be expected to provide
d psychological comfort for the human being as the ultimate luxury.

we see vernacular or traditional architecture in rural areas and partly designed
l pieces in few big cities.

a need for creating an awareness about designed architecture, quality of built
t and role of different consultants in integrated environmental design.

d, "*Integrated environmental design is a philosophy and method of designing hich aims to achieve the best possible environmental decisions. Each discipline or* on expands its design perspective so as to be involved in neighbouring disciplines ll design."

rated approach to town planning, designed architecture and landscape architecture ound to produce much better results and working conditions, with outstanding It can be achieved at no additional cost. A basic requirement is a competent design has a good understanding of up-to-date building methods, materials, environment ance standards. *James Andrews*, well-known architect, has stated that, "*Architecture ing art. It is for the performance of the user*."

k of the designer is inescapable. It is all around us in the city. Bungalows, apartments, pitals, school buildings, theatres, commercial complexes, stadia, flyovers, footpaths s, street furniture, lamp posts, toilet blocks, telephone and milk booths all are the the designer. We all experience, use and enjoy architecture. Hence, an awareness ronmental Design Evaluation" needs to be developed. For this, it is essential to n behaviour, with reference to designed environment. Behavioural scientists have n designs in order to give suggestions for improving the man-made environment. ncludes factors such as functional utility, available privacy, crowding and its effect human behaviour, and a feeling for social well-being. This gives information for cisions. An analytical vision regarding environmental design needs to be developed. k students to comment on a design by showing slides, photographs or after site

y between science and art is evident, whether we consider Architecture, Cooking ng of History. "Science" is about "Truth" and "Art" is about "Beauty", and as we one to another, we move from the objective to the subjective realms; from verifiable thetic experience."

Editorial Consultant: Sarayu Ahuja
Magazine: *Indian Architect and Builder, Oct. 1998*

ed that the main expectations of man from Built Environment are related to the t of:

action
ness
th of personal competence
vement in professional skill and performance

3. Built environment system—planning, design and constr tem.

3.2.1 Human System

A building structure stimulates not only the visual sense, but it is necessary to think of man as a perceiving organism and which he would perceive. The study of man is done with refe Anatomy, Anthropometrics, Ecology, Economics, Physiology Sociology, Anthropology, etc.

3.2.2 External Environmental System

The building fabric and its services covering water supply, dra physical climate.

A building can simply be considered as a construction on is an act of enclosing space upon a part of the earth with the or the surrounding land, hills or other existing buildings/struc and climate comes into consideration first and these vary f essential to collect data about topography, climate, rainfall, hu and minimum temperatures, sunlight and soil sub-structure. T to decide the details of the building environment or its comp walls, floor, doors and windows, etc., so as to enable it to st rain and wind. The walls and roof are also known as building that material which when assembled with others into an orga is the total of many materials, each with its own distinct qual composition. The proportion, scale and expression of the fab structure. Availability of materials depends on natural resour creations. It also instigates the development of new products system, the availability of natural materials and use of new structure.

3.2.3 Built Environment System

The expectations from a building, town planning and landsca

1. To provide utility, firmness and pleasure.
2. To provide physical and psychological shelter.
3. To admit daylight.
4. To exclude/minimise noise.
5. To resist snow.

its for the user by the provision of "Signage" system, essential
uildings.

onment to perform expected activities inside and outside the he efficiency and comfort of the user with an aesthetical back-bility' through interior designing and landscaping.

onsiderations should be taken into account in architecture. de the building is known as three-dimensional architecture, le the building is known as two-dimensional architecture. The height up to the sky.

LDINGS AS SYSTEMS FOR
E

s of buildings and visits to different buildings for evaluation nation during education and afterwards. Such imagination is g as a complete system. This study includes observations of ews with the user and the designer. It throws light on different ruction and problems in maintenance of buildings.

onsists of study of interior and exterior space and its quality. cts:

he entire building.

spaces, floor area, height, and contact between spaces at dif-d movements of the user.

ndards and means for the achievement of the same, design ons of materials and detailed drawings and control during

Study (Figs. 3.1 and 3.2)

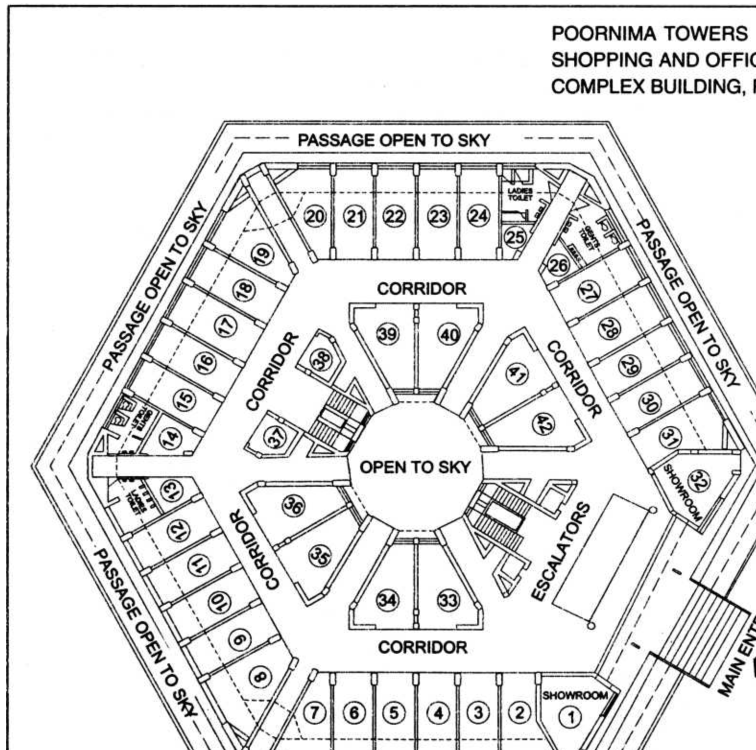
rnima Towers,— Shopping and Office Complex
lding, Pune
Poornima Promoters, Pune
noter—Shri N C Parmar, Pune
-Studio United, Pune
ultant—M/s Ruikar Associates, Pune
ge—Shri Parmindar Singh Bansal
uct a centrally air conditioned commercial complex for

(e) Space for horizontal and vertical circulation—lifts, staircases and esca

(f) Separate generator for electricity as an additional source of power, borewell for water supply.

Structure

1. RCC framed structure suitable to the hexagonal tapering shape c building.
2. Foundation and basement floor was designed for the uplift pressu 2 m because of the nearness of the Khadakvasla irrigation canal on the side.
3. Complex with a basement and ground plus four storeys.
4. Basement—Air-conditioning unit in the central part and parking space
5. Ground floor—42 shops of different areas.
6. First floor—30 shops of different areas.
7. Second and third floor-offices.



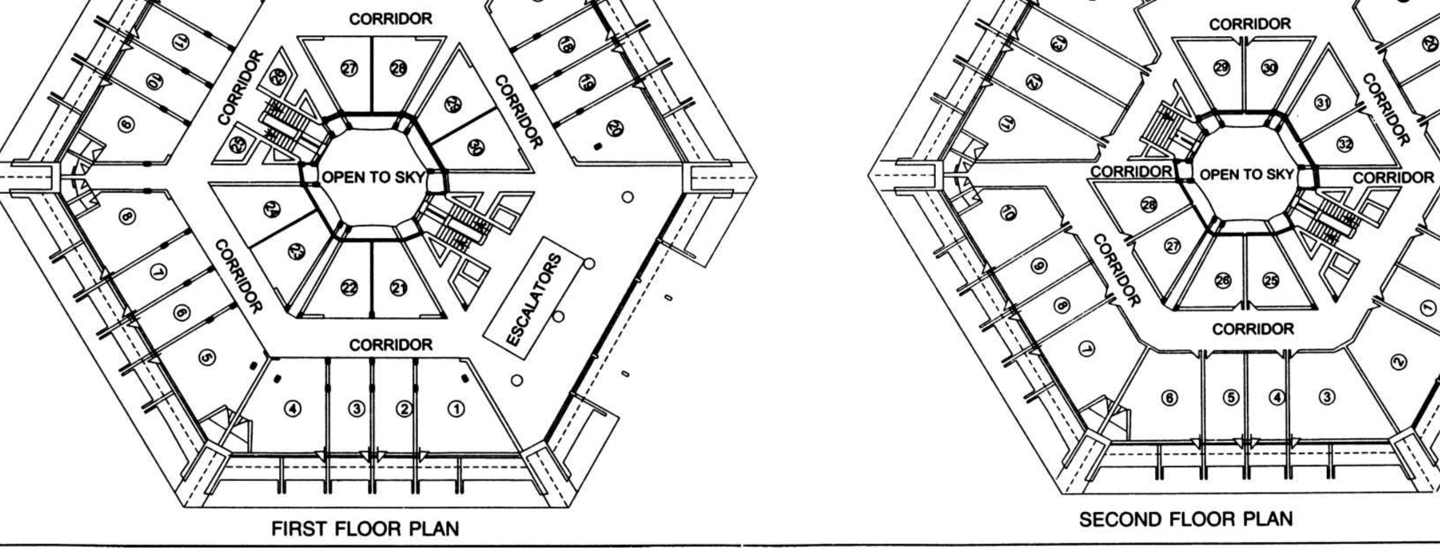


Figure 3.2 *Poornima Towers – First and Second Floor Plan*

Reading Exercise (Figs. 3.1 and 3.2)

carefully the three floor plans and horizontal and vertical circulation systems.
enance of the shopping complex requires a well chalked-out programme. Prepare
s for the same.
re notes for safety in the shopping complex.
interviews of builders or owners of shops and office premises and customers regard-
e achievements and problems, if any, to evaluate a building as a complete system.

ing Total integrated design should cover following points for efficient performance:

th reference to principles of architectural planning includes:
tation aspect
ect
iness
ping

2. Space

Planning for space includes:

(i) Treatment of interior floor surfaces
(ii) Furniture arrangement—type, material
(iii) Colour for walls, ceilings, curtains, furniture finish, clad
(iv) Light—combination of natural light and artificial lig
fittings, etc.
(v) Exterior and interior finish for walls—different mate
effect.
(vi) Indoor plants to bring nature and greenery inside the b
mind.
(vii) Mechanical ventilation—use of electric fans for circula
fans, air conditioners, in addition to natural ventilation.

Evaluation for interior designing of spaces is done w
considerations:

1. Function—efficient, meaningful, economical, orderly, d
2. Privacy—internal privacy and privacy from surroundin

rsons of different age groups—sitting arrangement, lawn,
, walls at different levels
ooking, toilet facilities
ging
r study
s
s, slides, sand boxes, etc.
untains, etc.
tdoor space is done by:
of the user

ollowing points will be useful—-utilisation of outside space of

e

nvironment or not
for maintenance or not

ber that architecture mirrors the various aspects of our lives—is said that architecture is a statement of the society's pattern. ural creation becomes a factor in man's life—its efficiency, its and psychological conditions. The architect's decision affects thus an active force in moulding society.

how to co-ordinate the work of architects, structural designers, ll other consultants, so that architectural success is achieved.

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uilt Form

lines, the fitness, the harmony, and so on of a structure, which ch either are or are not in the original conception ".

Architect: Faber
Book: *Aesthetics of Built Form*
Author—Alan Holgate

ruction are three stages in an architectural creation. Architects

Aesthetic attitude is related to the desire and education of the observer to search qualities. It is also stated that fashion and taste are considered to provide 'mental' d aspects of beauty appeal directly to the soul. The main characteristic of fashion is with which it changes.

Aesthetics is a branch of philosophy. Its aim is to search and uncover the elements of the beautiful. It deals with the theory of the principles related to the beauty in bu humanism in architecture.

Architecture has not come into existence due to a desire for beauty, but as a n survival from a hostile environment. Primitive man after satisfying his primary ne and energy to look towards nature, its variety of natural forms, texture and colou have inspired him to refine his food, shelter and clothing in such a way that they to provide not only physical satisfaction but even aesthetic pleasure. His shelter wa with available paints and figures. The habit of deriving aesthetic pleasure from obj a secondary psychological need. He must have learned about pleasure in rhythm b nature and rhythmical action. Rhythm is related to repetition of known things. was subsequently added in decoration. Next, he learnt the phenomenon of order, i. regular intervals by studying seasons in nature. Gradually, he must have realised the of symmetry by observing the growth of trees. Thus, symmetry, rhythm and orde improved his shelter to give him pleasure. Gradual technical improvement in cons additional safety from the weather and animals and refinements in forms for aesthe changed requirements and expectations from architecture. In addition to this, certa for surprise were added in the composition for emotional involvement of the obser

3.4.2 Feeling for Aesthetics and Utility

In architecture, certain relationships are basically important for a "well- buildin planned, constructed, aesthetically appealing building. The three conditions for w are—commodity, firmness, and delight. The first relates to fitness for the purpose, t the constructional aspect, and the third to the aesthetic quality which distinguishes from mere civil construction. An architect's skill is at test in planning a building.

It is the eyes which convey to our brain, the feelings regarding proportion and p good or bad, balance, rhythm, symmetry and asymmetry, about pleasing and colours, etc. In addition, our eyes also judge feelings regarding utility. As soon as sees a kitchen otta which is not of the correct height or width, she immediatel without taking any actual measurements, on the nonsuitability of the otta. The si for this is the direct and indirect training our eyes receive after observing great ma nature right from childhood. An effect of spaciousness within comparatively limited can be achieved by skillful treatment of form, colour, natural and artificial ligh elements of furnishing.

The exterior view depends upon the dimensions of the doors, windows, *chajjas* schemes selected, projections, effect due to interplay of light and shade, etc. Las

such depends upon the composition of the plan and the architectural design of the
r its final master effect.

eparing the plan, one considers the area and cubical requirements and also vertical
tal circulation. Now, one has to imagine how this building will look like when
The building will show solid portions of walls and voids for doors and windows
f at the same or different levels. Our eyes judge proportions and location of voids
olid portions. Some effect is also created due to projections of *chajjas* and canopies.
ing has some point of central focus, i.e., entrance door, steps and canopy. It will be
ed that the effect of overall beauty is related to the effect created due to proportion
ons; hence the same is highly important in architectural composition.

Unity

al composition includes both composition of the plan as well as composition of the
he structure. Economy of space and increase in essential services (water, drainage,
ir conditioning, etc.) are challenges to the architect.

ture is the expression of an idea in a concrete form. *Unity* in architecture can
d as an effect achieved due to the harmony among different elements which are
o each other according to their functional necessity. The elements may be single or
heir size may also change according to the function, nature of the mass, its correct
he axis, the placing of a dominating mass at a central or at a convenient place to
int of importance, etc. These are the factors which affect harmonious unity. Study of
ts, namely, mass composition, order, expression and materials of the exterior with
elation is essential in order to understand the unity.

Mass Composition

ree-dimensional shape in space required for carrying out various activities by the
y. Aesthetic space is added to the utilitarian space for its aesthetic satisfaction.
al space is added to the above two spaces in order to create architectural mass.
needed to construct mass. Hence, an architect is concerned with three inter-related
ely material, mass and space. Material and mass for static functions and space for
movement of man, i.e., for dynamic functions. Wide, narrow or vertical space is
s enclosure and its horizontal and vertical dimensions. Internal spaces are created
d the roof while external spaces are the spaces around the enclosed space. Openings
red interruptions in the surface continuity of a mass. The shape of openings may be
angular, circular or semi-circular. Their vertical and horizontal dimensions create
fects. Series of openings and their patterns create different effects related to their
ue to the effect of verticalness or horisontalness. They must harmonise with the
acter of surface and mass for aesthetical satisfaction.

developed from a plan, and a plan is prepared on the principles of symmetrical

in large layouts. Masses immediately adjoining the main axis
the more remote elements may be given individual treatment. A
our eyes cover a limited field of vision, and if symmetry can
eye is not disturbed by differences which occur beyond its ran

In the asymmetrical plan, the axis is brought to one side du
or pecularity of the site. This type of a plan in which there is
naturally less dignified than the balanced type, but it looks mor
is more flexible. Schools and commercial buildings accordin
designed asymmetrically. It will also provide for a possibility o
or in symmetry and balance.

On account of the radial property of certain figures such as
they are sometimes found useful in providing axes rhythmical

Symmetrical and balanced planning is also known as *form*
planning is known as *informal planning*.

With the introduction of the framed structure, planning
modular dimensions. The space is allotted in multiples of mo
from 1 to 3 m^2 or even bigger. Columns and beams are spac
is divided into squares. Various rooms and corridors are then
modules together.

3.4.6 Plan for a Health Centre (Fig. 3.3)

This plan has been developed on the principle of informal
are arranged on the side of the central corridor. Modular plan
different units. The central corridor is useful as there are roads
Informal planning is advantageous, as the construction is prop
will appear as one complete structure after each stage.

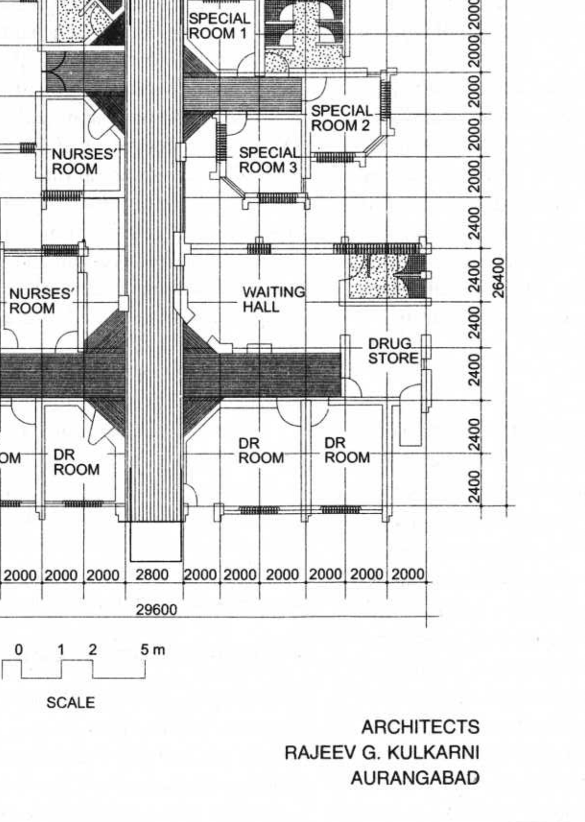
Reading Exercise (Fig. 3.3)

Prepare furniture layout plan for the following: (i) Mate
(iii) Waiting Hall, and (iv) Doctor's Room.

This system of planning is useful for large buildings with a
for offices, hotels, hospitals, factories, etc. The Japanese desig
known as *tatami* and is represented by a mat of approximately
is always an exact multiple of this unit.

Siporex or hollow concrete blocks of size 8" × 8" × 16" (20
in construction. This necessitates that the size of the room, d
of the room be in the multiples of 8" (200 mm).

Planning done on a modular basis gives proportion and r



3.3 *Health Centre – Ground Floor Plan*

omposition should satisfy certain rules of composition, since
r balance in composition, harmony and *weighed adjustment* of
balance in the composition very easily and accurately.

nt and dimensional relationship creates order or organic unity
easurement is man. It is essential to establish a relationship
an to universe by creating a well-related and effective human

*"Expression in building, yet, is not only reflective but also educative, with bui
the most immediate and continuous physical environment of man. Architectura
strongly shapes man's psychology and influences his aesthetic sensitivity."*

Architect: He
Book: *The Japa*

Expression appeals to man's senses through colours, shapes, lines, i.e., total c
establishes a psycho-physical harmony. Hence, one should realise the role of art in t
It throws light on the culture, life and aesthetic liking of the people in a region.

An important *question is on the primary object* in the creation of a building.
could be the *enclosement of space* for some defined human activity. Then the
question is on what should be the architectural expression for the building; s
structure, face materials or purpose. One would agree that it is for this purpose
is prepared. Human acceptance is one of the important factors in expression and
to *man's physical, intellectual and emotional involvement*. Visual order created by
establishes emotional relationship between the family and the house. The same is tr
types of buildings, i.e., there is a need for an emotional relationship.

Exterior and interior expressions are equally important. Exterior deals with ph
and external features while interior design creates effective acceptable interior
also establishes its relationship with the surroundings. Exterior is the result of inte
Creation of space and shaping of space aesthetically is an essential consideration.

Two considerations in architectural design are its aesthetic component and
component. Function varies as per proposed use of the building, hence it must fulfil
function. The next requirement is of a suitable structural system to serve the pur
enclose space. To construct space vertically to desired height or to span huge v
desired purpose is the need. The outward expression is related to the need of the pla
system and choice of materials of exteriors.

At this stage, one should know about the biological reaction while observing
The eye perceives and the body and mind together react to the impulse, creatin
of comfort or discomfort. Emotional reaction after viewing is responsible for a
state of mind. When man stands erect, a vertical imaginary axis is established al
imaginary horizontal axis passing through the eye at about 165 to 170 cms above g
Both axes are at right angles to each other. Height, width and depth of the objec
eye movements while viewing the object. These three dimensions form a dynamic
with each other which we refer to as *proportion*. Architectural forms are based on
forms. Viewing geometrical forms is different from viewing natural forms. It becon
to soften harshness and rigidity of geometric expressions; hence texture, colour an
an important role in the treatment of the exterior for creating human warmth. Contra
of colour and texture, shades and shadows of projecting mass/elements, lights for i
etc., help in achieving an aesthetic quality. Exterior treatments need to convey th

l purpose of the buildings.
on is related to the visual relationship of height, width and depth. It is geometry which is seen. Form also changes by substantial change in one of the dimensions. ermutations can be imagined by changing its height/width/depth or by changing all equally. A mass to be most satisfying, must have one dominant dimension and in mplex mass what we need is one dominant mass to make it effective emotionally. ffect is possible by giving one diminutive dimension, i.e., much smaller than other ions. The visual effect due to flatness will be emphatic. Openings for doors and d their shutters have a two-dimensional quality as compared to height and width. ness is small. In case of buildings for sports for badminton and basket ball, we vertical height and horizontal dimensions also. Door openings with more vertical and window openings with horizontal dimensions serve the desired purpose. ill be seen that proportion depends upon functional requirement of man—the user, space. A dominant structure with emphasis on vertical dimensions is required for e more point related to the choice of dimension and proportion is mass production s. Hence, door shutters of size 1000 or 900 mm × 2100 mm in multiples of 100 mm selected. Modular plans need all dimensions—length, width and height in multiples Dimensions also depend upon the age group of users. In nursery schools, furniture, level, height of the wash basin, bottom level of the black board, etc., are kept at a with reference to the height of the user. Human scale is essential for furniture and residential units. If kept at a low level, the height of the ceiling will create a feeling n or if kept at a higher level, it will create an uncomfortable feeling.

Proportion

en that the area required for a particular function can be calculated on the basis ce (e.g., 1.2 to 1.5 sq.m per student for a classroom). After deciding the height, alise the volume of the element. After deciding the area, one has to finalise the length and width. There may be a number of sizes and shapes for the desired ment of furniture controls the size of a room. However, the real problem with r is a proportion between the length and the width that will look pleasing. There oblem of the proportion between length, width and height of the room. Hence, should have a good sense of proportion. Proportion is related to form, rhythm Common sense inspires us to avoid a square shaped or elongated rectangle for a . In the same way, one can decide the height of the ceiling. No one provides a m for a bedroom or a height of 3 m for an auditorium. But then what is a good The size of the rectangle should satisfy our sense of proportion. A rectangle built onal of a square is used widely for window designs or rooms. If the width of a n, its length comes to $3 \times \sqrt{2} = 4.24$ m. Hence, for the effect of roominess the th to length should be 1 : 1.2 to 1.5. For a modular unit 3’ × 6’, the diagonal is omposition on the whole should have a pleasing appearance. Hence, the relationship

is related to the proper relation of several parts of the build and their relation to the whole design. Buildings are of differ monumental. The 'Intimate scale' is used to suit the needs of r staircases, steps (rise, tread), and even the height of handrails feeling of comfort and ease. On the other hand, ‘monumental of grandeur and grace, so as to impress the observer. This i width of the staircase, graceful height and size of columns, c and selective choice of materials for the finish. The 'proper qualitative results of proportion. The environment and surrou observer views a building as a whole along with the surrou of trees, plantations, walkways driveways, etc. It is normal p or figures in drawings of elevations near the entrance or in a judge the proportion between a human figure and the structu monumental buildings, but it has its own place in structural be the structure is created essentially for man.

3.4.11 Accentuation and Rhythm

Accentuation means emphasis. The element in a compositior which create an impression of decision, rigidity and function a column is a positive element. The elements which produce the e decoration are known as *negative elements*. In architectural co careful in deciding upon the emphasis to be given to the pos combination should create interest and life and vitality in the competitive or rhythmic monotony for increasing the effect o concentrated decoration or on the strength of colour will be u The attention of the observer naturally falls first on the spot o

Rhythm in architecture is the repetition or recurrence of a c Like columns, openings, and arcades, i.e., row of arches, etc. with life that it seems to be the very essence and expression eyes and appeals quickly to the mind.

In architectural composition, interest is created and increas elements. The distance between the various elements may no may be a gradual decrease or increase to slow down or to spee

Gopurams of many temples attract attention through rhyth

3.4.12 Contrast

Human beings by nature are fond of change. Partial or total composition with harmonious unity should create an intere the attention of the observer. *Contrast* is the means to create nd voids in elevation may give an excellent proportion with texture, colour, effect of light and shade are important tools in e the desired effect by using contrast. Different types of stone e masonry, stone and brick masonry in combination, plastered with fine sand finish, plaster with rough finish, pointings on colour on surfaces to attract the vision where it is prominently contrast brings liveliness. It is, however essential to see that ontrast are not splitting the composition into separate elements

tural expression but it cannot create one. It needs vision of a lect and use colour for the desired effect. It is better to select erials of different colours and textures.

fect of light to create contrast. Cube and circular shapes should rections. In case of a cube, one surface will look bright while ght creates the impression of depth and sensation of mass. In ill be a gradual change from bright to dull. All projections and nce, contrast is created due to bright surface and dull surface essential to create such contrast.

due to contrast, one should remember that matching may be ast is essential for structural beauty. One should study this by f facades and shadow patterns and changes in shadows by a nt source.

htage. It is to be considered with reference to use of various space, surface, line, point, etc. A vertical element has greater al element. Solid elements have greater visual weightage than ted elements. Red has greater visual weightage than yellow een two colours is created by reducing the area of the colour If red and yellow colours are given on a rectangular surface have a greater visual impact than a yellow surface. These two e red surface area is gradually reduced and the yellow area is ine separating the two colours, then a condition of balance will ual visual weightage. It is easy to create equilibrium through brium through balance. Proper balance satisfies the eye with ce of various parts of a designed stacture. In a balanced layout, plete absence of axes. Equilibrium between masses can be seen view is impressive. Symmetry shows stability, while balance

not need decoration. It will be seen that temples and palaces were made purposel while fortresses were without decoration. Architecture with a total utilitarian po will create identical buildings. In order to avoid this, designers started thinking elements in architecture which are mass, space, surface, line, texture, etc. It was fou to create architecture by using these basic elements without any decoration. It was an aesthetically satisfying architecture can be created by using only these basic ele

At this time, some designers pleaded about the emotional requirements from a Decoration to some extent is essential to emphasise an architectural effect. This adding emotional and visual qualities by achieving verticalness, horizontalness contrast, etc., to harmonise an architectural character. Decoration can be applied to or texture, but not to a mass. There is a difference between decoration and pattern. has a non-utilitarian aspect while pattern has utilitarian and emotional aspects. I greek column, or suitable pleasing decoration around the main entrance door or use decorate a surface has helped in creating interesting expressions.

3.4.16 Massing

An architect deals with different volumes which are required for different functio essential to create a visual organisation of these different volumes in a meaningful which will give functional and aesthetical satisfaction. There are different ways massing effectively. Arrangement can be done by different ways, namely the right-an provides maximum combinations and variety, the spherical system has limited co possibilities, while the diagonal system is also limited to a particular type only.

Clarity and harmony are the two main expectations from good massing communicate effectively with the observer. This will create an interest in the obs emotional involvement. Thus, imaginative composition is required.

3.4.17 Character of the Building

Creation of a pleasing impression with an emotional impact of character is the aim of a composition. If the same is the aim in design, it requires many considerations. The conveyed through the design is related to the creative gift of the architect. The f factor is the original brilliance of the architect and the second, the method of co the same through design. How the idea is conveyed is equally important. An archite building for some purpose. Hence, every building has got its own character.

The character is not in itself one of those fundamental principles of architectural c such as unity, contrast, scale, etc. Character grows out of the function of the building upon the manner in which architectural composition has been handled. Hence, t attracts one with its own strong personality. Character is achieved by the buildi the unusual perfect fulfilment of a programme. Such buildings are immediately re schools, hospitals, temples, churches, factories of godowns. This quality of charac out a tower going high up vertically. Though materials have changed, the traditional still followed.

onal character of a building is achieved through the effect produced due to the n horizontal and vertical lines. Emphasis on horizontal lines convey the idea of quiet, and is suitable for residential buildings, hospitals, hotels, etc. Emphasis on s on the other hand creates feelings of power and dynamism. Window openings l proportions often produce an effect of grace and elegance.

ng is a man-made thing. But the so called inanimate structure (Jada-Vastu) has s own animate life. The proportion and disposition of the various organs of the human ated to their function. Similarly, a building also is made of various organs having ctions, and as such its character and function are interlocked with one another in the ce, the characteristics of the activities that are to take place in the building should pression in the whole design. Authenticity or genuineness is related to function and nally, it may also be realised that a sharp departure from the accepted routine draws n of critics and common observers. Hence, imagination, individuality, and a sense of nd composition are the important tools with which an architect can produce elegant l designs.

ARCHITECTS ON ARCHITECTURE

ying planning and design considerations in architecture, it is interesting to study ews of architects on architecture.

rench architect **Auguste Perret**, "*An architect is a poet who thinks and speaks in nstruction*".

g to the American architect **Louis Sullivan**. "*The true work of the architect is integrate and glorify utility. Then and then only is he truly a master worker*". *defines design as* "*The architect's graphical solution of a project or a programme y, structurally and aesthetically*".

s, the first century Roman writer in his **De Architecture Libri Decem** (Ten Books ture) has stated the first principles and requirements of design: "*Utilitas, Firmitas,* i.e., utility (good planning for usefulness of area and space), sound construction, g appearance are the principles of good architecture. As these principles can never entirely, revolutionary architecture was based on notions added to the above three To this trinity, the idea of space as a positive architectural quality was added.

usier in France, **Behrens** and **Gropius** in Germany, **Oud** and **Dudock** in Holland, **n** in Scotland, and **Frank Lloyd Wright** in USA were responsible for changing the architecture, and they can be called the founders of modern architecture.

Lloyd Wright defined Modern Architecture as "power" that is to say, material rectly applied to purpose.

usier defined architecture not in Vitruvian terms, but in terms of the sculptured ght and shade. "Architecture," he wrote, "*is the masterly, correct and magnificent*

differ from another building if it is planned in a manner suit not the different parts of the buildings, by being destined for d from one another? Thus, one should not strive to make a buildi oneself solely with the *fulfilment* of practical requirements, it i pleasing. Architects should concern themselves with planning

Durand *goes on to say, "There are only two problems i of private buildings which was how to provide the optimum sums of money; and second, the problem of public building maximum accommodation for a given sum". Architect* ***V S*** *design purpose of any building is determined by its aesthetics product of the cultural value placed upon that building. The may be motivated either by symbolism or emotional interest".*

Case Study

Milk Collection Centre at Ale, District Pune Architect—Ravi Gadre, Pune (Figs. 3.4 and

The Brief

One hall, four rooms comprising a rest room, offic dispensary, load bearing economical structure.

The Design

"Use of Diagonal" is the main concept employed for the square rooms are placed diagonally to the corners of t load bearing structure more stable. This also allows the the elevations. Further, the corners of the wall junctions chajjas which come at an interval of 90 cm in the forn for the 23 cm load bearing structure. The stage height trucks which also serves as a stage, makes the hall n for gathering of the milkmen. The load bearing structur supported roof slab, as a permanent solution. Thus, the certain logic and discipline which is the major feature o

Outcome

The constraints like minimum programme and type of strong points of the design, with appropriate logic and l of material and construction.

Reading Exercise (Figs. 3.4 and

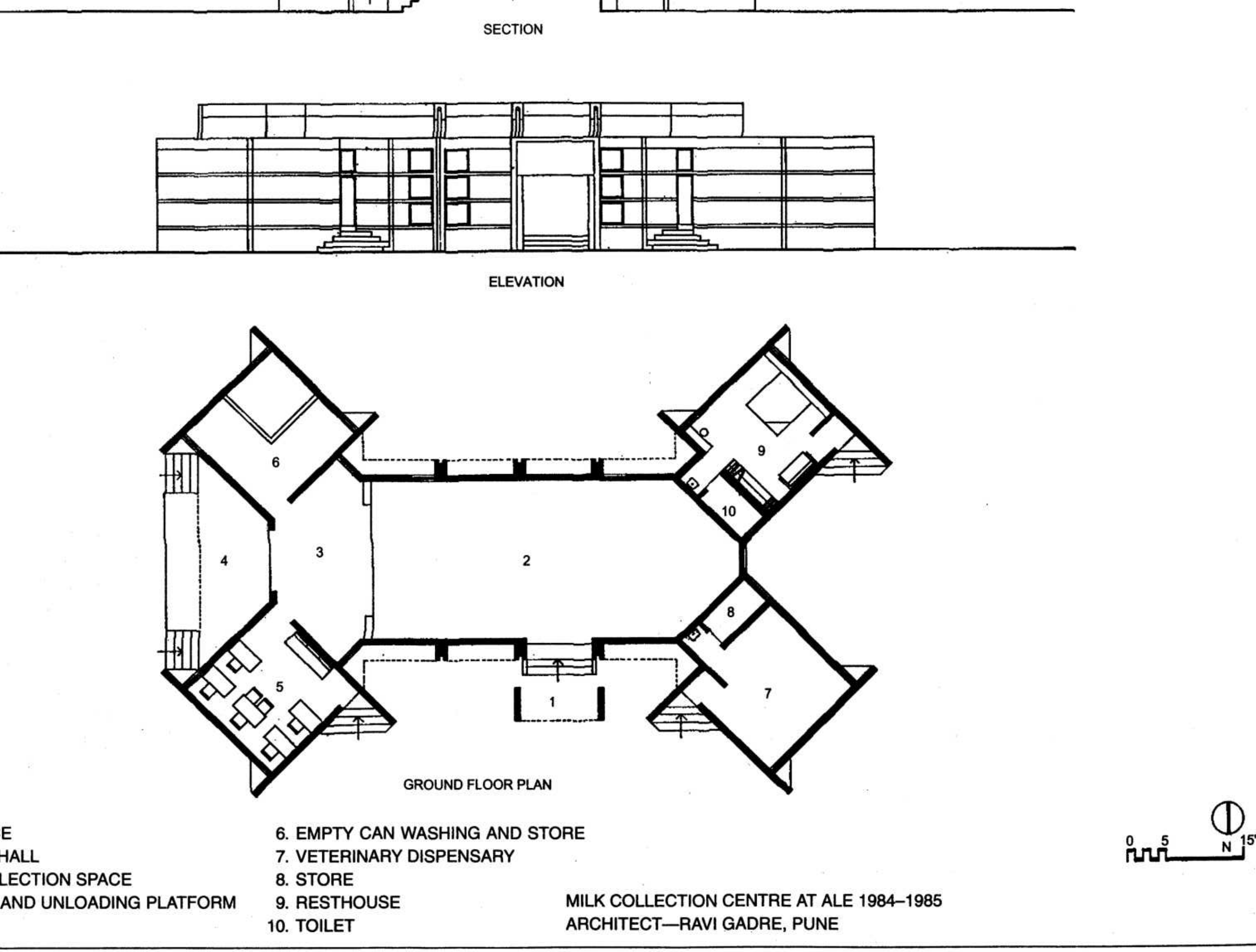


Figure 3.4 *Milk Collection Centre – Ground Floor Plan, Elevation, and Section*

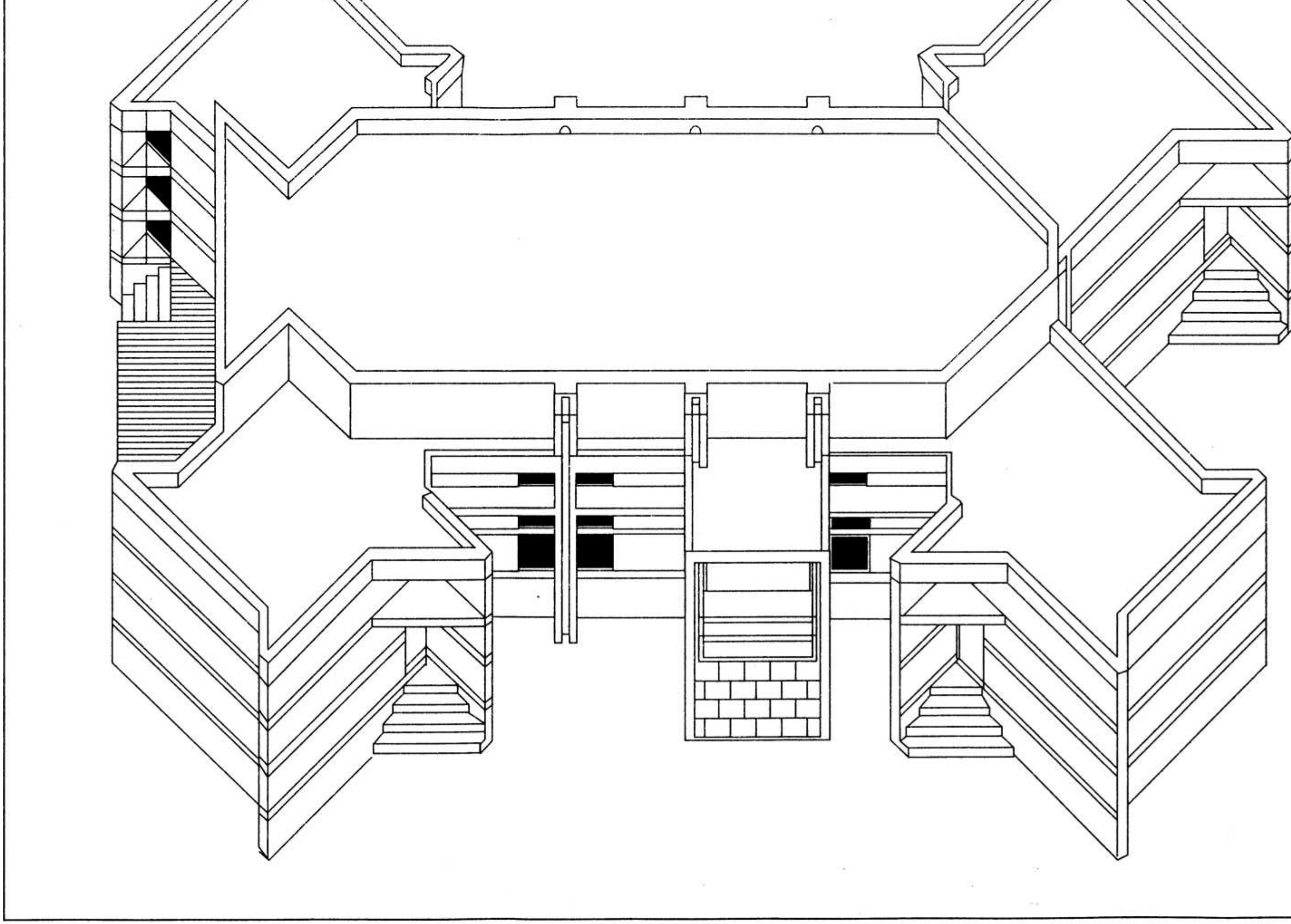


Figure 3.5 *Milk Collection Centre – Axonometric View*

bearing structure—state basic structural requirements for the load bearing structure sign of wall and footings. Study and state various elements which will be useful for onal strength of the structure.

4. Plan for plinth protection, hard and soft landscaping deta shade.
5. Axonometric view (Fig. 3.5) shows the difference in

om, toilet, kitchenette, verandah, economical structural
e. Total area around 60 sq.m.

is the theme of this design. Since it is a guest house,
y for more than two to three days.Thus, there will be no
he shape of the rooms. To achieve economy, the virtue
utilised. The periphery is less for the same area of a
tangular-shaped structure. Thus, the length of the wall
omy. This also makes the 23 cm load bearing structure
open verandah with built-in seating and kitchenette and
let is added opposite to each other. A common RCC slab
ot allow *chajjas* for the windows placed at the junction
onomy, the 45° sloping A C sheet roofing allows storage
eals the overhead water storage tank over the toilet.The
ssing in the bedroom and one over the folding dining
for the central dark portion. Thus, the total composition
tion of cylindrical, cube and triangular shapes. The major
which minimises the cost, and needs less maintenance.
e wanted more weightage to be given for economy and
cceeded in achieving.

tructural logic can create good designs. Aesthetical and
give permanent quality to the structure, making it an
t just a building.

ercise (Figs. 3.6 and 3.7)

the plan, the axonometric view and orientation, and comment

ea by preparing working drawings.
posed to achieve economy in cost.
tem for heating water, landscaping treatments, and plan's use-

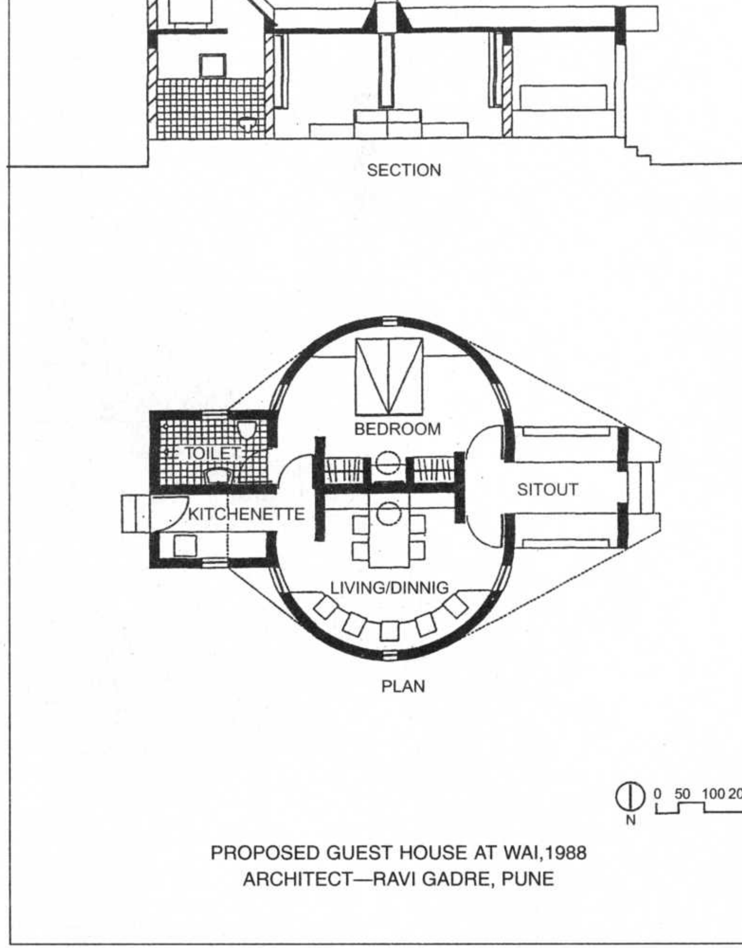


Figure 3.6 *Guest House – Plan and Section*

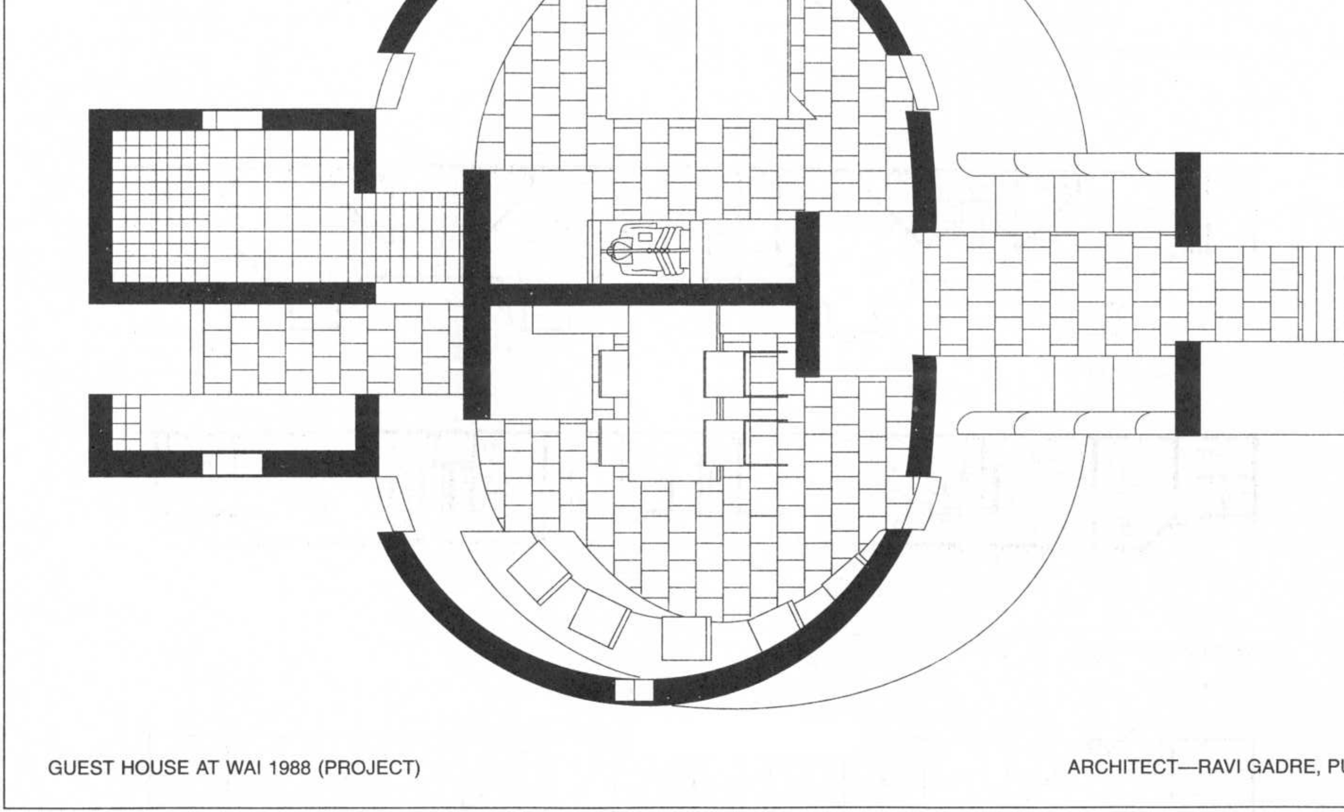


Figure 3.7 *Guest House – Axonometric View*

Case Study

dence at Wai for Mr S S Shah (1989–92) (Fig. 3.8)

wner Mr S S Shah

chitect	***Ravi Gadre, Pune***
C C	***Altron Consultants, Pune***
ntractor	***Mr S V Tatke, Wai.***
pprox. Area	***3710.0 sq. ft.***

sides. The size of the plot is 16' × 112', like an "EEL'S three independent units separately accessible, having tw dining, store, toilets, *verandah*, in each unit. (16' × 112'

The proposal

The plot size is divided into 28 squares of 8' × 8' size. T bedrooms at the first floor gives the required width an while creating ducts for air and light. The central doub

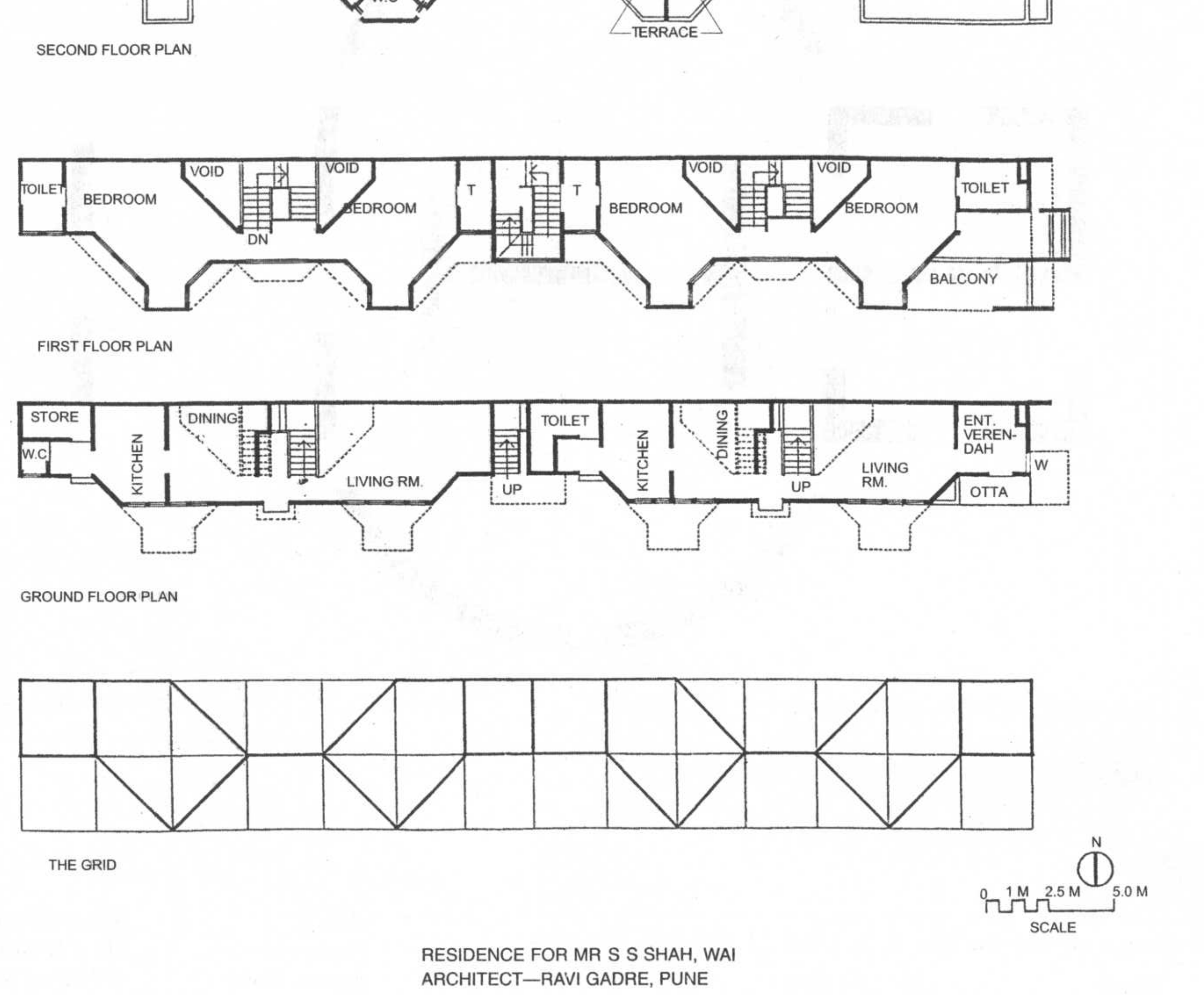


Figure 3.8 *Building for Residence – Plans*

Floor Plan—two units on this floor are connected to the ground floor by an internal ase.

d Floor Plan—One unit with an terrace and a separate staircase.

the advantages of planning with grid in a limited plot area having more length and idth.

and study plans with mirror image due to the rear wall not having openings. Mark sions for grid.

orientation with reference to the North, shown in the drawing. Give your com-.

Reading Exercise (Fig. 3.9)

ngalow for Pokarna Brothers of Ahmednagar t—Ravi Gadre, Pune

ping of various units and furniture arrangement shows the use of available space. t (9), Garden (10) and Terrace (11) at the first floor have added to the pleasure of or space, giving ample opportunity for landscaping and privacy.

the location, type of stair and entrance from units (4) and (5) on the ground floor,) and (7) on the first floor.

n units design provides safety instead of a bungalow with a single unit.

of an R C C frame for columns and beams above the terrace. What is it known as? its use and different ways for using the same.

nent on architectural planning.

Case Study

ospital Building at Indapur, Pune (Fig. 3.10)

oject Information

ner	***Dr Sanjay Deshmukh***
cation	***Shankar Co-op. Society***
	Kalthan Road, Indapur, Dist., Pune
chitect	***Ravi Gadre, Pune***
sign Team	***Ravi M Gadre, Sanjay Panchwagh and***
	Sunil Jagtap
C C	***M/s Altron Consultants***

The Proposal

There were no special instructions about the design of t that the design would respond to the nature and the re balanced nature is reflected in the elevation of the buildin thinking is reflected in pure and cleancut cubic forms. T is complimented further with the help of a skylight, framing the terraces, etc. This is further emphasised w colour scheme. The plan which was based on a certai the symmetry. On the second floor, only the front po at present. After future expansion, the total composit presently it looks as a complete structure, with powerfu

Reading Exercise (Fig. 3.10)

1. The plan for the hospital shows grouping of various are
2. Ground Floor—Hospital with essential units.
3. First Floor—Residence of the Doctor and three separa W C Second floor is connected to F F by two stairs one
4. Second Floor—Bed room with toilet, dressing units anc ning.
5. Study R C C projections for cupboards and windows of the terrace.
6. Terrace on the first and second floors have added to the p first floor and bed room on the second floor. Study the e tions, and use of various elements in the elevation treatr
7. Comment on architectural planning.

Case Study

Parmar House, 1205 Subhashnagar, Lane Shukrawar Peth, Pune-411 002 (Figs. 3.11

Owner	*Mr Sukan Par*
Architects	*Ravi Gadre, P*
Design team	*Ravi Gadre, S*
	Pradeep Solar
R C C Consultants	*S W Mone and*
Contractors	*Mr S D Deshr*

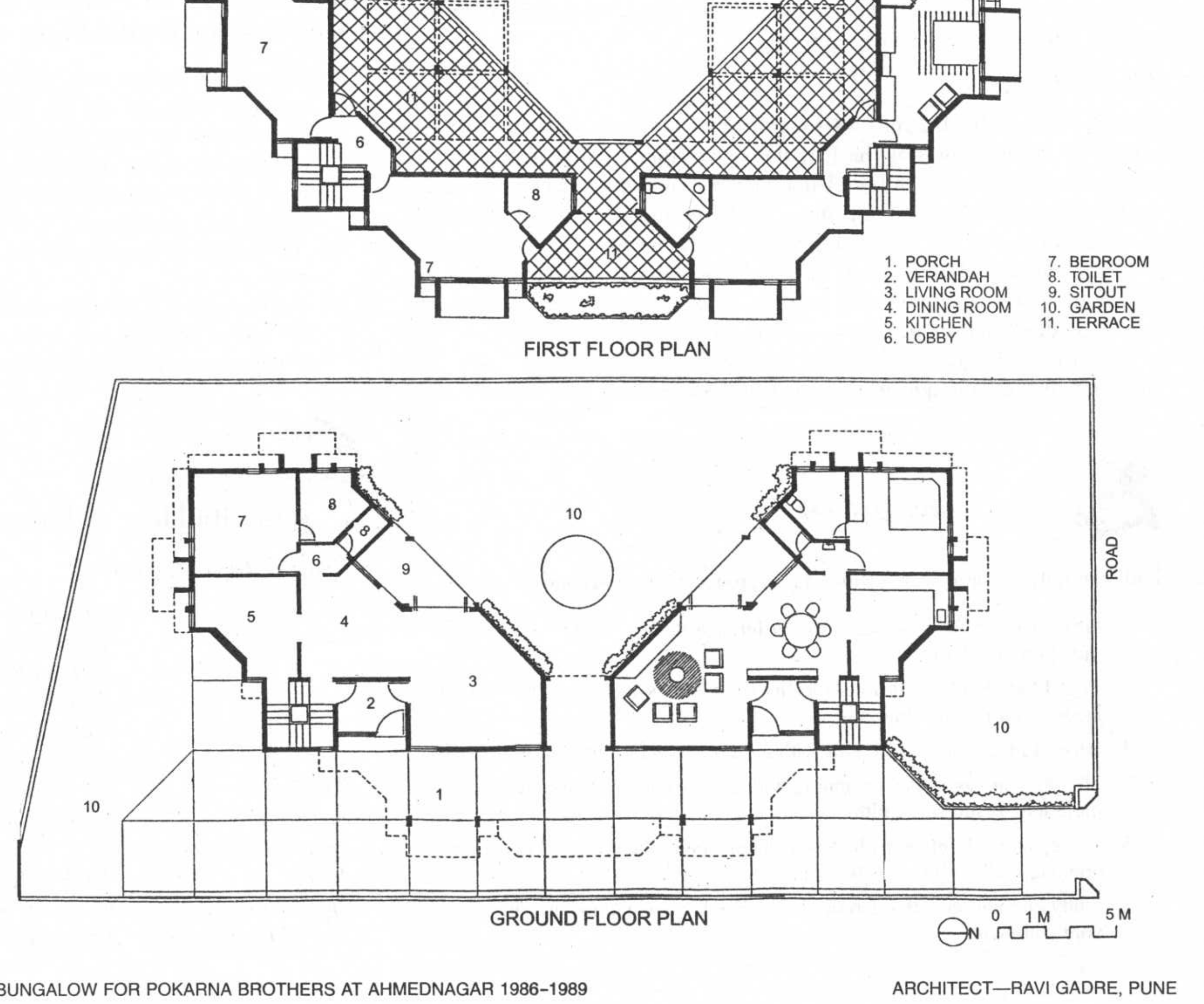


Figure 3.9 *Bungalow – Ground and First Floor Plan*

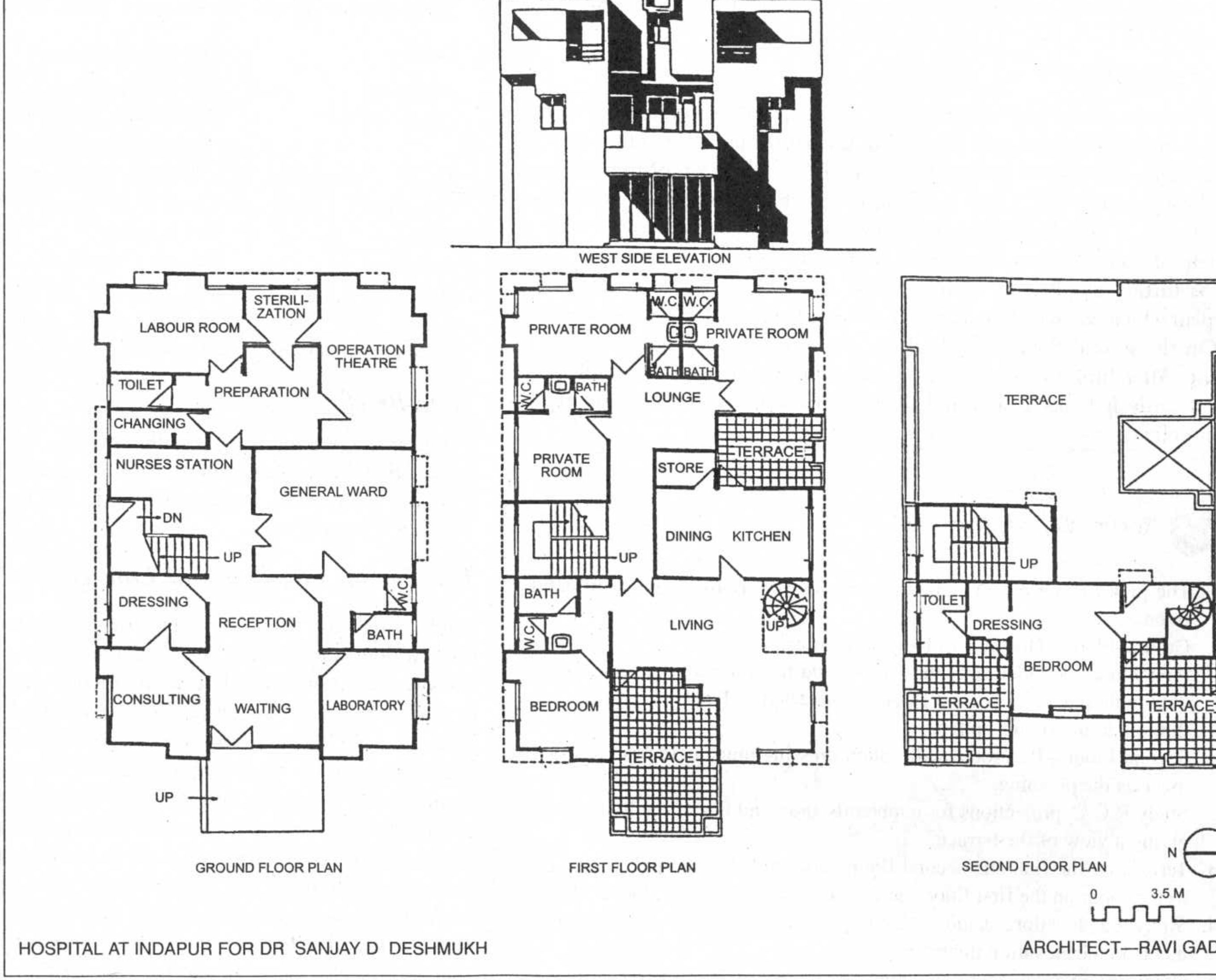


Figure 3.10 *Hospital – Plans and Elevation*

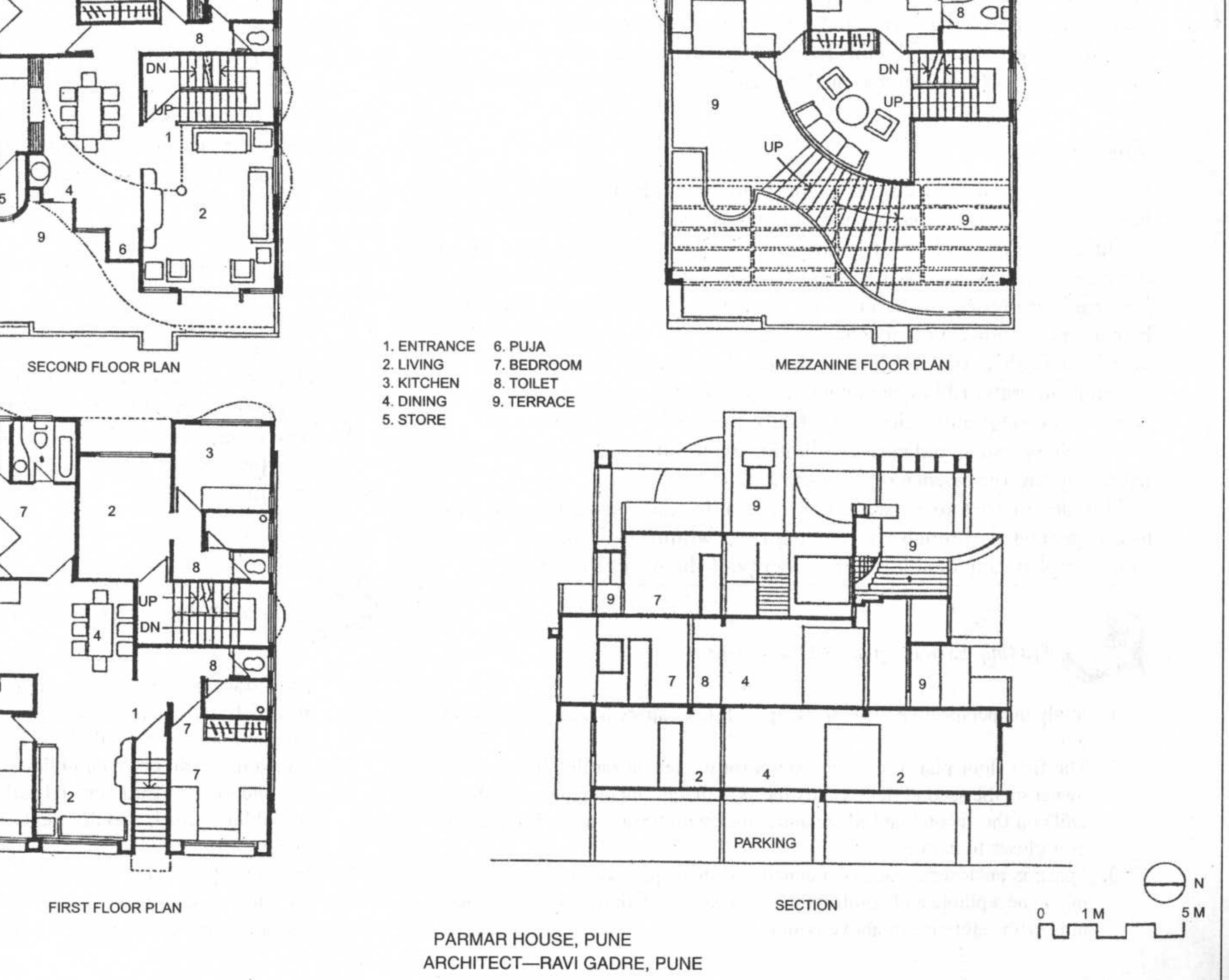


Figure 3.11 *Parmar House – Plans and Section*

Design Freedom and Liberty

visualising the design, the space restriction in the parking area and the oor was realised. There was more space, i.e., freedom for the second and ezzanine floor. The existing tenant had to be accommodated free of cost on rst floor only. Thus, a strict box-like form having maximum coverage, with arate access was inevitable. A base was thus formed like a podium for the osition of the bungalow above. The owner's requirements were split into two creating terraces. The second floor consisted of a living room, kitchen, dining wo bedrooms with toilets and a utility terrace on the east.The mezzanine consisted of two bedrooms with toilets and a family room. The landscaped es attached to the family room above the living room and at the roof level linked by planters and a flight of steps. This free-flowing terrace became the contributing element to the overall composition of the bungalow, indicating om'. Such an adjacent terrace gave a sense of connection with the ground. was noted by the architect in the city museum at Udaipur, where every floor courtyard garden, as it is built around a hill.

tructural frame with a planter metaphorically represented the space restriction. rame at the lintel level of the roof terrace was further enhanced by providing r terraces for the bedrooms. The picturesque surrounding was 'framed' by this . Thus 'framing and framed' became the sub-concept. Conventional methods aterials of construction were used.

Outcome

architect is desirous of a common phenomenon called 'Design Freedom'. He es that a good design is a result of such 'Freedom'.

ring the early phase of'modernism', architects got 'freedom' due to the new ials like RCC, structural steel and glass. This freedom is powerfully expressed chitect Le Corbusier, at 'Ronchamp Chapel' in France and 'High court' at digarh, etc. The fine example of 'Villa savoy' established the freedom in house n with main features like building on stilts, ribbon windows, white box, free ing and terrace garden. The vigor and vision of Le Corbusier is still valid

scipline, system, order, and dedication are the 'frames' of a good design which re the essence of 'freedom'.

is design tries to regard this 'freedom' by the composition of free forms, generated gh the requirements within an imposing frame, which emphatically establishes entity of the owner's desire.

Reading Exercise (Figs. 3.11 and 3.12)

Terrace Housing (Figs. 3.13 to 3.15)

This was our entry for competition for a 50 acre h leading builder had initiated this competition, his focus commercial aspects, (1) consumption of full FSI, and (i

Keeping their viewpoints in mind, we conceived a t This had an incremental quality and could be an added a This theme proved to be very powerful aesthetically. T demonstrated that 'aesthetics' of any building has to be falsely applied one. It also gave a vibrant and new look

We developed different types of buildings for this t one of them. The plan of this building was conceived o hence all the room dimensions were in multiples of 0.9 m presentation to the building. Seven buildings were grou of 20 m x 20 m, which made an interesting group of the further repeated to form a good neighbourhood unit.

Archit

Reading Exercise (Figs. 3.13 ar

1. The terrace housing scheme shows an axonometric vi vidual terraces, a layout plan with grouping of building and different floor plans.
2. An axonometric or "plan oblique view" is a simple way structional details. Terraces at different levels, grouping surfaces in colours show a three dimensional view.

   Tracing paper is kept on the plan, then the plan is tilted t from various corners as per the scale of the plan. If esse to 1/4, 1/2 or 3/4.
3. The total plot area, area for roads, open spaces, permis sible tenements decide the total layout. What are the rul they vary from area to area in the same city? Why are t
4. What are the rules for balconies and terraces? Terrace They can be utilised for different purposes.
5. Study different floor plans. Prepare a furniture layout p

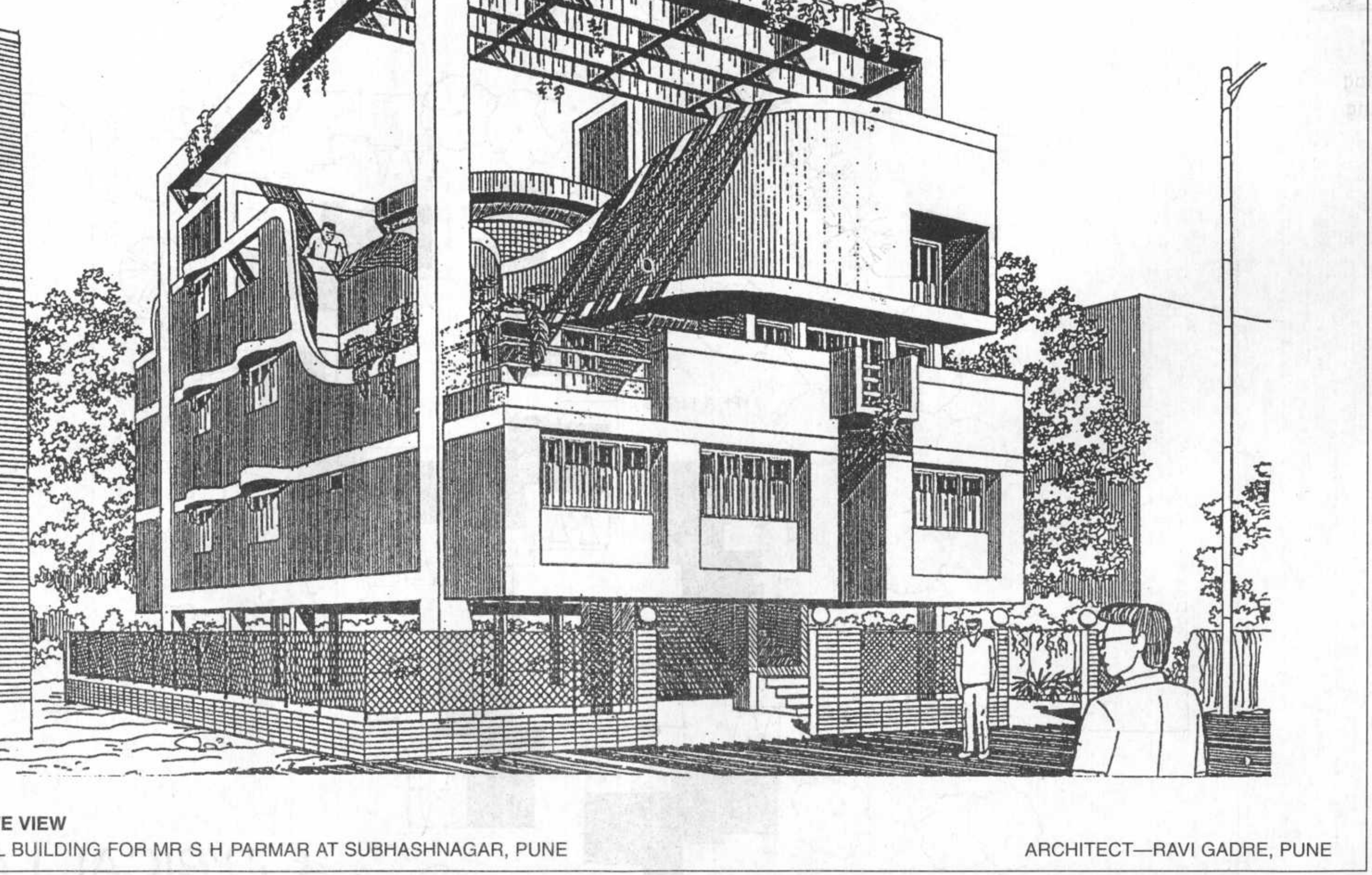


Figure 3.12 *Parmar House – Perspective View*

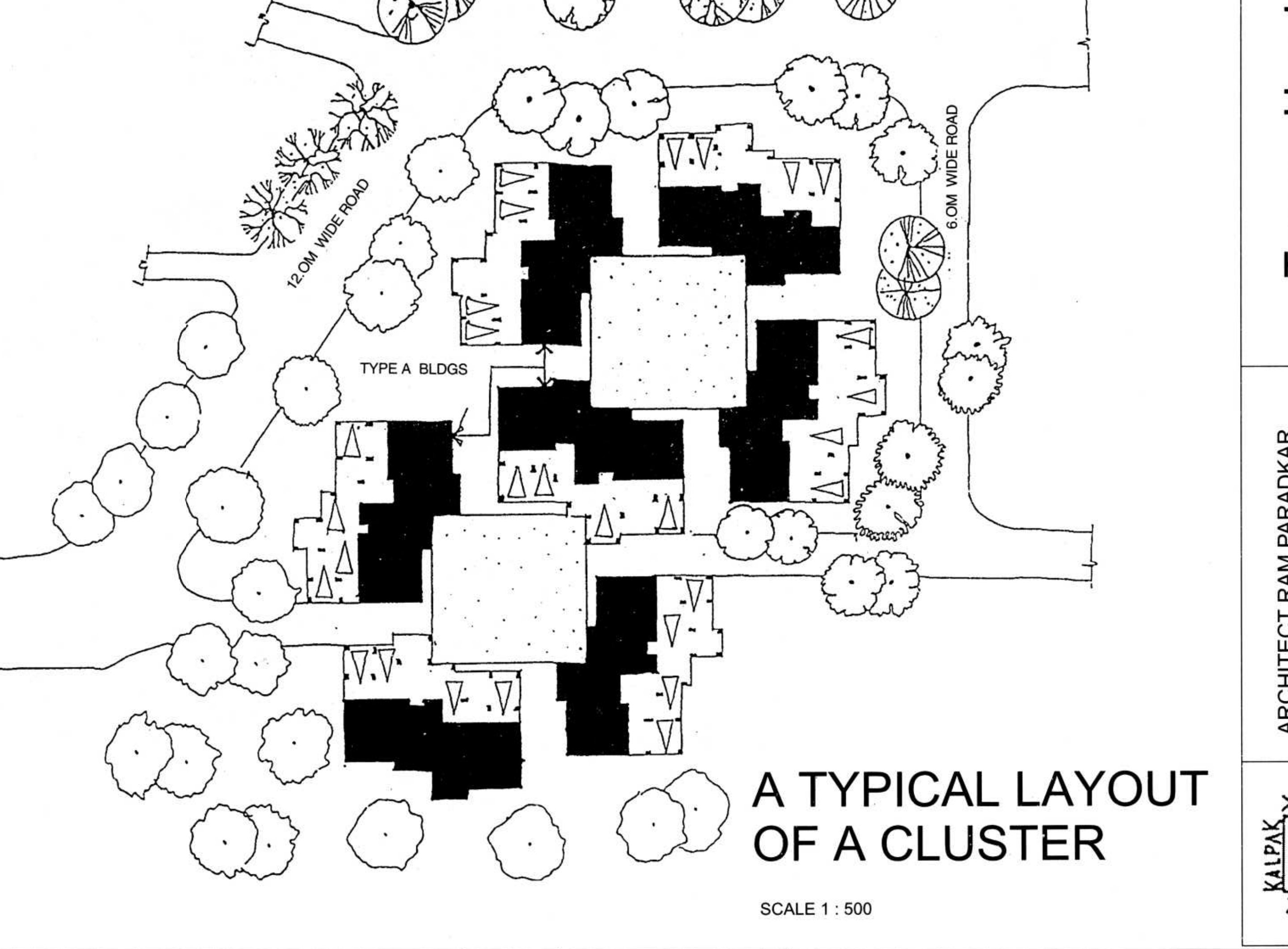
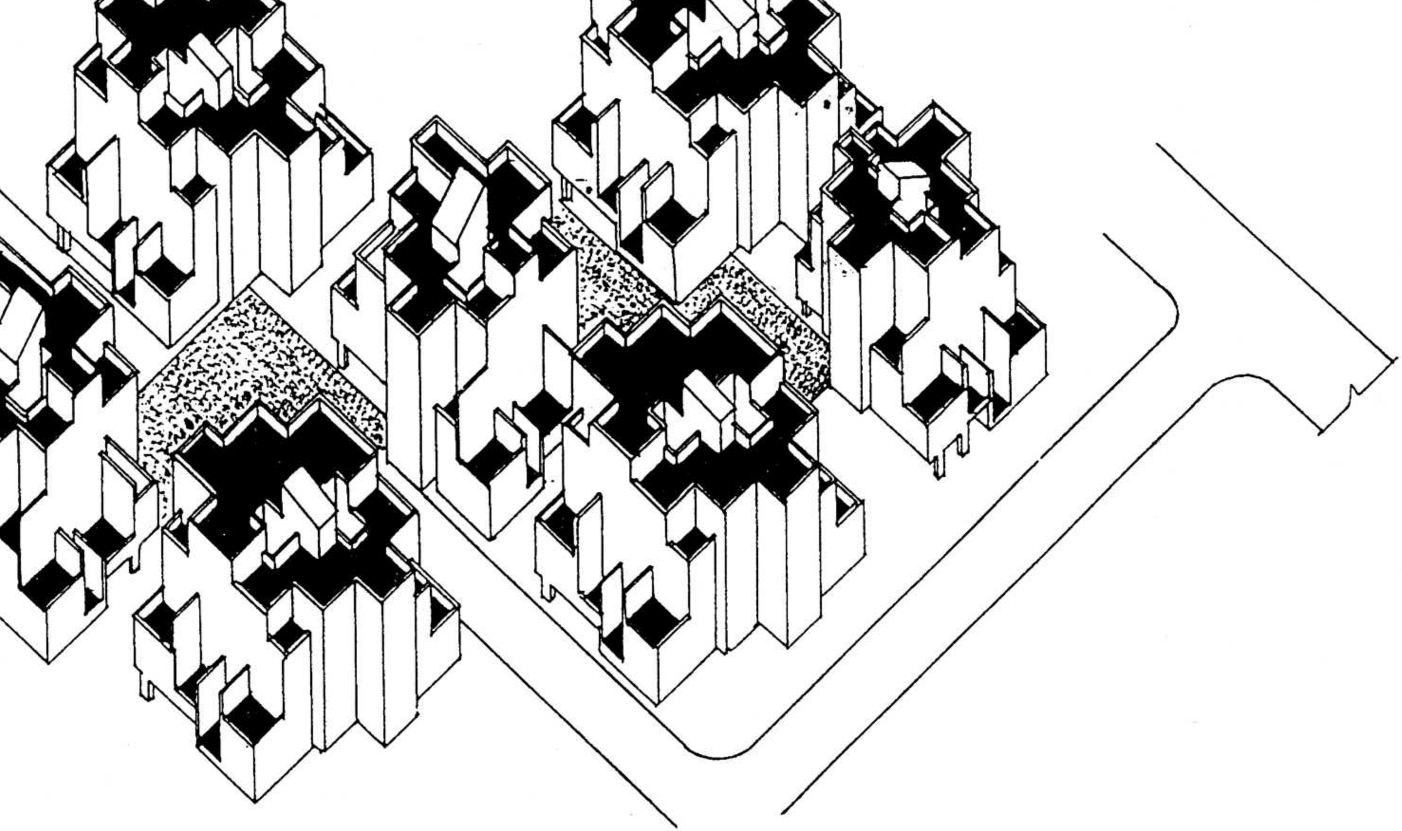


Figure 3.13 *Terrace Housing – Layout Plan*



GROUPING OF `A' TYPE BLDGS

- TERRACES AT DIFFERENT LEVELS CHANGE THE ENTIRE PROFILE OF THE BUILDING. THE PROJECTIONS WILL CAST INTERESTING SHADOWS DURING DAY TIME.

Figure 3.14 *Terrace Housing – Layout Plan for Neighbouring Unit*

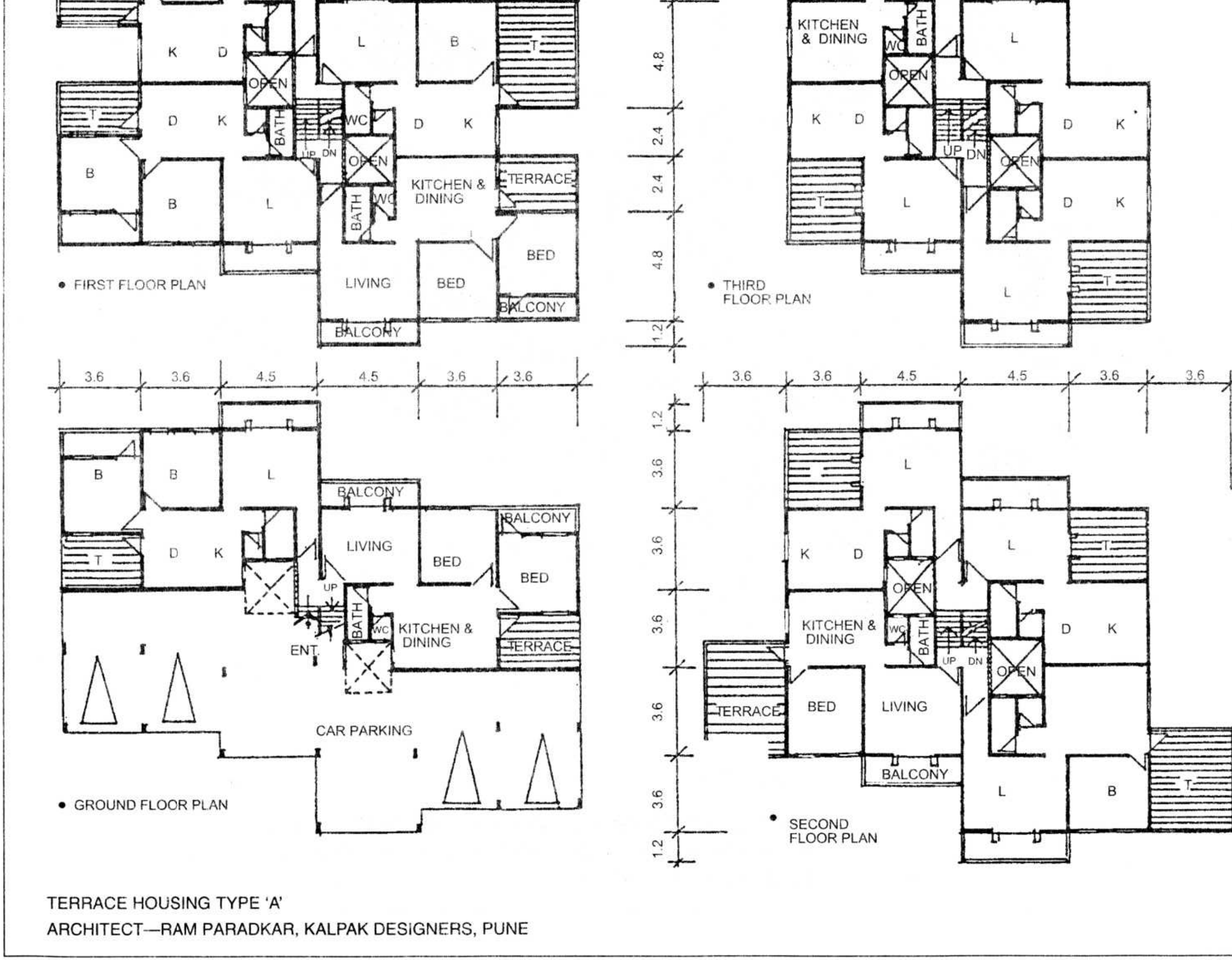


Figure 3.15 *Plans for Terrace Housing – Type A*

adkar, Kalpak Designers, Pune

ral design competition for a head office building of a co-
nji, was held in 1990. We participated in that competition

f, we realised that the programme demands in terms of
ared to the plot area. This had become a very challenging
practising in urban areas. On one hand, the plot (land)
on the other hand, the client's demands were increasing.
ow to meet these two opposite ends and still make a 'good
his project was an attempt to solve the above mentioned

l entrance with a pergola at the terrace level gave this
side the building, an atrium entrance lobby was provided
e top. The branch office was on the stilt floor and also on
ice requirements were accommodated on the top floor.

ercise (Figs. 3.16 and 3.17)

second floor plans and elevation. Prepare a list of various units
y the horizontal and vertical circulation pattern.
t structural safety, health safety, fire safety and constructional
ng like a bank.
gs to study the interior design, requirements of the conference
deposit vaults and parking areas, etc.
hedule for bank building—daily, fortnightly, monthly, yearly,
, estimate of maintenance programmes and agencies for the
ck list to check their work.

Case Study

onment Research Centre Building chwad, Pune (Figs. 3.18 and 3.19)

Mahagoankar, Pune

dian Institute of Architects Award for 1997 for Excellence an Architecture

dian Institute of Interior Designers Award for 1996 for ence in Office Interiors

5. A pyramid shaped glass roof (pyramid with 72 equilateral, triangular co glass panels) to form a mosaic pattern for dome. Provision of an alum frame on the outer, polycarbonate pyramid keeps out ultraviolet rays.
6. Anti-skid ceramic tiles.
   Project construction period: Fourteen months.
   Area: 970 sq.m. approximate.

Reading Exercise (Figs. 3.18 and 3.19)

The site plan and ground floor layout plan shows details regarding total planning r of the research centre.

1. Study the plans with reference to horizontal and vertical circulation, number time, in flow and out flow, etc.
2. (i) Auditorium 98 seater and 70 seater hall with typical seating arrangement i Chalk Board, Screen for projection, Projector trolley, (iii) Acoustical treatme ing, (iv) Central atrium with sky light (v) Stair, (vi) Library, (vii) Lobby, (viii) Class room, thirty seater, (x) Administration area, (xi) Manager's office, conf with projection screen facility, (xii) Waiting lounge, (xiii) Buffet lounge, (xiv All units are connected by properly located access points, fountain, landscapi parking fulfills the spatial and functional needs for a research centre.
3. Architecture is a performing art. It is for the performance, as stated by arch **Andrews**. Comment on the functional planning with reference to expected p of the research centre. Information boards and signage help in controlling Collect details for the same—designs, materials, cost, etc.
4. What type of acoustical treatment is essential for such a centre? Provision isolation and privacy to different areas within a building is the design require acoustics, sound insulation, sound system, HVAC, noise, etc., are the conside inspection for locating noise sources, noise levels and local topography, helps tion of the final design. Collect details for acoustical design.
5. What is meant by 'Air lock lobby'?
6. What are the different ways for providing sky light? Comment with referenc tion in the central atrium.
7. The facade of the training centre is clad with 300 × 300 mm ceramic tiles w makes a module of 600 × 600 mm with 10 mm grooves all around to provi tion joints for thermal expansion and contraction. How are tiles fixed to the w What type of care is essential?
8. Collect brochures for different types of ceramic tiles, their types, sizes, co

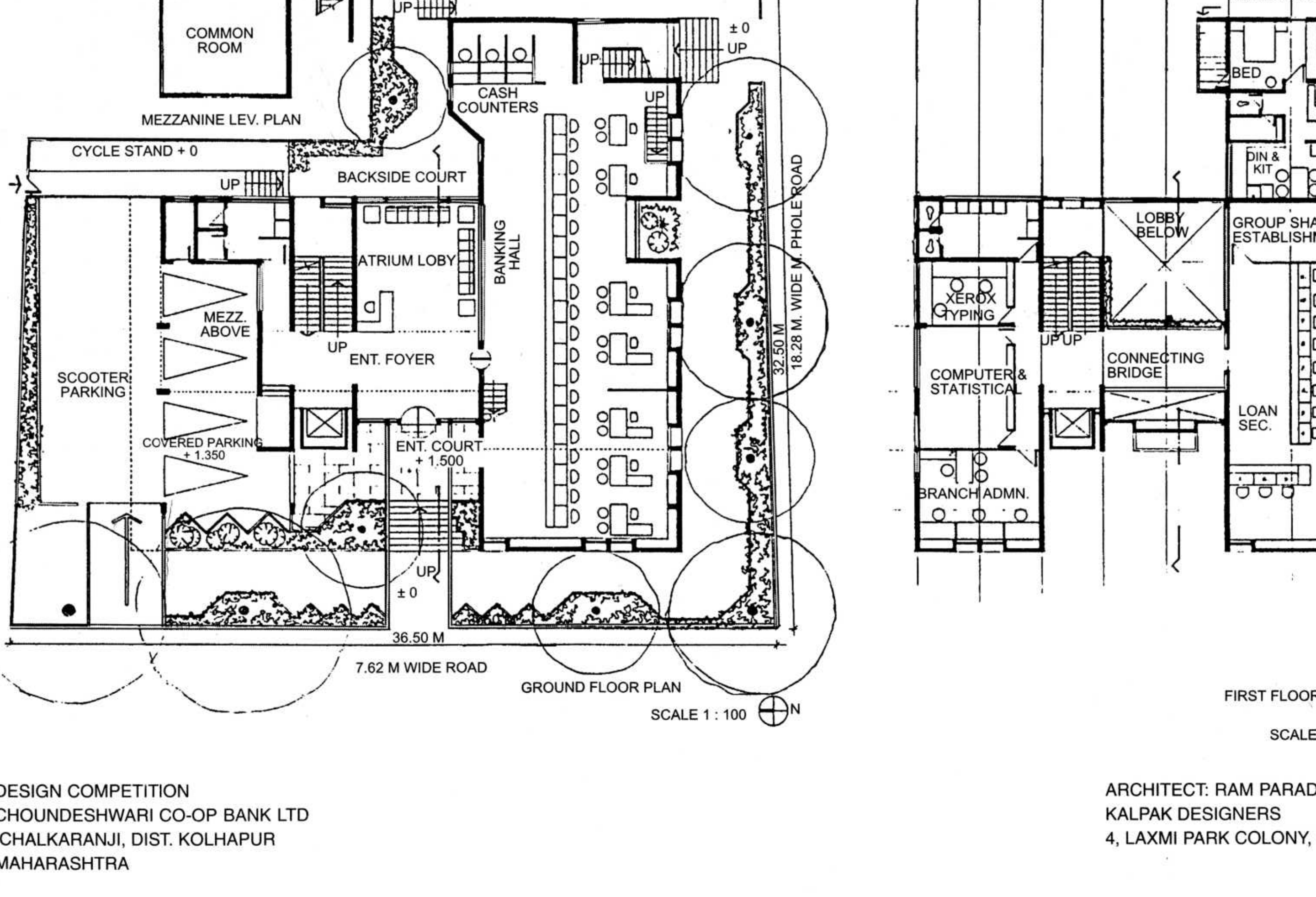


Figure 3.16 *Co-operative Bank – Plans*

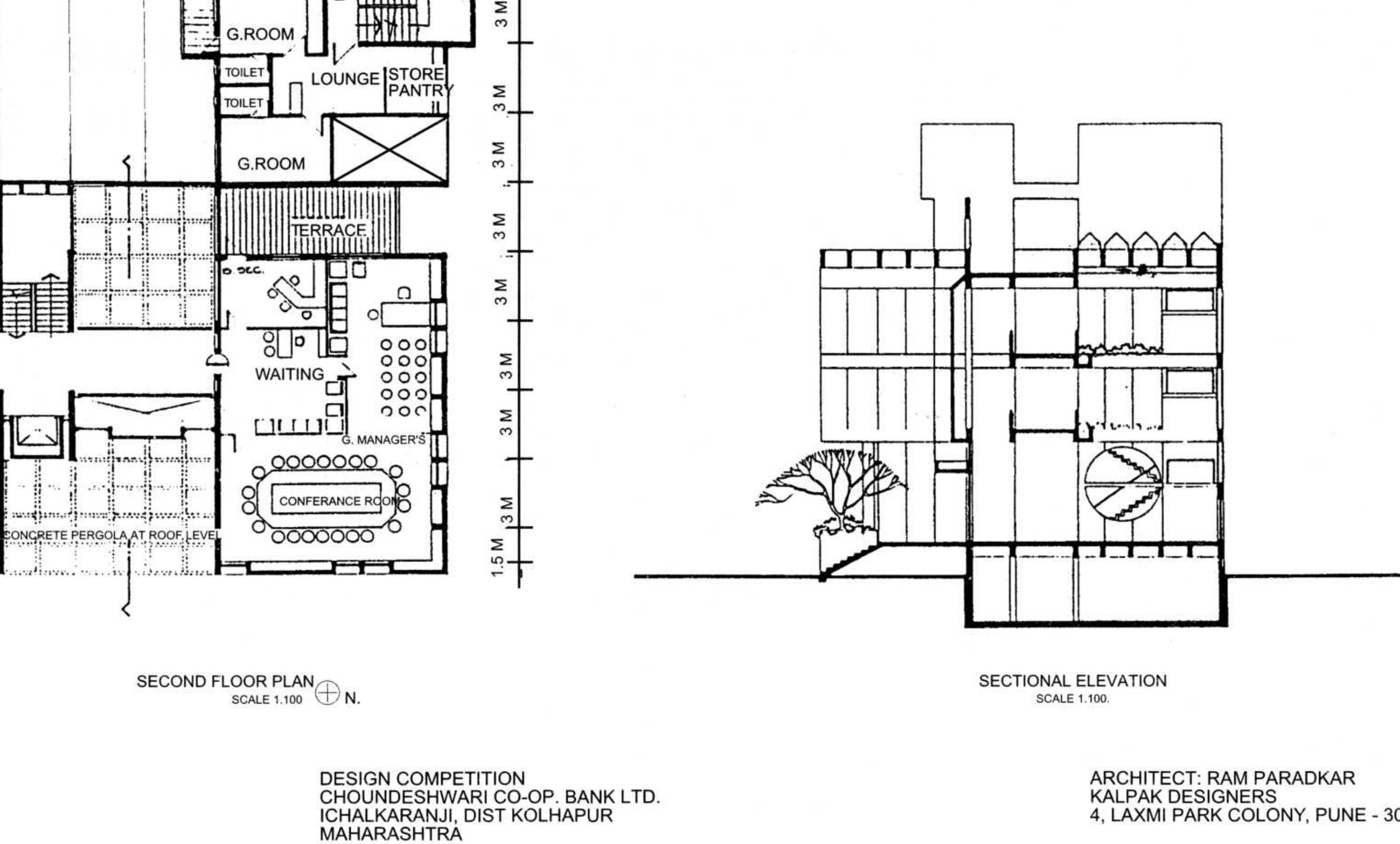


Figure 3.17 *Co-operative Bank – Plan and Sectional Elevation*

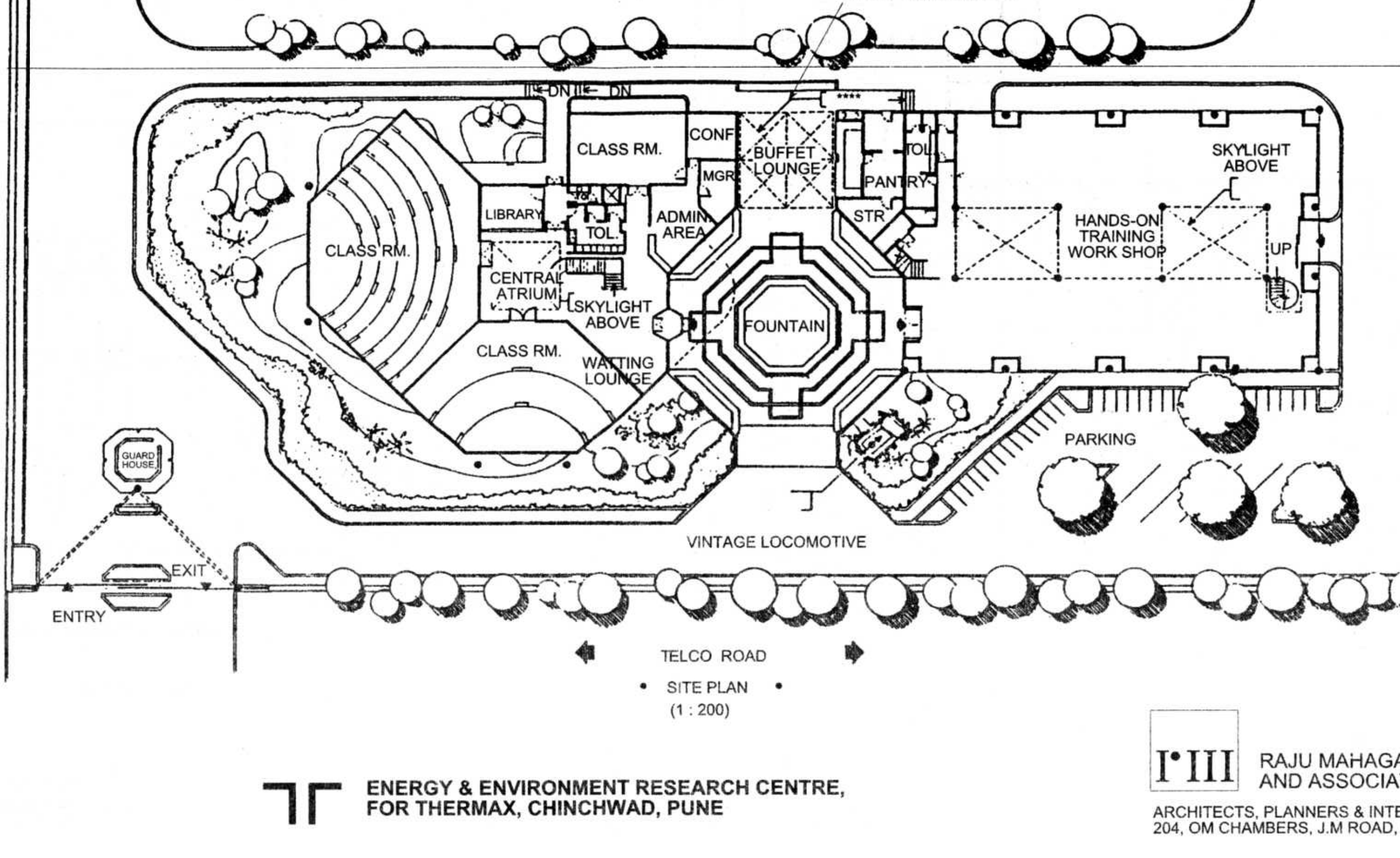


Figure 3.18 *Research Centre – Site Plan*

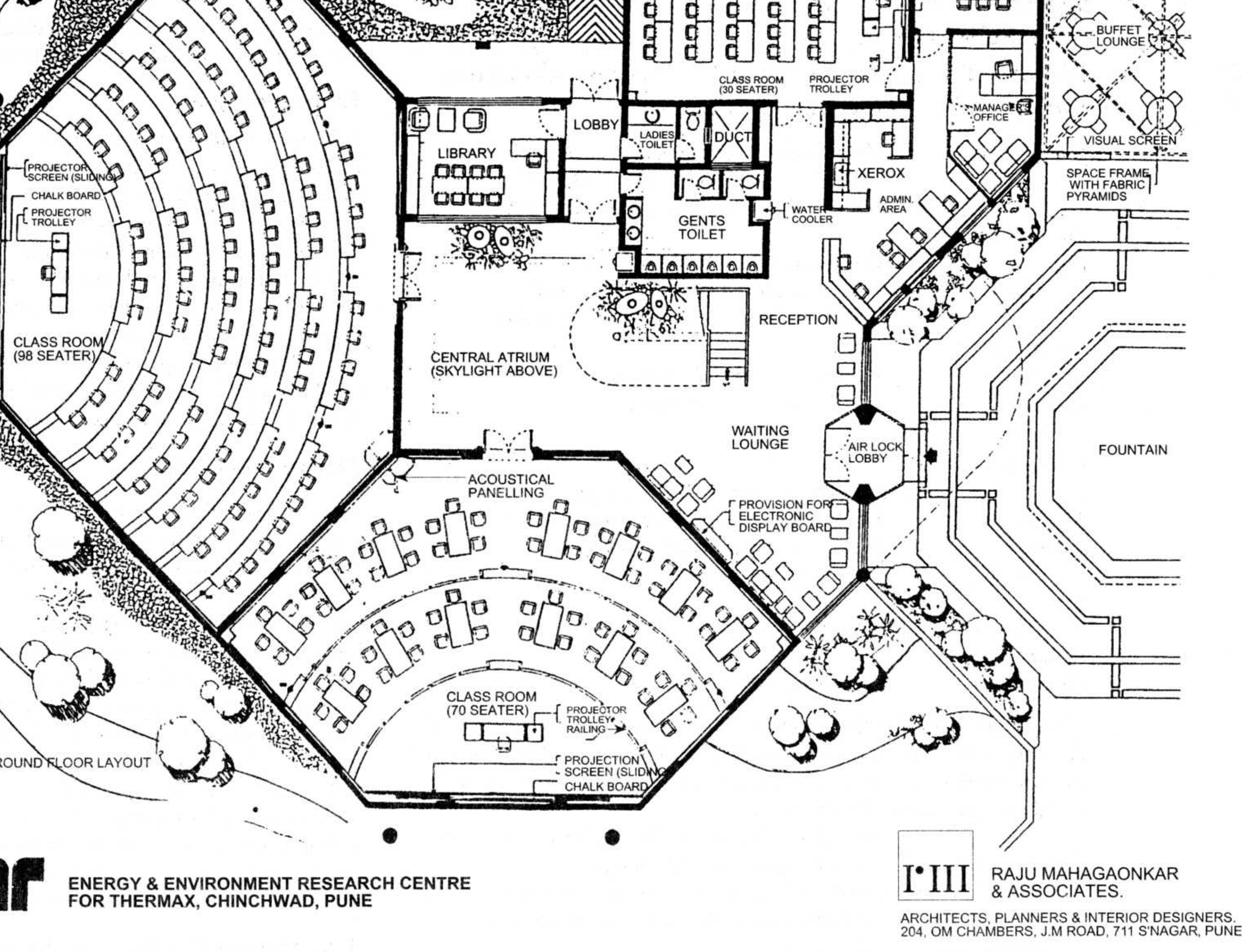


Figure 3.19 *Research Centre – Ground Floor Plan – Details*

...ners	M/s Kulkarni Engineering Associates, Ltd.
	195/6, Industrial Estate, Sangli 416 416
	Mrs. Prabhatai Kulkarni, Managing Director
...chitect and	Shri Pramod Beri, Managing Director,
...gineer	Beri, Architects and Engineers Pvt. Ltd.
	Gumpha, Tarabai Park, Kolhapur 416 003
...nsultants	
...ectrical	M/s Anand Electrical, Kolhapur
...aterial	M/s Rhino Machines, Baroda
...ndling	
...ntractors	
...vil	M/s Palande and Associates, Sangli
...brication	M/s K S Engineers and Fabricators, Sangli
...ectrical	M/s Deccan Electro Works, Kolhapur
...vered Area	4000 sq m
...st	
...ivil work)	₹ 1.20 Crore
...riod of	
...nstruction	1993–1994 (Ten months)

...design integrates the structure, function and form. The forthright detailing, ...ural logic, and economic construction has been forged to an architectural ...ssion. There is a straight-forward clarity of quality of light in the interior for ...orkers."

Ref: Jury's Report on the 9th JIIA Awards. 1997

...tect Pramod Beri uses six parameters for design:

Panchamahabhutas (befriending the five elements of nature)
Ardhanarinateshwara (balancing of the male and female forms)
Equipotentiality (skilful use of space)
Glorification (creating space relationships and retaining interest in them)
Heterogenity (skilful connection of the building at the sky and the earth level)
Night scape (careful attention to night architecture of the building.) Night architecture brings out space inside buildings which is normally not seen in the day time.

...ving his form of art, a spirited angle, Pramod Beri ventures to refer to his ...ecture as "cosmosis", while using the above six parameters.

...ct Description

...ndry building 'fit enough for the emerging twenty first century' was the ...given by Kulkarni Engineering Associates Limited, sister concern of former ...rni Black Decker Limited for their equipmentwise ultra modern foundry...

Design Concepts

Master Plan Plot measuring 140 m × 280 m broadly... (a) a foundry with possible future expansion and its all... as a sand plant, electrical switch room, compressor ro... overhead water tank and toilet block, (b) future fou... with laboratory facilities, (c) a future machine shop,... administration building.

Transformer location in the northern corner, its prox... maximum power and transportation led to the location... north-west side. A clean environment criteria decided lo... transformer, cooling tower, and overhead tank to be in t...

Various allied structures which were more transporta... prone such as raw material entry and sand storage w... right sides of the building as shown in the master plan.... structures were also indicated on the master plan.

Main Foundry Building The North was almost at a... This prompted a search for a roofing system deviating... Sawtooth type structure. After many schematic studies a... two skew triangular light strips over the triangular roof,... sides were placed which provided the basic daylight fro... mostly in the east portion of the triangular strip, prov... cross ventilation by the chimney effect with wind ente... sides and escaping from the roof louvres. To fully acco... wind was only let in from windows at lower levels, the... cladded.

The requirement of light from the side cladding was ... by placing triangular strips on sides of triangular brac... triangular top strips. They also hide the rain water gutte...

Ancillary Structures With best of smoke prevention ... soot does settle on the roof. Hence, usual solution of ... along roof slopes, in normal triangular roofs is not fea... a dramatic structurally compatible solution of hippe... fibreglass-cladded sides was worked out. It satisfied th... free lighting in an economical way.

Structural Innovations

Economic feasibility studies indicated economical span ... truss spacing. Funicular truss, a rarely used form of tr... economical. Column cluster was avoided with 9 metre... mid truss resting on a 6.5 m deep innovative N truss wh...

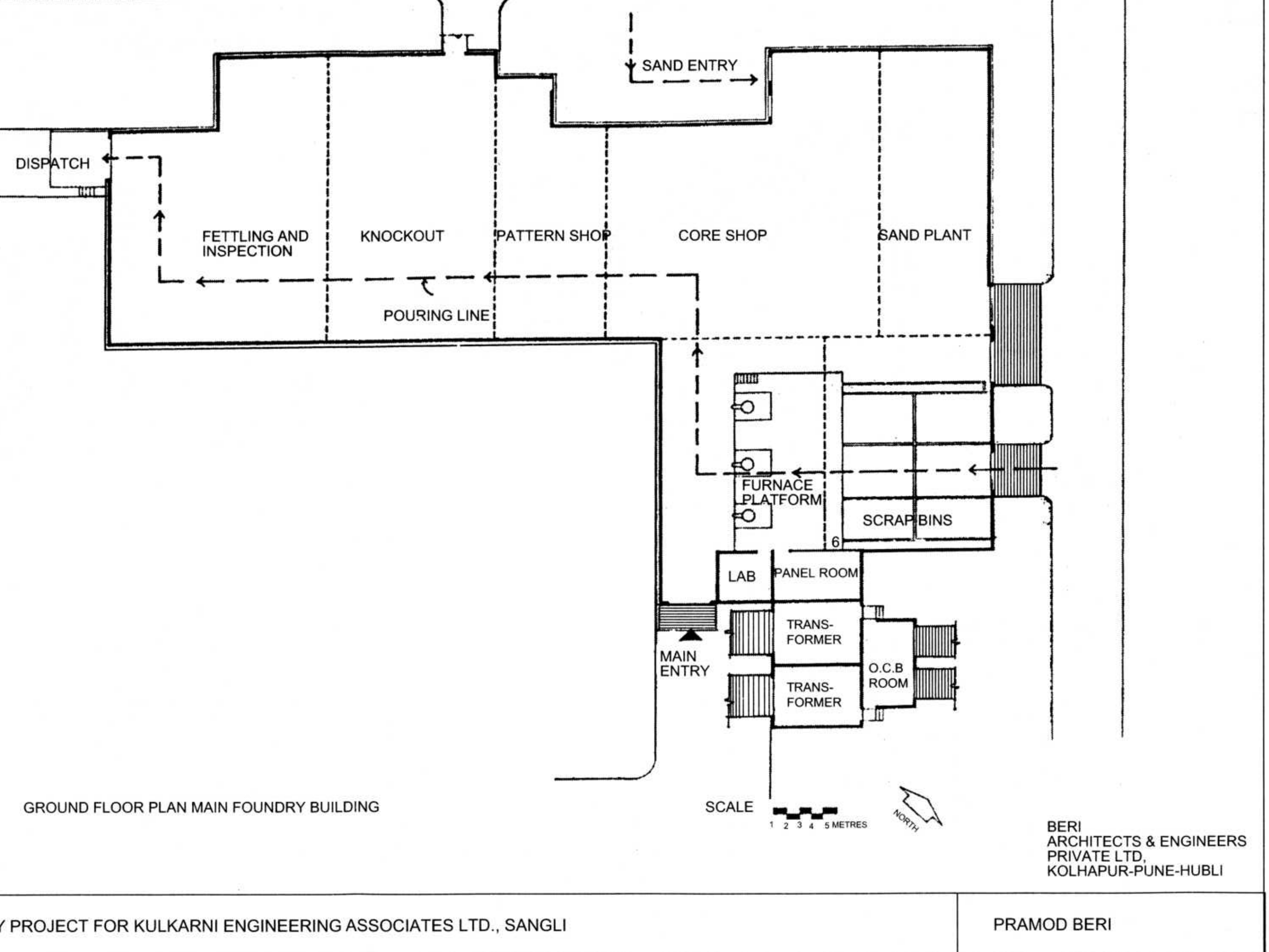
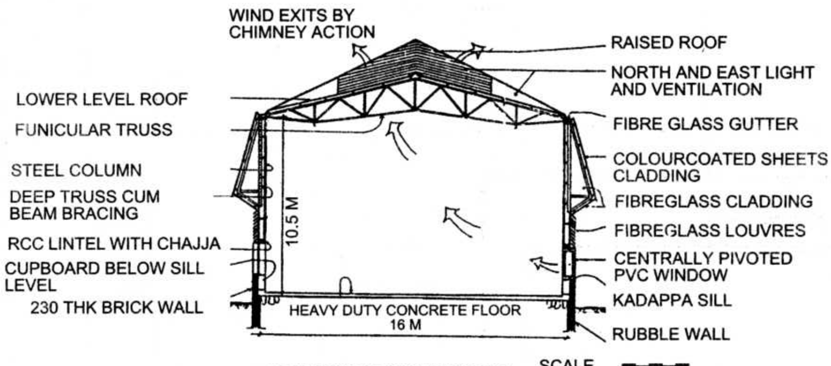


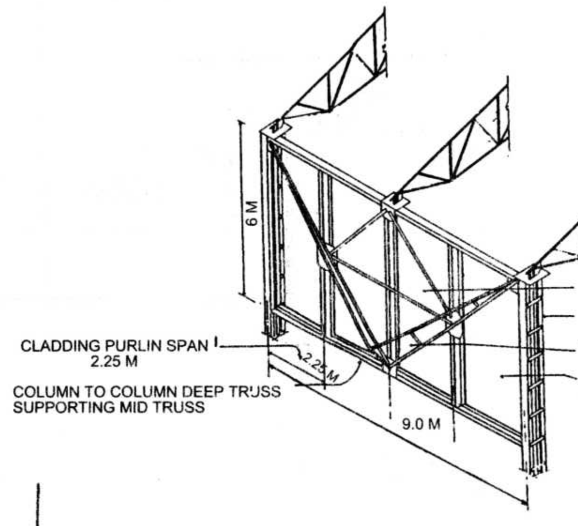
Figure 3.20 *Foundry Project – Ground Floor Plan*

ng than A C sheets. Cost wise compatible, colour coated sheets were chosen aluminium sheets from a washability and aesthetic point of view. Triangular ns of red coloured sheets were accentuated against background of off-white . Cladding sheets were used horizontally to create more appeal. Unbreakable glass was preferred for daylighting. Louvres of fibre-glass were used both in

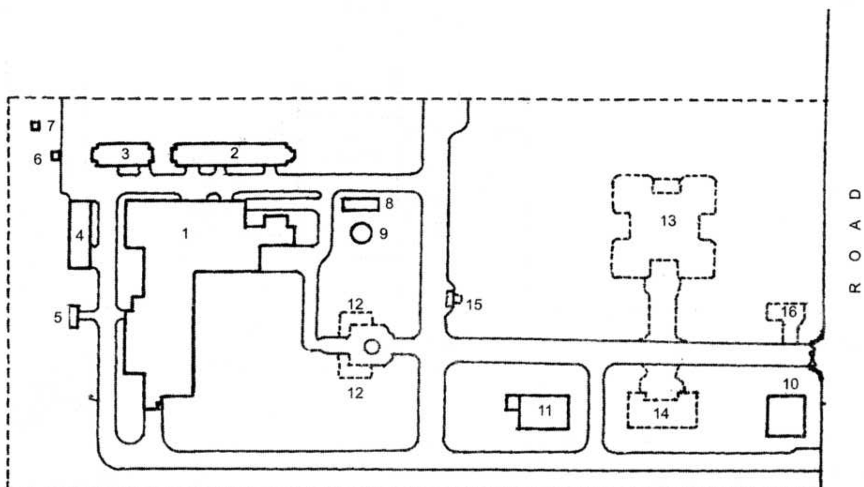
Conclusions – The building not only formed a positive activities, but was techno-ecologically compatible. It t criteria expected from a modern industrial building-prop minimum movement of men and materials, structura innovativeness, flexibility, energy saving with low answerability and above all, user friendliness.



SECTION `C' MAIN FOUNDRY



ISOMETRIC `A'



LEGENDS

EXISTING STRUCTURES

1. MAIN FOUNDRY BUILDING
2. COMPRESSOR, GENERAL STORE
3. SWITCH & GENERATOR ROOM
4. COAL & SAND STORAGE
5. TOILET BLOCK
6. M S E B METER ROOM
7. TRANSFORMER YARD
8. PUMP HOUSE & COOLING TOWER
9. OVERHEAD WATER TANK
10. CYCLE SHED
11. TESTING ROOMS

FUTURE STRUCTUR

12. FOUNDRY, LABO & OFFICES
13. MACHINE SHOP
14. GENERAL ADMIN BUILDING
15. WEIGH BRIDGE
16. TIME KEEPING & OFFICE

inery and power, discussions on care and safety for workers some of the factors involved in planning. Their planning to industry. Prepare a check list for planning of any industry. rtant consideration for many industries.

wo photographs for the foundry project.

space is an important requirement. Study details of construc-

avy duty concrete floor'.

s for welding (b) maintenance of steel structures and (c) erec-

Case Study

ation Centre for the Physically goan, Kolhapur (Figs. 3.22 to 3.24)

tower, simple, yet functional and well situated within its effect has great empathy with its content. The low profile stated restfulness and repose. The simplicity facilitates l user."

0th (Journal of Indian Institute of Architects)

(JIIA) awards, 1997

d, Kolhapur, a voluntary agency committed to the cause re of the physically handicapped persons, in particular, d, were alloted a sloping and undulating plot by the

vith a hostel to house 80 inmates (40 males and 40 females) for about 40 students. The office bearers, considering the hensive, and asked us to make the building user-friendly consideration difficulties experienced by the severely

tare rectangular site alloted for the project was sloping de by five metres. As it was imperative that all facilities oor, it was important to locate the various sections along aculate plinth level differences connected by easy-to-use ons were thus located on either side of a simple-to-use

the lower basement level and housing remaining facilities at an uninterrupted n floor level. However, this being a centre for handicapped, all the requiremen to be housed at one level. This meant having ramps, which had to be at 1:20 and they had to have some roughness for optimum wheelchair travel.

All cross entries were made to the main travel axis with chamfered wal smooth turning of wheelchairs. Spatially, the flat slabbed passage was kep low level which the inmates could relate to the various use areas except th kitchen has sloping pyramidal mangalore tiled roof to go well with the surrou buildings and create a more homely atmosphere.

The stair tower with the tank over it heralded the hostel location from the road and gave the structure a vertical element in an otherwise horizontal compo The pause space between two hostel wings opened into a paved landscaped for the inmates.

Structural context For slabbed areas, a precast joist/hollow block syster experimented with success, which insulated the structure besides achieving speed of construction over conventional slabs.

For the various sloping roofs, rectangular tubular steel framing was c over wood, for aesthetics and economy. Instead of false ceiling, marine ply false ceiling cum base for the tiles was adopted. This allowed the steel t common rafters to be spaced at 1200 mm centres in lieu of the conven 600 mm centres.

Enclosural context The whole building was done in painted exposed brick with some brickwork accented by rough cast plaster. The staircase towe had rough cast plaster, with slit windows. The full heighted low cost RCC *jalli* provided all along pause areas along the internal passage and let in ligh ventilation.

The cupboard projections with a sloped slab top and the top chamfered pillars on other side of external windows provided a delightful spatial relie went well with the roof form.The doors had to be well fitting, rebateless f with pivoted shutters for ease of operation.The bottom portion of shutters l be wheelchair impact proof. The toilet internal partitions and windows were aluminium sliding shutters. Special care was taken to locate hardware and f for easy use by the handicapped. The kitchen katta and other fixed furniture were also constructed with this thought in mind. It assured that except operat the overhead water tank, all mundane and daily activities could be carried o the handicapped.

Other context A unique feature of this building was a mural on the entrance depicting a girl on a wheelchair with wings indicative of the spirit that is a alive, inspite of the adversities faced by the inmates.The mural was conceiv the architect and got done from a local artist.

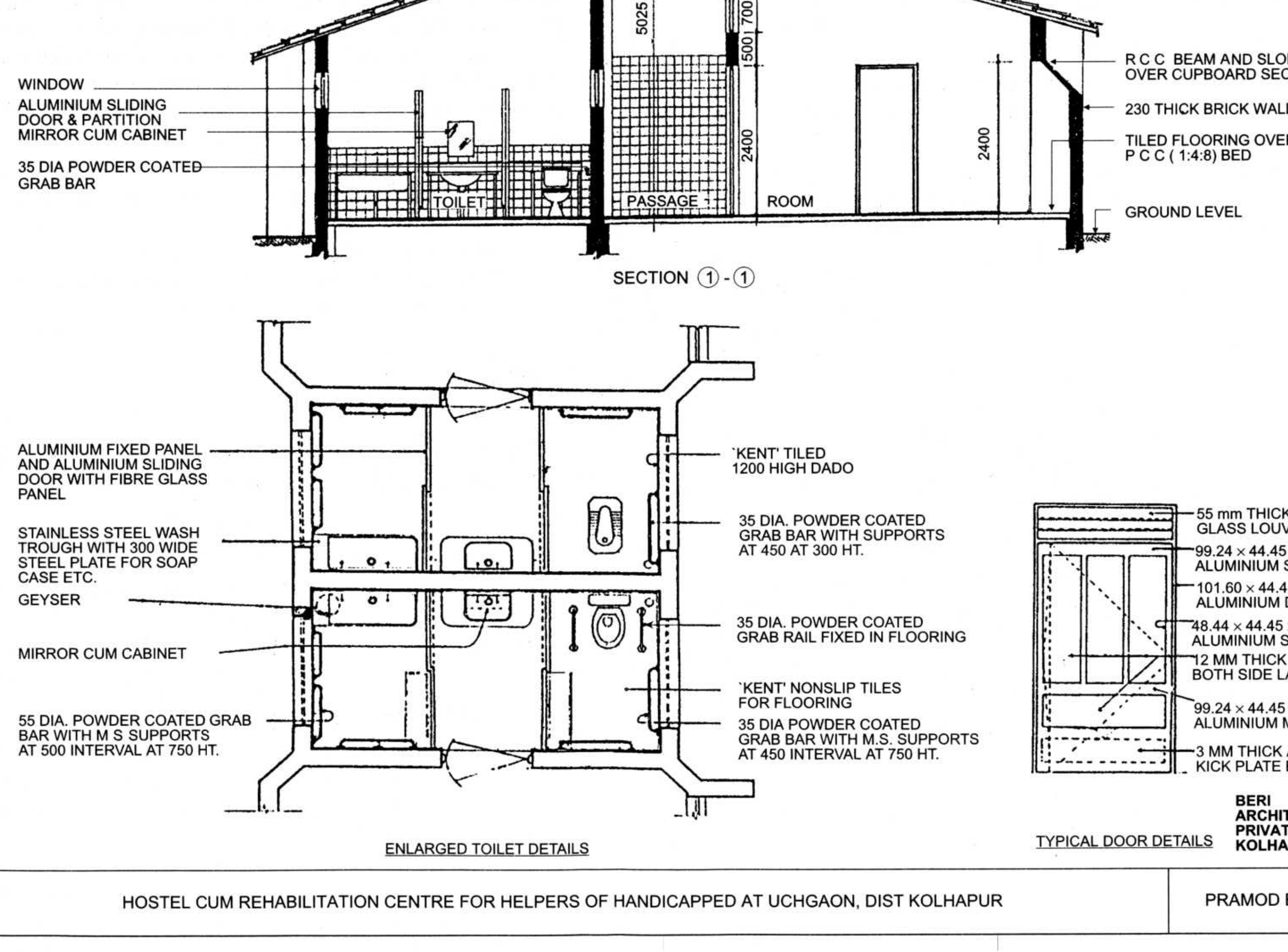


Figure 3.22 *Hostel Cum Rehabilitation Centre – Details*

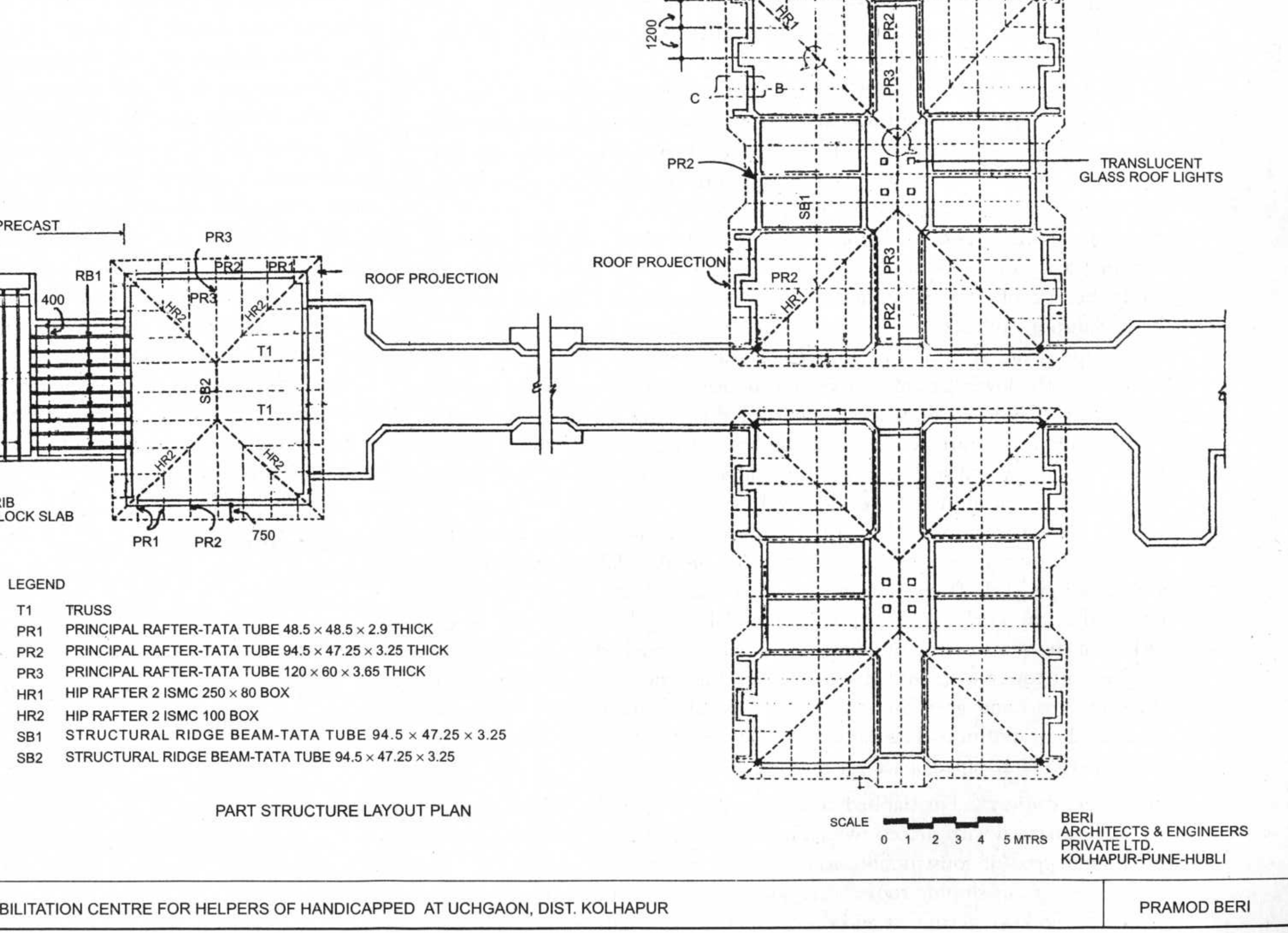


Figure 3.23 *Hostel Cum Rehabilitation Centre – Details – Roof*

ct Architect	Pramod Beri, Managing Director
n Team	Mohan Bhasme, Sanjay Patil
ical Consultants	G K Deuskar, M/s Anand Electricals Consultants, Ruikar Trust Building, Kolhapur
actors (Civil)	M/s Sanity Constructions, G-9, Gajlata Archade, 1155, Sykes Extension, Kolhapur 416 008
ical Work	M/s Swastik Electricals, Kolhapur
Sculptor	Sanjay Tadsarkar, Kolhapur
d of Construction	1994–1995
	About 1000 sq. m
ct Cost	₹ 40 lakh

finish, fixtures in toilets, ramp are some of the necessi provided in the hostel building.

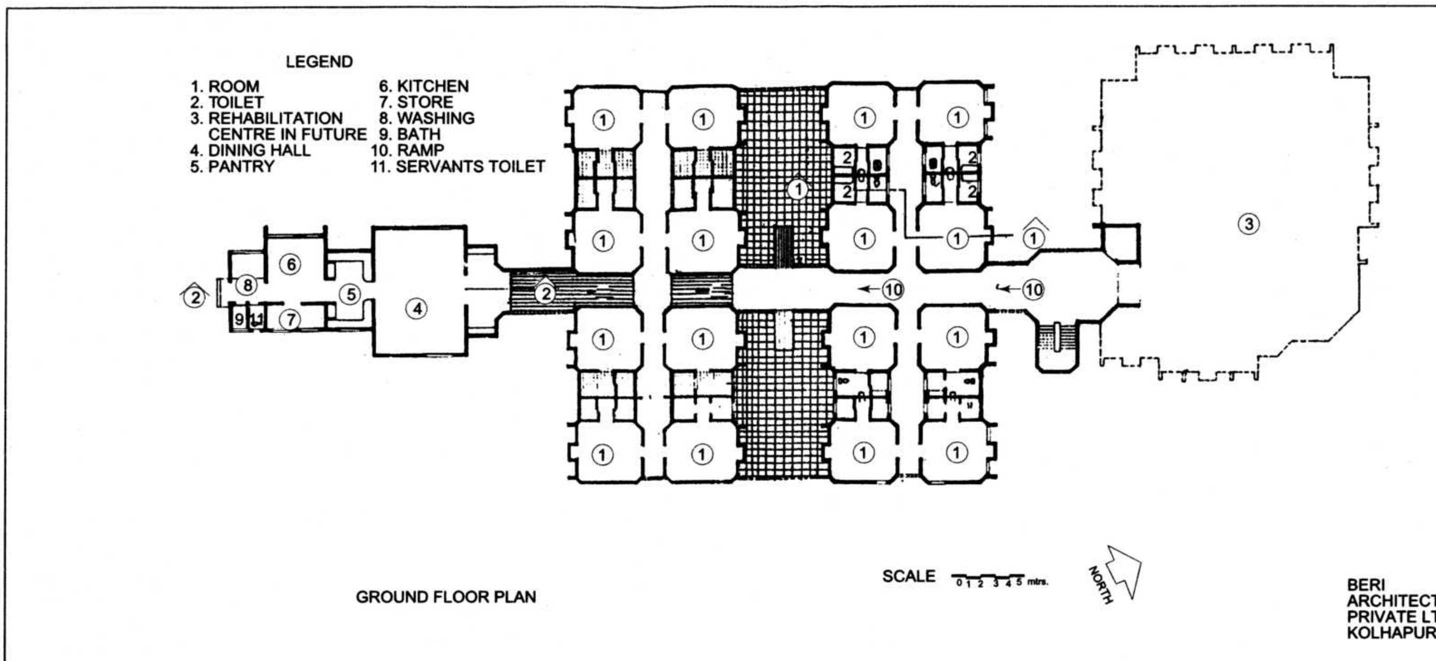
3. What additional considerations are essential for such bu
4. Visit such buildings and prepare a note for essential spec handicapped persons on their requirements.

Case Study

Hotel Project (Figs. 3.25 to 3.27)

Project Description

Karad, a small town with a newly started Medical col Pharmacy college and an emerging industrial base need the growing needs of the community.



e triangular plot measured about 4000 square metres. Ell
g was located parallel to the rear side of the plot, making
the main highway.

ne:

he highway noise and dust.

es of the building accessible to the road.

n space on the front side.

at a level of about two metres above road level, giving
lutterfree entrance. The dining hall, restaurant, kitchen,
er ground level. One ethnic restaurant was scheduled in
portion.

ation context An attractive inclined slabbed porch
e entrance hall. The entrance hall is flanked by stairs/lift
g an impression of welcome.

oors above it, three, with the upper two levels looking

National Highway travellers who would like to use only
ant or dining hall, to independently go down the steps
having to go through the entrance hall. Similarly, those
rear lawn could also go independently. Service entry to
d discreetly located in one corner.

ntional wide corridors for hotel rooms was avoided by
d taking subdued entries to the rooms, thereby offering

were perforated to give them an air of lightness.

ngle theme was repeated by giving chamfers, both in
ts.The glass mass at the entrance and room areas was
owers.

uilding was in conventional R C C framework, designed
o proximity of Karad to Koyana Dam).

rata, called for the use of underreamed piles with pile
me stabilisation of the soil, plus nominal raft: at the floor
nteract floor sinkage due to black cotton soil.

o sloping slabs and the cantilever porch was taken care
of the beams at both levels, with a frame action.

ept for the sloping slab over the porch which had a
cladding, all other areas were plastered and painted. The
at the parapet level in an interesting way.

party space had a plain lawn area and corner shrubs to afford flexibility for g
parties.

Conclusion

This well-planned hotel achieved its purpose—creating visual impact to a
highway customers, and to retain their interest in the building besides prov
delight, through well planned elements.

Project information

Architect	Beri Architects and Engineers Pvt. Lt Gumpha, Tarabai Park, Kolhapur
Project Architect	Pramod Beri, Managing Director
Design Team	Mrs U M Patil, B S Patel
Electrical Consultants	G K Deuskar, M/s Anand Electricals Consultants, Ruikar Trust Building, Kolhapur
Contractors Civil	M/s Shah Constructions, Karad
Electrical	M/s Arvind Electricals, Karad
Period of Construction	1986–88
Area	1600 sq. m
Project Cost	₹ 35 Lakh

Reading Exercise (Figs. 3.25 to 3.27)

Different floor plans show the total planning consideration for the hotel.

1. Quick service to rooms on all floors is expected. Study the horizontal and vert
tion systems and comment on the same for its adequacy or otherwise.
2. Cleanliness in the kitchen and the entire area is another expectation from the
of view. Prepare a list of specifications for the related items.
3. 'Mosquito control' is a must. What are the ways for controlling the same? W
windows are better suited for control?
4. Landscaping, information services, signage, musical system, T V are some o
tial requirements. Think of such details—collect brochures, advertisement fo
equipments, etc.
5. Flooring patterns, ceiling, imaginative lighting and furniture are factors relate
designing. Study details for the same. Prepare interior design plans for a ty
dining hall and kitchen. Visit any hotel to study different pipes in a duct.

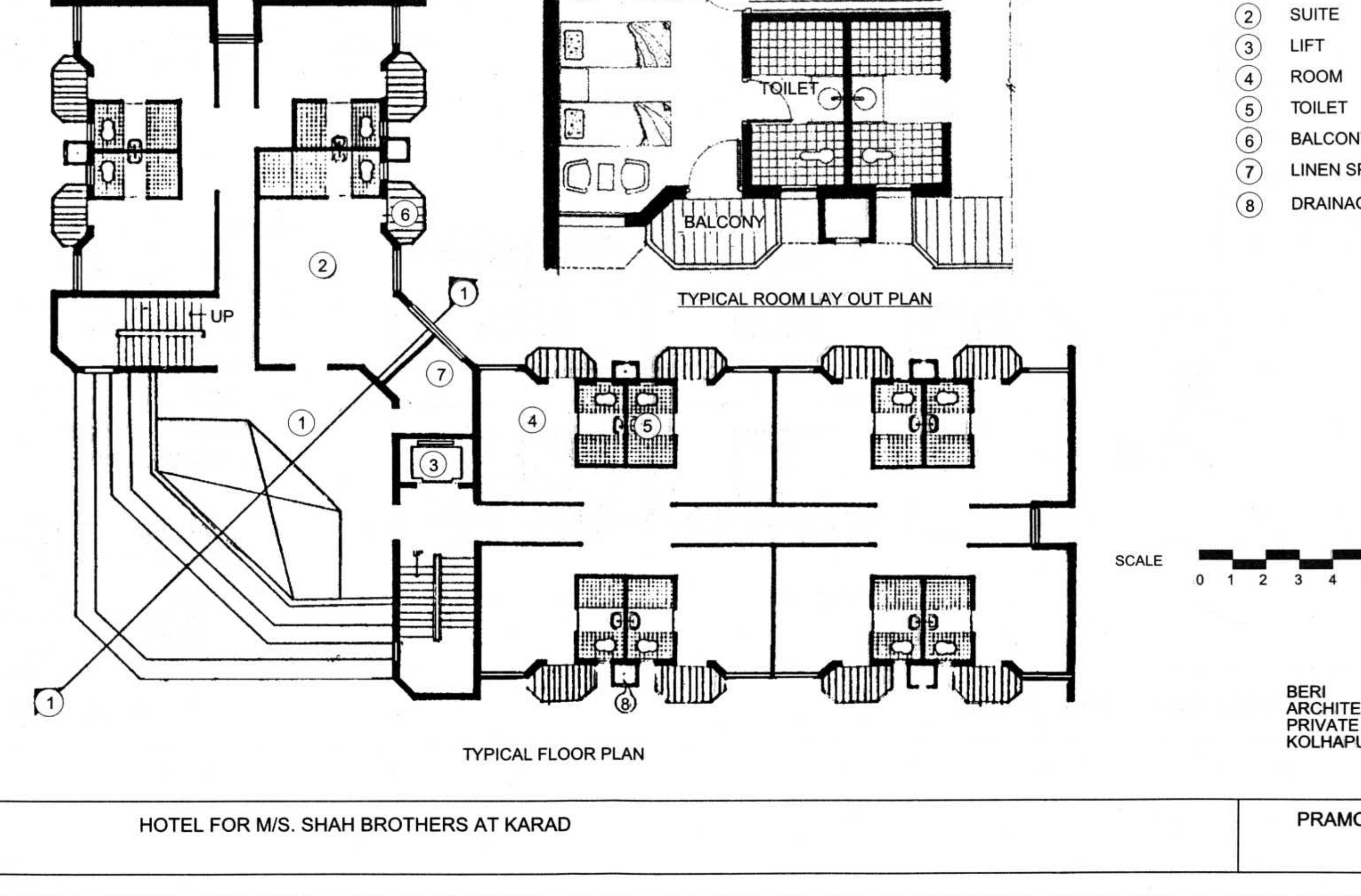


Figure 3.25 *Hotel – Typical Floor Plan*

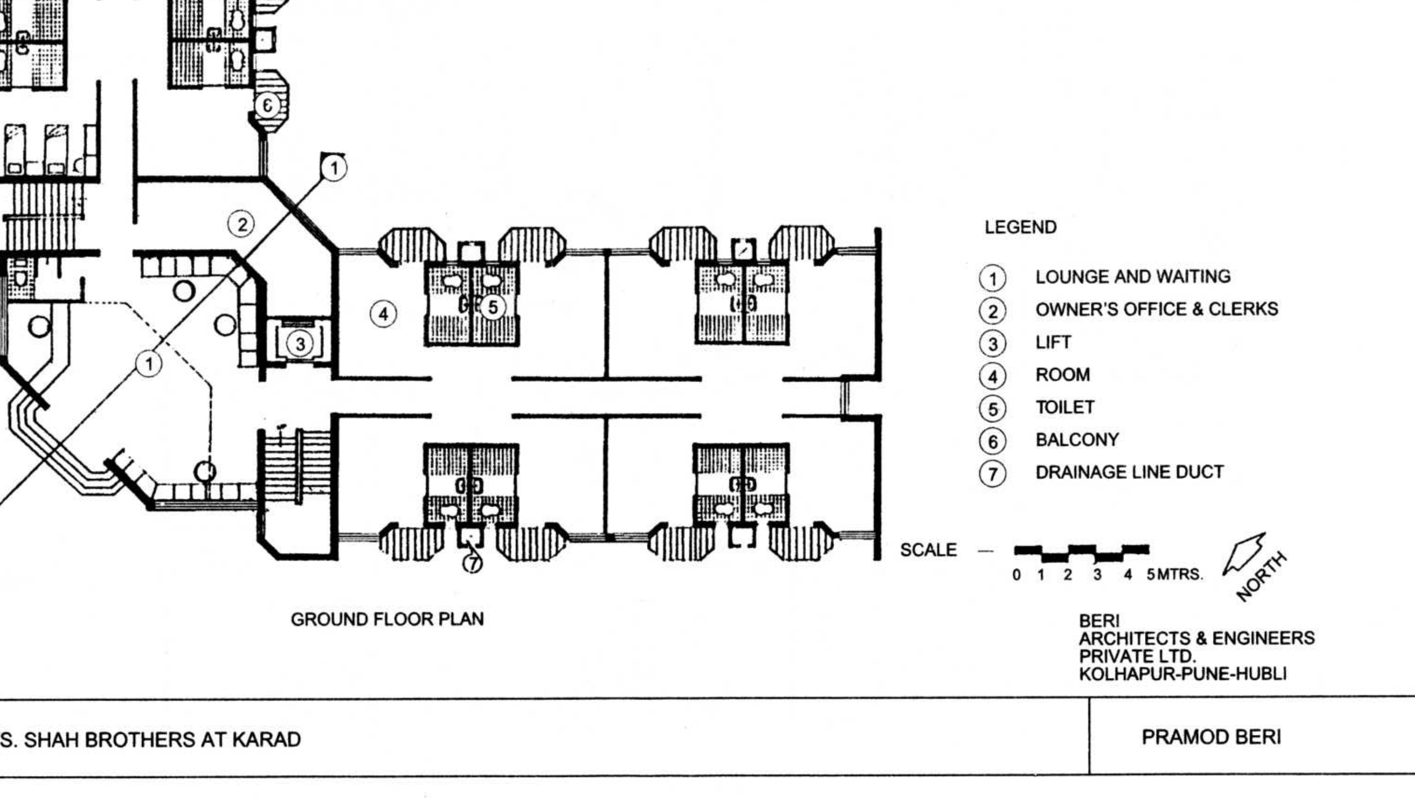


Figure 3.26 *Hotel – Ground Floor Plan*

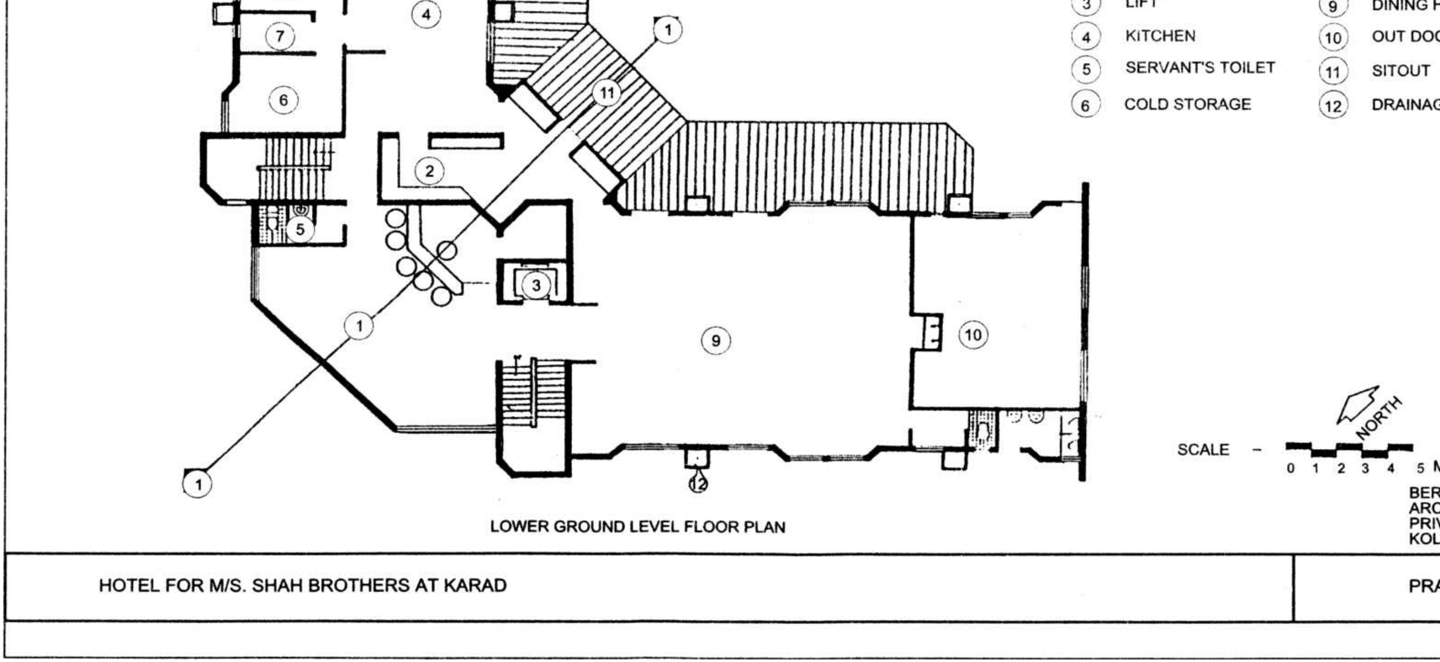


Figure 3.27 *Hotel – Lower Ground Floor Plan*

NTERIOR DESIGNING FOR PERFORMANCE VITH EFFICIENCY

ct basically designs on a grand scale unlike an interior designer, who works on a cale. While a designer concerns himself with intimate details like placing of a mi-en and a bed, an architect is concerned with general details like the placing of the bed room, etc."

Architect: Ahmed A Kasu
Book: *Interior Design*

Role of Interior Designer

1. *House Design*

"Your home is your castle, and always has been. But today it'a place of business, and somewhere to express your culture anon amenities is changing house design in fundamental ways."

Magazine:

"Sun, Space and Light versus Privacy, Security and Peace aning homes on limited city sites are many. Innovative use of liporary feel is the need."

Author : di S Ibba
Magazine : Rivista Arredo. S

oms

s have lost that tired and weary look. They are no longer ese rooms are now key features of contemporary homes. Bath- rooms in the home."

Trends, Vol. 12, No. 8.

n bedrooms and bathrooms cannot be roomy and comfortable. wisely."

Trends, Vol. 12, No. 8.

ng your mental and physical strength. But getting an undis- epends on the quality and comfort of the bed you choose."

Trends, Vol. 12, No. 8.

v mirrors-a small bathroom can appear luxuriously roomy.

Trends, Vol. 12, No. 2.

ns to formal elegance or subdued comfort, you cannot beat the ural stone.

Trends, Vol. 12, No. 8.

al stone will appeal to those with the most discerning taste, but ssible to all tiers of the market."

Trends, Vol. 12, No. 8.

tchens being efficient. But kitchens that are relaxing to be in, ortant. Kitchens are places where we unwind from busy lives, rooms where it is hard to tell where the kitchen stops and the

encourages creative combinations–timber, veneer, wall tiles, granite bench top a steel."

Trends, Vo

5. *Inside Outside*

"We tend to dwell upon the outside, the gross, the material, and ignore what is ins tle, the spiritual. We tend to imitate and look for guidance to the west, but only to th aspects. If there is to be harmony in design, the inside must meet the outside and v

Architect:
Magazine: Ins
De

3.6.2 Role of Interior Designer

Interior design today is more of a science rather than the aesthetic or artistic dec room or space. An architect deals with the total built-up space according to the fu of the plot, FAR permissible, budget, etc. He makes designs for the total space be enclosed, divisions of the internal space, location of doors and windows, etc. designer deals with individual internal spaces formed by the members of enclos roof and floor. Interior designing like architecture involves a deep study of livin patterns and habits of the users along with culture. The designer would therefore be study the cultural and social habits of the people for the space to be designed and t use of the internal space.

Interior design includes the study of the ultimate use of the area concerned, proper dynamics, ergonomics (scientific study of man in his working environment), anth (scientific measurement of man), etc. in order to achieve good proportion and impro and psychological comfort. Controllable comfort in light, ventilation, tempe flexibility in furniture arrangement is expected from and also is the aim of comfort environment.

An important quality of an interior designer is having knowledge of structure, a planning and construction. He/she should study the construction of a building by site and by studying working drawings of load bearing or framed structures. Consu the architect, the structural designer and with building services consultant is a acquainted with structural conditions of loading and the loading pattern. It is found accidents have occurred due to negligence related to structural design. (For example Towers" in Bombay in 1997). It can be concluded that architectural education is a for interior designing and for civil engineering with emphasis on structural stabilit or doors and windows, glazing, electrical installations—concealed or otherwise, ent, colour scheme of internal space related to the flooring, etc., is specified by the igner. These decisions are essential to save time and money; hence this system of an interior designer is found essential for both public and residential buildings.

iderations and components of interior design are:

al scope and purpose.

ents and materials of structural forms—walls, floors, ceilings, windows and doors.

ents of heating and lighting.

ents of utility—treatment of walls, floors and ceiling, coverings and finishing, fur-g, upholstery, etc.

ents of visual pleasure—colour, indoor plants, ceramic relief on wall, etc.

e, the interior designer has to think of:

Spatial Planning

Colour

Materials

Furniture

Lighting and

Ventilation

n consideration in interior design is its relation with the personal taste of the owner. ccess of the interior design depends upon how the feeling or "utility" is created different units of furniture and colour schemes—colour of the wall, curtains,

nterior Space

s defined as the stable shape in a given space. It consists of members of enclosure ls, roof and floor. The designed form of a building separates it from the external so creates internal space. Windows and doorways, i.e., the openings in the external e spatial transitions between the exterior and interior space. They mediate between and inside environment. A building is also considered as the container of activities, al space is divided by different areas and volumes, i.e., rooms which are specified cal activities. Floors, walls and ceilings of various areas give form to the individual y be large or small according to the activity/function. Quality of light, ventilation, ach room and its relation to the adjoining spaces can be studied from the plans, and ing partially constructed or completed structures.

hitecture, the use of available space is important in interior designing, since well-ace has a direct psychological impact on the physical and mental well-being of the in. Creation of well-designed space, its visual flow and continuity and integration nd external spaces need several considerations.

such as air conditioning, heating, electrification, plumbing, drainage, acoustical

Square rooms are rare while rectangular rooms are more exceptional. Circular space is common, elliptical spaces may walls give a impression of dynamism as our eyes move along

The ceiling controls the height of a particular room. A low with a friendly environment. A high ceiling is associated with of the ceiling and its relationship with the width and length o of the scale of a space. The ceiling may be flat and at the sam may even have a shape related to the pitch roof.

Other elements that need more attention are doors as acce to other internal spaces, pattern of movements, shutter ope through the windows, privacy, light and air, grill for safety, ma steps, railing, treatment, etc.

Thus, it will be seen that design of interior space demands should remember a comment related to interior designing Uttam Jain.

"*Interior designing today is not a luxury. On the contrary, efficient and increased use of the available space. It has to be on it*".

3.6.4 The Total Programme of Interior D

The main aim of interior designing is related to the functional enhancement of interior space which in turn is related to aesthet cleanliness, expected lux intensity of light, pleasing colo controllable ventilation, etc. Requirements of the client chang building. Hence, the initial stage consists of the study of the fu and commercial buildings, hotels and restaurants, shops, offic have different functions. Initial discussions with the client a down the total requirement, budget, time limit, materials and s planning and finalising the interior design. Initial sketching sh do, how the designed interior space will be perceived and how

The total programme of interior designing consists of the f

1. Analysis of the programme
2. Synthesis
3. Evaluation
4. Sketch plans, elevations, axonometric/perspective view
5. Approval of the owner
6. Working drawings, notes, specifications, estimates for f
7. Supervision of work up to completion
8. Handing over of the completed work
9. Critical analysis after completion, i.e. environmental an

rspective views and models: After approval of the final layout, plans, elevations to show the proposed design for effective or perspective views are prepared to show three dimensional pared as per necessity. Drawing with the help of a computer more detail and in less time.

is stage, approval of the owner is taken with reference to the e required for completion, etc.

pecifications and estimates: At this stage, detailed working notes and specifications, so as to appoint different agencies rk in different stages is finalised and the final estimate is l. While preparing working drawings, economy and quality of as to avoid wastage. Correct measured drawing of the existing ct working drawings up to mm accuracy. Decisions regarding of the structure are taken in consultation with the architect, he building. Approval of fixtures, fastenings, tiles, etc., is done Duration for interior designing work may be from few months account is to be avoided. The best way is to keep all drawings ncies ready for speedy work.

npletion: Full control over the work is necessary by periodical xisting difficulties. Designers and their supervisors should be ess of work. Finishing work demands more attention for the ion of completed work, e.g., Plaster of Paris work, flooring, r some period.

l work: Cleaning the site, final finishing touches, final approval r systems, if any, is obtained from the owner. The final bill is val and payment.

ental audit: It helps in chalking down various points related e to the completion stage. This is done with reference to the

ry response

e for new materials/agencies for work

deo film of the completed work for future use.

and knowledge of the market. The scope of choice varies in

with alternatives. The next thought is related to the creation of the desired moo style with suitable materials, texture, colour, quality of light, thermal and acousti Space, furniture design and body dimensions, personal and social distance, thermal requirements for noise are the basic considerations. Information related to the body functional dimensions as per age/sex group is available which helps in finalising d

Alternative layout plans are prepared with reference to the above information a also checked/corrected as per the facts of visual perception.

2. *Human Perception*

Our eyes get visual information of what we see and our brain interprets this data to this information. In this process, our eyes continually move, scan, focus and refoc visual details. We recognise an object or figure with reference to its backgroun perceive its visual shape, size, colour and texture. The optical environment plays a role in recognising forms or objects seen. Objects look different because of factors s shape, colour, texture, light, proportion, scale, balance, harmony, unity and variety, emphasis.

These factors are known as "visual characteristics". Light, natural and artifici important role in visualisation. Spotlights and dimmers create dramatic effects.

3. *Furniture Designing*

A building is incomplete without the necessary furniture. Whatever may be the fur building and activities inside its various areas, we need furniture according to the a furniture should be designed to get an aesthetic appeal as well as to improve the e the user. Take a simple example of a chair. We need it for dining, sitting in the living relaxing, in a cinema theatre to watch a movie comfortably, in an office to work effi a restaurant to enjoy food and company. We see different designs suitable to the fun into consideration the time, one will be intending to sit on the chair and the nature is expected to do, viz. to read, write, talk, dine, or to relax. The same kind of chair sensible for different functions. It needs changes in all dimensions, with a function the hands and the back, cushioning and finishing. The chair design should have and functional appeal. It is again related to the stimuli of the various senses. Hence aesthetics, one more aspect is important for furniture designing and that is Ergonon

Ergonomics is the scientific study of man in his working environment. It dea problems of design for human use and convenience. All physical, physiological, psy social, legal and other implications of man-made systems on humans, should be o an ergonomist. An ergonomist should be able to answer questions regarding the kin which should be designed to achieve particular goals or to meet a particular requiren ergonomics is indispensable in furniture design. The manufacturers and designer m a proper way so that even low cost furniture fulfils the basic ergonomic requirem are meant for sitting which is essential for many activities. Sitting is physiologically standing although a sitting posture has some disadvantages. It causes loosening o of other furniture units is equally important. Storage cupboards, dividers, wall osets, wardrobes, kitchen cupboards and racks, etc., should be large enough to requirements that need to be stored, but the depth and the shelf height should ond the reach of the shortest person. Furniture arrangement for activities should to consideration the functional aspects. Architects do take into consideration this ple while preparing plans, but it is mainly to finalise the locations of doors and the plan. Interior design of furniture suitable to the activity, colour, tapestry takes eration the colour of the wall, curtains, interior lighting, indoor plants, carpets and sed colourful fixtures, such as shades for electric fixtures, etc.

nore, i.e., lesser the furniture, the more free space you have. Hence, unnecessary should be avoided. The level of furniture may be lowered, if there seems to be Hence, the divan or sofa distance from the floor to the top of the cushion could be n, to the top of the writing table 650 mm and to the bed top level 425 mm, and so l composite effect of all units in a room is important. It is harmony and proportion olour and light that gives the visual impact. The furniture units must also be flexible rent arrangements are possible depending upon the need, function and taste of the

designing for offices, shops, restaurants, cinemas, hospitals, etc., has become a job. The comfort and convenience of the staff and economical utilisation of the ace are important aspects. In these cases, one more area comes into prominent at is flooring. Choice of the floor finish and design patterns of tiles have a primary Some areas may have carpets while some may have tiles of different types, sizes

ys, new varieties of materials are available—wood, steel, aluminium, glass, heets, wall papers, tapestry, paints, plywood, blockboards, PVC tiles, mirrors, fferent materials and design as well as tiles of different types. It is a challenge to the recommend a suitable type for the interior design. Different books and magazines e with colour photographs to develop a vision about interior and furniture design. ty of this field is to suggest a design suitable to the liking of the user by developing taste.

like the earth itself are 'shapes in spaces' and to be plastically complete, require them form and relate them to the surrounding space. Colour is the visual shape of

Author: Bart Van Der Leck
Book: *Colour in Townscape*

a certain psychological value. Its visual impact is important for creating the desired tmosphere. Colour affects emotion. Therefore, it is a very useful tool in interior

or increase the effect of space where necessary. A touch of a make a wall look attractive.

Colour Scheme The designer/colour consultant should kno decide on a colour scheme:

Dry distempers, oil bound distempers, plastic emulsion wall papers of different colours, and designs, etc., cater to di different shades of desired colour are also available as per th computerised analysis and process.

Table 3.1 (Colour Terms)

Primary Colours	:	These are red, yellow and blue. Al from these three colours.
Secondary Colours	:	These are orange, green and purp primary colours.
Hue value	:	It is the lightness or darkness of shade of red or dark red.
Chroma	:	It is the intensity or purity of a co which it has been diluted or neut
Shade	:	It is the darkened value of a colo
Tint	:	It is the diluted value of a colour addition of white.
Monochromatic	:	It is a colour scheme using value
Analogous	:	It is a colour scheme employing on the colour wheel. If yellow, y in which yellow predominates, n
Warm colours	:	These are colours which seem to i.e., red, orange and yellow.
Cold colours	:	These are blue, green or violet w surface seem to recede from the or warm.

- Hue : It is the term used to designate the name of a col different hues.
- One has to know many characteristics of a colour.
- Colour can make an object appear larger or smaller. A lig than a dark coloured one.
- Colour can make objects seem lighter or heavier. Dark a

nish Blue	Retiring Relaxing Depressing

n blood circulation. The blood pressure increases the respiration ours tend to dim sound and quench the senses, enhancing the ard orientation is furthered in the presence of cool colours.

walls should be considered in the context of the most dominant ea, hills, trees, and surroundings.

effective colour scheme than simply picking the colours mat ch of a science as an art and follows very specific rules about mony means an aesthetic arrangement of various parts to form of colour harmony consists of knowing which colours to use, what order to put the colours in, as well as the proportion of effect.

ferent colours and shades and information about their market using surface coverage per litre, number of coats required is y of different interior works finished by different designers, nd stage.

s are grown indoors. Not only do they provide relief through ful as an architectural aid. They can be used to contrast vertical with angles. They serve as a visual barrier and camouflage light and have a colour pattern. Plants can be kept anywhere, window sill or in the balcony. Interiors of offices, restaurants, s get a new look with the addition of plants. Indoor plants also rs.

ior design is incomplete without indoor plants. A room that has ractive if a few plants are placed in it. Flowers in vases or in to create a stunning effect whenever they are kept.

corative and ornamental foliage and different coloured leaves e year round. They are easy to care for and need only two to ers require still less sunshine.

gether to form a focal point may be done and a marvellous ng foliage, shape and texture. Plants grow well together. They d the air is moist around them. Tall dramatic plants are placed ller plants around their base in a pyramidical shape. The area ention if there is a colourful arrangement of plants.

rniture arrangement or colours of the wall frequently, but the

6. *Electrical Lighting*

Illumination is the principal consideration in certain types of buildings such as theatr departmental shops, and restaurants. Indirect and direct lighting with many co and designs can change the look of the interior, e.g., false ceilings with lights illumination in offices or controlled illumination required for theatres or cinema. T system can create the desired background and mood. The following guidelines ar when working out the lighting arrangement:

For work places—active floating lamps
For a festive atmosphere—bright and glittering lamps
For homes—shaded lamps
For intimate surroundings—dim lamps.

Ambient lighting is essential for an efficient environment. For a lighting technolo and sunset at a definite point of time are identical in terms of lux readings (1 lux m^2). One is transition from darkness to daylight, the other from daylight to darkne thrilling and exciting, yet they create and encompass different feelings and moods.

Lighting has a psychological impact on the person using it. One would certainly a well lit space or atmosphere in a working environment or in a kitchen, where certainly be desirable to provide dim, subdued or diffused lighting for a restaura Therefore, technological understanding of illumination levels is highly essential and the role of a lighting engineer is also important. The lighting engineer, in collabo the interior designer, tries to create an artificial environment to meet the requirem user. The involvement of the lighting engineer right from the blueprint stage can le combination of artistic flair and scientific precision in interior design. Improvemen luminaries (light fittings that hold or contain a lamp) and computer aided design h to provide better lighting to fulfil the needs or specific purposes in homes, office grounds, theatres, swimming pools, shopping complexes, etc. Halogen lamps fittings are used. Both direct and indirect lighting schemes are made use of. Th be constantly borne in mind while preparing a design for lighting are lighting ha software needs, budget, safety, maintenance, practicalities, standards and regulati new lighting products regularly appear on the horizon extending the range. The de and functional aspects of lighting can only be achieved with specialist expertise, lighting engineer. He can highlight the salient features and create the mood of any exterior through planned lighting. The art and science of lighting involves the follo

1. Knowledge of basic character of light, its colour and behaviour.
2. Knowledge of different types of lighting, fixtures and their types.
3. Selection and placement of fixtures—concealed or otherwise to achiev effects.
4. Design of lighting as decor in buildings such as shops.
5. To create different effects—glamour, romance, dignity, tranquility, etc.
6. Integration of lighting design along with architectural design.

stes a lot of energy. Hence, direction lighting is preferred, using many varieties of nps of different watts and beam widths. These lamps can be used to concentrate the he spot where it is needed, leaving the surrounding area in comparative darkness.

p known as "inside white with window open" is used for reading purposes, as it ncentrated beam of light on the table. Its satin frosted upper surface does not allow escape from above, thus focussing the beam on the spot where it is wanted. It is itable for drawing boards, work benches, homes and hotels for showpiece lighting. of a television lamp is coated with aluminium, thus allowing light to escape only per portion. It helps in viewing without straining the eyes. It is fixed behind the et.

ent lamps are the ideal light source for offices, shops, factories and departmental r advantage is low wattage consumption and high efficiency. The life of an average amp is five times longer than that of an incandescent lamp, and it consumes only one energy. Now a 26 mm diameter tube is found to be more economical as compared to ube. It consumes 10% less power and gives an equal amount of light. Thus, a choice ade between, say tungsten filament lamps, fluorescent lamps, mercury or sodium mps, LED etc., as per requirement, utility and energy consumption.

hting is not merely a matter of interior decoration. It should be remembered that n depends upon it. Efforts should be made to give the benefits of design and new roducts to the common man in all types of built environments, as there is no end to ogical needs of humanity.

uld remember the following words said by **Barbara Nelson**, an interior designer. *our interior environment by what we choose and that environment shapes us in 's why I want the bests. It gives me a sense of wonder and enriches my daily life in ractical and spiritual ways.*"

Case Study

rniture Layout for Aurum M/c Tool, Marketing and Services ior Designer—Ar. Ravi Gadre, Pune (Fig. 3.28)

rst stage in interior designing is the study of requirements of the owner as per ons, available floor area and door and window locations.

ic plan with regard to transformation of the available space is proposed. The ving factors are considered for this purpose:

Number of persons to be accommodated.
Furniture requirement.
Light, ventilation requirements.
Computer, telephone and other services for communication.
Privacy in different areas.

Reading Exercise (Figs. 3.28)

Study carefully the furniture layout plan with reference to all poin

1. Two cabins with the division by diagonal line have crea cabin.
2. Reception/waiting area (3675 × 2625)
3. Meeting Room (3675 × 3900)
4. Find out the total number of persons to be accommodat
5. Store (2700 × 825) and pantry.

Space creation for different functions is the first stage. The is to create "livability" or an acceptable environment for thought to the following factors for the same and prepare yo and estimate:

1. Design of tables, chairs in cabins and the reception area
2. Meeting hall—tables and chairs.
3. Floor type—pattern, finish, etc.
4. Artificial light through ceiling of plaster of paris or othe
5. Material for various partitions of areas.
6. Doors—types, finish, fixtures suitable to the office.
7. Total colour scheme—floor, ceiling, walls, colour for venetian blinds.
8. Find the rate per square metre for interior designing wo

Case Study

Interior Design for Renovation of Flat (Figs. 3
Owner: Shri M A Bapat, Pune
Interior Designer: Patsons Engineers and Inte Vivek Patki, Pune

Renovation of old flats as per new requirements of t the work of the interior designer. Knowledge of interior the structure is essential to complete the job with satisfa

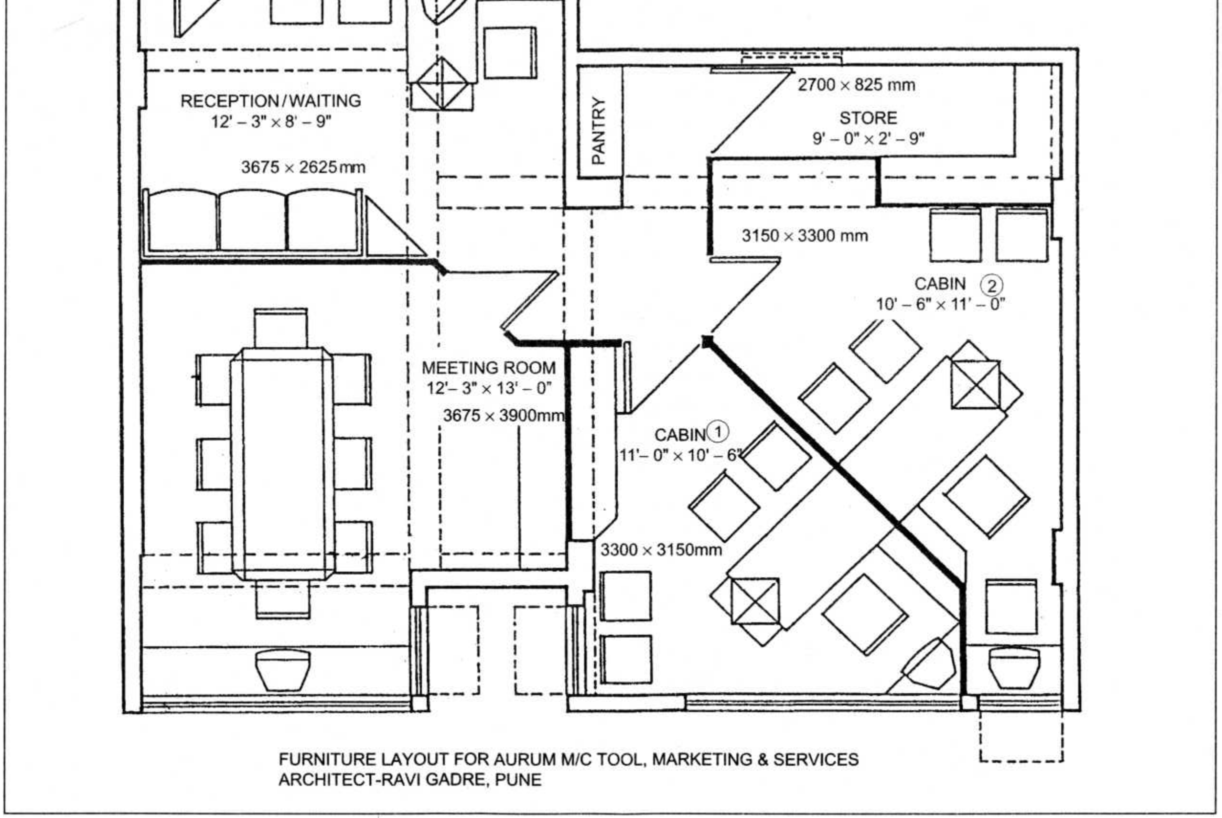


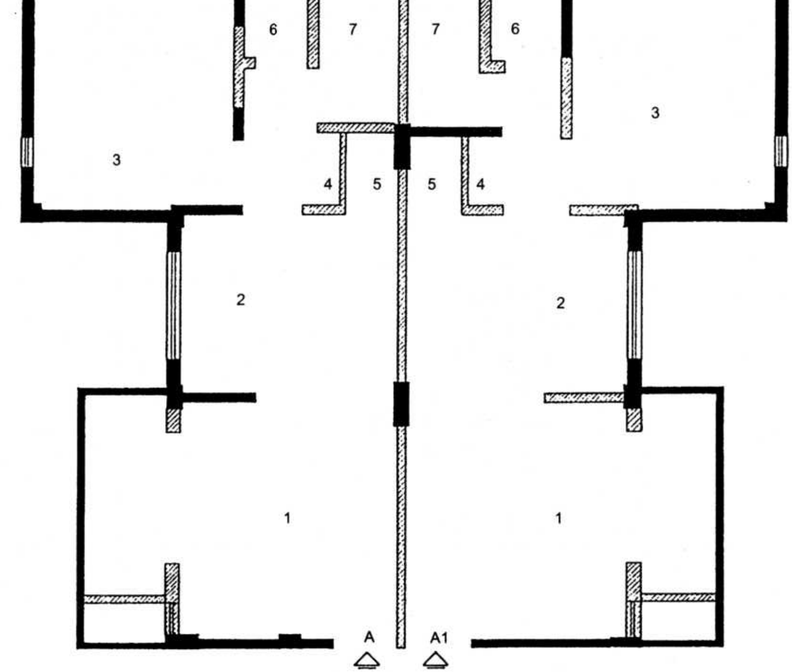
Figure 3.28 *Interior Designing Details – Furniture Layout Plan*

e walls.

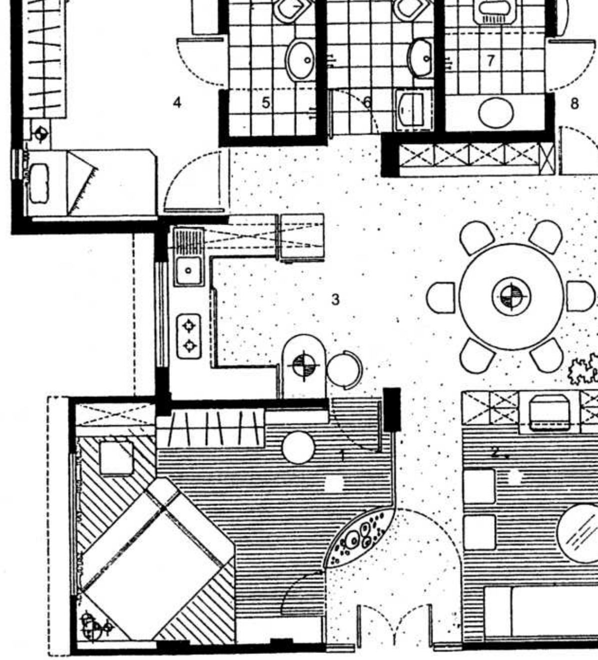
Cs and two bathrooms) into three toilets (one attached to each non use).

balconies (for rooms (1) and (2) and bedroom (3) on the left for additional floor area.

5. Provision of steel grill work for windows, powder coated aluminium window quito protection.
6. Necessary plumbing work, electrification, PVC flooring in rooms, ceramic dado for toilets, kitchen otta with granite finish, plaster and painting work.
7. Furniture design—Dining table, storage and display units. The total work wa on a turn-key basis.



PLAN



PLAN

TWIN BLOCK A AND A1 FOR MR M A BAPAT

1. LIVING/BALCONY
2. KITCHEN
3. BED/BALCONY
4. WASH BASIN
5. STORAGE
6. W. C.
7. BATH ROOM

WALLS TO BE DEMOLISHED SHOWN THUS

PROPOSED INTERIOR LAYOUT FOR MR M A BAPAT

1 GUEST BED ROOM
2 LIVING
3 KITCHEN/DINING
4 BED ROOM
5, 6, 7 } TOILET
8 BED ROOM

0 50 100 200 CM

N

Figure 3.29 *Renovation of Flat – Plans*

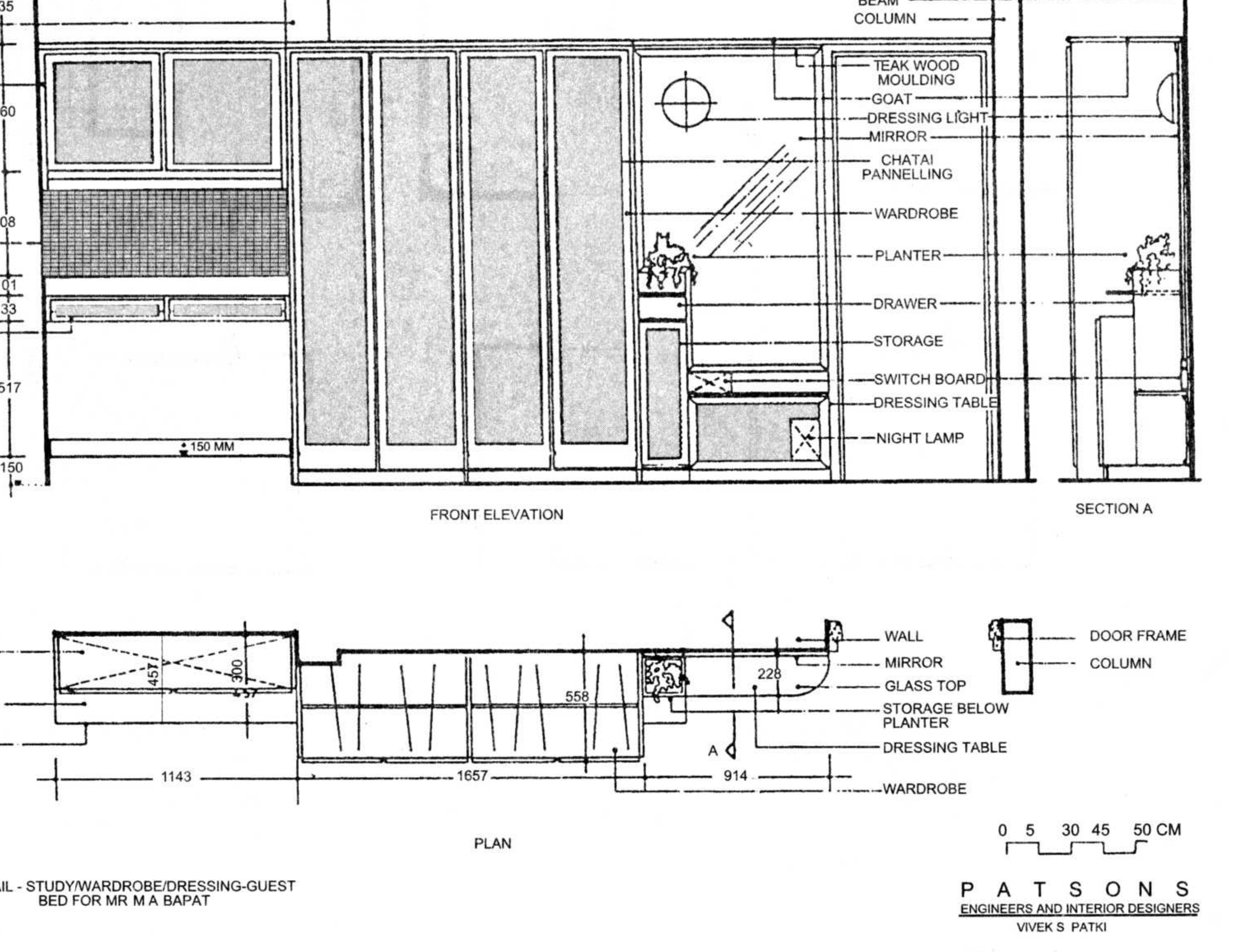


Figure 3.30 *Renovation of Flat – Details Furniture Unit*

ook good, they should feel good too".

Interior Designer: Kelly Hoppen
Book: *East Meets West (Rizzoli, New York)*

ior design for the flat and the kitchen, as seen in the axonometric view shows details vork. Study carefully all details—furniture, toilet, kitchen, bedroom, etc. 'Livability' on visual pleasure due to harmony in specifications, order in placing of furniture, ng with light points, etc.

deals with space contained in volume. Primary elements of form are point, line, olume.

: A point is the generator of form.

: A line is traced when a point moves in any direction.

: When a line shifts in a direction other than its own, we see a two dimensional element, i.e., a plane.

: When a plane is extended in an oblique direction or perpendicular to its surface, the result seen is the volume.

32 which shows the volume or space available for the kitchen interior(l). Kitchen g. 3.32) shows kitchen details—otta, cupboards, breakfast table, freezer, etc. c view (3) shows a three-dimensional view, flooring of ceramic tiles, window, s above otta, etc. Movement in the kitchen is to be minimum, everything required sy reach, at a predetermined place to reduce fatigue.

design is a challenge today because of new materials, for tiles and otta finish and chnological components. An innovative, stylish, functional and efficient kitchen is ion. Kitchen design is supposed to create an environment which is highly individual. lesigner needs to give attention to detail for optimum use of space. Creative cooking tasteful kitchen. Hence, a durable, perfectly finished and totally functional kitchen ner's aim.

are not considered as just a work place. Considering the time spent in the kitchen, pected to create a pleasant, relaxed environment for every day cooking duties. g, dining and kitchen space have become a centre of our home, a focal point where er. A breakfast table becomes a point of attraction and hence TV location also needs ocation with reference to living, dining and kitchen areas. Placing of appliances and s in the kitchen, needs planning.

hen floor is expected to be attractive and comfortable, nonslippery and able to great deal of wear and tear. Flooring also needs finish to be tough, easy to clean and water and grease. Heavily polished floors are dangerous for children and elderly

g for hot and cold water, lighting natural and artificial, and cost of flooring material, and maintenance are the considerations for selection of flooring, tiles for dado

but in a small kitchen every sq. cm. is important. Think abou has been decided upon.

Reading Exercise (Figs 3.31)

This plan shows details for the interior of a flat. Total p construction work is done by Patsons, Pune.

1. Carefully study the plan with reference to-horizontal c windows, furniture arrangement, location of the kitchen
2. Flexibility is required in furniture arrangement. Thin different rooms.
3. Collect brochures for wooden flooring tiles, method of fi designs and advantages for the same.
4. All windows are of powder coated aluminium. State ad with reference to wooden, steel and PVC windows.
5. Collect details for cost of interior work per square metr
6. Concealed wiring is done for all electrical work. Collec cost, care during supervision of RCC slab work, etc.
7. Four small squares shown in the toilet (6) and the passag skylight from the terrace. Collect details for the same.

Reading Exercise (Figs 3.32)

3.6.6 Kitchen-Axonometric View and Pla

Study the kitchen details in this plan. Discuss about the plan mentioned regarding creation of an environment. Suggest add Collect brochures and information for

1. Granite for kitchen otta—colours and rates.
2. Ceramic tiles for dado—colours, patterns, sizes and rate
3. Exhaust fans—different types.
4. Various fixtures for kitchen storage units.
5. Trollies for storage.
6. Sinks—materials, sizes, rates.
7. Taps and water purification equipment.

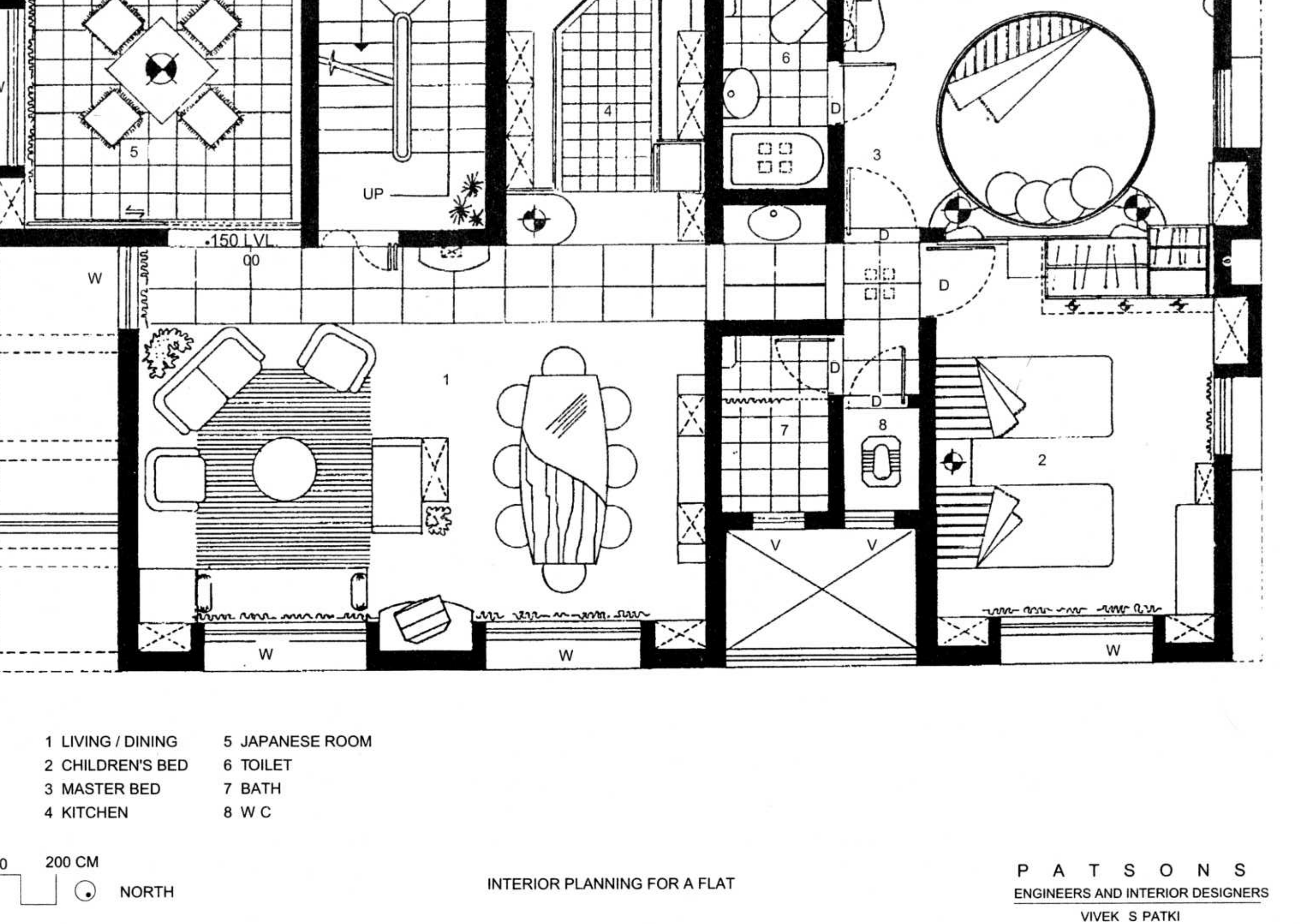


Figure 3.31 *Residential Flat – Details for the Interior*

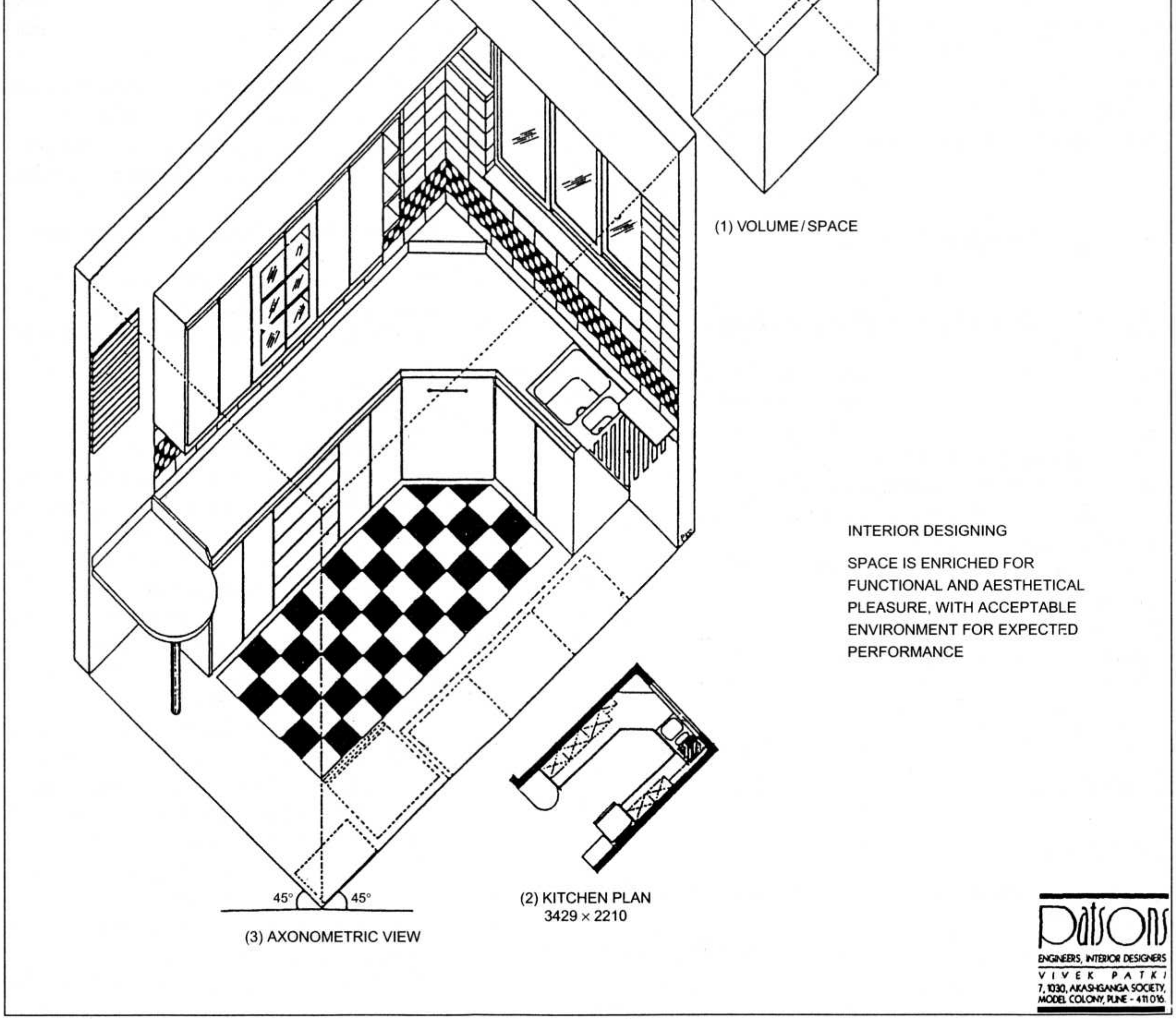


Figure 3.32 *Interior Designing – Kitchen Plan and Axonometric View*

Architect: Jerry Macneil
Book: *The Guild*

pattern, and furniture design is a part of the interior designer's that interior space becomes more effective, pleasing and eye rk. Architectural art and craft work has served to unify and ancing the architectural integrity of the entire interior space work also gives a richness and meaning to people's lives. Art fferent private and public interior spaces. It is stated by **'Mark** that "*When we live with arts and crafts, it is very much like eling should be protected, nurtured and appreciated*".

is found to be useful for architects, interior designers and ving list gives details about different architectural works for sans are available:

vindows, etc.

ver.

grill work.

is objects of art.

rk, decorative masonry.

ows, railings, furniture, storage.

s, windows, staircase wall, roof work.

ceiling, plaster work.

and landscaping—fountains, benches, sculpture.

es.

ctory of such artists and artisans along with their types of works ke their services useful for all architects, interior designers and

RUCTURE

integrated stable object on earth consisting of architectural the same. Hence, it is considered as a stable shape in the space. uilding arrived at as a result of the provision of internal spaces f the programme. It is thus the product of the internal space the required space units, connected to each other horizontally pace to be enclosed. Such space is enclosed, spanned and then

classified as the self-weight of the structure and live load of movable things. The ele structure should absorb the forces mentioned above without causing damage to the

It is necessary to calculate the total load and study the load flow pattern so as safely all forces down to the foundation.

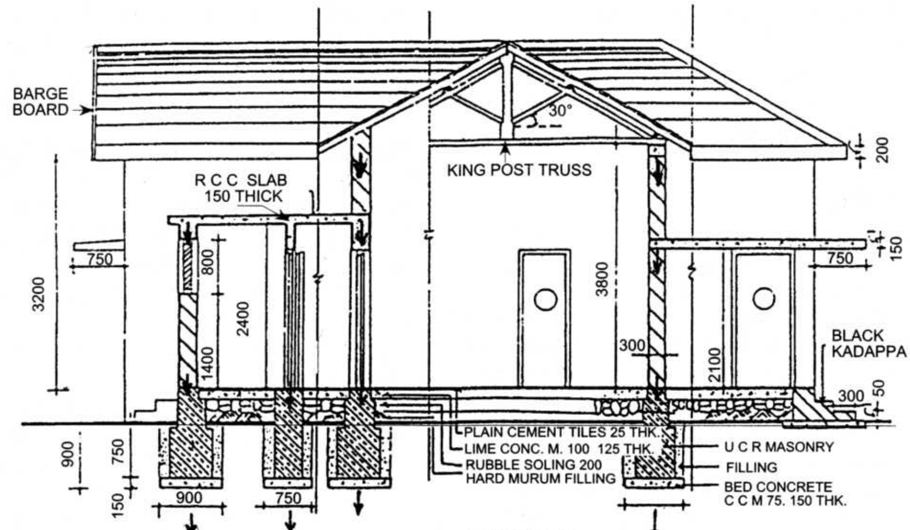
1. In solid construction, load is expected through heavy homogeneous wall mas floors transmit load to the walls and walls transmit load to the soil through the (Fig. 3.33).
2. In a skeleton/framed construction, slabs and beams transfer the load to colun umns in their turn, through footings to the soil below. It may be a RCC or s structure (Fig. 3.34).
3. A surface structure consists of the roof in the form of folded plates or shel flow pattern is studied through the roof and various supporting members, i.e. columns (Fig. 3.35).

Determination of space for the desired function becomes the primary work, whil of the structure for the same becomes secondary. Structural engineering is a for process. There is a genuine art in its integration with the overall architectural intent development.

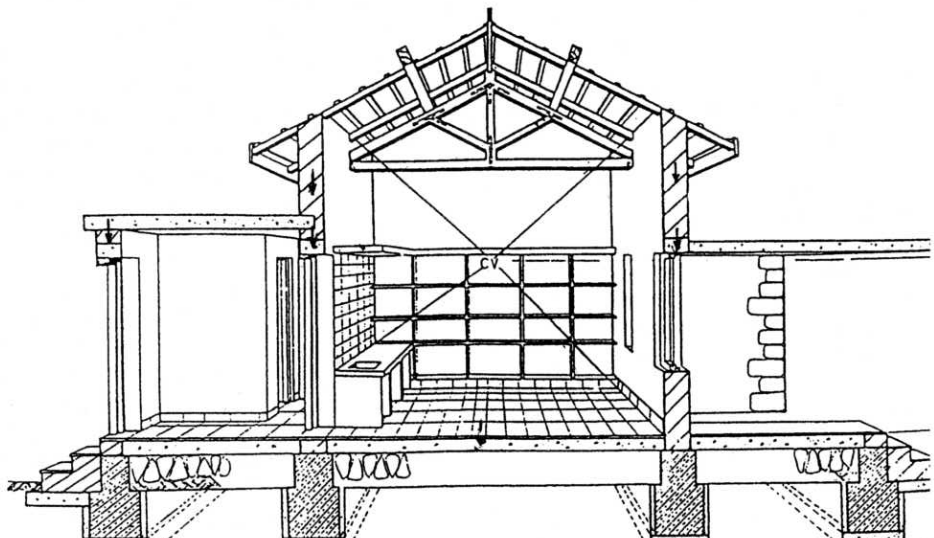
It should be kept in mind that the structure influences the form of the buildir does not determine it. The design and construction of a structure depend upon the of material and construction techniques. A study of the history of architecture w important role, the structure has played in the development of architecture. As the and materials were gradually replaced by new systems and materials, architectural improved. Today, science and technology enables us to build any form.

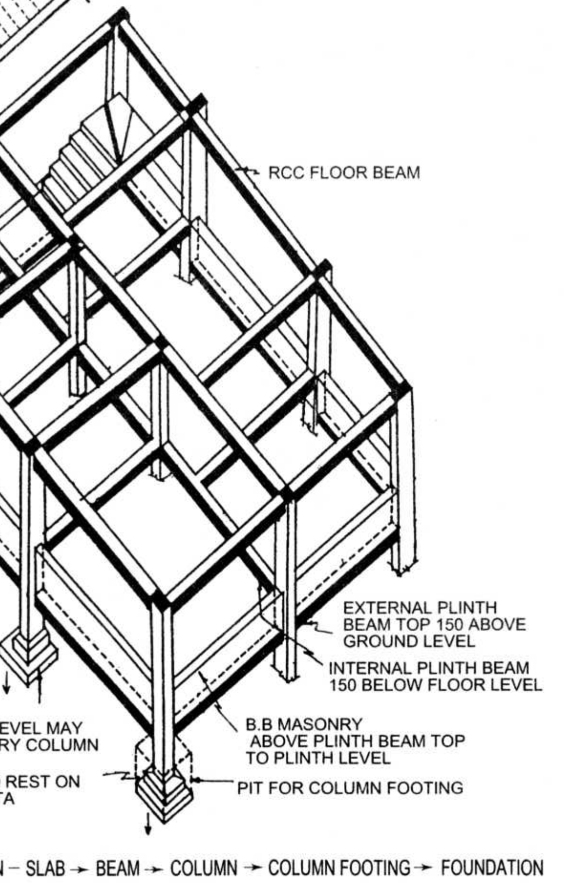
3.7.1 Technological Developments and Structural Ana

Load bearing structures of stone and brick can be built only up to a maximum height with the result that the floor area becomes considerably reduced. With the d of modern technology, framed structures of RCC or steel have not only provided o to bridge and enclose large spaces, but have also become a source of inspirati architectural achievements, e.g., skyscrapers, stadia, auditoria, industrial building hangars, etc. Developments in science regarding the study of behaviour of mat different conditions of load, temperature and humidity, properties of soils and the under different conditions, have helped architects to a great extent. Now there is no on empirical calculations or rules of thumb, since computers can provide alternati in no time. Plastic design for steel and *limit state design* for RCC has provided regarding the vast reserve of strengths available in materials. Plastic design is the structural analysis of steel structures, i.e., beams, columns and frames, based on which may or will cause a collapse of the system. Collapse occurs when the framewo a nonrigid system by the formation of a sufficient number of plastic hinges. Thre hinges, redistribution of moment takes place before the collapse of the structur


BARGE BOARD
30°
KING POST TRUSS
R C C SLAB 150 THICK
750
800
2400
1400
3200
3800
300
2100
750
150
200
BLACK KADAPPA
300
50
PLAIN CEMENT TILES 25 THK.
LIME CONC. M. 100 125 THK.
RUBBLE SOLING 200
HARD MURUM FILLING
U C R MASONRY
FILLING
BED CONCRETE C C M 75. 150 THK.
900
750
150
900
750

SECTION AA


CV



ric View Showing Structural Details for Framed Structure

of Structures

inimal, adequate, sculptural and pretentious. Structures which
nount of materials are classified as minimal. Gothic structures
e least' is the aim. The same aim is kept in mind in ship building

Factor of Safety

Whatever may be the type of structure, one who is connected with architecture shou
forces for which structural analysis is essential. Stability, i.e., equilibrium, streng
and factor of safety are the essential conditions to be checked in structural analysis
should satisfy these conditions.

Stresses and strains are due to loads, structural behaviour and the nature of mate

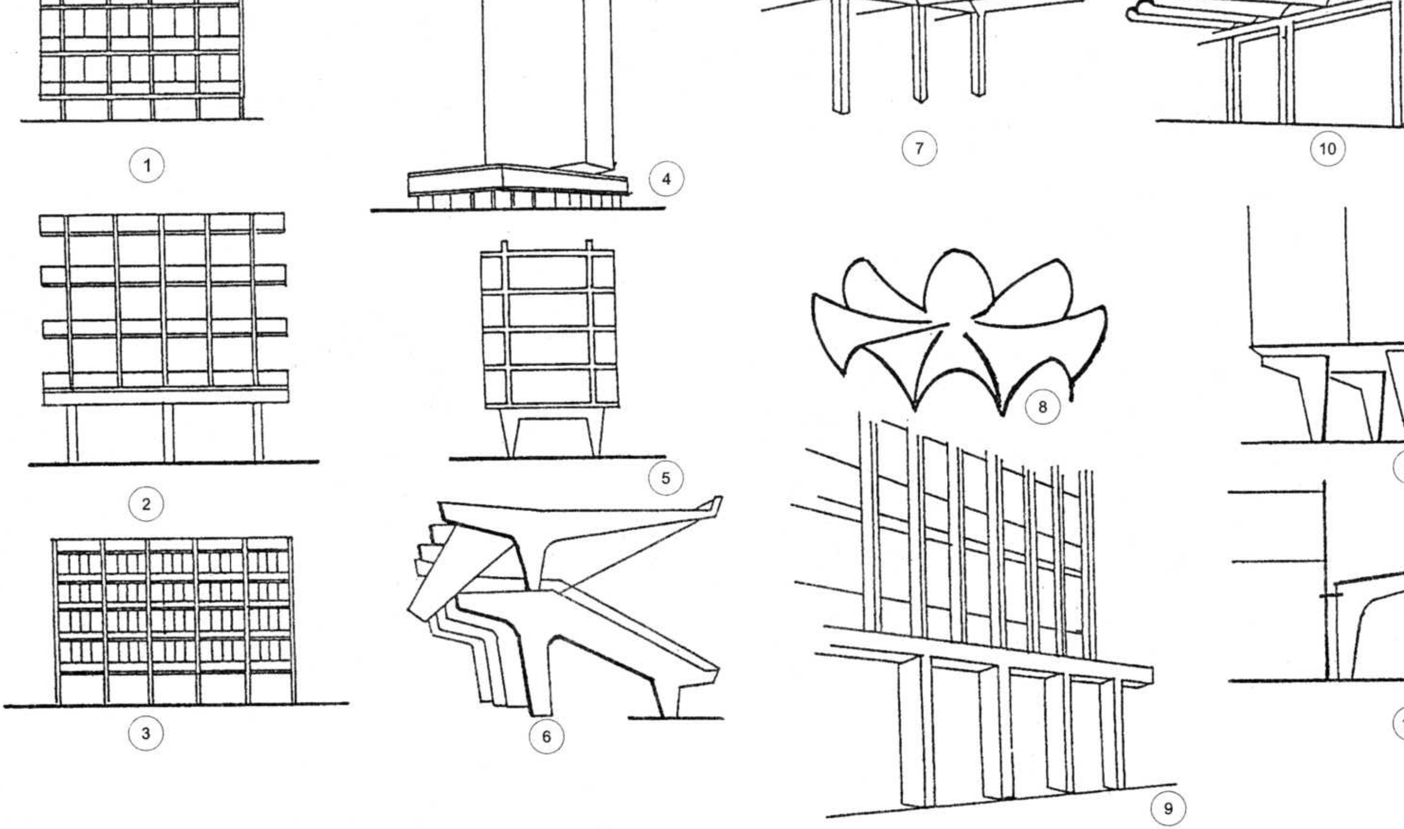
1. *Stress Due to Loads*: Gravity loads and horizontal forces due to external ager
a structure. A gravity load consists of self-weight and superimposed load, i.e., li
load due to snow, rain and also buoyancy. Horizontal forces are due to wind and e
The pattern of airflow depends upon the shape of the building, roof, its angle t
surrounding buildings and their height, width and length. Dynamic effect is cause
movement of vehicles or cranes, or people jumping on the floor, etc. Impact ar
effects are caused due to stationary machinery such as cranes. Rubber blocks and
in absorbing vibrations. Basement walls are supposed to resist earth and/or water p

2. *Stress Due to Structural Behaviour and the Nature of Materials*: Stress is also ca
the nature of the materials, behaviour of the structure and connections between th
members. Elastic strain causes shortening or lengthening of the material under l
deformation causes flow in concrete and nonrecoverable changes in the shape of
sag. Thermal expansion and contraction set up movements in metal and concre
corrosion create destructive forces. Hence, prior to the design, it becomes necess
the behaviour of steel, wood, concrete, stone and brick under the above mentioned
acting independently and/or in combination. An uneven settlement for the foundatio
of metal and wooden columns, splitting of concrete and wood, tipping over of wall
tension in beams, excessive deflection of cantilevers, torsion, punching shear arou
and tension at corners in slabs, all adversely affect the structure.

3. *Stability*: Stability, i.e., equillibrium is the first essential condition which is to
for the two conditions, F = 0 and M = 0, where F is the force and M the moment. A
considered with all forces and moments. Horizontal and vertical forces should be
so that the structure does not move or rotate. Hence, it should be ascertained that
as a whole is in equilibrium and so is every element. This can be done by drawing
diagram showing all forces and moments.

4. *Strength*: After checking and satisfying the condition of equilibrium, the size of
the distribution of stress is checked for every member to verify the strength of th
The section should be adequate to resist stress (stated as the force per unit area). S
strain which is defined as a unit deformation. There are two types of structural me
type carries axial forces causing direct stress and the other carries couples or she
shearing stress, bending stress and torsional stress on sections normal to the
members.

5. *Stiffness*: It should be remembered that although a structure may be in equilibr



(1) (2) (3) (9) SKELETON CONSTRUCTION, RECTANGULAR PLANES OF BOX - SHAPED FORMS AND GRID

(5) V- SHAPED SUPPORT OF RIGID FRAME

(4) HIGH RISE BUILDING A CHALLENGE TO TECHNOLOGY

(6) STADIUM WITH A CANTILEVER ROOF

(7) FOLDED PLATES

(8) CIRCULAR ARRANGEMENT OF SHELLS

(10) USE OF CYLINDRICAL SHELLS IN CANTILEVER CONSTRUCTION

(11) V-SUPPORTS WITH WIDE CANTILEVERS

(12) USE OF V-SUPPORT AND CANTILEVER FOR CANOPY

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Figure 3.35 *Framed and Surface Structures – Types*

type of loading (static/dynamic) and the workmanship during
n be defined as the load which will cause the stress to reach a
king stress for/in the material. Failure load can also be defined
ve deflections or vibrations, and ultimately complete collapse.
that in every structure and design, checking of every member
portant is the design of the connections between the various
a symbol of unity of art and unity of technology.

sis: Today computer is used for structural analysis, design and
more details.

Case Study

gs
ciates, Pune

ercise (Figs. 3.36 to 3.44)

ral details and schedules and are used by fitters to cut and place
ers. Drawing and detailing should be self explanatory, so as to

C structure are (i) slabs to cover a large area, (ii) beams to
beams to support slabs and walls and plinth beams connecting
port walls, (iii) columns to support beams, and (iv) footings to
olumns over a large area which depends upon the load bearing

ws key plan and an index plan for RCC columns and footings
hod for numbering of columns. Combined column footing is
ns. Tick mark those columns. Study column location for the

le of RCC columns and Footings/plinth side for part (1) and
umn shows essential details and the schedule gives details of
The size goes on reducing from plinth to the top floor level as

x plan for RCC plinth beams. What is its purpose? Is there a
l and internal plinth beams? Why? (Figure 3.41 shows sched-

plan for RCC slabs and beams for a typical floor and types of

Step 3-To calculate unit loads of parapet walls, grills, weather sheds, etc.

Step 4-Design, (from top floor to ground floor) first slabs, then stairs, beams, c
column footings.

Step 5-Preparation of structural drawings and schedules.

Nowadays, computer aided design is done with the help of softwares.

Strucural design for multistoreyed structure.

Figure 3.43 shows a 75 m height building, loading diagrams, deflected shap
diagram. The chart in Fig. 3.44 shows stresses and moments. Note Figure 3.4
deflection. Actual deflection may be very less and it is not possible to be seen wi
scale of drawing; hence deflection and BM is exagerated to show the deflected sha

A-Tower resting on 16 columns having 75 m height and slabs at 3 m interval
software will enable us to view the loads applied horizontally acting from left to ri

B-This view shows actual deflection pattern.

C-This view shows B M diagram for columns, beams with combined effect c
and wind load.

Figure 3.44 Computer output showing +ve and -ve BM and values for the design
such a building, manual analysis and calculation work is tedious and time consumi
use of a computer will give design data in comparatively less time. Proper load c
should be made to get the final design data, particularly in case of wind coming
directions.

Collect information about software packages for structural design of fram
multistoreyed structures-wind, earthquake, dead and live loads. (Refer to Chapter 6

Case Study

Mahavir Bhawan (Fig. 3.45)

Name of the work: 'Mahavir Bhawan, Aurangabad
Name of the Architect: M/s R B Nagpal, Aurangabad, Pune
Name of the Consulting Ingenieur: Shri R N Bhat, Pune

Proposal

To construct a community hall for a variety of purposes, such as marriages, rel
functions, and meetings with residential accommodation and facility for k
and dining.

General scope

Requirements for the building were decided as under:

(a) A hall for the main function, entrance foyer, office, toilet facilities fo

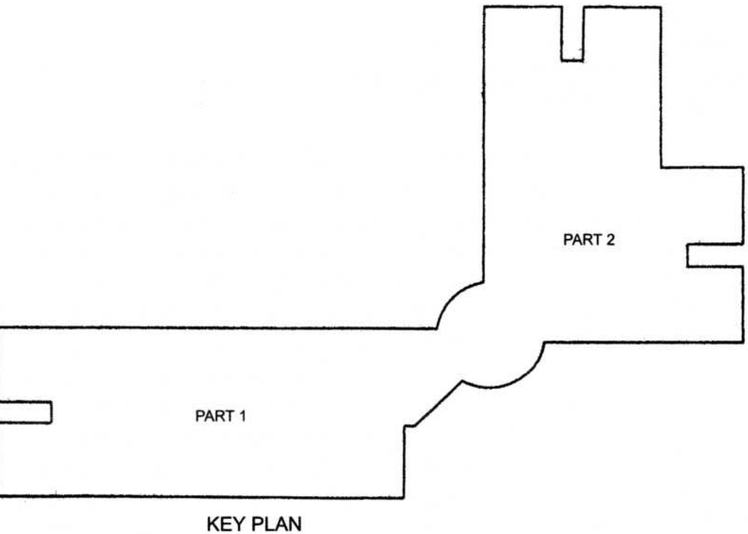


Figure 3.36 *Key Plan for Building*

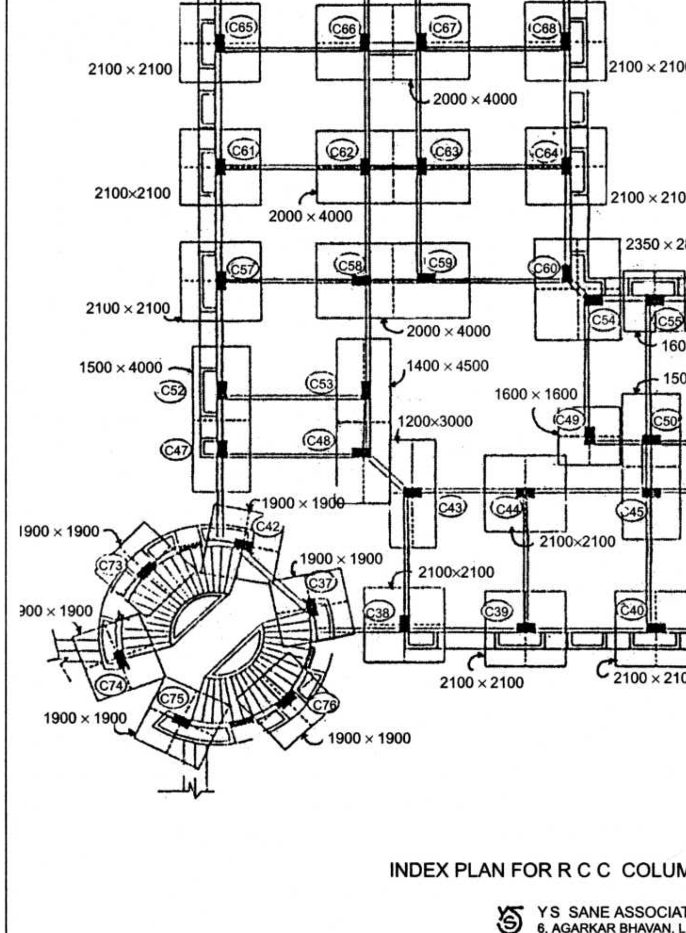
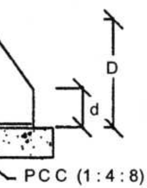


Figure 3.37 *Index Plan for RCC Columns*

EQD.	1750 x 1750	COMBINED	2250 x 2250	COMBINED	COMBINED	COMBINED	1350 x 3150	2050 x 2050	1750 x 1750	2350 x 2850
	1600 x 1600	FOOTING	2100 x 2100	FOOTING	FOOTING	FOOTING	1200 x 3000	1900 x 1900	1600 x 1600	2200 x 2700
	450, 150	CF1	500, 200	CF2	CF3	CF4	600, 200	500, 200	450,150	600, 200
ELAT HWAY	10Ø10		17Ø10				14Ø10	17Ø10	12Ø10	18Ø 10
	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450
EL	8Ø12	4Ø 16 4Ø12	8Ø16	8Ø16	8Ø16	8Ø16	8Ø16	8Ø16	4Ø16 4Ø12	4Ø16 4Ø12
	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450
EL	8Ø12	4Ø16 4Ø12	8Ø16	8Ø16	8Ø16	8Ø16	8Ø16	8Ø16	4Ø16 4Ø12	4Ø16 4Ø12
	230 x 375	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450
EL	6Ø12	8Ø12	8Ø12	4Ø16 4Ø12	4Ø16 4Ø12	4Ø16 4Ø12	4Ø16 4Ø12	4Ø16 4Ø12	8Ø12	8Ø12
	230 x 300	230 x 375	230 x 375	230 x 450	230 x 450	230 x 450	230 x 450	230 x 450	230 x 375	230 x 375
EL	6Ø12	6Ø12	6Ø12	8Ø12	8Ø12	8Ø12	8Ø12	8Ø12	6Ø12	6Ø12
	230 x 300	230 x 300	230 x 300	230 x 375	230 x 375	230 x 375	230 x 375	230 x 375	230 x 300	230 x 300
EL	4Ø12	6Ø12	6Ø12	6Ø12	6Ø12	6Ø12	6Ø12	6Ø12	6Ø12	6Ø12
								230 x 300		
EL								6Ø 12		

BLDG-A—PART 1, 2



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YS SANE ASSOCIATES
6, AGARKAR BHAVAN, L B SHASTRI MARG, PUNE 30

Figure 3.38 *Structural Design – Schedule – Columns and Footings*

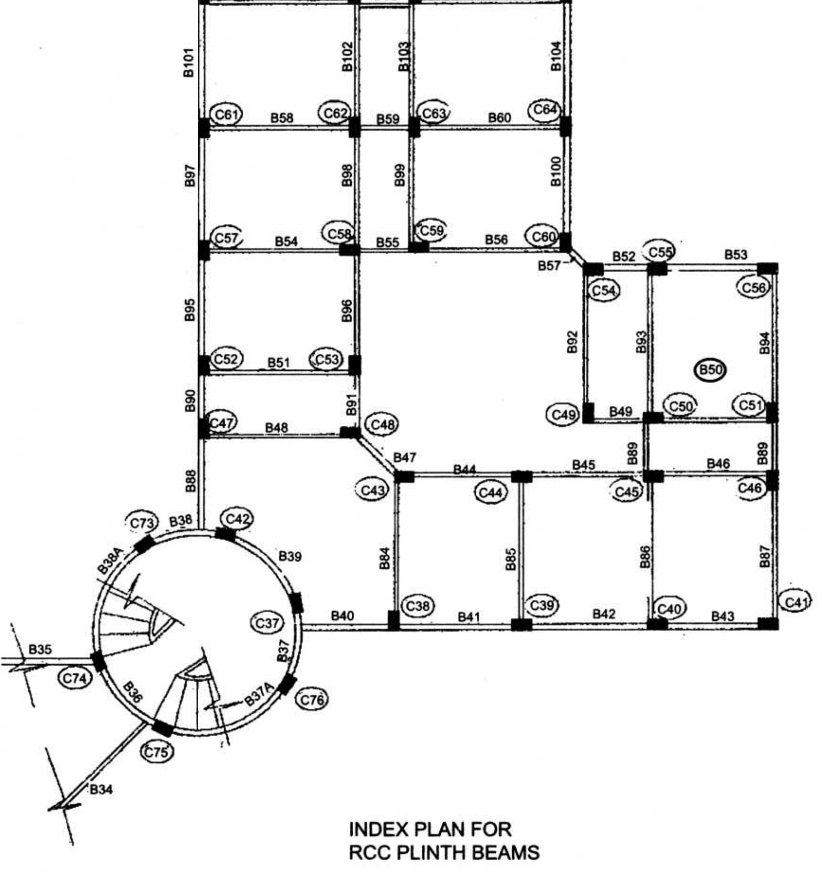

Figure 3.39 *Structural Design – Index Plan – RCC Plinth Beams*

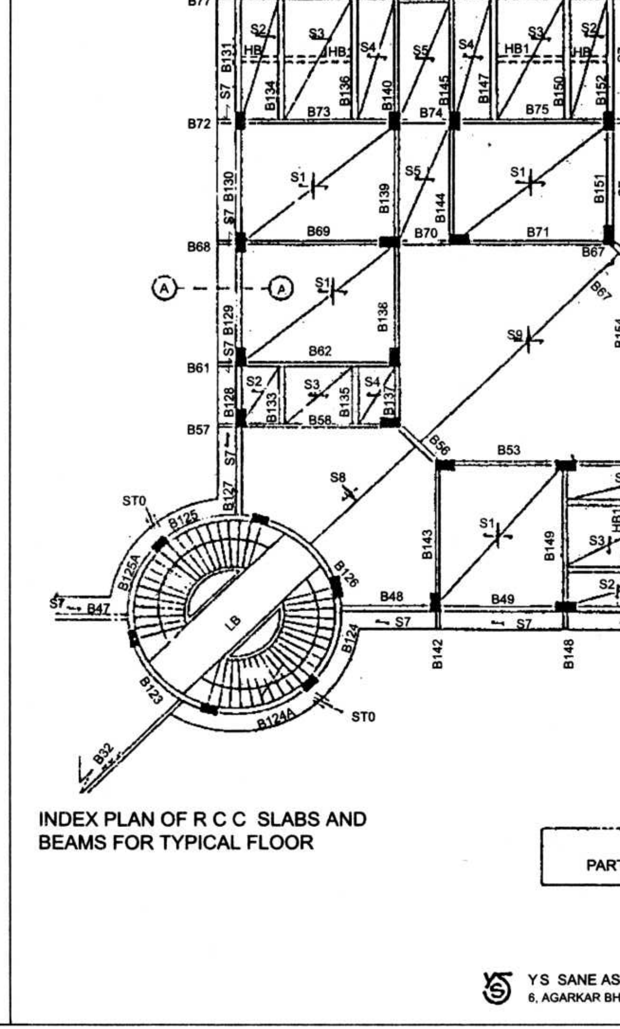

Figure 3.40 *Structural Design – Index Plan – RCC Sl*

	B.	D.	STR.	BENT UP	@FROM FACE OF SUPPORT	STEEL	DIA	NOS AND SPACING		
D 46, 2, 103, 107 105	230	450	2 φ 12			2 φ 10	φ8	@ 250 C/C ALLOVER		1 φ 12
	230	450	2 φ 12			2 φ 12	φ8	@ 250 C/C ALLOVER	CANTILEVER	1 φ 12
	230	450	3 φ 12			2 φ 10	φ8	@ 250 C/C ALLOVER		
3A, 39	230	750	2 φ 16			2 φ 16	φ8	@ 250 C/C ALLOVER		
4,	230	450	2 φ 12			2 φ 10	φ8	@ 250 C/C ALLOVER		1 φ 16

SCHEDULE OF R C C TYPICAL BEAMS

	OVER ALL SIZE		STEEL AT BOTTOM			TOP	STIRRUPS		REMAKRS	EOS
	B.	D.	STR.	BENT UP	@FROM FACE OF SUPPORT	STEEL	DIA	NOS AND SPACING		
	300	SLAB THK	3 φ12			2 φ10	φ8	@ 250 C/C ALLOVER	HIDDEN BEAM	
D 22 144 60	150	900	2 φ12 + 1 φ10			2 φ10	φ8	@ 250 C/C ALLOVER		2 φ12
	150	400	2 φ12			2 φ 8	φ8	@ 200 C/C ALLOVER		
4, B150	150	400	2 φ16			2 φ10	φ8	@ 200 C/C ALLOVER		
	150	300	2 φ12			2 φ8	φ8	@ 200 C/C ALLOVER		
6, 147	150	300	2 φ16			2 φ10	φ8	@ 200 C/C ALLOVER		
	150	900	2 φ12			2 φ16	φ8	@ 150 C/C ALLOVER	CANTILEVER	
	150	900	2 φ16			2 φ10	φ8	@ 250 C/C ALLOVER		
2	150	600	2 φ12			2 φ10	φ8	@ 250 C/C ALLOVER		1 φ12
	150	600	2 φ16			2 φ10	φ8	@ 250 C/C ALLOVER		2 φ16
, 103 115, 155, 3, 72, 4	150	600	2 φ12			2 φ10	φ8	@ 150 C/C ALLOVER	CANTILEVER	2 φ12
4A	150	900	2 φ16			2 φ16	φ8	@ 200 C/C ALLOVER		
	150	600	2 φ16 +1φ12			2φ12	φ8	@ 250 C/C ALLOVER		
	150	600	2 φ12			2 φ10	φ8	@ 250 C/C ALLOVER		
	150	600	2 φ12			2 φ10	φ8	@ 250 C/C ALLOVER		2 φ16
158	150	600	2 φ12			2 φ10	φ 8	@ 250 C/C ALLOVER		2 φ12
	1200	375	12 φ12			12 φ10	φ8	@ 200 C/C ALLOVER		

Figure 3.41 *Structural Design – Schedules*

S2	100	Φ8 @ 150 C/C ALL STR	Φ6 @ 150 C/C DIST	SUNK BY 500
S3	100	Φ8 @ 150 C/C ALL STR	Φ6 @ 150 C/C DIST	SUNK BY 200
S4	100	Φ8 @ 200 C/C ALL STR	Φ6 @ 180 C/C DIST	
S5	115	Φ8 @ 200 C/C ALT BENT UP	Φ6 @ 150 C/C DIST	
S6, 8	150	Φ8 @ 150 C/C ALT BENT UP	Φ8 @ 150 C/C ALT BENT UP	
S7, 7A	115'	Φ8 @ 150 C/C ALT BENT UP	Φ6 @ 180 C/C DIST	
S9	165	Φ10 @ 150 C/C ALT BENT UP	Φ10 @ 150 C/C ALT BENT UP	

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Figure 3.42 *Structural Design – Schedule for RCC Typical Slab*

ning

s with horizontal and vertical circulation.

Basement—Kitchen, dining and storage.

Ground floor—Reception hall for functions.

First floor—Residential accommodation.

Second floor—Terrace, rooms, hall with toilet.

ture

RCC framed structure for basement, height 3 m, ground floor hall— 6 m up to the bottom of the slab and 4.8 m up to ceiling. First and second floor, 2.7 m.

Arrangement for rooms on the first floor was finalised first, in order to locate the columns as per the size of the room.

The reception hall on the ground floor is required to be a hall free of columns (span 15 m) and hence it was decided to provide M S fabricated girders at 3 m c/c on columns with RCC slab on top.

Internal columns in the basement were located with reference to the requirement of the entrance foyer on the first floor and to reduce the span so as to control the depth of the beam.

First floor—Fabricated floating steel columns with cover of concrete are provided on top of the fabricated girders and RCC slab is provided on beams.

The design is found economical since dead load is reduced. This could also have been achieved by prestressed girders, but the cost would have been more though the number of prestressed beams required is less.

The top RCC slab is proposed to be given a five course waterproofing treatment.

Case Study

Hollow Cone and Hollow Dome or Hyperbolic Parabo
Columns of Buildings or Factory in soil which have low

Consulting I

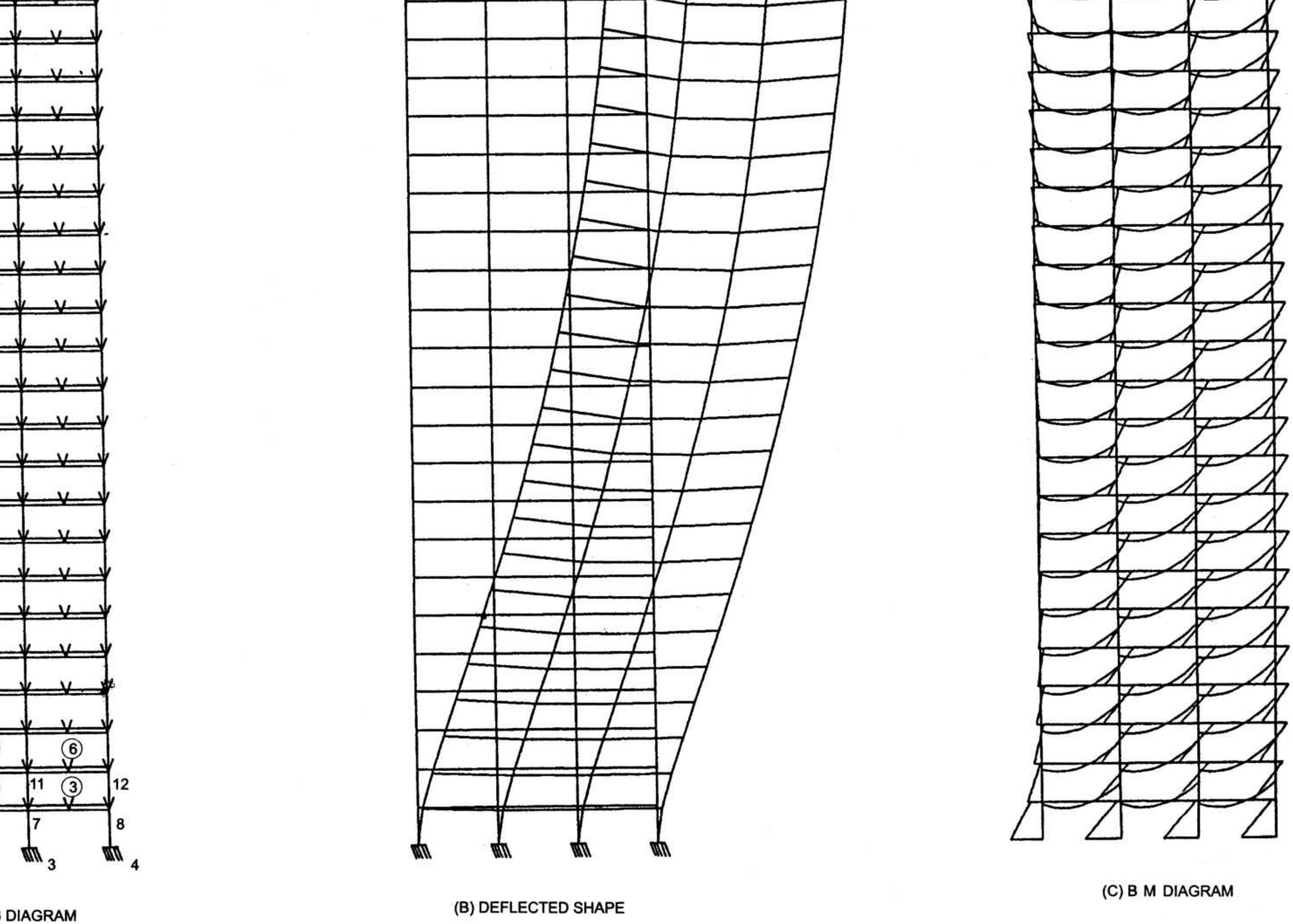
This type of foundation was adopted in designing prin
1953 when he designed Mexico City Custom House.

Based on the same principle, Mumbai-based consu
Mr M N Patel designed column footings for their proj
1961 where bearing capacity of soil was 2 t/sq. ft wher
hardly 672 lb/sq. ft (22 t/sq. m in dry condition and 3.
same design procedure is well explained by the British a
book *Design and Construction of Foundation* (Cement
London). IS code 9456: 1980 specifies design principles

Mr R N Bhat was assigned to design a sugar fact
factory area covered under roof measures around 550
machinery installation on foundations, such as a cane cr
by turbines, 30 to 40 ton steam producing boilers, 400
steam turbine for power generation and boiling equipr
capacity was 10 t/sq.m and the water table was at 2.75 t
level. The test pit excavated at the site was inspected.
was as smooth as the plastered face of a wall with mark
on it. It withstood the sun for four days and even after pr
to resemble raining conditions.

Auger piles were tried but IS specification specifies n
3.5 to 4.5 m for double under rimmed piles but because
the auger did not work below 3 m.

From the two articles mentioned at the beginning



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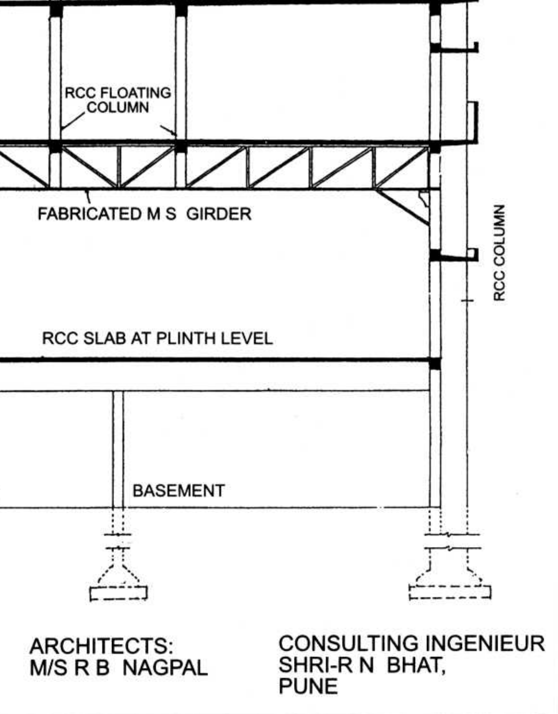
6, AGARKAR BHAVAN, L B SHASTRI MARG, PUNE 30

Figure 3.43 *Multi-storeyed Structure – Details – Computer Aided Design*

		6	.14	6.31	.00	.00	.00	– 18.72
	2	5	– 1.24	13.95	.00	.00	.00	14.34
		6	1.24	13.42	.00	.00	.00	– 12.74
	3	5	– 2.07	11.47	.00	.00	.00	– 7.19
		6	2.07	29.59	.00	.00	.00	– 47.19
2	1	6	. 82	– 6.26	.00	.00	.00	– 18.80
		7	– .82	6.26	.00	.00	.00	– 18.77
	2	6	– 1.23	13.69	.00	.00	.00	13.68
		7	1.23	13.69	.00	.00	.00	– 13.68
	3	6	– .61	11.14	.00	.00	.00	– 7.67
		7	. 61	29.92	.00	.00	.00	– 48.68
3	1	7	2.01	– 6.26	.00	.00	.00	– 18.59
		8	– 2.01	6.26	.00	.00	.00	– 18.95
	2	7	– 1.24	13.42	.00	.00	.00	12.74
		8	1.24	13.95	.00	.00	.00	– 14.34
	3	7	1.16	10.74	.00	.00	.00	– 8.78
		8	– 1.16	30.32	.00	.00	.00	– 49.94
4	1	9	1.25	– 8.59	.00	.00	.00	– 26.03
		10	– 1.25	8.59	.00	.00	.00	– 25.50
	2	9	– .47	14.32	.00	.00	.00	15.44
		10	.47	13.06	.00	.00	.00	– 11.67
	3	9	1.17	8.59	.00	.00	.00	– 15.88
		10	– 1.17	32.47	.00	.00	.00	– 55.75
5	1	10	1.35	– 8.64	.00	.00	.00	– 25.94
		11	– 1.35	8.64	.00	.00	.00	– 25.93
	2	10	– . 94	13.69	.00	.00	.00	13.64
		11	.94	13.69	.00	.00	.00	– 13.64
	3	10	.60	7.56	.00	.00	.00	– 18.44
		11	– .60	33.50	.00	.00	.00	– 59.36

Y S SANE ASS
6, AGARKAR BHA

Figure 3.44 *Multi-storeyed Structure – Details – Computer Aided Design*

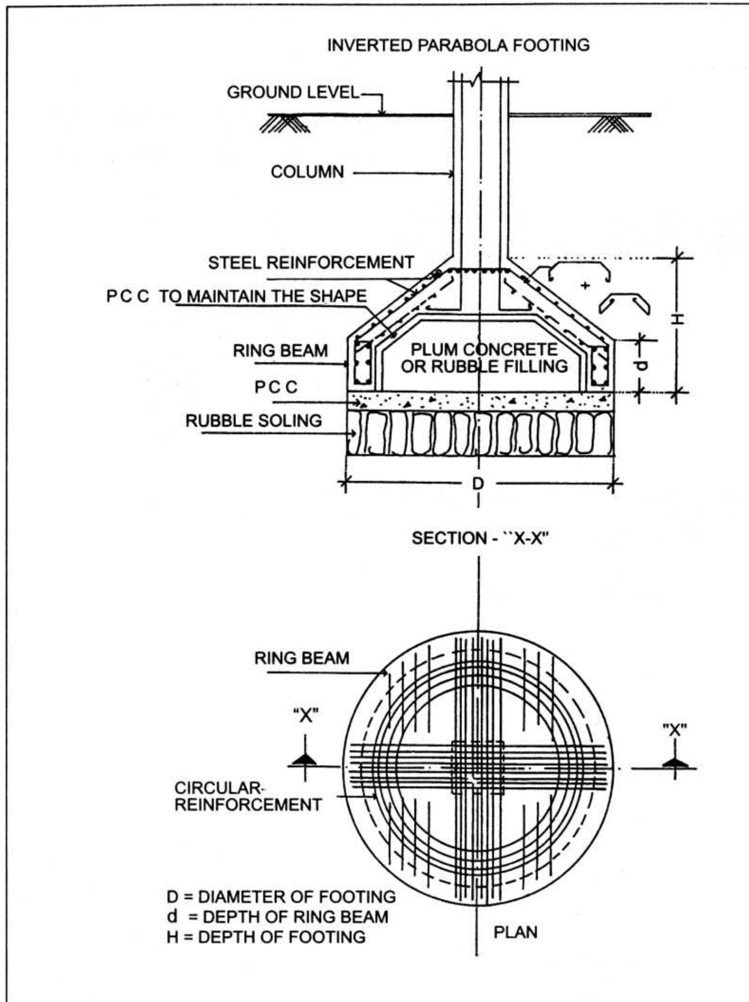


Structural Framing Details – Mahavir Bhavan

om face of column around periphery in the footings as
r stability of structure at the time of earthquakes.
show:
ng indicating soil strata and its behaviour.
de and dome shape by stone and soil to receive 1:3:6
nd workable smooth surface for reinforcement binding
urface for placing of M200 footing concrete.
nding.
l columns to receive external ground level beams for the
th and super structure.
.5

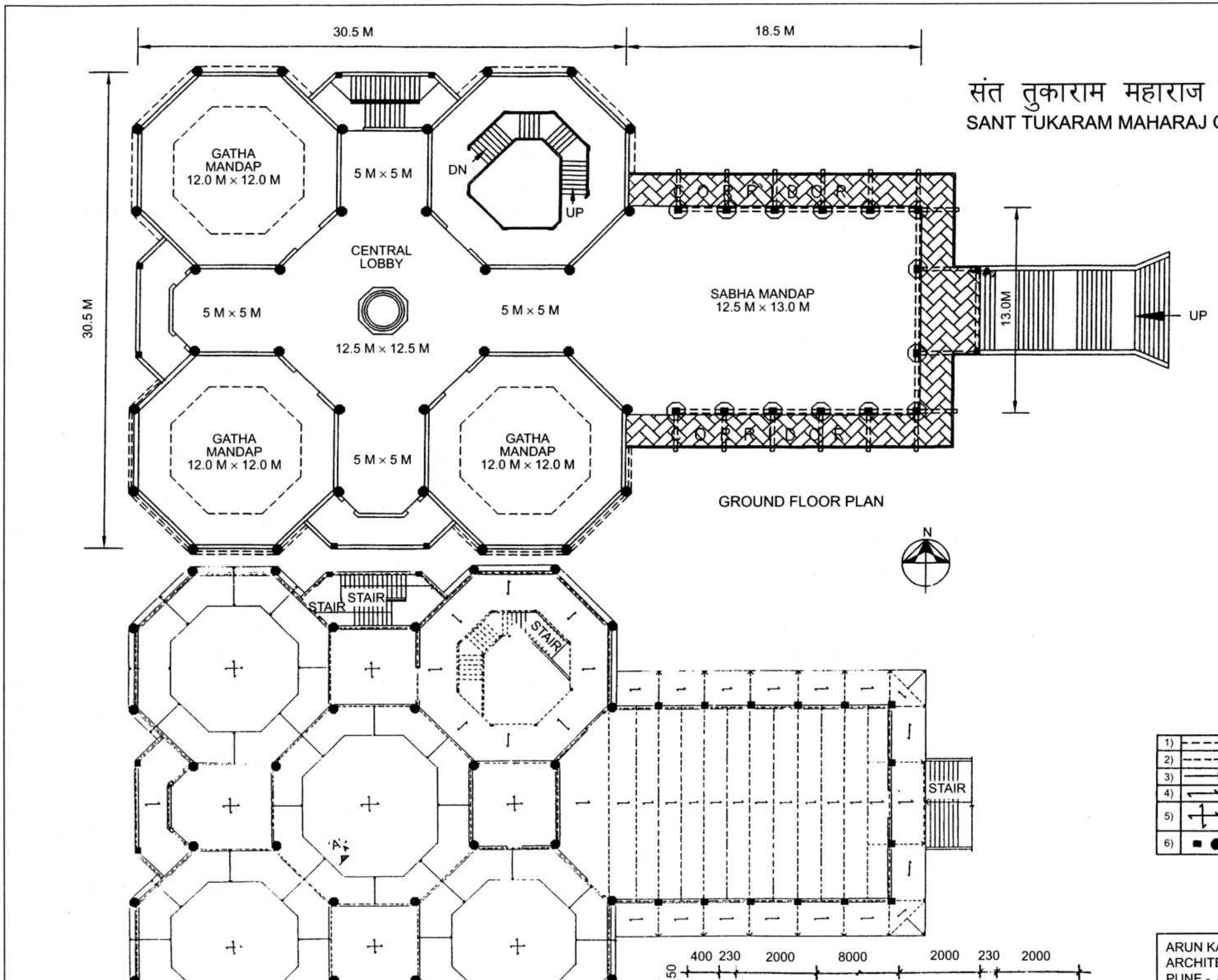
work was completed successfully and economically in the year 1994.

Ref-Note by M
Consultin



...ns with foundation, plinth beams, etc., were already in existence with all ...sary RCC details for reference of what had been done.

plinth level so as to provide the ground floor with five internal space of 12 m circles with octagonal columns a...



span supported the balanced cantilever slab to support a two
tral columns. For outside columns, the beam was designed for
only on the internal side.

and gave a pleasant view of the ceiling.

Ref-Note by R N Bhat
Consulting Ingenieur

Case Study

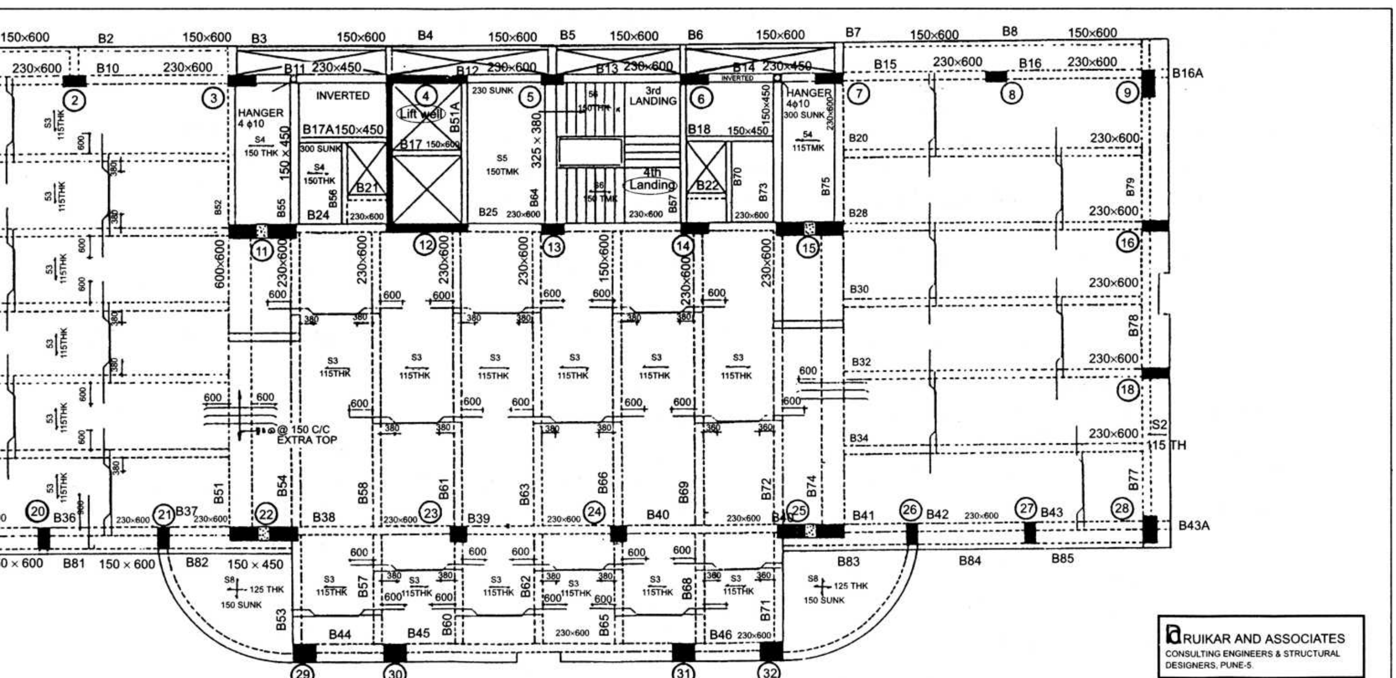
g
Building

Promoters & Builders : Shri Sai Builders
Architects: Pandit Joshi & Associates
RCC Consultants: Ruikar & Associates

opted. In effect, large office areas without columns are obtained.

2. *Structural Design Aspects*: This is a seven storeyed RCC structure des
for commercial loads as per IS specifications. The wind and earthquake
are also considered as per relevant IS codes. Lateral analysis is carried
using-computer software.

   Different load combinations have been considered to arrive at the
design.
3. *Economics*: As far as possible, the same beams and columns have
adopted for all the seven floors. This has resulted in achievement of
quality apart from economy.
4. *Material for construction*: Total RCC work is carried out in M-20
concrete and the structural steel Fe 415.
5. *AC ducting/false ceiling*: Depth of the beam is restricted to 600 mm
by considering margin for A C air condition ducting and false ceiling s
clear head room of 2550 to 2700 mm (8'-6" to 9') is available.



t is the main co-ordinator of project works with different consultants and specialists l stage of their inception to the final stage. Hence, he should be aware of his role ous stages of the project for active participation. Since all consultants, specialists rats cannot be involved in the decision making right from the initial stage, a certain r their work is done on the basis of general experience of the architect. The project r's platform is a common meeting ground for all, to contribute their expertise. Thus, e for the co-ordinator to prepare a performance chart for each consultant which guiding document. In the first phase, consultants and the co-ordinator decide the e project and expected performance requirements, estimated cost and time, so as oval from the owner. In the second phase, a preliminary conceptual planning by t shows the layout, structures, facilities and services related to the project. Now nsultants such as the structural engineer, electrical, air conditioning engineers and rs specialists are asked to contribute to the project through design details. In the third e project, during the construction work, input from various specialists/consultants on a time-to-time basis. Properly trained and experienced supervisors and workers in the field. It is necessary to guide final year students with reference to different areas in their project work, so that they have in depth knowledge of that area. This grounding will help in field work in the future.

Role of the Civil Engineer

neer is connected with the Built Environment in different roles such as:

oter and Builder (refer to Chapter 5)
ural Designer
lation Consultant
ity Surveyor and Estimator
t Manager, Resident Engineer, Site Engineer/Site Supervisor
rator
r
onment Consultant
Proofing—Damp Proofing—Termite Proofing Consultant
bing Services Consultant
ing Services Consultant
afety Consultant
nd Material Testing Consultant
stics and Noise Prevention Consultant
Engineer
rete-Quality Control Consultant
ing Maintenance Engineer and Estate Manager

Structure is a means through which an architect realises the does not make architecture, it makes architecture possible. A the existence of the building, but to reinforce the spatial inte as an active element of architectural expression to provide fr the functional need of many multi-storeyed buildings, indoor s aerodromes, industrial pavilions or for exhibitions such as the need is of space as a flexible medium. An architect mou the demand of the function. The structural designer submits The search for a unique form suitable for such buildings/ str different types of shell roofs. The intended form must expres It cannot exist by itself. The structure through modern techno form. In nature, the form and structure are integrated. This sh

The choice of the structural system must be rational and lo structure must be suitable for the space enclosed and consisten structural behaviour. Hence, it is necessary to differentiate bet elements. New techniques of analysis using computers allow s enabling accurate prediction. But one should remember tha capable of being built as a construction technique. Techniq to fantasy designs. Weathering, corrosion, efficiency, semi-s are some of the important constraints that finally affect prote lifetime. The main criteria by which any structural system sho any design should be directed is speed of construction and r gross built up area.

Structural design is closely connected with environmental requirements for all types of buildings, while others are re building, e.g., air-conditioning, thermal insulation, humidity, of lifts.

So far as the structural design is concerned, these services c four groups:

1. ***Environmental services***: These are necessary to control services such as heating, lighting, mechanical ventilation, etc.

2. ***Supply services***: These are connected with providing physi building users such as provision of hot and cold water, gas, el other communication systems.

3. ***Disposal services***: These are connected with removing v surface water drainage.

4. ***Space for central plant***: Space is required to provide, g mentioned above. Discussions with the architect and ser specialists such as those dealing with refrigeration, air condit etc., are necessary to finalise the location and area for various

ating and steam pipes may impose heavy loads both on the
her points of intentional or accidental restraint. Care is also
ent due to deflection of large span beams or floors affecting

d cladding materials is related to the accepted standard of ther-

oists and conveyor are devices by which material and people
ing. The location, shape and size of the above mentioned units
e structural design.

sm, durable structural material and economical design for
for which coordination is necessary between all concerned.
structural and services drawings is a must to avoid waste of
This is one of the greatest lacuna in big industrial projects even
, where the egos of different departmental units/persons take
on of work.

er, it is necessary to develop good analytical mind and ability
hitectural drawings, models, site visits, study of method of
rk, checking of reinforcement, site laboratory procedure and
uctural designer to work more efficiently. "Why like this?"
the design. Books/codes give general information. Practical
he basis of the demand of the structure and site conditions.
s at test while explaining structural drawings, schedules of
ntechnical persons in simple words. It is useful to write and
tructural engineering is getting new challenges from different
ctural designer should read journals in order to get knowledge
field.

ork, i.e., mould for placing the concrete, and design of false
steel is the work of a structural designer. Economy of the cost
main considerations.

Case Study

g Plans

Sacred Heart Town, Pune;
Laxman Thite
C E Godse

ng Plans for Buildings M, N, O, P, Q, U (Figs. 3.49,

building. It shows various structural members with their numbers, col
beams and type of slab—one way or two way. Structural framing p
prepared with due considerations for economy of cost, with economica
and numbers of members and as per soil investigation report.

4. Structural design includes work of structural framing plan, stru design of members and drawings, schedules for reinforcement. Stru supervision work is essential to check the placement of reinforcement drawings and schedules.
5. Structural detailed drawings are necessary as per elevation, sunk i levels, staircase, etc.
6. Discussion with architect at initial stage and before finalisation is nec to avoid waste of time.
7. All structural drawings and schedules should be self explanatory to avoi of time and wastage of material on site.

Case Study

Name of the Work:	***House Complex, Apoorva Apartments, Parvati, Pu***
Architect:	***Ravi Gadre, Pune***
Structural Designer:	***Kishore P Jain, Pune***

Study carefully different plans for stilt, first, second and third floor pla Apoorva Apartments shown in Figs. 5.10, 5.11 and the photographs.

1. Details shown in
   A. Stilt floor plan for Apartments 1 and 2.
   B. First floor plan for Apartments 3 and 4.
   C. Second floor plan and third floor plan for duplex apartments 5 and 6
2. Study locations of terraces on all floors.
3. Study structural framing plan Fig. 3.51 for fourth slab level, i.e., for the floor plan. Study locations of columns, beams and types of slabs-one wa two way, sections A-A and B-B.
4. Study plan for third floor without details about location of structural me columns and beams. (Fig. 3.51)
5. Compare Figs. 5.10, 5.11 and 3.51 to study location of columns and b and type of slabs.
6. Structural details for open well staircase (Fig. 3.52).

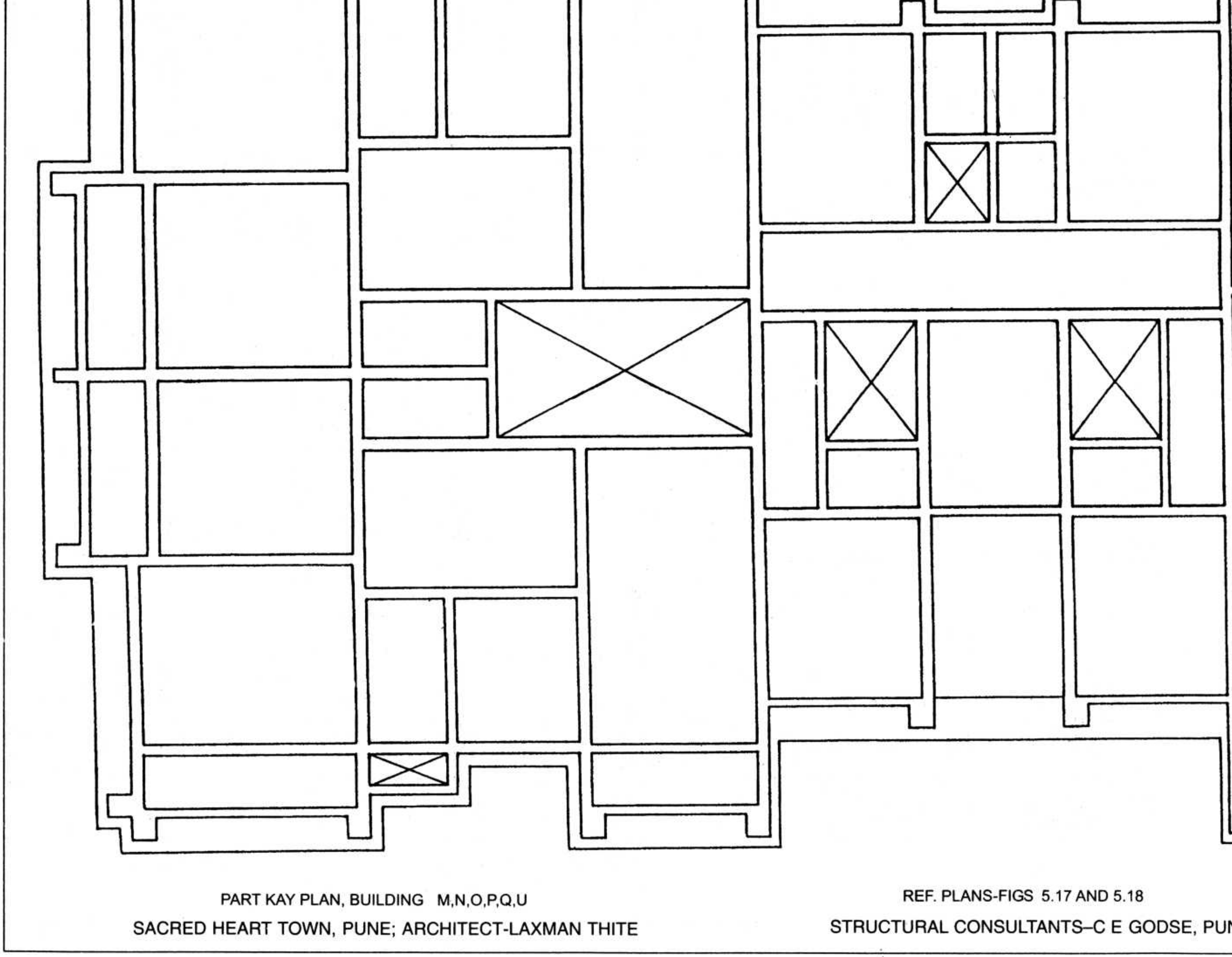


Figure 3.49 *Structural Framing Plan – Sacred Heart Town*

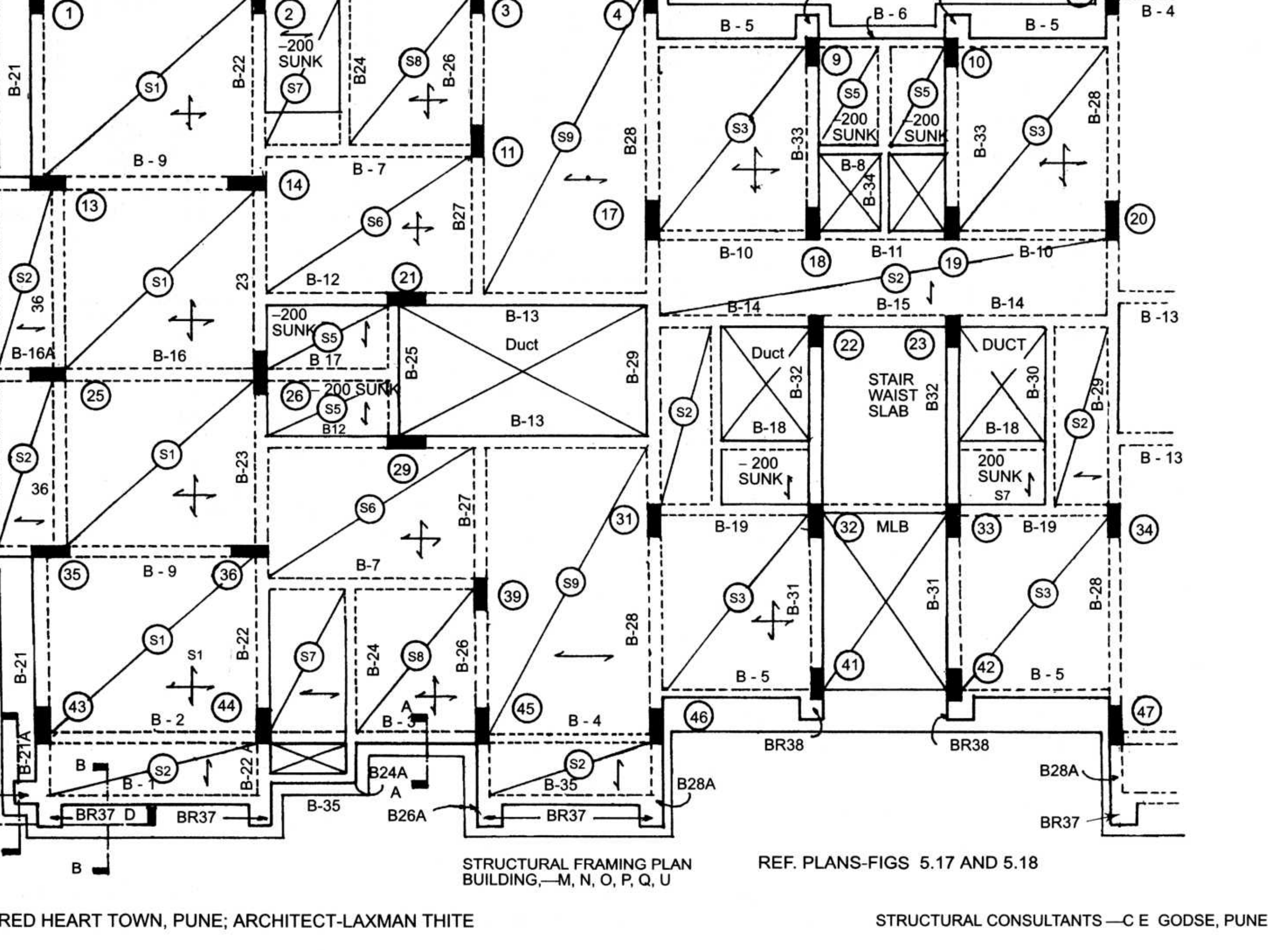


Figure 3.50A *Structural Framing Plan – Sacred Heart Town*

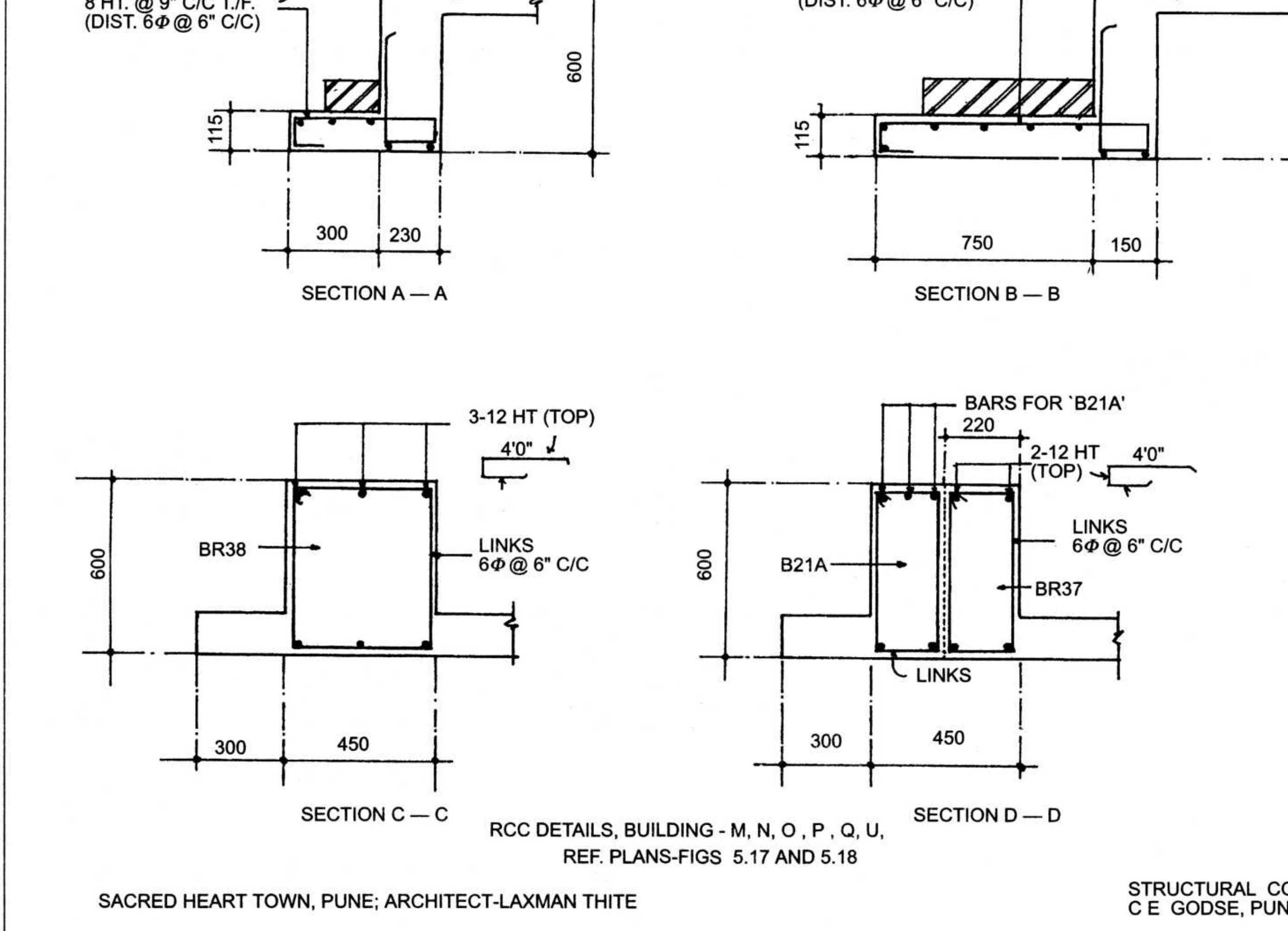


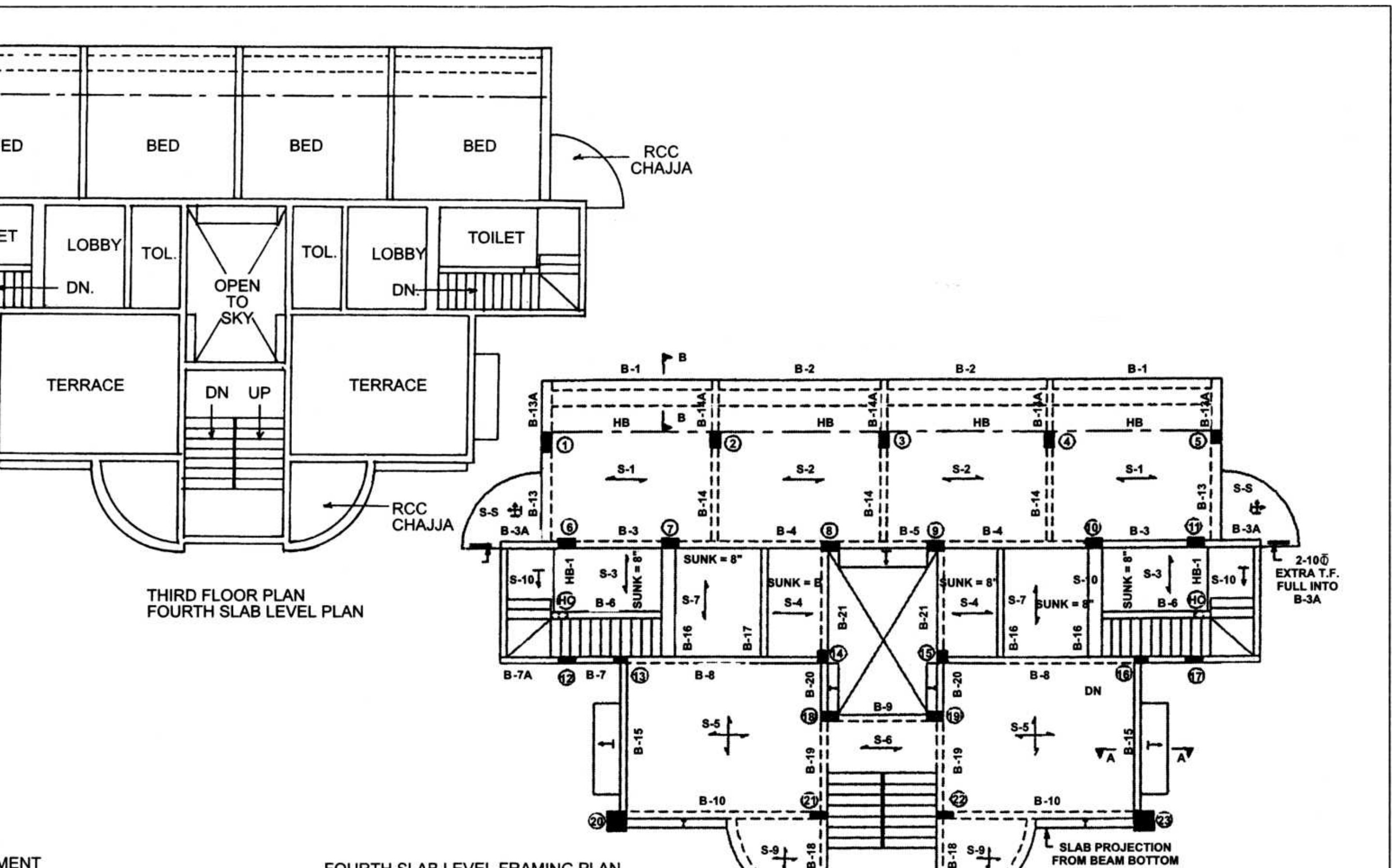
Figure 3.50B *Structural Framing Plan – Sacred Heart Town*

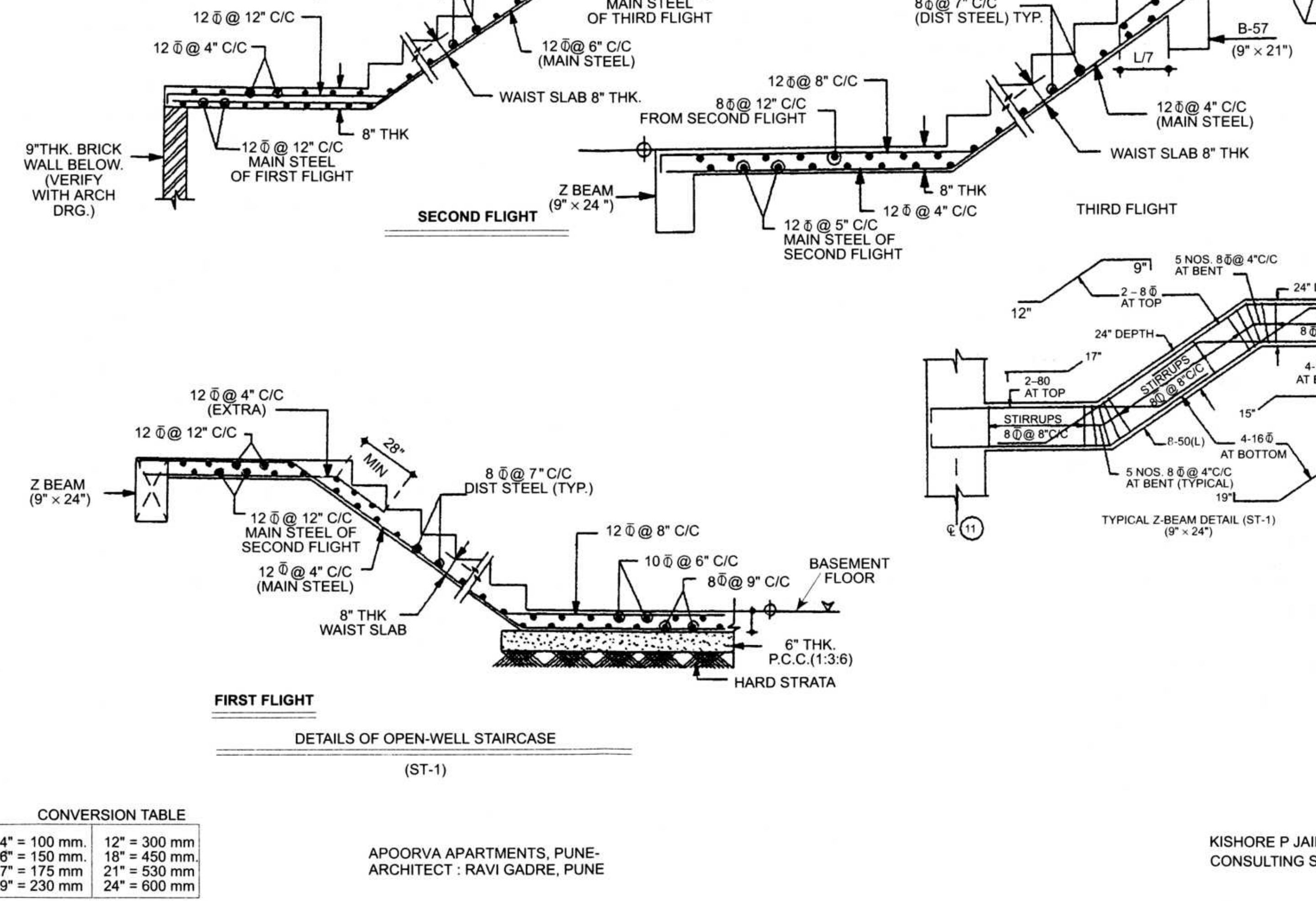
and correct understanding for spanning of slabs is essential for an. Study of different plans for residential and public buildings, gradually improve imagination essential in structural design.

he foundation is an integral part of the structure and except od ground, it is essential to design foundations as per standard are:

A detailed site investigation involving deep bore holes and laboratory testing necessary for heavy structures like multi-storeyed buildings and industrial plants loads. The latter need different types of foundations because of vibrating and machines. There are other sites where it is first essential to know the bearing cap soil and then find a suitable solution taking into consideration the nature of the st purpose of the soil exploration is to collect information for the following purposes:

1. The type and depth of the foundation
2. The bearing capacity of the soil
3. Predicting future settlements





CONVERSION TABLE

4" = 100 mm.	12" = 300 mm
6" = 150 mm.	18" = 450 mm.
7" = 175 mm	21" = 530 mm
9" = 230 mm	24" = 600 mm

Figure 3.52 *Structural Framing Plan – Apoorva Apartments*

amic and Impact Forces Certain industries have vibrating
ines. These require special foundations. They are supposed to
safety and stability, and also to deal with the separate problems
ibrations through the soil. These vibrations should be kept at
detailed information on the machine performance including
d forces, etc., is essential to limit the vibrations and amplitude
e foundation should satisfy the following requirements:
ability for the machine,
e of vibration within the prescribed limit, and

e are various geotechnical processes for improving soil
ermanently. The processes are:

nd
improvement of load bearing capacity.
d to improve the properties of the soil. It may be noted that
ultant becomes necessary here, depending upon the nature of
hould also be noted that such foundation work needs efficient
according to the design and desired safety. If the foundation
tee for the superstructure.
stigation consists of:
ted to the work
es—details

s—details
s
results

n procedure
dations
ations

ations While designing foundations, following points are
plans and details, foundations in problematic soil—reclaimed
andom fill and dumps, black cotton soils, foundation settle-
lculation of settlement of foundation, code, practice, visit to
dation, foundation plans, pile driving process, pile load test,
ost of foundation work, specification and safety precautions.

imator A quantity surveyor and estimator is professionally

1. Preparation of estimates by corelating drawings with specifications, correctin
   ing of items to remove ambiguity at a later stage.
2. Analysing rates with reference to rates of materials, labour, hire charges of m
   the area of the proposed building and scrutinising the rates quoted in tenders
   builders.
3. Value engineering—to guide the architect while preparing appropriate specifi
   able to the soil, climate and functions.
4. Measuring the work done, scrutinising the running and final bills.
5. Analysing the actual costs with estimated costs, material requirements and fin
   ing data which will be a guideline for similar types of buildings.

Estimate for the work to be executed is prepared with the help of detailed draw
details, specifications for various items, materials, and finishings. It is skill and pr
which gives approximately correct estimates without the necessity of inclusion of
during the construction work. The estimator bases his estimate on the existing m
and estimated future variation. An experienced contractor is well aware of the d
estimate and chances for extra items at a later stage. It is always wise to correlate
thoroughly the drawings, items, and specifications at this stage to avoid disputes at a
This emphasises the need for correct drawings.

Computer for estimation Construction estimation is a complex task, involvin
complicated calculations for materials and a constant race against deadlines. Quali
are now available for creating accurate estimates expeditiously, and analysing proje
schedules in textual and graphical formats. Efforts should be made for setting u
database of information on all resources like labour, material, equipment, crew and
Take-off quantities involve taking measurements off the contract drawings and
calculations to determine the quantities. (Refer Chapter 6 - Softwares for estimate

Cost planning techniques Quantity surveyor's work in cost planning involves th
steps:

1. Preliminary estimates based on floor area, market conditions, size, number
   specification level, services, site and foundation conditions, etc.
2. Cost planning of the scheme at the development stage—shape, height, optim
   area of the building.
3. Cost planning at the production design stage—cost checks on the working
   post contract cost control, control of cash flow and time limit for completion
4. Cost modelling techniques—optimisation information technology and cost p
5. Project management systems—comparison between manual and computer s

A quantity surveyor's services are useful for contracting companies. Appoi
professional quantity surveyor could effect cost saving to the client/ contractor fa
contractor's expenses on the quantity surveyor.

Project Manager, Resident Engineer, Site Engineer, Site Superv
Construction Team

Construction is defined as engineering in action and for this, one should realise er/owner to control total construction programmes, as per the planning and design tect and other appointed consultants. His main job is to report progress of work, etc., to the architect so as to give instructions to the project manager, i.e., the representative. The resident engineer with his skill, knowledge and experience helps taking quick decisions to avoid delay and mistakes, in making prompt payments st of work. Joint inspection with the project manager will help in maintaining the nstruction with quality.

ager The project manager is supposed to be the contractor's key person in site . His role mainly consists of directing and controlling the construction work on hires machinery and equipment, purchases materials and employs sub-contractors. dered as the main person who makes profit for the contractor through satisfactory as per the conditions in the tender. A project manager should be aware of the ings:

ples of site management.

ct control through site meetings.

ffice control through accounts, clerks, messengers, drivers, watchmen, storekeepers, ashier.

ct-contract close out-handing over of the completed building, shifting of excess ials, documents to be preserved, and final accounts.

er Site engineer is a key person in the construction team. Following are some of s of a site engineer:

ntrol progress.

g and approval of materials.

ration of reports regarding daily and weekly progress of work and monthly s.

ration, checking and payment of bills.

and weekly meetings for continuous interactions, and feedback to facilitate the tion of work in a planned and efficient manner.

eck and report work done as per the (i) construction schedule, (ii) material schedule, quipment use schedule, and (iv) labour schedule.

clearing of the site and winding of the operation.

sor A site supervisor, building supervisor, or site inspector is a person appointed tractor, and given the authority and responsibility to supervise the work of a ople by close contact. He works under the site engineer. His main work includes on with the construction team, familiarisation with the work site—safety measures, e equipment and supervision of the construction work—quality control, site records, dure, etc.

visor should develop skills related to the following:

nunication in different languages.

n operating and checking construction equipments—finding faults and for simple s in pumps, vibrators, electrical equipment, concrete mixers, vehicles, etc.

approached in the initial stages. The court may then set aside t arbitrator, a sanction of law.

An arbitration agreement implies a written agreement to s opposing parties under dispute to arbitration and as such to a therein or not.

If this agreement is to be legally valid, the basic requisites

1. The agreement must be in writing signed by all parties i
2. References to differences must be clear and explicit.
3. There may be present or future differences.
4. Name of an arbitrator is not essential in this agreement.

An arbitrator is different from a valuer. In the valuation pro the parties, at least not initially. Valuation is an art of fixing for a specific purpose. The two parties, e.g., a seller and a this valuation. However, when both parties do agree and ente purchase of the property, and then try to settle the terms or m starts. In such a case, after the rise of the dispute and conc they may agree to refer the matter to an arbitrator, since both seriously and sincerely desirous of concluding the agreement

An arbitrator is also different from an engineer or an a constructional field include a condition that the decision of the final, binding and conclusive. This clause amounts to an arbitra go in for arbitration that can only be regarding disputes. When a more definite and concrete form, they become disputes. Wh tion would be preferable to avoid the delay, trouble and expens resolved through regular courts. Arbitration is the most effici common sense substitute to an action in a court of law whe to both parties. Hence, in any contract, an arbitration claus reference to arbitration on all matters, questions, disputes, d out of and/or concerning/relating to the contract. The referenc requires assent from both sides under dispute. This should cle to avoid ambiguity or misinterpretation of matters under the a

An arbitrator is competent to decide questions of both law a him. The court does not enter into the merits of dispute of reaso is a bonafide mistake which, as such, does not appear on the is a domestic tribunal appointed by the parties under dispute i Hence, his decisions, right or wrong, are binding on the said pa misconduct of the arbitrator or of the arbitration proceedings.

Arbitration is a simple and efficient tool for resolving d contract for construction of works, supply of materials, etc. It forms of construction contract as an alternative to court proce

Disputes arise when there are breaches of conditions of c s on the period, circumstances, time, requirement, etc., from

founded in 1968 to bring valuers under one banner to enable
t code of conduct.

hitect may choose this profession related to the valuation of

e., fellowship and associateship of the institution is awarded
o meet stringent qualifying requirements or to those who have
ion in valuation conducted by the institution.

rnals/literature, codes/laws, (ii) various practices followed for
to know site conditions and details of work with physical check
n of value, is a must to become an expert valuer. Professional
ied projects and knowledge of current and past facts are much

fundamental duty is to determine the market value of a property
, structures and also machinery in case of factories. He must
f the principles of the subject, good experience, quality/habit
t of mind and above all commonsense with the knowledge of
or properties concerned.

must possess a good and critical knowledge of the following
:

nt
ones and tenures
partment especially of *talathis* and *tehsildars.*

authorities

k in all its aspects including water supply, drainage, electricity

taxation details

l failures

Following are the general purposes of valuation for which a valuer's opinion is

1. Purchase of the property either for occupation, or pure investment
2. Sale and mortgage
3. Fixation of rent as per importance of the area under consideration
4. Land purchase or land acquisition
5. Auction and betterment charges
6. Speculation and probate
7. Insurance and income tax
8. Wealth tax and capital gains tax
9. Estate duty
10. Partition of property
11. Gift tax
12. Determination of value for court fee stamp
13. Public property such as a cinema, theatre, marriage hall, etc. An architect als valuer.

Environment Consultant The subject of Built Environment is important wi to energy saving and efficiency improving designs. It is related to building scienc ing physics or in other words, to the livability of a building. The effect of the clin is a factor of considerable importance. Our daily life cycle comprises of the states fatigue and recovery. It is essential that the mind and body recover, through recreat sleep, from the mental and physical fatigue resulting from the activities of the day. question is of comfort, i.e., acceptable internal comfort conditions. The factors to the designer include climatology or external environment. He also deals with the bu consisting of walls with openings for doors and windows as well as the fabric of t the constructional barrier between the external environment and comfortable int tions. It is not feasible to regulate outdoor conditions or the external environment task of the designer is to create the best possible indoor climate and optimum total c latter may be defined as the sensation of complete physical and mental well-being.

Human thermal comfort is the main problem in tropical climates. It is related no air temperature but also to other factors such as humidity, radiation and air moveme responsible for thermal effects. Hence, environmental science deals with the follow

1. Heating, ventilation and air conditioning.
2. Lighting—natural and artificial lighting for all types of structures.
3. Noise and acoustics, sound insulation for machine vibrations and external no
4. Moisture—waterproofing, damp proofing, humidity and refrigeration.
5. Electricity and power supply.
6. Water supply.

The basic human needs are of air, warmth and light. There are other factors relate such as noise, glare, dirt, space and privacy. The final environment depends upon th features:

1. Position of the building with reference to the north, i.e., orientation, as

tant consideration to optimise the situation.
d insulation of the construction due to the materials used in construction.
stic qualities of the interior.
sion of additional electric and power points to provide flexibility in using electric ment.
sion of alternate electric supply in case of power failure, such as generators.
well and pump for additional water supply.

se factors are interdependent. More window area will provide more breeze but noise rusion and undesired heat gain in summer will be the negative aspect. Designing h reference to meteorological data, acceptable comfort factors with reference to nentioned above, orientation and physical layout along with landscaping to effect ng and improving efficiency. The environment consultant is supposed to study all with reference to the function of the building, site and surroundings, climatic data ultation with the architect, landscape architect and other specialists or consultants to mum environmental decisions that require an overall integrated approach.

ofing, Damp-proofing and Termite Proofing Consultant

giving aesthetical pleasure and a healthy environment inside and outside the building the life of the building is the real expectation of the clients. Factors responsible for e initially the quality of planning and construction and later on the maintenance dically and sometimes specially. The constant attack of the natural elements, like, d wind will finally test the quality of construction. Quality of workmanship is thus t factor.

ing Quick changes in the temperature increases chance of thermal cracks in the of the RCC slab. Hence, precautions in planning, designing and construction with ng techniques are essential to stop the problem of leakages. Inspection of the terrace and after the monsoons and of floor slab of the toilet block is essential.

ons for leakages are mainly climatic variations and defects in planning and design of Materials for concrete, water, cement ratio, grade of concrete, mixing, transportation, nsolidation, use of vibrators, curing, honey combing, leakages through the form are some reasons for the development of cracks.

ve measures can be taken in two stages:

nstruction Stage

ding proper slope to the roof slab.

n of rain water pipes for quick disposal of rain water. Number of pipes and loca- one pipe for 10 to 12 m^2 area, minimum diametre 100 mm, spacing between two 6000 mm. Method of fixing of rain water spouts for terrace slab, division of total rea by ridge lines with reference to the location of the rain water pipe.

fications for concrete work, location of weak spots after concreting, grouting of points, connection of the terrace slab and parapet wall, lowering of slabs of toilet s.

g of concealed water supply pipes

locating spots of leakages, locations of rain water spots, scr treatment, grouting of cracks/epoxy/ injection and film type tr

Damp-proofing Dampness is the presence of hygroscopic or the life of building and creates unhygienic conditions. It inclu of moisture in the building.

Damp-proofing includes the following:

1. Study of causes of dampness
2. Effects of dampness
3. Methods of damp-proofing
4. Materials for damp-proofing
5. Damp proofing treatment for the foundation, basement,

Termite proofing Termite is the common name of a group of live in communities. Termites digest wood, paper and other ma the aid of protozoa present in their bodies. Pests like cockroach are carriers of diseases. Hence, it is essential to protect buildi the help of various pesticides.

It is necessary to carry out pre-construction treatment, and this purpose which includes the following procedures:

1. Protection of the site by insecticide solution.
2. Soil treatment to provide a barrier between the ground a
3. Protection at the plinth level by providing continuous entry of termites through walls.
4. Soil poisoning systems along the entire perimeter of the through holes made about 600 mm apart.
5. Periodical inspection of the building and surrounding ar termites.
6. Study of different chemicals to control bugs, cockroach
7. Preparation of an estimate for pest control work.

Plumbing Services Consultant In any building, the supply system and a beginning of the sewerage or drainage sy services. Plumbing services give life to the builiding. Hence, installed and adequately maintained plumbing system is a mu

Preparation of layout plans for the water supply system plot area, number of buildings, layout of buildings and inter water supply and drainage line, roads around the plot, depth line below road level or invert level, plinth levels of differe connection, meter box, ground water storage tank, pump hous

The layout of the drainage system consists of location of man holes, intercepting traps, etc. Design of drainage pipe li to chambers, design of diameter, material, flow direction

...ially essential to achieve comfortable, efficient and economical
...ue engineering is a science that saves money. Value engineering
... analysis, lateral thinking and generation of innovative and
...nance. It also affects savings in cost of material and labour with
...nd evolution of fresh ideas which are productive. Knowledge
...logy is also required.

...es occupy space. They are connected to the construction. They
...lls for pipes, need provision of ducts for water and drainage
...d support and leakages may harm walls and floors.

...c buildings are getting bigger and much more complex. They
...ning and different services.

...es and Specifications Plumbing services includes plan-
...nstallation of water supply, drainage and sanitation and gas

...nning, design and installation of electrical installations, air
...nstallation of lifts and escalators. Additional services include
...vices, communication services—telephone, telex, fax, E-mail,
...nd lighting conductors.

...r lighting analysis, thermal analysis, sunlight analysis, air
...tical analysis. Energy saving architectural design is possible
...er.

...done as per plumbing rules of the plan sanctioning authority
...d book-SP: 35 (S and T) 1987 and water requirements for fire
...s of water, rate of supply in litres per head per day, diameter
...d storage to overhead storage tank and from overhead storage
...onsiderations involved.

...f drainage system includes: Design of pipes, traps, as per one
...phonage pipe, septic tank, connection of drainage system to

...ainage line is essential to check if there are any leakage

...be designed with reference to:

...for proper performance, diameter of pipe, minimum length of
..., etc.

... between the water line and drainage line.

... system with no danger of siphonage or forcing of water seal
...y use.

...ls, protection of concealed pipes of hot and cold water.

...er—design of system, storage and connections to different

Specifications for trouble free maintenance, safety for building services and sp...
for water supply pumps, pipes, leakage free connections, safety valves, etc., are...
considerations for plumbing services. Use of new materials and machinery as w...
economical design needs co-ordination with the architect, structural designer, servic...
and plan sanctioning authority. It is essential to achieve coordination right from...
planning stage to a certain period before the completion of work.

Building Services Consultant The planning, design, construction and in...
electrical power systems, air conditioning and heating facilities is included under...
building services. It is designed and carried out in accordance with Part III Buildin...
(Section 2), Electrical Installations (Section 3), with air conditioning and heatin...
National Building Code of India. The planning design including the number of li...
lifts (passenger and services), capacity of lifts depending upon the occupancy of bu...
is taken as per Section 5, Installation of lifts and escalators of the National Build...
India.

Air conditioning consultant Today, air conditioning has acquired great impo...
conditioning at homes, restaurants, hotels, libraries, cinemas, theatres, hospitals, ...
buildings, offices, etc., has become very common. It is now an essential service. If...
of an extensive nature such as the air conditioning of the entire building, a specia...
already done similar work in other buildings, will be very useful. He will be abl...
guidance during the planning stage as to the space required for air conditioning...
location of ducts and the costs involved, taking into consideration the function of t...
For a civil engineer as well as a builder/structural designer, it is necessary to know...
basic units and arrangements in the air conditioning plant and process so that in the...
design, proper care is taken for their provision. Then it becomes easy to co-...
construction work along with the layout or provision of machinery, ducts and pipes...

The owner should be well aware that air conditioning systems are expensive a...
a large amount of power. It is also not eco-friendly. Hence, the aim should be of...
conditioning. The factors to be considered while selecting equipments for air cond...
(i) safety against fire, (ii) operating cost and efficiency, (iii) space for machinery, (i...
condensation, (vi) system design, and (vii) design of ducts.

Air conditioning is the process by which control within an enclosure or area...
over certain or various parameters such as (i) to maintain relative or absolute humi...
(ii) to maintain a temperature of +21°C to 24°C ± 3°C, (iii) particulate contam...
gaseous contamination, (v) odours, and (vi) air movement and distribution.

Cooling is generally achieved by mechanical refrigeration. Any other means...
humidification, dehumidification by desiccates, evaporative cooling, heating, heat...
recovery etc., is also used individually, or a combination of the above in parts can a...
air conditioning.

Various points to be considerd by an architect, structural designer and site eng...
planning, designing and construction are:

1. Provision of required space, its location, both on the floor or occupied areas a...

ble design for foundations for machines so as to avoid transmission of vibration to ural members.

sion of access to equipment, ducts and false ceiling for maintenance.

m to provide adequate fresh air so as to avoid sick building syndromes.

of the process and product, wall and floor finishes and the roof structure.

interaction with the air conditioning consultant, electrical engineer and architect is ial during all stages of planning and construction. Finalising specifications for fin- treatment of outdoor spaces, and energy conservation methods in close consultation other specialists will achieve satisfactory results with minimum maintenance cost.

onsultant for Electrical installations Planning and design of electrical installations and for different types of machinery need the services of the electrical engineer/ engineer.

rical system is broadly classified in two categories: (i) Low Tension, i.e., LT and (ii) n, i.e., HT for voltages above 440 V. A consumer whose power requirement is more is considered as HT. The total work in electrical installation includes:

ection from the supply point, overhead or underground line.

sion for transformers to reduce the voltage as per necessity and distribution through phase system.

load is calculated taking into consideration present and future requirements.

hting Points	Max. 100 W
Point	60 W
haust Fan Point	60 W
Socket	50 W
A Socket	Avg. 500 W
yser Load	1.5 kW to 3 kW
Conditioner	1.5 kW/ton
t	5 kW
ter Pumps	5 kW

of electrical system, equipments and the whole process from planning to completion services of an experienced electrical engineer.

rical engineer should be involved in the project right from the conceptual stage to completion.

ed type of wiring requires finalisation of all planning details at an early stage of PVC pipes are used in the slab, it is recommended to have pipes with at least 2 ss, i.e., of heavy duty pipe; pipes in the wall may be of 1.5 mm thickness. Casing cept is becoming popular due to its reasonable cost, acceptable aesthetic looks and f installation. In selection of wires, switches, safety devices, cables, street lighting ., the advise of an experienced electrical engineer is required.

or industries Planning, designing and construction of industries requires an pproach and also the services of a mechanical/electrical engineer.

suitable from the administration point are also important cons of the total plot area.

The requirement of the length and location of electrical ca finalised with reference to the total requirement as per locati shops. Location of transformers, and/or separate generators fo electrical distribution system for easy maintenance and safety in shops, cables are provided in ducts kept below the floor so a to individual machines. This needs a floor plan showing an machines, their foundation blocks and supply lines for electric

In short, consultations with mechanical and electrical eng should be held and their requirements regarding the foundatio at an early stage. Light, ventilation, fire safety, movement of l outside the shops, type of floor finish and wear and tear are oth final and an integrated plan of individual units. Landscaping is roads with trees and greenery to create a cheerful environmen architecture after the second world war has shown concern fo The number of workers may vary from a few people to thous for shops or for process plants along with a separate buildin upon the extent of the project.

Fire Safety Consultant Shortage of space is one of th of population in a small area. An outbreak of fire in any bui may cause loss of lives and property. Domestic electric appl synthetic, decorative and plumbing materials are also respons plan sanctioning authority insists on safety of occupants again permission rules, along with Indian Standard Specifications fo as per IS: 2217-1963; fire fighting appliances in accordance w Building Code of India-Part IV Fire Protection. Care should be orientation of buildings in accordance with the above mention

A building cannot be made fireproof as there is no existing fireproof. The building can only be made fire resistant withi materials that are fairly resistant to fire. The need is for control certain practices so that occupants have sufficient time to esca

A fire protection consultant suggests and also insists on prevention, (ii) fire detection, and (iii) fire fighting. The details of the building and also the area and height of the building.

1. ***Fire protection***: This involves identification of suitable fire fire appliance and vehicles around the building. Site planning The city area is demarcated into district zones based on fire h structures according to occupancy. Provision is made for a m with a proper balcony approach, corridors, a properly ventila for fire escape, steel frames and steel shutters for doors, fire

a satisfactory supply of water which is accessible to the fire
. Automatic sprinklers should be installed in basements used
500 sq. m, in departmental stores or shops covering an area of
owns/warehouses and also in theatres, dressing rooms, stage,
rating system is used for protection of the boiler room, carbon
as per IS: 6382-1971. In addition to the above, it is necessary
g, and if necessary, even evacuation from the building in the

y of the building, it is highly essential to bring together all the
to study, specify and provide essential provisions as per the
he codes of respective countries and recommendations of the

ings which are more than 15 m in height and special buildings
and industrial, for storage of hazardous ingredients as well as
area more than 150 sq. m. are supposed to cover additional
n. The information has to be indicated in the plan for the
occupants. The information details required are as under:

ehicles with details of the vehicular turning circle and a clear
nd the building up to 6 m in width.

in and the alternate staircases along with a balcony approach,
bby approach.

enclosures.

ts.

herever provided.

nber, service ducts, etc.

s—Air conditioning system with position of fire dampers, me-
, electrical services, boilers, gas pipes, etc.

transformer and the switchgear room.

f any.

stem network.

ntrol connecting all fire alarm systems, built in fire protecting
ss systems, etc.

f the static water storage tank and pump room along with fire
umps and the water storage tank.

e protection installations such as sprinklers, wet risers, hose
oxide installations, etc.

t aid and fire fighting equipment installations.

viding essential fire safety measures includes the following

ferent materials. It is necessary to know their specifications, properties, sampling
procedure so as to accept the material. These details are useful for comparison of m
is available in the market. It is necessary to test such samples. The need is for soil
material testing laboratory and the services of soil and material testing consultants
who is authorised for such certification.

Soil testing The stability and design of the building depends on the strata on wh
It is essential to know the strata pattern. Different kinds of soil generally found a
cotton soil, (ii) red soil, (iii) silt, sand and gravel, (iv) shadu, (v) soft murum, (vi) h
(vii) soft rock, and (viii) hard rock.

It is essential to know the bearing capacity of different kinds of soil. Static pen
method is used for soil and clay, and plate bearing test for murum and rock, etc. It
to know different properties of soils, their colour, clay content, etc.

Site engineers should know the procedures and necessity of the following tests

1. Proctor compression test
2. Moisture content determination test
3. Consolidation test
4. Liquid limit test
5. Shear test
6. Shear box test
7. Triaxial compression test
8. Unconfined compression test
9. Penetration test

Important test results and certificates are shown to the structural designer.

Properties of materials It is necessary to test materials in order to ascertain their p
mechanical properties.

Various physical properties are specific gravity, density, bulk density or unit weig
water absorption, hygroscopicity, permeability, fire resistance, thermal properties, he
thermal resistivity and sound transmission. Sound absorption and sound insulatio
resistance, durability and soundness are other properties.

Mechanical properties are elasticity, plasticity, toughness, resilience, hardness,
ductility, fatigue, creep, abrasive resistance, impact strength and tensile, compressiv
strength. Mechanical properties of a particular material help us in analysing it
quality.

A representative sample is selected for carrying out different tests.

The Bureau of Indian standards lays down specifications for sampling, testing a
conditions for tests like temperature, rate of loading, moisture content, etc.

Acoustics and Noise Prevention Consultant

"*You may forget noise but your body, never*". **Dr Samuel Rosen**

Acoustics is the science of sound. Its consists of different branches like architectur
electro-acoustics, physiological acoustics, musical acoustics, ultrasonics, etc. It

ay lines, bus stops, vegetable markets, mangal karyalayas (Wedding Halls) etc.
erence while giving a lecture or a musical performance is annoying.
se can distract one from one's task. It may lead to inefficiency, lack of attention and
rability at high decibel level.
ernal noise is to be reduced, measures have to be adopted. A noisy environment may
loss of business.

n the design of houses, halls, auditoria, theatres, cinema houses, libraries, etc., the signer has a very important role. He considers and takes into account the need of the the type of environment, frequency structure of the noise, duration and consequent equired in external noise levels or proposed improvement in internal sound levels. ntrol of sound in an enclosed space is his job. His general aim is to provide the best or production as well as reception of desirable, comfortable and effective sound or usion of unwanted and undesirable noise is an important aspect of acoustics.

requirement of acoustics are as below:
equate level of sound evenly distributed in the auditorium or hall.
able reverberation time (decay of sound) appropriate to the enclosed space and its on.
ction of background and external noise.
nce of echoes and other similar acoustic defects.

esign of an auditorium or a big gathering place such as a church or a temple, the s are:
and intelligible sound and its quality reception.
reception of musical performance covering fullness of tone, definition, blend and ce of sounds. Such a receptive auditorium is called a concert hall, opera house or a ding studio. In India, it is also known as a *natya griha* or *rang mandir*.
lti-purpose auditorium has to be designed for more than one purpose and a correct romise has to be made in its designing, e.g., church, town hall, school hall, college nd other such multi-purpose halls including marriage halls and *mangal karyalayas*.
nt materials are used for the walls and roof to reduce the sound energy reflected rface and to absorb the same. Sometimes a false ceiling is provided. The perfect given an absorption coefficient of 1.0, e.g., an open window.
on of a surface = Area of surface (m) x absorption co-efficient of that surface. The rption is SABIN.
ngth of sound is measured in DECIBELS. A decibel ratio is always made with the standard value for the threshold of hearing. It is a logarithmic ratio of two atio of the proposed or existing quantity to a standard quantity.
ecibel) is the smallest change that the human ear can detect. A lOdB (decibels) decrease makes a sound approximately twice as loud or as half loud. An aircraft ake-off has a sound level of 130 dB, while normal conversation is between 50 and shold of hearing is 0 dB corresponding to sound pressure of 0.00002 Pa Pascal (Pa) t of pressure.

distribution of sound with the help of electrical energy. Re- done with the help of various electronic equipments like am loudspeakers, etc. Co-ordination is essential between the acou consultant at the planning stage.

Decisions are related to (i) seating capacity of the hall, parameters and noise control, (iv) acoustics treatment design- height, slope of the sitting area, type of chairs, (v) sound rein piping, (vii) location and planning of AC plant, AHU rooms, and vibrations.

Tests and trials essential for necessary adjustments if any, audience.

Safety Engineering The essence of any construction cident of any sort during its construction. Accidents not onl considerably to the cost of construction, cause delay in the co and equipment and create disputes. The aim of the safety prog accident reduction. Thus, it is essential to study and follow s prescribed by the National Building Code for Construction.

The following considerations are to be given importance:

1. Planning, designing and construction of work is do constructional, structural, fire and health safety.
2. The total responsibility for construction is to be taken designer and contractor. Assurance of the good quality and their certification is an essential part of their work.
3. Workmen's Compensation Act, 1923, Payment of Wage regulations, etc., is to be studied and followed.
4. Preparation of check list helps in keeping control over t
5. Design of form-work needs several considerations wi unequal settlement of supports, level and plumb, cross while concreting and removal of form work.
6. Safety programmes are essential during operations such and blasting, electrical installations and lifts, and demol
7. Safety programme is essential for workers and supervi bridges.
8. Study of cases for accidents helps in taking precautions
9. Training of supervisors and site engineers is essential fo treatment.

Concrete-Quality Control Consultant The main a guarantee assurance. For achieving high strengths in cement designed with reference to the available material. Concrete having specified crushing strength at 28 days as measured in s

lls, weathering, corrosion and chemical action due to pollutions,
, behaviour of the user, bad housekeeping, termites and rodents
rioration of a building. Visual signs of such deterioration are
ials, surfaces attacked by air and water borne chemicals and
ening of fixtures, discoloration of surfaces, leakages of water
oilet floors. Stuffy nose, dry throat, lethargy, chest tightness,
kin, headache, loss of concentration are some of the symptoms
some building occupants but cannot be clinically diagnosed
ly treated. Work related to this is done by the World Health
d that the above symptoms are said to disappear soon after
fective building. It is essential to check the temperature and
ons for regulation of fresh air, routine servicing of HVAC and
g.

luce maintenance, selection of materials, fixtures, study of
services, and preparation of maintenance programme with

ection report.

amera to record evidence, corrosion of M S bar.

on and post-monsoon periods.

fing, termite proofing schedules.

ween and around buildings—hard landscape, walls and fences,
inth protection work, soft landscape, trees, shrubs, lawns—
tering.

storic buildings.

e.

il engineers is related to building maintenance. Tremendous
housing, construction of ownership flats/apartments, etc. The
face is regarding the maintenance of buildings. Construction
r quality of materials, inferior type of concrete work and lack
easons for bad quality and workmanship. This will definitely
and builders sincerely decide to give better returns to the flat
strict quality control and realising the importance of each and
the integrated constructional requirements.

nobody is an overall personal owner. They are tenant owners.
concerned is essential which requires a basic mental set-up
together. Daily, monthly, and yearly maintenance is needed to
eakage in taps causes waste of water, encourages water leakage
es cost of pumping of water and reduces life of pumps. Pumps

throughout its life.

Geopathic Stress Consultant Geopathic Stress is the name given to the har
of natural radiations that emanate from the interior and surface of the earth.

Research in this field indicates that being exposed to geopathic stress for exte
of time can weaken one's immune system and increase the risk of disease. Certai
features underground are said to be responsible for these stresses. The archia
planning for residence considered this aspect carefully and the guidelines to allow
on a particular location were followed scruplously. The ancients carried out various
and studied the growth pattern of trees and animals on the proposed location to arri
conclusion, about the suitability of the place.

Study of geological and archeological parameters, human sciences and huma
essential for further study.

Case Study

New Professional Approach for the Maintenance of Buildings by Amar Builders, Pune

One time maintenance deposit

It has been observed that it is easy to construct a building, apartment or pre
but to maintain the same is very difficult. In most societies, members wh
initiative to work do not get the proper co-operation from all other members.
avoid all these hassles, it has been a policy of Amar Builders to help the me
with all the information and guidance for smooth functioning of the society
time maintenance deposit is one of the policies adopted by them for all
projects.

Whenever a project is completed, the main problem faced by most
societies is fund collection. Our answer to this problem is one time mainte
deposit. This deposit is collected from all members at the time of possessio
deposit may vary according to the size of flats and the amenities provided
society. For example, a building having amenities like a lift, swimming
garden, health club, etc., will require more maintenance than a building with
these amenities. In Amar Nagri, where a swimming pool, health club, club
etc., have been provided, the total maintenance deposit collected was ₹ 35,00,
This amount is being kept in fixed deposits on which the society is earning m
interest. The interest amount is approximately ₹ 45,000/- per month. The
expenditure of the society, like sweepers' salary, security, water bills, co
MSEB charges, swimming pool maintenance, etc., amounts to approxi

at the time of society formation. In Amar Nagari, they have collected sinking (deposit) at the rate of ₹ 10/- per sq. ft., which amounts to ₹ 9,28,810/-. This nt has been invested in long term deposits. As per cooperative societies aws, the members of Amar Nagari are supposed to pay ₹ 40 lakh per year, i.e., 00/- per month. Now to get ₹ 3,33,000/- per month, they have to collect the it against the sinking fund which will give them interest up to ₹ 3,33,000/-. they have collected ₹ 9,28,810/- which will become four times the amount years, i.e., ₹ 40 Lakh and the interest on it will be ₹ 50,000/- per month. twenty years the deposit will become sixteen times of the principal value, i.e. Lakh and the interest on this amount will be 1,70,000 per month. In short, llecting one time deposit against sinking fund, the society will receive much than what has been prescribed in the bye-laws. It is estimated that after fifty this amount would be equivalent to ₹ 100 Crores. The sinking fund amount e utilised with the consent of the registrar of co-operative societies only. This nt is to be utilised for any major repair work undertaken by the society.

rther it has been the policy of Amar builders to help and guide the members new society regarding the appointment of the managing committee, adoption e-laws of the society, etc. They provide the society with all the necessary nery such as share certificates, letter heads, vouchers and other material which the managing Committee to function from day one.

Courtesy-Shri Amar Manjrekar
Amar Builders,
Pune-Solapur Road
Wanowari, Pune 411 013

– Idea of one time maintenance is good but now it is found that the total nt of interest varies according to the rate of interest on deposit. It is observed his rate of interest is reduced during last few years hence it is necessary to se aomunt of the periodical additional deposits.

Case Study

nbing and Building Services for
esidential Building
ultant S N Joshi, Pune

Reading Exercise (Figs. 3.53 to 3.58)

passive system and active system?

7. Study the electrical layout plan with electrical legend. (
8. The toilet development plan shows details for piping. St same. Prepare a check list to check work during supervi
9. Study the plan for fire fighting. What are the rules for th theatre or hotel to study fire safety systems. (Fig. 3.57)

3.9 ARCHITECTURAL ENGINEERING

An ideal Built Environment needs the co-operation and co Technology has opened up endless opportunities through ne and applications. Stadia, swimming pools, multistoreyed b shopping complexes, etc., display the contribution of many s **Tredgold**, civil engineering is the art of directing the great so use and convenience of man. It is a social engineering where the benefits of advances in technology without reducing the qu needs a Built Environment for various activities. The main nee of two important classes of people—the architects and civil who wish to develop their career in Built Environment in di builders, should know more about architecture and the role of the help of a civil engineer in different roles to gain success process. On the other hand, modern architecture also needs the fundamentals of structural design as well as an engineer w architectural problems. There is an urgent need for getting toge the imaginative practical engineer who is aware of the intrica blind slave.

For all this, a change is essential in our education system. I study of case studies of buildings/structures/housing schemes executed by different architects and structural engineers, with t be given due importance. For example, if the construction of a complex is explained with slides, stating the inherent probl the construction process which were met with and an analys process will enrich all concerned, viz. architects, builders, s Such case studies of different types of Built Environment wi concerned, including new entrant teachers. It will inspire the structural engineers, builders and the like. Many complaints f will be nearly eliminated through a serious review of their cas

The Institution of Engineers (India) has started an Archi bring Engineers and Architects close to each other. The Bu from other streams also, such as mechanical, electrical, refriger etc. There is a need for material science not only to develop n

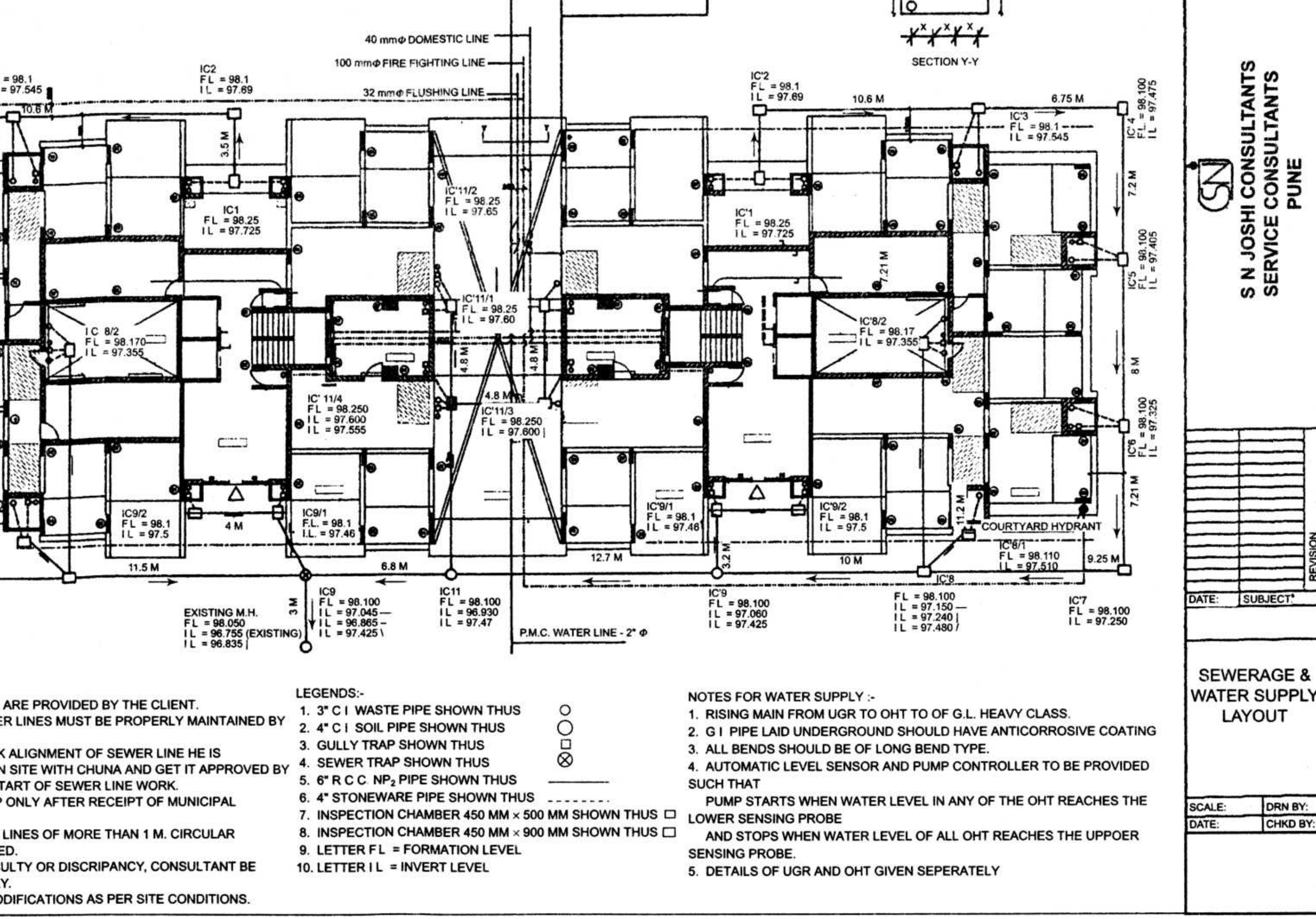


Figure 3.53 *Details – Sewerage and Water Supply Layout*

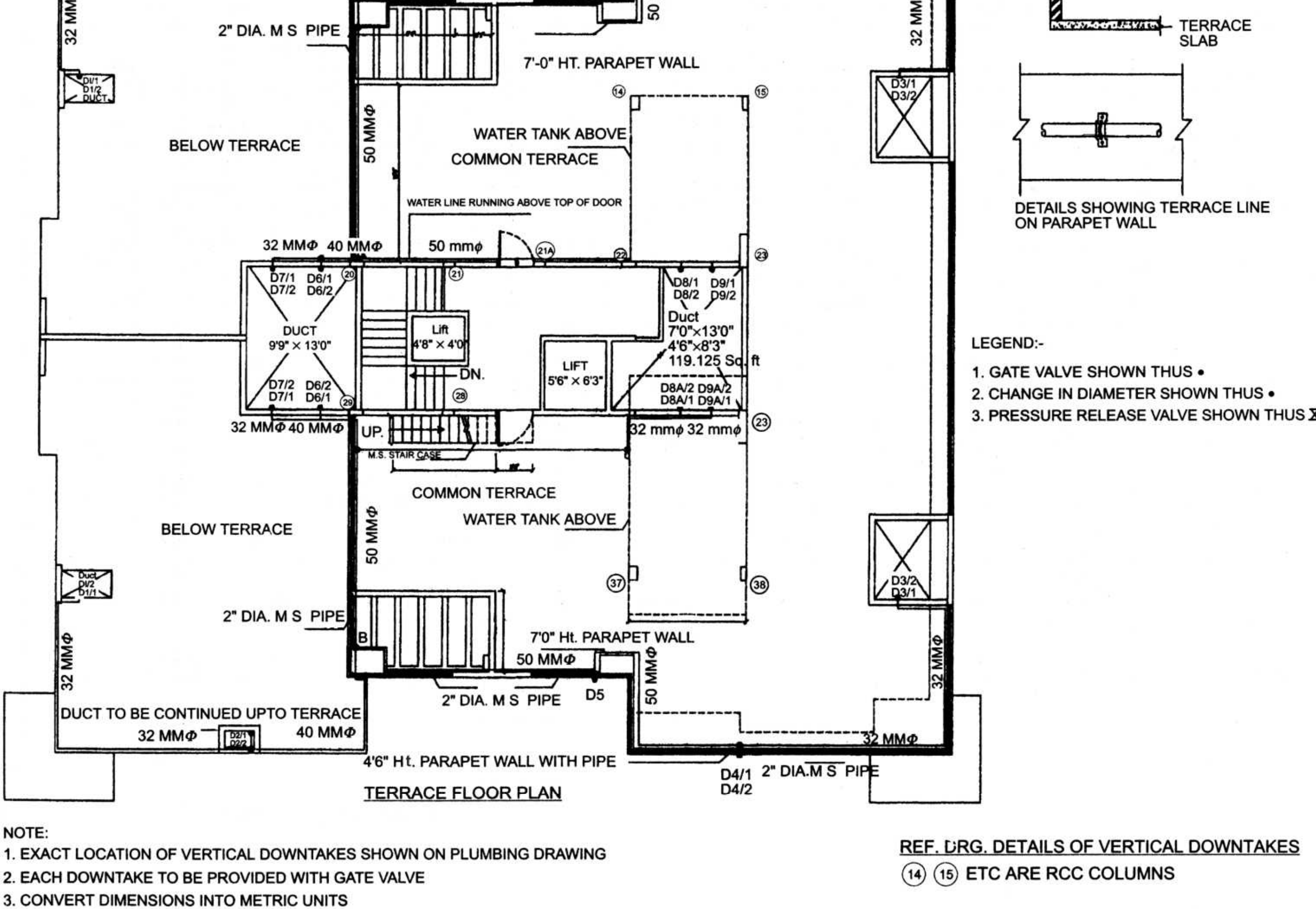


Figure 3.54 *Details – Terrace Floor Plan – Water Line Layout*

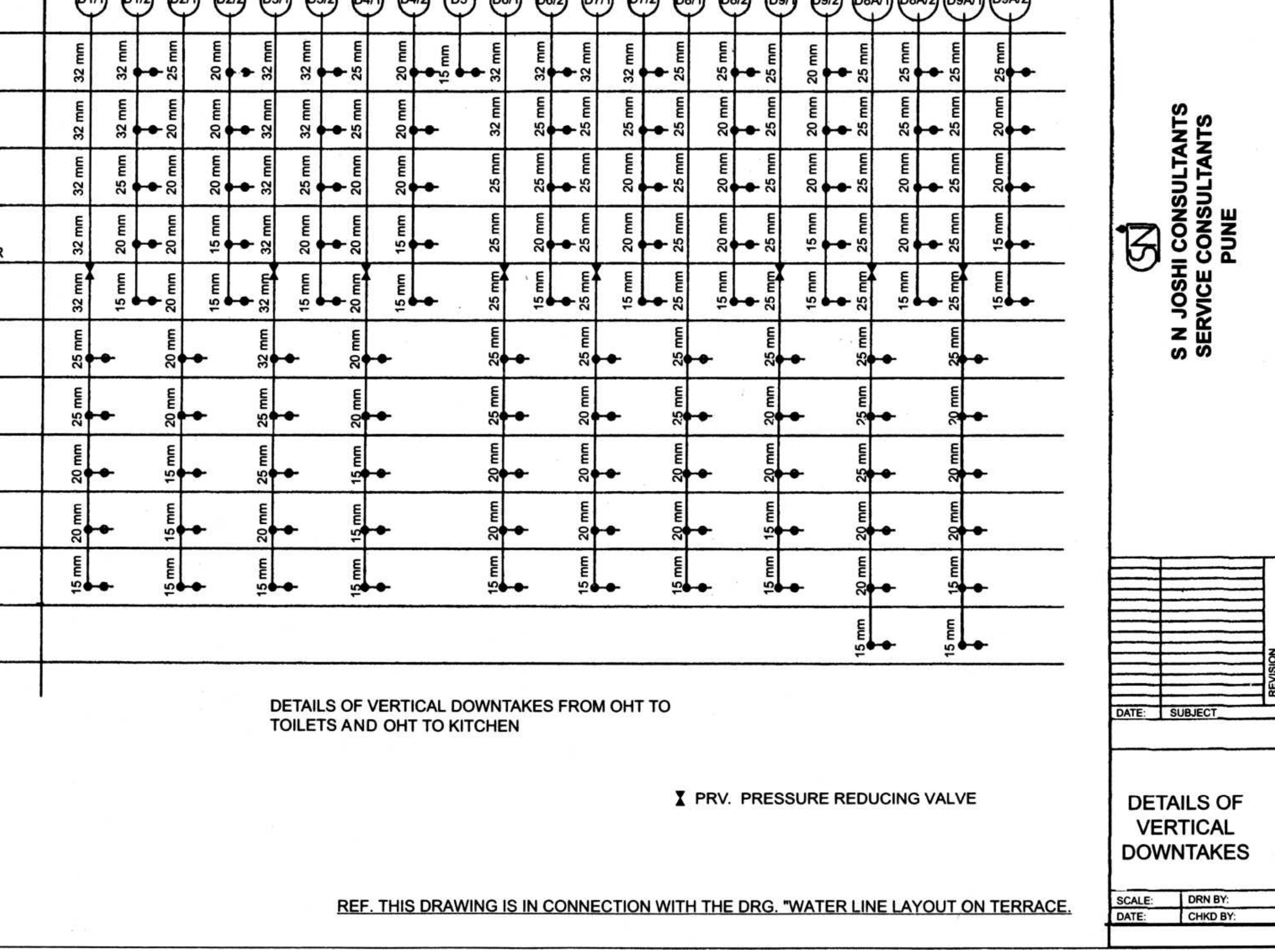


Figure 3.55 *Details of Vertical Downtakes*

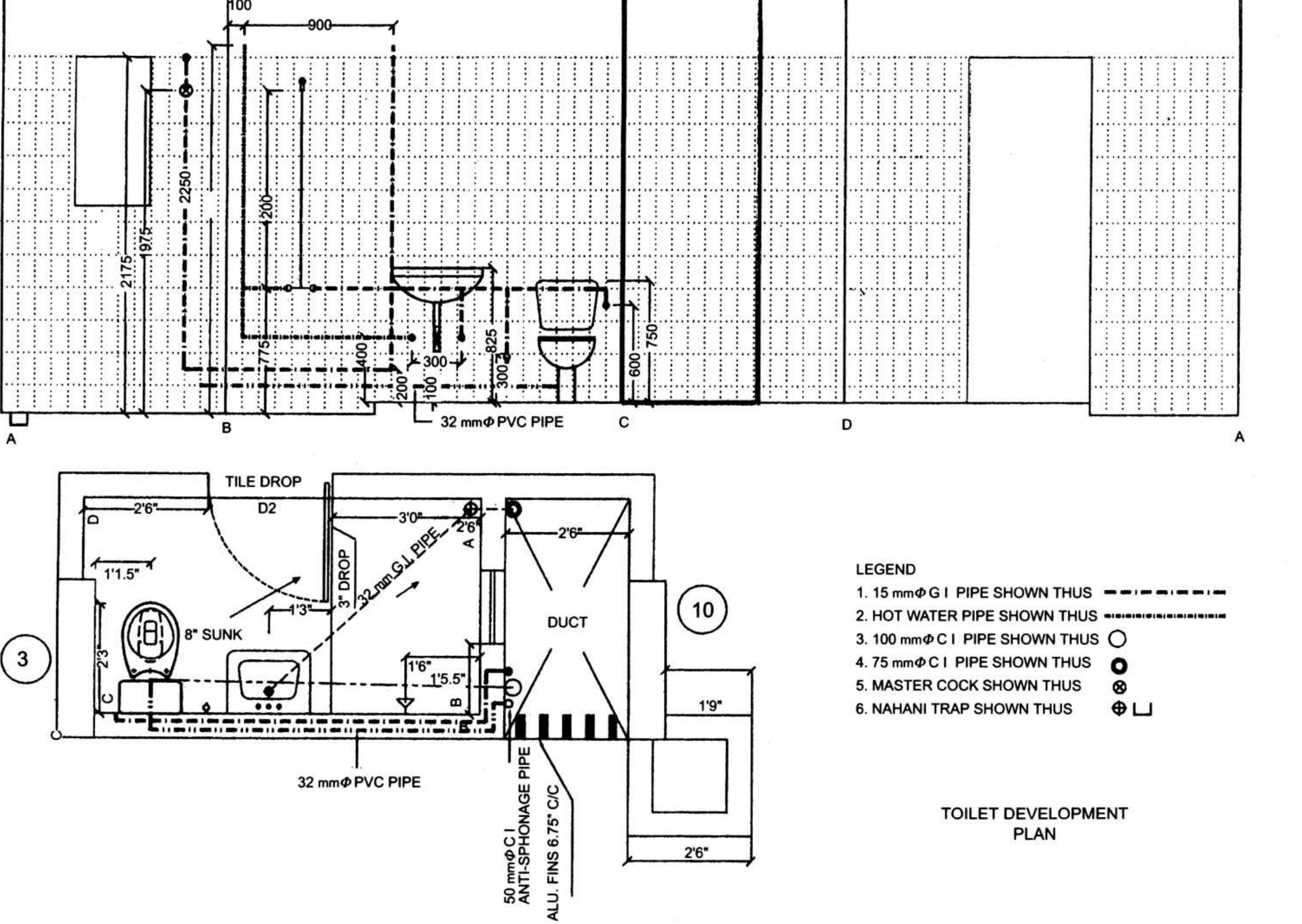


Figure 3.56 *Details – Plumbing Layout – Toilet*

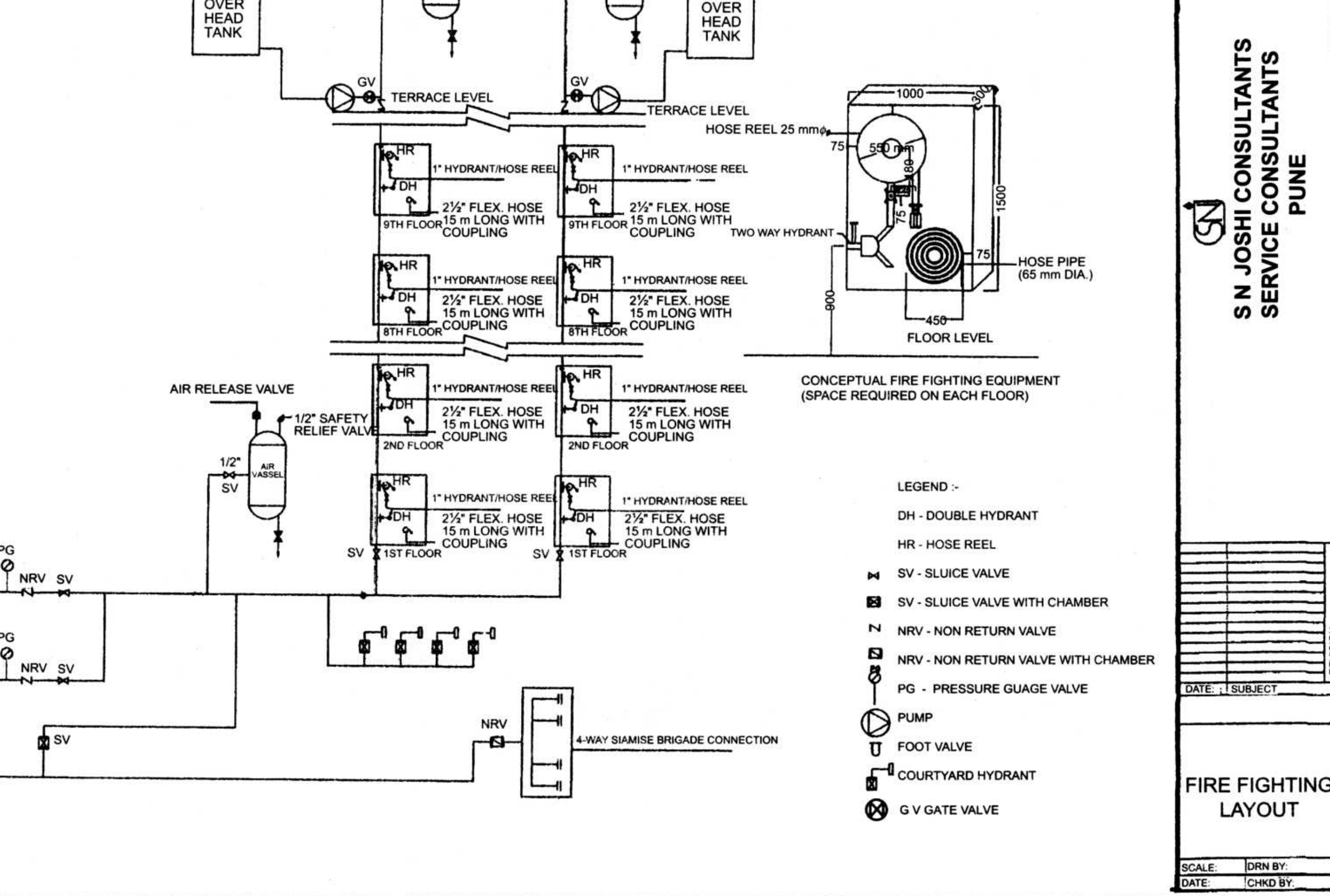
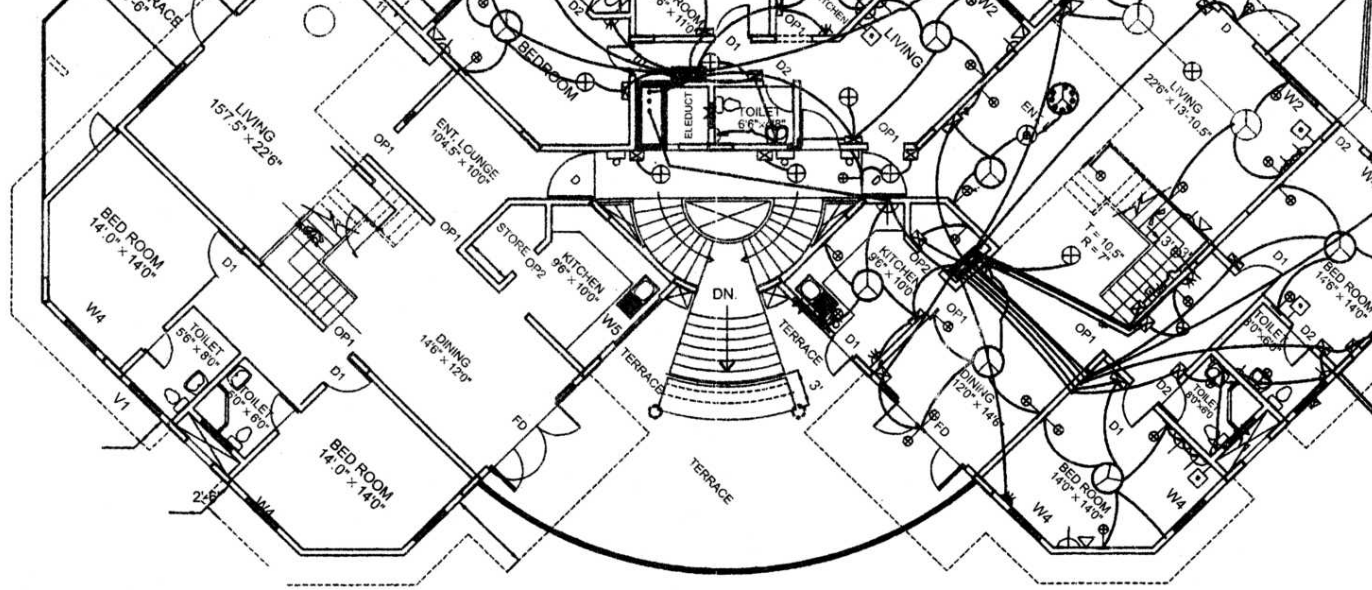


Figure 3.57 *Details – Fire Fighting Layout*



ELECTRICAL LEGEND:-

1. **MAIN D B**
2. **SWITCH BOARD WITH HALF POINT**
3. **SWITCH BOARD**
4. **BRACKET LIGHT**
5. **CEILING LIGHT POINT**
6. **CEILING FAN**
7. **6-A 5-PIN SOCKET WITH 6-A SP CONTROL SWITCH**
8. **16-A 3 PIN SOCKET WITH 16-A SP CONTROL SWITCH FOR A.C.**
9. **16-A 3-PIN SOCKET WITH 16-A SP CONTROL SWITCH OTHER THAN AC**
10. **EX. FAN**
11. **TV/ANTENNA OUTLET SOCKET**
12. **MTNL TEL SOCKET**
13. **DOOR-CALL BELL-PUSH**
14. **WALL CEILING FAN**
15. **CONDUIT PIPE 25 mm**
16. **CEILING LIGHT WITH FAN**

LEGEND FOR HEIGHTS

1. HT OF MAIN D.B. :- BOTTOM OF M.D.B. AT 6'-0" FROM FINISHED FLOOR LEVEL
2. HT OF SWITCH BOARDS:- BOTTOM OF SWITCH BOARDS AT 4'6" FROM FINISHED FL
3. CONVENIENCE SOCKETS, T.V. AND TELEPHONE OUTLETS: BOTTOM AT 0'-9" ABOVE FLOOR LEVEL IN ROOMS
4. OUTLET OF POWER PTS. FOR GEYSERS IN TOILETS: AT THE BEAM BOTTOM LEVEL
5. CEILING ROSE FOR EXHAUST FANS: AT THE BEAM- BOTTOM LEVEL IN TOILETS AND
6. BRACKET LIGHTS- OUTLET AT 6" TO 9" BELOW SOFFIT OF ROOM SLAB
7. OUTLET CONVIENCE POINTS ON KITCHEN PLATFORM : 2'-0" ABOVE FLATFORM TOP

NOTE: TV AND TELEPHONE CONDUITS WILL BE DRAWN IN FLOORING
CONVERT ALL DIMENSIONS IN METRIC UNITS.

Figure 3.58 *Details – Electrical Layout Plan*

d to Built Environment

es of varying durations from two to twelve months are
y for civil engineering and allied branches.

arious universities or polytechnics or Art and Science Colleges
ion of knowledge but also as an employment potential after
urse. "Earn and Learn" system is now very common. These
e useful for those who wish to develop their career in some
Built Environment.

te courses are recommended single or in groups, as per time
the interest of the learner concerned.

Courses

pliances
e and repairing
nce

nance

nce of bio-gas plants

on equipment

er

5. Earthquake engineering for buildings and dams
6. Building services
7. Management of construction projects
8. Valuation
9. Arbitration
10. Promoter and builder
11. Safety and fire safety consultant
12. Colour and colour technology
13. Estate manager and building maintainer
14. Testing of materials and quality control
15. Material science—latest material technology
16. Architectural engineering
17. Computer software courses for surveying, structural design, project m
computer aided drawings, estimation and rate analysis
18. Waterproofing, damp-proofing, and termite proofing
19. Environment consultant
20. Acoustics and noise control
21. Plumbing and building services consultant
22. Concrete quality control consultant
23. Restoration of old buildings, monuments and repairs of old structures
24. Contractor for landscaping work
25. Project management consultant
26. Lift-sprinkler and drip irrigation consultant
27. Air conditioning consultant
28. Computer controlled equipment for lighting and fire safety
29. Solar energy consultant
30. Geopathic stress consultant
31. Legal procedure for purchase of land, documents, various acts.

The present age explodes into the future. If this explosion is not anticipated, we
to face unexpected development in the future. If future shocks are to be avoided,
wise to anticipate the future, based on the present after observing and experienc
and present environment. Futurology involves planning, foresight, commonsense, i
and then anticipations with pleasure. It is in this futuristic intelligence and research
computers developed and expanded throughout the world in the last forty years, an
of chips have increased from 5×103 floating point operations per second (ENIAC
entire memory) reaching upto 5×1012 flops.

3.10 PROJECT WORK

et.

the changes in planning and construction in postmodern architecture. Use Inter-

he following places in your city and collect feedback from the users:

heatres (b) Shopping centres

nstitutional Buildings (d) Apartments

ibrary buildings. Study their planning, designs, landscapes, etc.

the interior designs of the following:

partments (b) Banks

hopping Complexes (d) Libraries

otels (f) Restaurants

hotel construction projects and collect constructional details of various buildings umbing services.

(c) Housing complex (d) Shopping cer

(e) Bus stops (f) Railway stati

(g) Hospitals (h) Hotels

12. Collect working drawings, brochures, information on schedule of rates, etc.

13. Collect details about the services of consultants mentio

(a) Lift, sprinkler, drip irrigation consultant

(b) Marketing expert

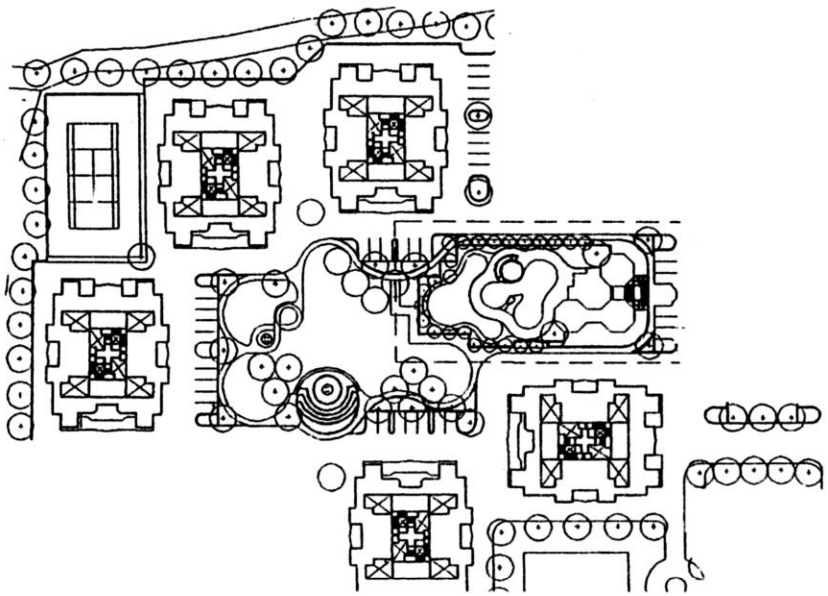
(c) Software expert

(d) Building economics consultant

(e) 'Restoration of old buildings and repairs of moun

LANDSCAPE ARCHITECTURE

4



Topics covered in this chapter

Geology

"The geology really determines the soils, the soils determine what kind of vegetation there is going to be. The geology also determines the slope of the land. This influences the whole environment and you understand all aspects of it, because they are related to each other."

Landscape Architect: Ian L McHarg
Book: *Design with Nature*

Settlements and Sustainability

Settlements have increasingly adverse impacts on nature. We need to pay more attention to urban planning and design, reduced resource usage and recycling so that more aesthetically pleasing cities can coexist with nature for mutual sustainability.

Editor: David Chapman
Book: *Creating Neighbourhood and Places in the Built Environment (E and FN Spon.)*

Heinrich Engel, in his *book The Japanese House—A Tradition for Contemporary Architecture* has said *"Garden in building, like all material creations of man, is one form of establishing human scale in the indifferent physical order of nature; of establishing a humanised environment. As such, garden is architecture and not nature."*

4.1 NATURE AND MAN

Modern ecology sees man as a part of nature. Landscape architecture helps in bringing man closer to nature by allowing him to think about the scenic visual quality of outdoor space. Hence, it is rightly considered as a part of environmental design. Cheerful, colourful and refreshing landscape creates a stimulating environment.

Mass tree plantation on hills and on the slopes of hills, in green belts, on river banks, around industries and in open spaces is found useful to control pollution, noise and dust. It also controls temperature and humidity. Towns with well planned landscapes, with mass tree plantation act as environmental filter number one.

The relationship of human beings with the surrounding physical environment is long and instinctive. It is developed gradually right from childhood through paintings, poetry, literature, films, television and while observing flowers and plants. A garden is considered as an extension of the house while parks in towns are considered as lungs with clean air for citizens. Brazil forest is known as the lungs of the entire earth. Thus, gardens and parks give an opportunity to develop man's love for nature. Psychologists say that crime is also reduced under such healthy environment.

Landscape architecture includes design and development of land for human use and enjoyment, conservation of natural wealth, protection of health and provision of comfort. A landscape designer deals with natural sciences, climatology, soil science, botany and many other disciplines. Towns with open spaces for parks and gardens, residential and other types of buildings with their open spaces around the buildings and their terraces, industries with their specific problems of controlling pollution, amusement parks, hotels, aerodromes, roadways, river banks, etc., are some areas that require the services of a landscape architect. A landscape architect works with ecologists, horticulturists, architects and service engineers, besides clients.

4.2 URBAN LANDSCAPE

An urban landscape projects the total nature of town planning, building form and land use. Building forms are contained within plots or land use units, which are in turn set in the framework provided by the roads in the town plan. They appear in unison as picturesque, homogeneous areas when viewed from the top.

Rural surroundings as compared to the urban surroundings consist of natural features such as agricultural or horticultural plots, hills, trees, plants and fresh air. The nearness of river with flowing water adds to the refreshing quality of nature. Nature of surroundings, i.e., environmental changes as per the geographical location, climate and type of vegetation are very important for landscape designing. Rubanisation (Rural shift to Urbanised areas) requires well planned futuristic designs.

The main question related to urban landscape is that land as a whole, is a limited resource. The world has 80 billion hectares of land, only 50% of which is straightaway lost in hills, valleys, rivers and deserts. The available land has to be used in a manner which would benefit the present and future generations. Land use planning needs several considerations related to the social and economic needs, not only for the present but also for the future. Laws regarding acquisition of land control the speed of development. Land is required for setting up residential and commercial complexes and transportation services such as roadways, railways, waterways and airways. These are termed as *infrastructure*. Hence, land available for tree plantation and soft landscaping is the remaining land in towns after land is allocated for roadside plantations and open space. Depending upon the location of town, some land is also available on river banks, around lakes or the seashore. The type of soil and climate plays an important role in finalising landscaping details.

It is relatively easier to think about such details while developing new towns or industrial estates. We face many problems in old towns with *gaothans* surrounded by areas developed under the town planning schemes. Encroachment of land and rapid illegal development in the fringe areas are additional problems.

Towns with attractive scenery attract tourists. Municipalities and industrial development corporations should make efforts to improve towns with different landscaping projects, which will attract tourists, minimise pollution and provide employment to many. Selected spots on hills or river banks can be developed by constructing view points with gardens, and pleasing utilitarian transformation.

The premises of Tata Motors (Telco Pimpri, Pune) is a well-known example of a green revolution in an industrial landscape. 364 hectares of barren and rocky land was converted into a green park, with two lakes and four ponds surrounded with mass tree plantation. A calm, quiet and refreshing place for workers, bird sanctuary for 150 species of birds, half a dozen varieties of fish culture and a tree bank is what it boasts of now. Nallah Park project (Osho Park), Koregaon Park, Pune is another example of transforming an ugly nallah into a charming Japanese style landscape with a spectrum of colours. Lalbag Garden in Bangalore, Botanical Garden in Ooti, Rose Garden in Chandigarh, and gardens around many historical places such as Taj Mahal in Agra, "Bibi ka Makbara" in Aurangabad, Hanging Garden in Bombay, Lodhi Gardens in Delhi, Talkatora Stadium premises and landscaping around Lotus Temple in Delhi are few such examples. Many housing, commercial and educational complexes in Bombay, Pune, Bangalore, Jaipur, Ahmedabad, Delhi and other cities have set a new trend in creating pleasing landscapes with the help of architects. This should act as a source of inspiration for the future generation.

4.3 SOFT AND HARD LANDSCAPE

A well-known principle of general planning, "planning from whole to the part" is also important in landscape planning. The area not used for construction of buildings and for transportation systems should be transformed by well designed landscaping. This transformation is to be done with the objective of achieving "visual unity and harmony." This calls for selection of materials suitable to their function and sympathetic to the surroundings, as landscaping elements are seen alongwith nearby architecture, man-made objects and overall background of sky, hill, river, lake or sea. Hence, involvement of landscape architect is required in the initial stages of the urban design programme, so as to keep a control over the total or group development and to suggest guidelines for other concerned designers.

The total landscape design consists of two parts—*soft landscape* and *hard landscape*. The details mentioned in the following lines will throw light on various considerations in soft and hard landscaping which will help in achieving unity in design with low cost maintenance.

Soft landscape deals with plantations, their unitary selections, types of trees, shrubs and hedges, vines and climbers. It also deals with ground cover, planning of gardens, terrace gardens, and their maintenance.

Hard landscape deals with design of space for people and their pedestrian movements. It includes footpaths and cycleways and also deals with areas around view points, space between buildings, paved surfaces from road to the entrance of a building or around buildings. Human scale, their to and fro movements, visual quality of the surrounding and relation to the building and its finishing material are the major considerations in this design. This has been depicted beautifully in the design of Chandigarh township by Le Corbusier.

A harmony between soft and hard landscapes results in pleasing patterns and scenic views in small or large available plot areas. It also gives a picturesque identity to the town. Imaginative utilisation of the total available space finally adds to the visual quality of natural and man-made features in the town and around the buildings.

4.3.1 Soft Landscape

The main point to be remembered in soft landscaping is the number of years it will take to reach the approximate form as visualised in the original design. It necessitates good maintenance during this period.

Water, soil and plants are three important factors related to soft landscape design.

Water

Water is essential for the survival and growth of plants. It is absorbed through the root system. Mineral nutrients are also made available through the root system from the soil solution. Climate, nature of soil and type of plant decide the quantity of water. Sprinkler irrigation system is found to be economical for plants and lawns with uniform and timely distribution of water without wastage. Drip system for trees, micro sprayers, pop up sprinkler systems and computer controlled systems are developed for efficient water management, proper growth and productivity.

Soil

The topsoil consists of fossils and various mineral elements essential for plant growth. It is created by the activities of the soil fauna and stabilised by organic molecules. Nature requires 750 years to create thick topsoil of 3 cm. Top soil is supported by subsoil. Care should be taken not to disturb both during construction, at least in the area where soft landscaping is proposed. It is essential to test the type of soil. Sandy soil, clayey soil, chalk soil and loamy soil are some common varieties. Loamy soil is a mixture of clay, sand and silt and is the best soil for a wide range of plants. Humus in the top soil is created by soil organisms such as bacteria, fungi and insects which decompose organic matter. Humus is useful as plant food. Water content in the soil depends upon pore space present in the soil. Loamy soil contains, up to 50% of volume of pore space. It is the gravitational water that is useful for the growth of the plant. Another important point related to soil is the air in the soil which is essential for plant growth, as roots take up oxygen and release carbon dioxide. Acid soils between pH 5.7–6.7 are found to be useful for plants. Plants require Nitrogen (N) for leaf and stem growth, Phosphorus (P) for root development, Potassium (K) for flowers and seeds. Fertilisers are selected as per the analysis of the soil and type of plants. These fertilisers contain N, P and K.

Plants

Climate, light, water, and soils are some of the main considerations for the healthy growth of plants. All factors vary from site to site. Temperature variations, wind conditions, nature of the soil, its fertility, acidity or alkalinity (pH) and the amount of sun and shade decide the type of plants and the technique for maintenance. Plants use sunlight to convert carbon dioxide and water to carbohydrates and oxygen by the process of photosynthesis. The percentage of light depends upon shading by buildings, amount of cloud cover, shading vegetation and deposits on the leaves. Study of plants and their requirement of light helps in selection of the right type of plants in the right location. Study of plant ecology by horticulturists is useful for the selection and grouping of plants in different geographical zones.

Tropical countries need shade giving trees. Fruit bearing trees, trees and plants having medicinal value, trees with fuel and calorific value, and of building material value should be planted. Nurseries need to be developed near water spread areas behind dams so as to grow healthy plants and trees till a height of one to two metre for successful plantation.

Plant Selection Detailed observation and collection of information regarding growth of plants and trees, their long-term form, texture and foliage colour help in taking decisions in their selection in towns and countryside. The form of a plant is related to its overall shape, and the arrangement of its branches, leaves, buds and flowers. The growth may be upright or wide spreading. The form also depends upon whether the tree grows alone in the open or in a group. Texture is related to the impact of different parts—size, shape and surface of the leaves, texture of the trunk and of the branches. Evergreen plants have a consistent texture throughout the year. Textural contrast with the surroundings helps in creating an eye catching effect. The colour of leaves and flowers and their seasonal changes help in creating interesting spots or view points. Warm colours like red, yellow and orange seem to reduce the distance between the plants and the observer, while cool colours like blue, green and purple appear to recede into the background providing a cooling effect on the general mood.

Planting schemes should be designed in such a manner that the landscape remains green and colourful throughout the year. Hence, a study of combination of various plants, their forms, texture and colour would be useful. This could be done by observing gardens and nurseries in different seasons. Flowers and fruits attract birds and butterflies. Shrubs and trees having scented flowers should be planted along paths and near seating areas, close to the windows.

Trees alongwith shrubs are found useful to create shelter belts. They also help in dust control and help in soil stabilisation on slopes. They take up groundwater and release it back into the atmosphere, cooling the air and increasing humidity.

Plantation of Trees Trees are valuable assets. They should be preserved as much possible. Tree survey and arboricultural assessment helps in deciding their preservation or tree transplantation. The location of trees, extent of their feeder roots, and ground level decides the location of buildings, layout of pathways and roads.

The type of tree, its root and branch system, height after full growth and climate are considered while selecting trees for plantation near buildings. This avoids damage by roots to the building foundation, underground services and overhead cables.

Roadside planting is finalised as per speed of movement. Tree groups are found to be suitable as compared to individual trees. Plants for streets, urban squares and meeting places should be selected carefully. Barren and depressing sites can be transformed by planting colourful and flowering trees which provide shade and a pleasing visual view. They may be planted in rows and in groups depending upon the location space and surroundings. Trees are essential in parking areas. They help in reducing the glare of the shining surface of vehicles and provide shade in summer. Countrysides can be made pleasant by planting trees along roads in groups at selected points. Farm owners may be guided in plantation of trees along boundaries of agricultural or horticultural fields. Planting of fruit bearing trees and plants having medicinal value should be encouraged.

Shrubs Shrubs with colourful flowers are assets for the landscape. They are planted in groups of a single species by creating well planned beds. They require systematic maintenance and pruning.

Hedge Hedges act as barriers with thorny plants as screens with their height and foilage. They are useful in marking spaces as per geometrical patterns. They help in controlling soil erosion. Trimming helps in developing dense hedges. A hedge is kept wider at the base than the top to make it stable. It acts as a good enclosure.

Climbers Fences, outdoor structures, canopies and entrances to the garden are covered with climbers to provide shade, colour and scent. They need supporting structures which may be made of metal or timber. The total design should match with the scale and surrounding details. Creepers do not need support. Twisters need support of wires.

Ground Cover Ground areas not covered by plants, trees, shrubs or creepers need a pleasing and colourful cover. This is achieved through lawns or by various ground cover plants which are economical as compared to the cost of the lawn. Such evergreen ground cover plants are useful in small or big areas to maintain continuity. Herbaceous plants with a variety of leaf texture and colour are found to enrich landscape design. They need minimum maintenance.

A green lawn in a garden is a very attractive sight. It is found to be a popular method of ground cover in small and large landscape design, terrace gardens and for golf and other sports. Seeding or turfing are two methods for the development of a lawn. It needs ground preparation and maintenance. Hence, before finalising areas for lawns, several factors are considered, such as surrounding plantations, suitable type of trees and plants, area suitable for moving, good watering system, provision of a well-drained fertile soil and climate. The services of an experienced designer is required to finalise details of surface preparation, seeding and periodical maintenance.

Plants are available from nurseries. On some large landscaping sites, nursery is developed right from the beginning.

Other considerations which are important for a successful landscaping project are:

1. Study of climate and planting season for different types.
2. Preparation of land.
3. Method of planting.
4. Protection of plants from the wind, sun and animals.
5. Support for trees in initial stages—staking.
6. **Mulching**—A process of spreading organic or inorganic materials over the ground and around plants in order to retain moisture, and control weed growth. Farmyard manure is used as organic material while gravels or pebbles are used as inorganic materials for mulching.
7. Yearly maintenance programme.

4.3.2 Hard Landscape

Hard landscape deals with areas in towns related to the pedestrian movements. Areas in a town are mainly occupied by buildings and roads. Areas around the buildings, footpaths, open spaces, etc., require treatment of paved surfaces for safe and comfortable movements for people of different age groups in all seasons. Selection of materials for paving, construction techniques and maintenance are the main considerations. The visual impact of colour patterns, texture and finish is important in the selection of materials. The whole design must be sympathetic to the surroundings which consist of environmental architecture, and soft landscaping with trees, plants, hedges as also ground cover. Along with the treatment of paving, provision of enclosures, i.e., physical barriers to provide visual screening is also decided. It may be in the form of walls, hedges, railings, and fences to demarcate a boundary for the right of ownership. It also covers the provision and selection of the right type of street furniture—well-designed dustbins, benches for sitting, and lighting near buildings, in open spaces around buildings, car parks, street lighting, low level lighting in garden pathways and for illuminating fountains.

Paving

The selection of the right type of material for paving depends upon the availability, cost, appearance, strength, slip resistance, durability and ease in maintenance.

Natural stone, bricks, concrete and asphalt surfaces are common materials. The total area to be covered is one of the factors related to cost. Stone or brick was the common choice in ancient days. Today, stone and precast concrete blocks are used for kerbs or edging. Precast concrete slabs are found to be convenient. They may be square, rectangular, hexagonal or circular. Various finishes are available to reduce slipperiness. Precast concrete gutters are found to be convenient. While designing paving with precast concrete slabs, different patterns are possible which create interest in the design. A smooth finish joint with grooves is found suitable. Concrete paving can be designed for car parking. Concrete paving blocks with interlocking shapes are available with different colours. They offer flexibility in design by using different types of bonds as per availability of area. It is suitable for covers and areas around trees and plants. Nonheat absorbing and nonglare paving materials are developed in countries with a hot climate. Concrete, i.e., "in situ" concrete is found to be suitable for low cost paving. It is laid in 75 mm to 300 mm thickness as per load bearing requirement, on a supporting base course, 800 mm to 150 mm thick. Maximum area must be 10 sq m with 1:60 slope for easy drainage.

Asphalt, hot rolled and mastic asphalt surfaces are found suitable for large areas, for heavy as well as light pedestrian traffic. They have a high maintenance cost.

Enclosures

Trees and hedges used for soft landscaping help in enclosing particular areas, if planned for enclosing. The aim of enclosures is to impart privacy, provide visual screening, and mark boundaries. Walls and fences are the common methods for enclosing areas. Chain link, strained wire, or welded mesh is generally preferred for fencing. Metal railing along with gates is preferred for the main entrance and side walls. It may be of cast iron, or mild steel which offers different designs.

Landscape Furniture

An interest is created in soft and hard landscape through the judicious selection of landscape furniture. It helps in remembering a particular place and its view points. Careful location of furniture helps in increasing functional efficiency. Total integration of architecture, trees, plants, paving, ground cover and landscape furniture will encourage the use of outdoor space. Seats could be placed in such a manner that they add comfort and at the same time serve as good view points. Seats should provide protection from summer sun, allow to enjoy winter sun, and protection from rain. Their level and maintenance, as also grouping of seats or provision in isolation are some of the factors to be considered in the design. Seats around trees for small and large groups with natural shades of foliage are also preferred. Seats may be in the form of walls, steps or raised grass banks.

Landscape furniture also includes different types of plant containers which attract attention by their location, design and finish. Soft and hard landscaping need one more element, in the form of signs and information. Visually pleasing sign boards for pedestrians and vehicles are essential for guidance. Protection from vehicles is provided to people, buildings, and trees by means of bollards. They may be of stone, metal or timber. Spacing depends upon the purpose and location. Dustbin locations are decided as per convenience and utility. Various interesting designs are used for this purpose.

4.4 BASIC LANDSCAPING PRINCIPLES

"Garden in building is an integral part of building. It is related to the interior organism of the house; it complements indoors, functionally, economically, and aesthetically and accentuates the architectural idea."

Architect: Heinrich Engel
Book: *The Japanese House*

The extent of landscaping varies from small areas around buildings to gardens and parks, housing complexes, industrial complexes, amusement parks, waterscapes in the garden, terraces on buildings, hotel complexes in and around cities and numerous other areas. The demands of the client, budget, nature of land and climate are some variable factors involved.

Some common basic principles to be remembered and implemented in landscaping are as follows:

1. ***Unity*:** Plants, gradients and structures all work harmoniously together.
2. ***Balance*:** To use mass of vegetation, colour or form to create equal visual weight on either side of the centre of interest.
3. ***Proportion*:** To take into consideration the scale of the building/buildings, ultimate size of trees and shrubs.
4. ***Variety*:** Breaking of monotonous effect by selecting suitable shapes of trees and plants with variety in texture and colour. To create elements of surprise in landscaping.

In order to study these basic principles, the easiest way is to study different styles of gardens through visits, books, watching television-gardens, towns, complexes and by collection of literature and photographs.

4.4.1 Study of Garden Types

There are two basic types—*formal* or *geometric style* and *informal* or *natural style*. Formal style consists of a symmetrical landscape with straight lines, geometric patterns and perfect balance. After studying architectural style, the plan is prepared with provision of hedges, fountains, pools or sculptures.

Informal style consists of asymmetry in the design with curves and apparent roundness. The English, French and Japanese designs have typical characteristics with a basic well-balanced theory behind their creation. Knot, oriental, wild, cottage, spanish and contemporary styles also show their typical nature. Climate, availability of land and its nature and love for nature are the main factors related to various changes in the design as per the environment available and surveyed.

Literature with coloured photographs show pleasant creations in the garden. Study of such literature is necessary for inspiration and development of visualisation in order to understand reasons for aesthetic appeal. A cluster of bamboos, forest of palm trees, lush foliage of trees and plants, colours of bougainvilleas, creepers, clever selection of landscape furniture, landscape design blending with the design of the major structures of the complex while softening and complementing their bold architectural lines, pathways, ramps and steps, cozy corners for sitting, and rockeries with harmony in total design create places and spots worth enjoying and remembering.

The designer's hand should not be seen is the main expectation from a design. A well-planned and maintained garden develops man's aesthetic awareness and helps people to ponder the values of life. This also improves the quality of life. A Japanese landscape design may be without plants or with plants but they consider gardens as cultivated environment, a purposely designed space around the house by which man enriches his life. They also think of gardens as an architectural spot and not nature. In their design, a garden becomes meditating space that brings together the contrasts of technical and organic substance, of geometric and natural form, and of human and the infinite scale of nature and God. To the Japanese, nature lives, and all components, each stone, each plant, each waterway, has a soul just as of a human being. Their small residential garden is to be seen and enjoyed from the interior of the house. There is no separate design of house and garden as in the west. A garden is an integral part of the house and of life.

In Europe, the pathways are kept wide, their garden is planned with unusual botanical specimens from different parts of the world. They create an impression of wealth and luxury. In Japan, it is planned as a retreat for secluded ease and meditation. In Japanese gardens, stones provide the framework for space; so locating them in a harmonious fashion is fundamental. It is believed that curiously shaped and especially large rocks or stones are places or spots where the Gods would descent from the heavens. Gardens may be designed as dry landscapes with sand and rock and without plants, or with waves of sand and moss, and carefully placed stones. Some gardens are designed with white sand amidst greenery to enhance the beauty of the moonlight. They are known as *moon viewing gardens*. The contrast is beautiful like men and women created by nature or God.

4.5 ROLE OF THE LANDSCAPE DESIGNER

"Sympathy with the site, sympathy with climate and sympathy with the people who would use the gardens. These three sympathies deserve special emphasis, since they form excellent criteria for judging any environmental design."

Landscape Architect: R A Preece
Book: *Designs on the Landscape*

Self maintaining and low maintenance landscapes are important considerations in ecocentric landscape design. A landscape is compared with the human body, hence it needs regular care. Water, food, pruning and protection are the needs of a landscape. Today, landscaping in and around industrial zones has proved to be useful in controlling pollution and noise. It has also provided colourful and dense space with mass tree plantation for workers to refresh and relax. Projects of transformation of ugly nallahs into gardens have shown the possibility of converting dirty areas into colourful green areas, Osho Park in Koregaon area of Pune is an example of beauty in landscaping. Irrigation systems, lighting, paving and water features, signage graphics, polymer meshes for fences, are some of the areas where several technological advancements and provisions have taken place. Landscaping of flyovers by creepers, landscaping in crematorium to provide a healing effect when life has been lost, amusement parks and waterscapes have shown different areas where a landscape architect can create pleasing surroundings.

The role of architects and engineers in landscape designing should be realised. Landscape engineering is a new area for civil engineering contractors. It includes earthwork, construction of pavings, walls, fountains, ponds, enclosures along with plumbing and electrical services. Study of the inherent characteristics of a site to influence planning and design, knowledge of ecology, microclimate, arboriculture, etc., is essential for formulation of a programme brief for landscape design.

4.5.1 Assessment of Land

Site visits for the assessment of land is essential, for collection of data, and for preparation of a site plan.

1. ***Nature and extent of the land*:** Shape of the plot, boundary lines and their lengths, north direction, details of surroundings, views, existing trees, plants in the area and around the site, wind and rain direction, nature of land, flat or sloping, contours, high and low areas, topography and natural water drainage system, and approach roads to the site, are different factors which have to be considered.
2. ***Geology and soils*:** Soil survey—type of soil, pH value, its suitability as garden soil, nutrient deficiency, texture, degree of compaction, and depths of the topsoil and subsoil, nature of humus, subsoil drainage system and test for the same, soil water condition, determination of pore space, water table level, need for organic, and artificial fertilisers are other major factors.
3. ***Existing vegetation*:** The detailed survey for the type, location and physical condition of trees, plants, hedges and ground cover helps in finalising the integrated plan. It includes trees to be retained, removed or transplanted.
4. ***Existing buildings and services*:** Building(s) to be preserved should be marked on the plan along with water, drainage, telephone and electricity service line. A survey of the existing roads, approach roads, view points from the site and their marking helps while preparing the final integrated plan. Rules and regulations regarding development of layouts should be studied in detail.

Sources of water for gardening—municipal supply or from bore well, and their availability should be noted.

Site analysis and site survey information influences different alternatives for layout. If the area is more than 16 hectares, help of an ecologist should be taken. Discussions with a horticulturist and local farmers would be useful in case of new areas away from towns.

4.5.2 Design Procedure in Stages

1. Discussions are held with architects regarding the proposed plan of the building, entrance, pathways, parking, compound wall, existing and final levels of the ground, etc.

A base map is prepared for marking of grids on the architect's plan or on tracing paper. Discussions with the client, preparing a budget and estimating the maintenance cost are other stages in landscaping.

2. ***Base Map*:** A base map is prepared showing boundary lines with dimensions and arrow towards North, and directions of the wind and rain. Marking of a building showing basic areas such as kitchen, living room, bedroom, entrance to the building, location of doors, and windows in external walls to locate view points, marking of circulation patterns from the entrance gate to the building and around the building, area for the garden, play area for children, kitchen garden, tool shed and water falls are fundamental aspects of the base map.

Layout details vary for different types of projects such as hotels, housing complex, hospitals, etc. It is essential at this stage to check locations of different services such as water, drainage, electricity, telephone, etc.

3. ***Balloon Map*:** It includes discussions with an architect and owner with reference to the base map for finalising treatment of different areas for the lawn, play area, etc. Checking of placement of the building related to the sun, good scenic views, width of the paving, steps, ramps, etc, checking of the path on ground by marking pegs, modifications if any and marking levels for earth work is taken at this stage.

4. ***Plants*:** Selection and placing of trees, shrubs, vines, ground cover, plants for lowering temperature, plants for texture and colour, deciduous and evergreen plants, fast and slow growing plants, plants in containers, hedges for defining areas, plants for harmonious colour scheme are covered under this head (Fig. 4.1).

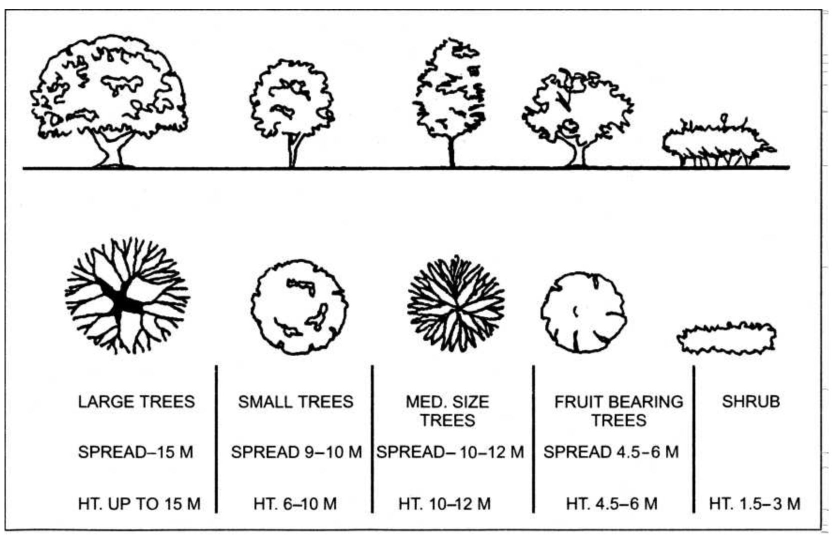


Figure 4.1 *Symbols for Trees and Shrubs*

5. ***Land Drainage System*:** Study of slope of the ground, adequate surface drainage for flat land, control of erosion problems in areas with steep slopes, study of the water table level., etc., is an integral part of this system.

6. ***Irrigation*:** This includes water management for efficient utilisation and conservation of water for proper growth and productivity. Requirement of water for small and large gardens, parks and golf course is analysed. Selection of the right type of system—sprinkler and/or drip system, micro sprayer, pop up sprinkler system, drip system for trees, nursery beds, computer controlled system for economical and efficient watering, etc., come under this head.

7. ***Final Plan:*** It covers all essential harmonising and integral aspects. These may be listed as follows:

(a) *Hard landscaping details*—selection of paving material, type of finish, edging for separating different areas to create a decorative effect, to hold pavings for linking different areas by bricks, stone and concrete.
(b) *Retaining walls*—for sloping sites to provide level surface in different stages, walls with stone, concrete garden walls, gates and fences.
(c) Detailed design as per importance with various considerations related to safety, privacy, control, wind and noise to avoid/control unnecessary view.
(d) *Materials*—stone, bricks for walls with mild steel or concrete grills.
(e) *Gates*—size, location, harmony with walls and surroundings, mild steel, cast iron or timber.
(f) *Pools and fountains*—location, types-natural, formal and informal. Plumbing system, swimming pool location and shape, floor and wall finish with waterproofing, RCC and fibre glass.
(g) *Pumps*—location and capacity.
(h) *Lighting*—for safety, security and decoration, selecting areas for lighting effects.
(i) *Landscape furniture*—benches for sitting, signages and information boards, locations of dustbins.
(j) *Terrace gardens*—Consultations with the structural designer regarding lawns, pools and flower beds.
(k) Drainage to avoid water logging, water proofing with coal tar, bitumen roofing, epoxy resins, etc. Selection of plants for spread of foliage, plants to withstand windy conditions, root system for less depth of soil.
(1) *Transplanting tree*s—If it is necessary to transplant existing trees then ball and burlap method is used. Pits are prepared at new sites and then trees are lifted from the previous position after excavating a pit around the tree. They are then transported, and replanted in the new location. A support is provided in the form of bracing.
(m) *Maintenance programme*—It is prepared for the guidance of the client. It includes a detailed yearly programme for the garden, structure, pumps, lighting and pathways, fertilising, mowing, pruning and watering.

Case Study

Landscape for 'Kalyani's Residence at Pune

Landscape Architect—Shobha Bhopatkar, Pune

Study all presentation drawings showing various considerations for landscape. All drawings are self explanatory. (Plates 4.1, 4.2, 4.3, 4.4, 4.5)

This landscape is evergreen and colourful with fountains and lawns to give pleasure throughout the year. It is the trees, plants and shrubs that create a colourful environment. When one variety of plant stops flowering, another variety starts. An attractive combination of bright and soft colours around the bungalow, location of the swimming pool, guest house, walkways and parking creates a pleasing landscape. Different elements are linked together skilfully. Finally health, fitness and visual pleasure is achieved through a well planned, developed and maintained landscape which is considered as a long-term investment.

Reading Exercise

1. Write down names of different trees, plants and shrubs written in drawings. Refer to a horticulturist's catalogue, visit different landscaping projects and study their planning, methods for plantation and maintenance.
2. Hardscape requires different colourful designs. Patterns of paving, texture and colour play an important role. Collect details for different materials suitable for paving of walk-ways and parking areas.
3. Swimming pool construction demands different specifications and materials. Collect details for the same.
4. Write down different items for preparing estimates for details shown in the drawings.
5. Prepare maintenance schedule for landscaping.

Case Study

Landscape Development for Housing Complex
Plate 4.6 (Figs. 4.2, 4.3, 4.4)

Project	***'Woodland' of Paranjape schemes Construction limited, Pune***
Landscape Architect	***Pradeep Devarchetti and Associates***

Project Description

The site acquired for the housing complex was a grove of mangoes and other fruit bearing trees. This greenery gave the site a character of a wood, and hence, the name 'woodland' was coined for the complex.

Even though the complex consisted of multi-storied buildings with a separate bungalow and shopping centre, the developer wanted the site to be merged with nature.

Site Condition

The area of the site was about 2.8 ha. (7 acres) and was fairly levelled. It consisted of mango and other fruit trees, randomly planted. Some of the trees were 100 years old with beautiful foliage. There was an ancient well on the south-west corner of the site.

The orientation of the site was east-west which was good from the landscape point of view.

While planning the layout, the buildings were allotted in the area in such a manner that minimum number of trees had to be disturbed. Some trees were transplanted in suitable locations in the open space. The other trees in the open space were kept undisturbed.

This gave advantage for the landscape design, as readymade full grown trees were available.

Design Concepts

An informal layout was developed as a master plan to suit the site along with the group of buildings. The planning of open space of the housing was a challenging task to cater to the outdoor recreational needs of people of different age groups, from toddlers to adolescents and teenagers to elderly retired persons.

Therefore, common interacting spaces like play area for children, a tennis court, a club house and swimming pool, and an amphitheatre were designed in the landscape.

While designing the open space, care was taken that the vehicular movement should not interfere with the pedestrians. The open space was to be visible from all the buildings. Activities in the open space were segregated, so that they do not interfere with each other.

Planning

The landscape had been structured in a manner to utilise the corners and the periphery of the site with the recreational elements:

1. A childrens' play area with play sculptures. A pergola covered with climbers and several existing trees abutting the play area were designed with pedestals for sitting and watching.
2. A small amphitheatre was designed over the underground water tank for functional gatherings and passive recreation.
3. A jogger's track was designed along the periphery of the premises in a meandering way. It ran beneath the trees along the existing nalla, along the road and ultimately terminated at the temple. It covered a length of 300 m.
4. The same was true about a cycle track, but it was planned in the central open space.
5. A lawn tennis court was designed at one corner of the premises for active recreation.
6. A temple was designed near the existing well along with trees for the devotees and the elders of the society.
7. A swimming pool and a club house with a party lawn was designed in the open space as a focal point. The club house accommodated a card room, a table tennis room, a gymnasium, a changing room for the swimming pool and society office. The club house was run on a membership basis to raise the fund for maintenance of the landscape.
8. Society parking was planned on the stilt floor, while visitors parking was located along the internal roads at few points under the shade of trees.

Planting

Plants also play a major role in creating a colourful and lively visual atmosphere. Selection of suitable plants was guided by the climatic conditions and the local and native factors of the soil. Plants which required minimum maintenance and had an ornamental value were considered ideal.

Trees, shrubs, ground covers and lawns provided as greenery at varying levels and in different forms, thus helps to soften the visually sharp tall and firm lines and bulk of buildings. Therefore, taking advantage of the existing full grown trees, a few colourful trees were added to give an interesting colour to the site.

Along with the trees, a variety of colourful shrubs and ground covers were planted to make the combination scenic and to provide privacy and safety.

These variety of plants created a 'green' space which changed with the seasons and also succeeded in breaking the monotony of a dull and drab environment.

Conclusions

The centrally located open space acts as breathing space in the complex and infuses health and liveliness into the image of a dry concrete jungle, improving the living conditions. It provides recreation and relaxation facilities and is useful as a means of social interaction with outdoor space in today's modern community. It also improves local weather conditions at the micro-climate level.

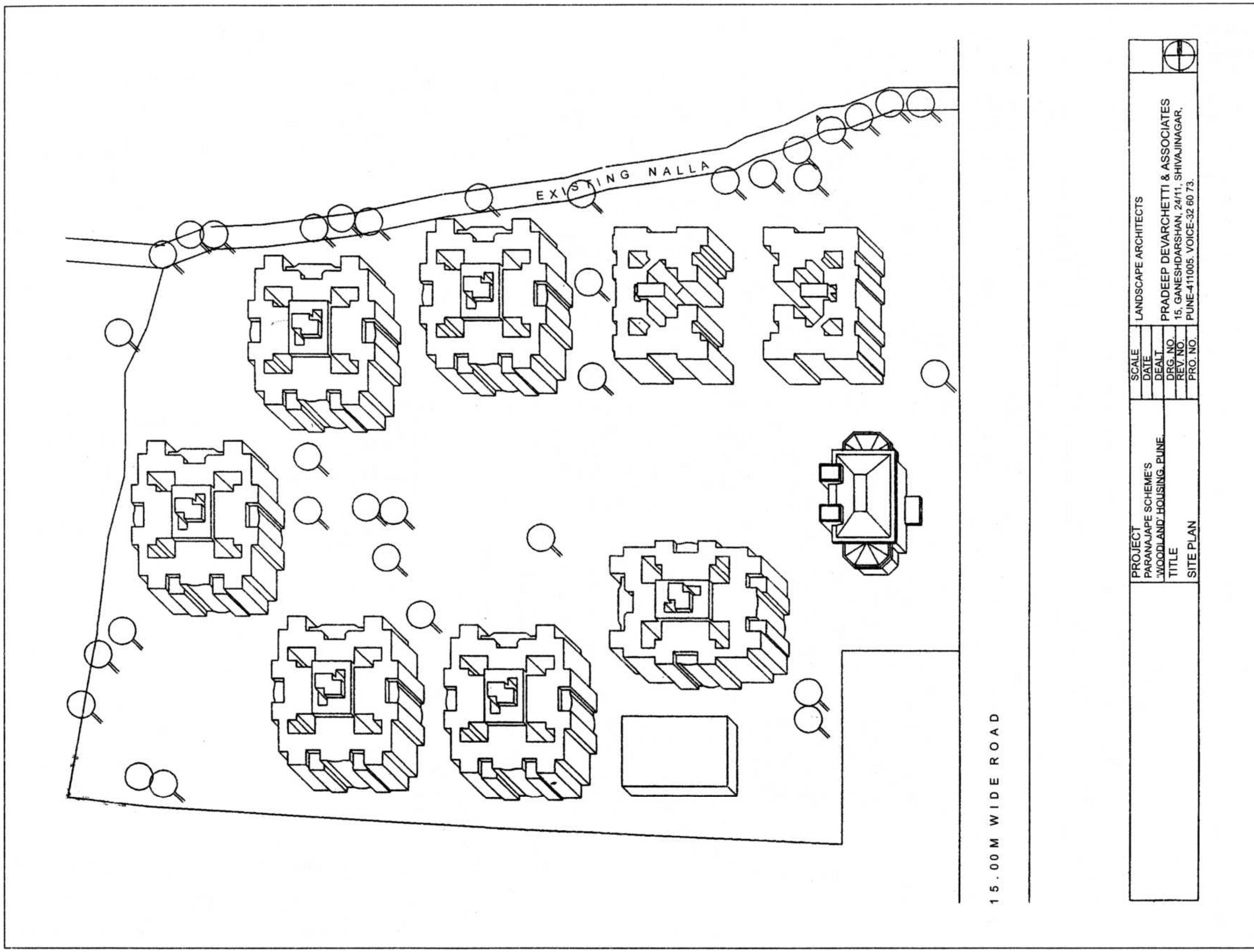


Figure 4.2 *Site Plan before Landscape – Woodland Housing, Pune*

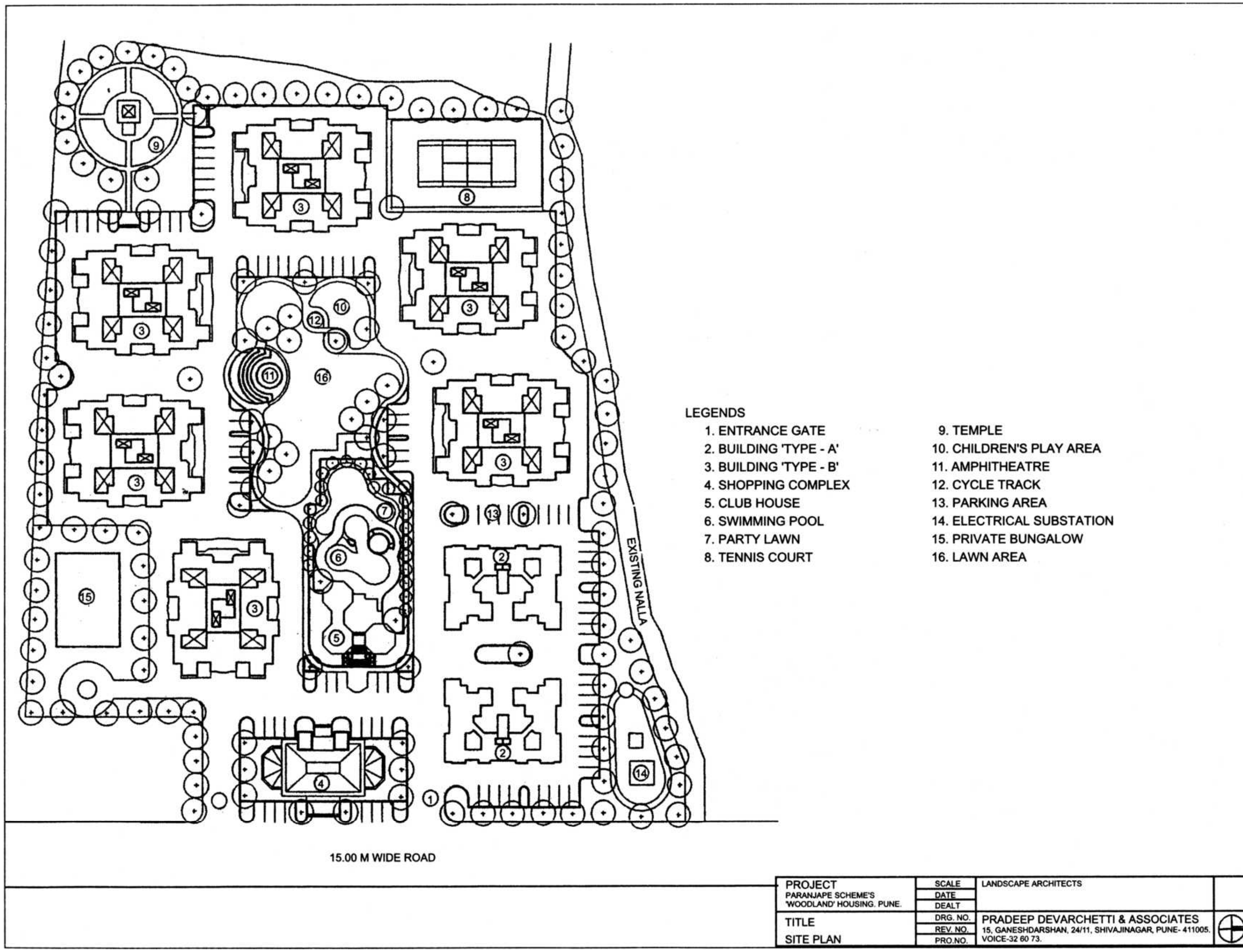


Figure 4.3 *Site Plan after Landscape – Woodland Housing, Pune*

PLANTING PLAN: PHASE NO.–1.

TREES:

KEY	BOTANICAL NAME	COMMON NAME	SPECIFICATION	SPACING	QUANTITY
BV	Bahunia verigata	Kanchan	1.50 stem ht.	–	3 No.
CF	Cassia fistula	Amaltas	1.50 stem ht.	–	3 No.
CL	Calistimon lanciolatus	Bottle brush	1.50 stem ht.	3.0 m c/s	15 No.
DR	Delonix regia	Gulmohar	1.50 stem ht.	5.0 m c/c	6 No.
JM	Jacaranda mimosifolia	Nili Gulmor	1.50 stem ht.	5.0 m c/s	6 No.
RR	Roystania regia	Bottle Palm	1.50 stem ht.	3.5 m c/c	18 No.
TA	Tabebuia arjensia	Golden Tabebuia	1.50 stem ht.	–	3 No.

SHRUBS:

KEY	BOTANTICAL NAME	COMMON NAME	SPECIFICATION	SPACING	QUANTITY
Ac(r)	Acalipha godseffiana	Red Acalypha	0.3 m ht.	0.5 m c/s	75 No.
Ac(g)	Acalipha wilcasiana	Green Acalypha	0.3 m ht.	0.5 m c/c	75 No.
Cl	Cresalidocarpus lutesince	Areca Palm	1.0 m ht.	0.9 m c/c	25 No.
Cr	Croton variety	Croton variety	0.6 m ht.	0.5 m c/c	15 No.
Ep	Euphorbia pulcherrima	Red dwarf poinsettia	1.0 m ht.	0.9 m c/c	15 No.
Hb(s)	Hibiscus snowflacks	Hibiscus snowflacks	0.6 m ht.	0.6 m c/c	50 No.
Pc	Plumbago capensis	Chitrak	0.6 m ht.	0.5 m c/c	60 No.
Tc	Tabernaemontana sp.	Tagar	1.0 m ht.	1.2 m c/c	10 No.
To	Thuga orientalis	Morpankhi	0.6 m ht.	—	25 No.

GROUND COVER:

KEY	BOTANICAL NAME	COMMON NAME	SPECIFICATION	SPACING	QUANTITY
ac	Allocasia sp.	—	0.30 m ht.	0.30 m c/c	02 sq. m
al(r)	Alternanthera red	Red Reep	0.07 m ht.	0.15 m c/c	06 sq. m
bc	Brunfelsia calyciana	Brunfelsia	0.30 m ht.	0.15 m c/c	05 sq. m
dg	Duranta goldiana	Golden duranta	0.30 m ht.	0.30 m c/c	54 sq. m
ih	Iresin harbesti	—	0.30 m ht.	0.45 m c/c	14 sq. m
lc(y)	Lantana camara	Yellow Lantana	0.15 m ht.	0.30 m c/c	11 sq. m
ls(v)	Lantana sellowiana	Violet Lantana	0.15 m ht.	0.30 m c/c	18 sq. m
ne	Nephrolepsis extalta	Fern/Necha	0.15 m ht.	0.30 m c/c	06 sq. m
oj	Ophiopogin japonicus	Bamboo grass	0.30 m ht.	0.30 m c/c	01 sq. m
vb	Verbina sp.	Verbina	0.15 m ht.	0.30 m c/c	08 sq. m

CLIMBERS:

KEY	BOTANICAL NAME	COMMON NAME	SPECIFICATION	SPACING	QUANTITY
Bv	Bougainvellia spectabilis	Bougainvellia	1.2 m ht.	—	10 No.
Cg	Climitis gauriana	Ran Jai	1.2 m ht.	—	06 No.
Pv	Petria volubilis	Petria volubilis	1.2 m ht.	—	10 No.
Qi	Quisqualis indica	Madhu Malti	1.2 m ht.	—	18 No.

PROJECT
PARANJAPE SCHEME'S
'WOODLAND' HOUSING, PUNE.

LANDSCAPE ARCHITECTS
PRADEEP DEVARCHETTI AND ASSOCIATES
24/11. FLAT NO. 15, SHIVAJINAGAR PUNE-411005

Figure 4.4 *Planting Plan – Trees, Shrubs, Ground Cover, Climbers*

Hence, such landscape developments are absolutely essential to improve the overall environmental conditions.

Ref—Landscape Architect-
Pradeep Devarchetti

Study text and the drawings. Imagine a housing project without landscaping and then draw a site plan showing various details for proposed landscaping. This is known as transformation of unused area in a plot. 'Livability' is achieved through landscaping with the construction of a club house, swimming pool, tennis court, childrens' play area, cycle track, amphitheatre, jogging track and lawns.

Reading Exercise

1. Collect information about software for landscaping—'land-cadd' used for planning, detailing for parking, fences/retaining walls, recreation areas, circulation system of roads and pathways. The special features of the software are: (i) landscape design's growth simulator will show plant growth which is based on actual mature heights and diameters of the plants in the drawings, (ii) details for plants are available in plant database, aesthetics, uses, water requirements, common/scientific names, growth rate and service life, (iii) it is also possible to view the result in 2-D or 3-D, (iv) automatic plant table is created with the symbol, quantity, name and size, field information from the database in a specific format, (v) it is also possible to visualise the selected plants on the screen.
2. Prepare a list of items for proposed landscaping work, a schedule showing stages in the work, and the time and expenditure required in each stage.
3. Consider total plumbing work for the club house, swimming pool and landscaping work. Think of a plumbing layout, water storage, etc.
4. A low maintenance landscaping project is needed. Think of essential features for the same.

Case study

The Meadows, Blue Sky with Colours of Nature (Figs. 4.5, 4.6) Plate 4.7

Location:	***Aurangabad, Maharashtra State***
Consultant Architects:	***Nadkarni, Mahajan and Associates Aurangabad.***
Landscape Architect:	***'forethought'—Design Consultants Jayant Dharap, Pune***
Interior Design:	***Porus Master and Associates Mumbai***
Contractors:	***Civil—Rajesh Bharukha, Aurangabad***
Horticulturist:	***Dr. Nigam, Aurangabad***
	Total area—13 acres—5.20 Ha.

Total built-up area of building in phase I is 2185 m^2

Landscape area covers all of 8 acres = 3.2 Ha plus

Area of balance 5 acres = 2 ha

Cost of building civil work	= (₹) 2,10,79,565
Cost of landscaping	= (₹) 32,69,508
Cost of landscape light fixtures	= (₹) 1,40,000
Cost of drip irrigation	= (₹) 4,00,000
Cost of labour	= (₹) 1,00,000
Total cost of landscaping	= (₹) 39,09,508
Year	= (₹) 1995–96.

The resort is spread over 13 acres (5.20 ha) out of which 8 acres have been developed in the first phase and remaining 5 acres (2 ha) is proposed in the second phase. The first phase consists of 36 cottages, set in clusters of six, arranged to form a series of inner courtyards. Each cottage is a single storeyed pyramid in concrete with brick walls and an overlying tiled roof.

Most of the cottages overlook an inner courtyard or the pool. The distinct feature of this resort is stated as "the continuum of flow from the architecture of built spaces into landscape architecture". There is no distinguishing line where one stops and the other takes over. A 1.6 km walk along the periphery of the plot, lined by three rows of trees and shrubs is an enjoyable experience. This attracts attention as the outer most line of the bougainvellia and inner two rows of trees and shrubs have been planted along a zigzag path. The total result is due to the team work of the owner, architect, landscape designer, horticulturist and contractor. Framed by the blue sky and bathed in the colours of nature, the meadows is like an oasis of greenery in a barren stretch of land.

The following are excerpts from an interview with Shri Jayant Dharap, landscape architect with reference to project details and articles published in *Indian Architect and Builder* (Anniversary Issue), 1996 and *Inside Outside,* April 1996.

"Basically, what a landscape designer does, is to create a setting for a building by relating the exterior to the interior. So, it is very important for him to visualise how each and every corner is to be used, the needs of the residents, and how they will interact with the surroundings ... ensure that the building and its exterior form a cohesive unit."

"Landscape designing has caught on faster because of the commercial angle given to it. With increasing competition amongst builders, and a limit to the facilities and finishes that they can provide, they have now turned their attention to providing larger gardens and playgrounds and better landscaping which is probably why the latter has become so important these days."

"The best results are obtained when the landscapist is involved with a project right from its inception. In Meadows, I was involved from the time the site was chosen which resulted in a very early dialogue with the architect, Nadkarni and Mahajan and what came into being was a totally cohesive design, ..." "I found designing a holiday home which was a venture between a private garden and a housing complex, particularly satisfying. One great luxury was space, which is usually restricted in private homes and housing complexes. Besides, I was given a lot of freedom."

"Good landscaping is above all, sensitive to the specified requirements of the programme as well as the unmentioned ones and captures the spirit of the built form or the environment it is supposed to support or surround."

"A sensitive landscape development is 'eco-friendly' in that any undue imposition in the natural existing situation is avoided—be it planting or land form."

"A good design is one in which the designer knows where to stop."

"The cost of landscape development could vary from ₹ 200 to ₹ 600 per m^2, depending on intensity, space for landscapes and development involved."

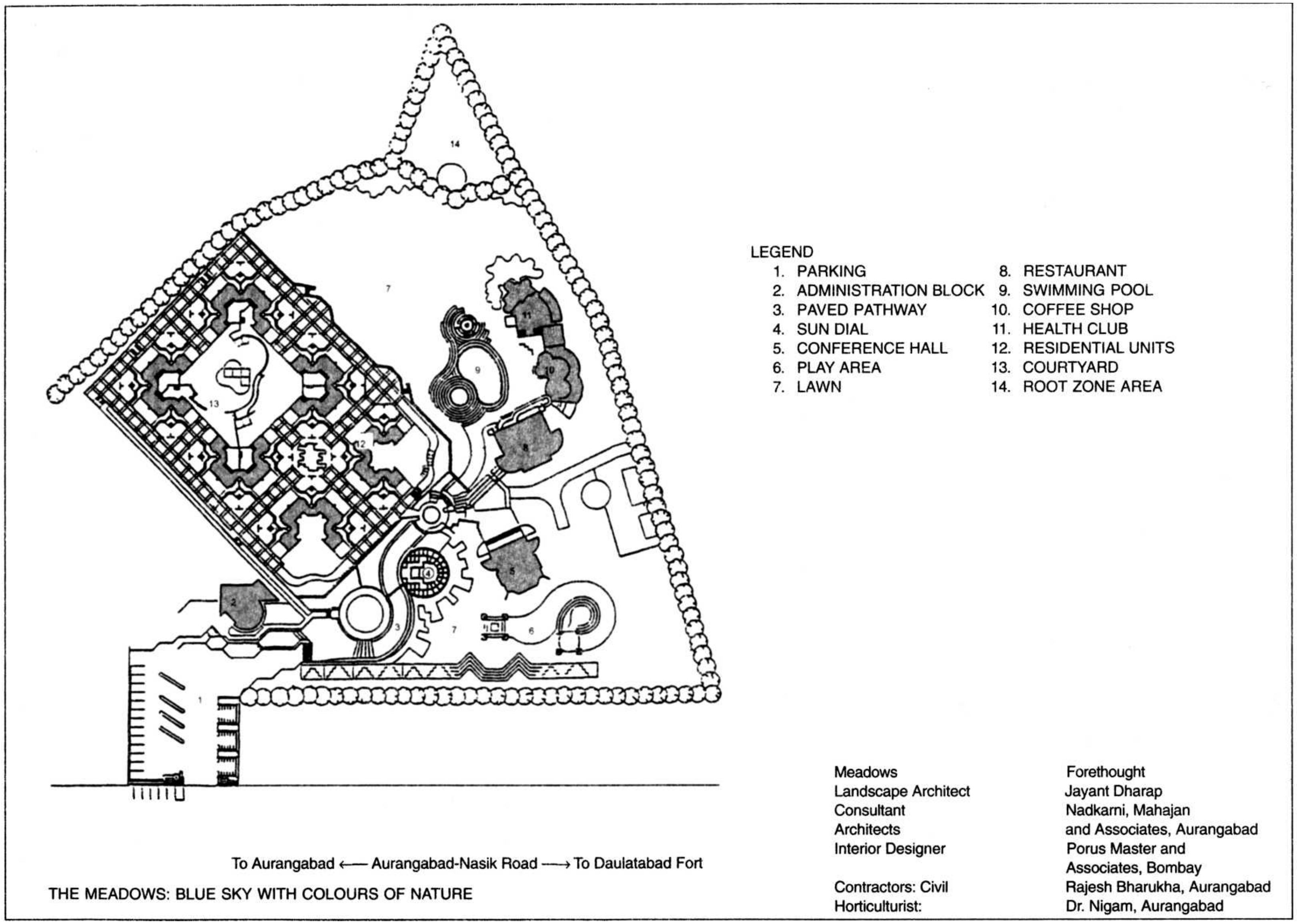


Figure 4.5 *The Meadows – Layout Plan*

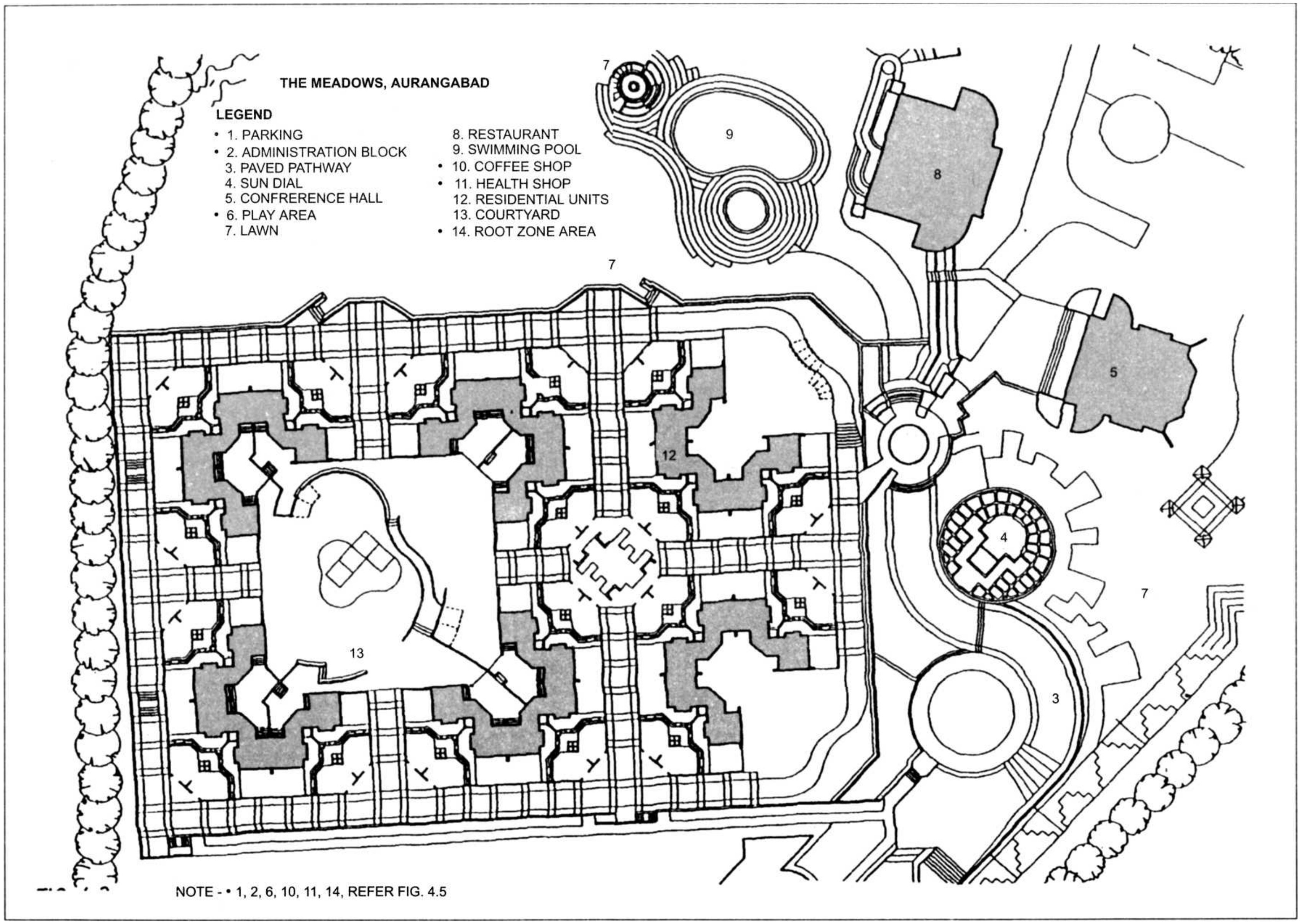


Figure 4.6 *The Meadows – Layout Plan, Details*

Reading Exercise (Figs. 4.5, 4.6) Plate 4.7

Study the text and drawings for this landscaping project.

1. Cost details regarding landscaping work gives an idea about the basic cost. What is important is the cost of maintenance, of the nursery, of drip irrigation system, etc. Collect details for sprinkler and drip irrigation systems.
2. Study the layout plan, from the entrance to various areas at different levels, grouping of areas and architectural treatment. Colour, texture, shape for different materials of paving work, pathways and colourful plantation gradually change the environment and one is mesmerised by the blue sky and colours of nature and the entire view.
3. Collect details for seeding and turfing methods for the development of lawns, water and soil requirements and procedure of maintenance.
4. Collect information for landscape furniture and art objects.
5. Study of successful landscape projects are useful for getting an idea about planning, designing and maintenance. Collect such details by visiting landscape projects.

4.5.3 Estimate for Landscaping Work

The total expenditure consists of the following items as per the design of the landscape:

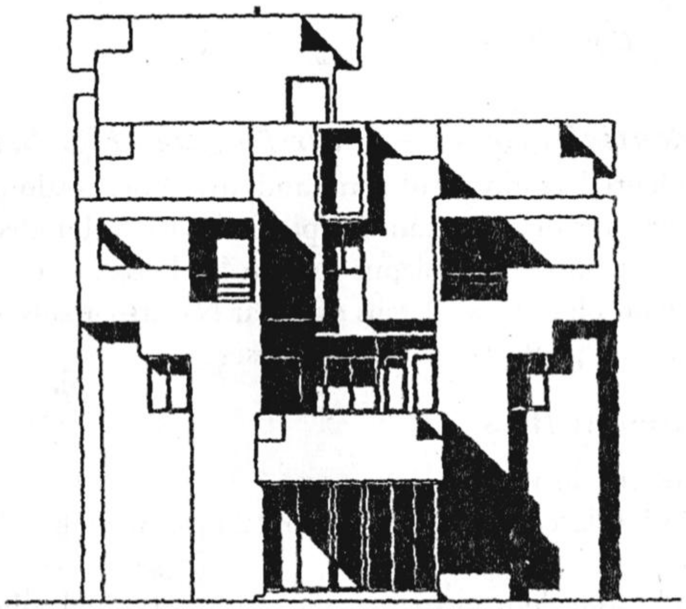
1. Site clearance, levelling work.
2. Construction of pathways, steps, ramps, gates, fences, walls, etc.
3. Water supply system—pump, plumbing, watering system for plants.
4. Purchase of garden soil, fertilisers, plants, for various purposes.
5. Landscape furniture, lighting system, etc.
6. Expenditure for plantation and maintenance in the initial stages.
7. Consultation fees of various specialists.

4.6 PROJECT WORK

1. Collect brochures for plants, their technical details, flowering seasons, etc.
2. Visit different landscaping projects to study details about landscape design, plantation, cost estimates, preparation of project report with drawings and photographs.
3. Visit different nurseries to study various types of plants, their rates, and plantation techniques.
4. Visit gardens around small buildings, bungalows, terrace gardens, lawns of golf course and gardens on hill sides.
5. Prepare landscape designs for (a) bungalow, (b) housing complex, (c) industrial complex, and (d) public garden. This should include site survey, soil survey and preparation of drawings and estimates.
6. Study sprinkler and drip irrigation systems. Study their design details, total expenditure and maintenance cost.
7. Prepare a detailed procedure for planting a lawn in a garden, a lawn on a terrace and a lawn on an uneven surface. Prepare estimates for their maintenance.
8. Prepare detailed drawings for the construction of pavings with different materials—stones, bricks, concrete, and precast concrete blocks. Prepare estimates for (a) construction of base work, (b) concreting, and (c) finishing.
9. Collect brochures for landscape furniture, plant containers, children's play equipments, lighting fixtures and systems, dustbins and their market rates.
10. Study the procedure for waterproofing systems and prepare estimates for the same.
11. Prepare charts to collect data for landscape design—(a) site, (b) climate, (c) soil, (d) vegetation, (e) services, and (f) maintenance.
12. Study different garden styles—Western, Japanese, Mughal, etc. Collect photographs and details of plants of each style.
13. Study different types of fertilisers, their use and precautions for using them.
14. Prepare a project related to the development of a nursery—site selection, layout plan, and care.
15. Prepare reports regarding the role of a civil engineer as contractor in landscaping work. Collect details on different areas, specifications, estimates, etc.

5

PLANNING, DESIGNING AND CONSTRUCTION OF BUILDINGS



Form

"The form of a house arises from human purposes. Forms are therefore expressions of purposes and indeed in a sense are purposes"

Author: Aristotle

Design

"Design is that professional branch of art which combines the aesthetic sensitivity and free creativity of the artist with the scientific knowledge and intellectual discipline of the technician for a social useful purpose"

Illinois Institute of Technology, Chicago

Construction

"Building construction is engineering in action"

Author: Vinita Shah
Book: *Human Resources Development in the Building Industry—A Study in Bombay*

Topics covered in this chapter

5.1 OWNER/PROMOTER AND BUILDER/ARCHITECT

5.1.1 Owner

Beautiful bungalows, flats, attractive skyscrapers, school buildings, cinema theatres, hospitals, markets and many such different types of buildings are coming up every day. The work site for such buildings is always busy with some type of activity. First, there is a vacant plot, then a temporary hut for a watchman is constructed, heaps of sand and metal, bricks and stone start collecting. Gradually the scene changes, and there emerges a superstructure ready with windows and doors, plaster and colour. The same cycle of activity is repeated on every construction site, though the cost may vary. The owner or client may be a person wishing to construct a bungalow, or an industrialist in need of a structure for his new factory, or it could be a businessman intending to invest in an ultramodern air-conditioned cinema theatre. In short, the owner is a person with an intention to construct and erect some structure on his site.

5.1.2 Promoter and Builder

Another agency in the building industry comprises of the promoters and builders. They may be owners of the land or persons interested in investing money in building construction. They may be technical or nontechnical persons. Today, they are the most important people in the creation of the built environment. A *promotor* is a person (or a company) who promotes commercial, residential/or industrial schemes. A developer is a person who develops land with essential amenities, roads, water, drainage and electricity. A builder is a person who builds on the said land. But nowadays, these terms are used interchangeably, as the functions often overlap. Hence broadly speaking, the promoter and builder team can be used to include all works, purchase of the plot, development, construction and sale, maintenance and formation of a co-operative society or registration under apartments. In case of housing schemes, it is the promoter and the builder who with the help of other consultants, control the construction project.

There are two types of ownership housing schemes. In one case, the scheme is developed on a small individual plot of land in a layout where there are one or two buildings. In the other case, development is made on a large plot of land. The flats may be of the same size or of different sizes and the scheme may also have shopping units. This is generally designated as a *housing complex*.

A promoter-builder buys a piece of land and builds flats or apartments. Sometimes, due to the scarcity of vacant plots and land, the promoter buys a plot with some existing buildings.

Case Study

Residential Project—Amar Nagari (Fig. 5.1)

A residential complex of flats and row houses along with common amenities was planned and completed by Amar builders, Pune. The site was situated on Pune-Solapur road in Hadapsar, Pune.

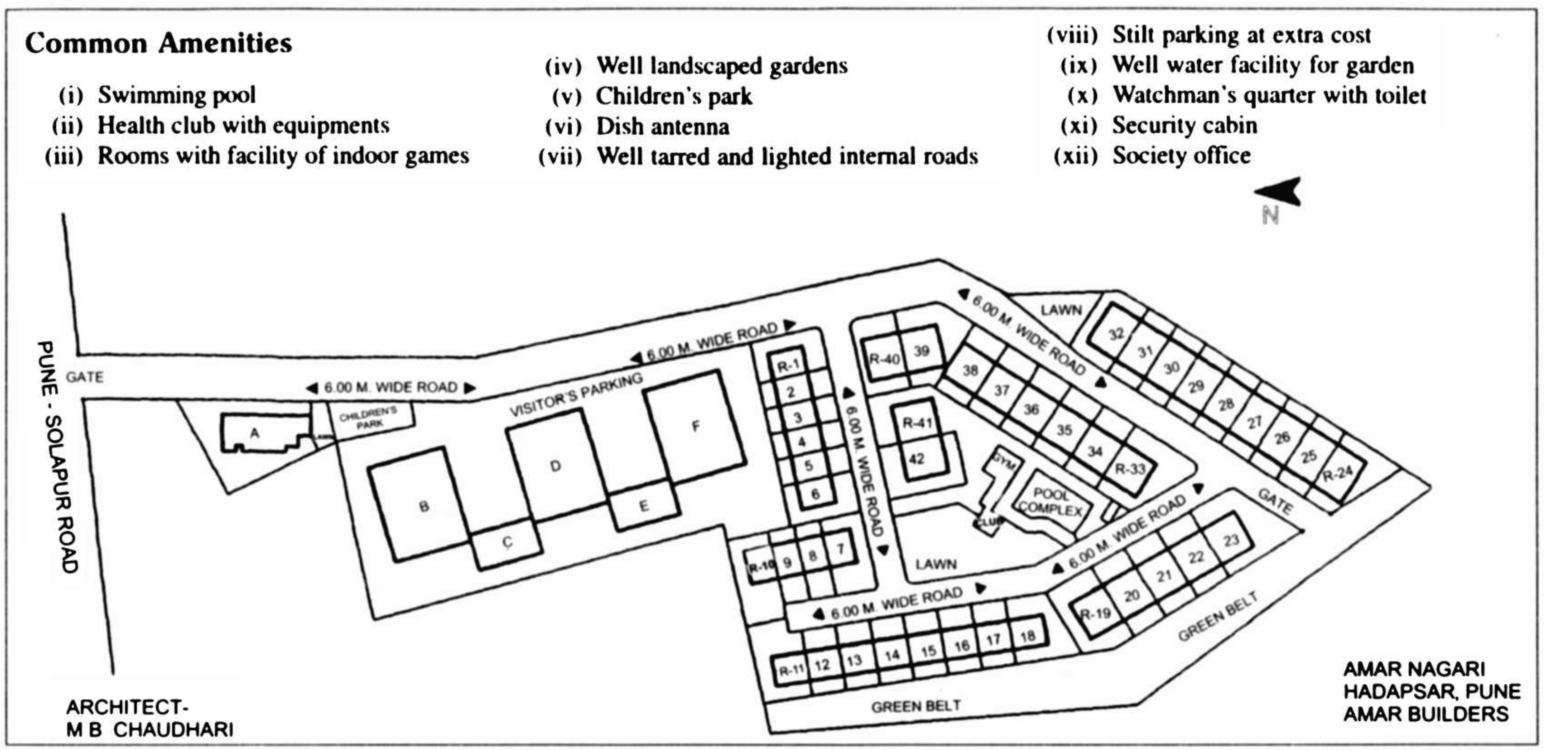


Figure 5.1 *Layout Plan – Amar Nagari, Pune*

The layout plan shows details of Amar Nagari—roads, open spaces, club and swimming pool, flats and row houses.

Amenities in flats

(i) Flooring in white mosaic tiles.
(ii) Marble kitchen platform with 1200 mm high coloured glazed tile dado.
(iii) Bathroom floor in spartek tiles with 2100 high tile dado.
(iv) W C floor and 1200 mm high dado in coloured glazed tile.
(v) Aluminium sliding windows with fixed grill.
(vi) Waterproof flush doors for toilets and balcony.
(vii) Veneer flush door for the main entrance and commercial flush door for bedrooms.
(viii) Single loft in bedroom and kitchen.
(ix) One fan and geyser for each flat.
(x) Concealed copper wiring and pipe fittings.

Amenities in Row Houses

(i) Spartek tile flooring for hall, bedroom and kitchen.
(ii) Flooring in spartek tiles with 2100 mm high, coloured glazed tile dado in toilets.
(iii) Black granite kitchen platform with 1200 mm coloured glazed tile dado.
(iv) White mosaic treads for staircase.
(v) Aluminium sliding windows with fixed grill.
(vi) Single loft in kitchen and bedrooms.
(vii) Concealed copper wiring and pipe fittings.
(viii) Boiler with mixer in one toilet.
(ix) Commercial flush doors for bedrooms and water proof flush doors for toilets and terraces.
(x) Designed veneer flush doors for the main entrance.
(xi) One fan for each row house.

Case Study

Y-Nis Y-Nos Apartment Project, Pune (Figs. 5.2 to 5.8)

Salient Features

Inspired by Perfection

"When it comes to your home, you perceive it as a perfect dwelling place." With this in mind, we present a project, Y-Nis Y-Nos. The project site is behind Hotel Vaishali, on the Wrangler Paranjape road and commands a majestic view of deccan gymkhana and the surrounding areas, with its bustling shopping centres, hotels, restaurants, schools and colleges.

This promises to be an ideal home for individuals who love the city and like their houses to be located at the centre.

The Developers

"Archway Homes and Properties" is a professionally managed company having a team of qualified engineers and chartered accountants who are well-cemented with a professional outlook. Thus, it is a construction company that stands for building perfect homes.

The Scheme

Y-Nis Y-Nos residential complex has an aesthetically pleasing elevation with an exotic blend of architecture and design. This building has seven storeys with two lifts. Y-Nis Y-Nos offers two, three and four-bedroom terrace flats and duplexes. To add to the convenience of the residents, flats have more than adequate parking space. The terrace flats promise the best. One could cultivate one's own garden which could be used to entertain guests with barbecues, parties or just to enjoy a cup of tea in the evenings.

Amenities

Individual Specifications

Flooring	**Bathrooms**
Kitchen—Kotah flooring Living room—Marble flooring Bed rooms—White mosaic flooring Toilets—Ceramic tile flooring	Ceramic tile dado, Powder coated square fittings including hot and cold mixing units Pastel coloured sanitary fittings and exhaust fan
Windows	**Electrification**
Powder coated aluminium sliding windows with security grill and marble sills	Concealed electrification and 'M K' switches
Kitchen Otta	**Common Facilities**
Jet black granite kitchen otta with stainless steel sink, instant geyser, water purifying system and exhaust fan	Intercom connections for the building, satellite dish antenna connection. Two lifts. Solar heating system for hot water in bath rooms. Society office and toilet on ground floor. Landscaped garden with water body.
Developers	**Creditors**
Archway Homes and Properties, Pune	Architects—Vishwas Kulkarni and Associates, Pune Legal Advisor—Viol Khaladkar RCC consultants—YS Sane and Associates. Environment Consultants—SN Joshi,

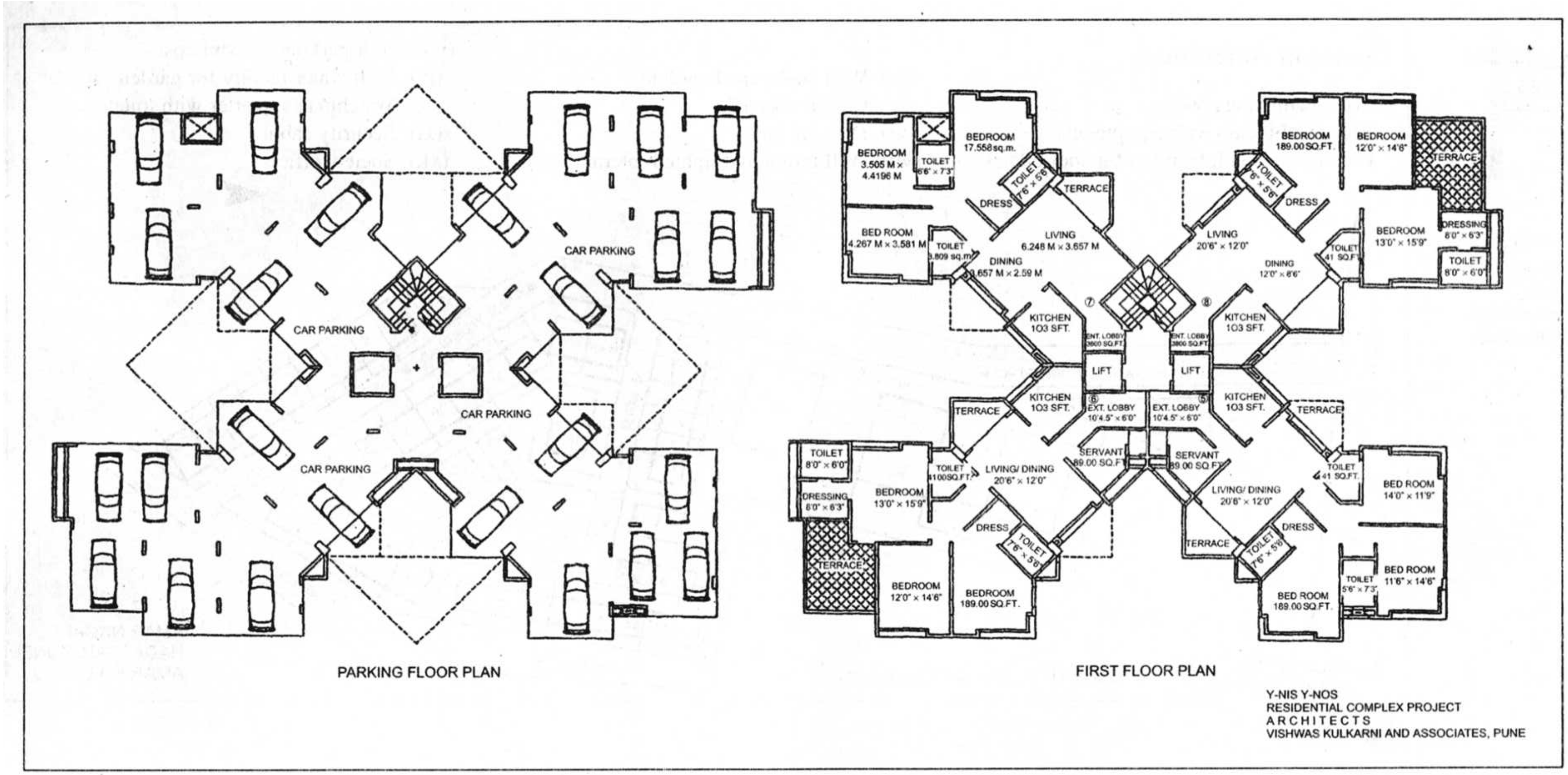
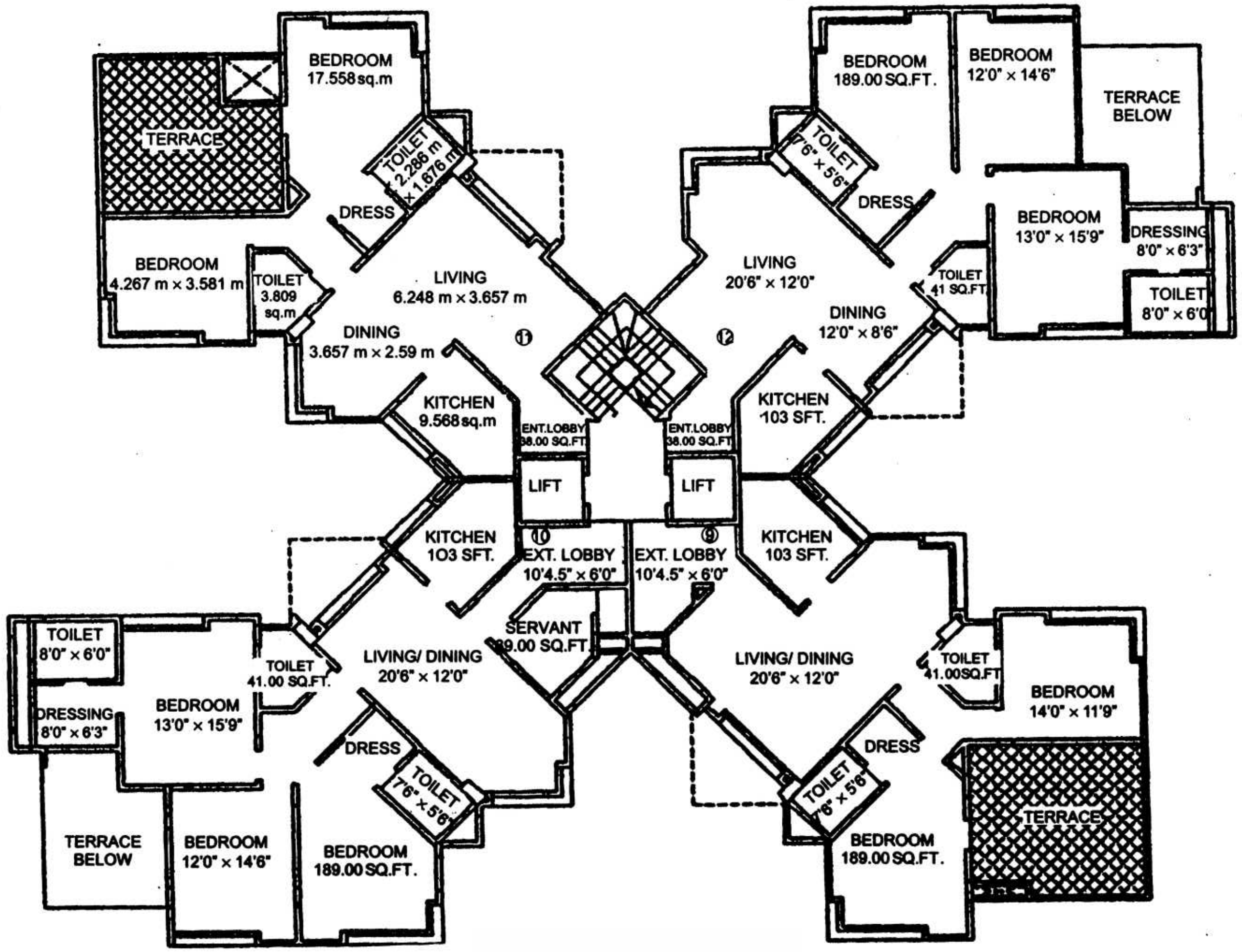


Figure 5.2 *Y-NIS Y-NOS Parking and First Floor Plans*

Reading Exercise (Figs. 5.2 to 5.8)

Study all the plans in detail. Hold group discussion with reference to the following points:

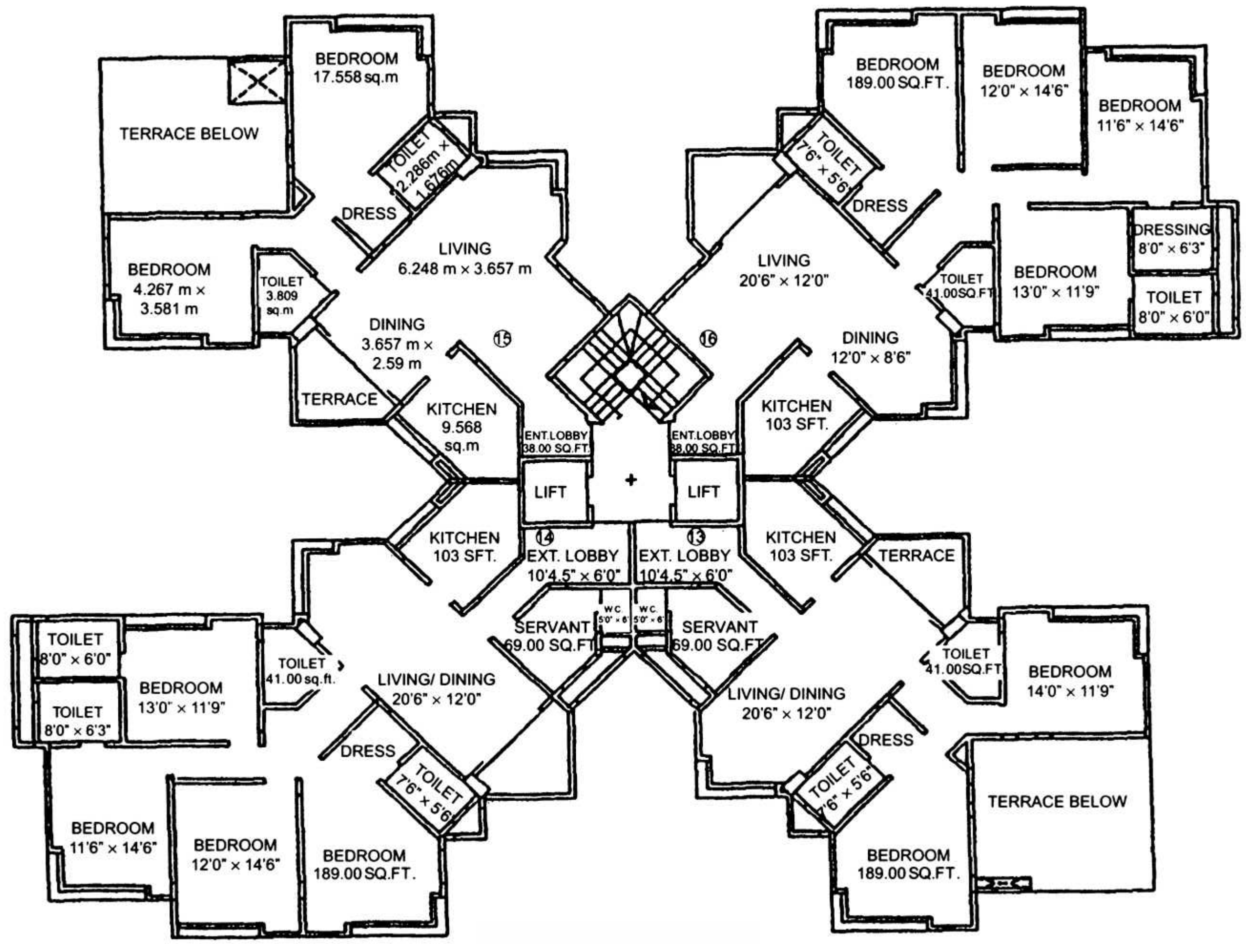
1. Structural planning of the total project.
2. (a) The structural frame work, placing of columns and beams.
   (b) Cantilever projections for the terraces.
   (c) Considerations in designing, concreting at different levels, checking of form work and reinforcement.
3. What are the specifications for the provision of a lift? Collect details for lifts—cost, special features, maintenance and safety considerations.
4. Study rules for water supply, drainage system, fire safety and electrical services given in the handbook of National Building Code of India-2005. Study locations of toilets, kitchens on different floors and their suitability for efficient, economical, easy to repair water supply and drainage system.
5. Comment on the necessity of a terrace, rules for terrace and different treatment of the same to make life pleasant, happy and closer to nature.
6. Collect data for different methods of water proofing for toilets and terraces.
7. Convert all room dimensions in MKS units.



Read
7'-6" × 5'6" = 2.286 m × 1.676 m
12'-0" × 8'6" = 3.657 m × 2.590 m
103 sq.ft = 9.568 sq.m
38 sq.ft = 3.530 sq.m

Y-NIS Y-NOS
RESIDENTIAL COMPLEX PROJECT
ARCHITECTS
VISHWAS KULKARNI AND ASSOCIATES, PUNE

Figure 5.3 *Y-NIS Y-NOS Second Floor Plan*



Read
20'-6" × 12'-0" = 6.248 m × 3.657 m
14'-0" × 11'-9" = 4.267 m × 3.581 m
189 sq. ft = 17.558 sq. m
41 sq. ft = 3.809 sq. m

Y-NIS Y-NOS
RESIDENTIAL COMPLEX PROJECT
ARCHITECTS
VISHWAS KULKARNI AND ASSOCIATES, PUNE

Figure 5.4 *Y-NIS Y-NOS Third Floor Plan*

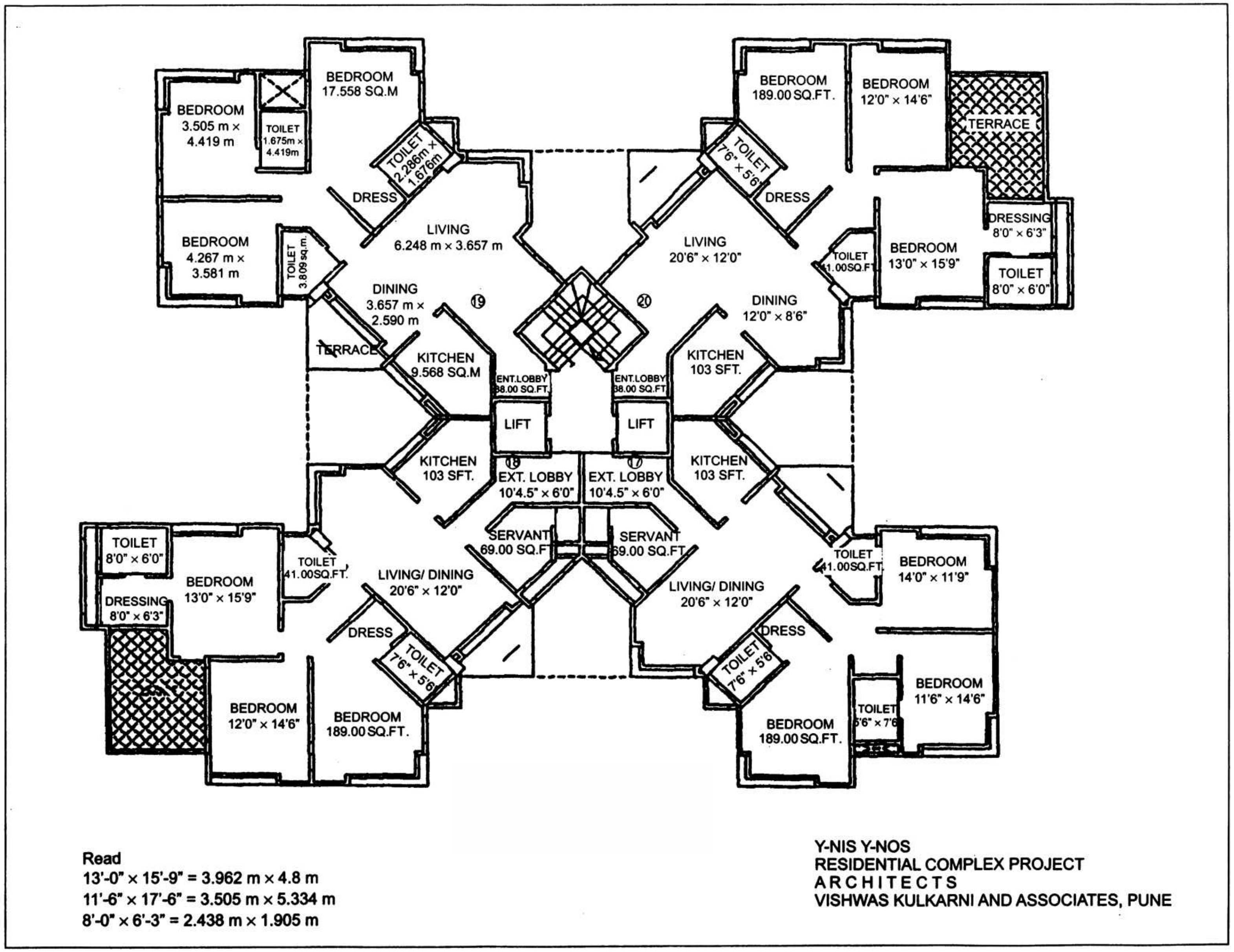


Figure 5.5 *Y-NIS Y-NOS Fourth Floor Plan*

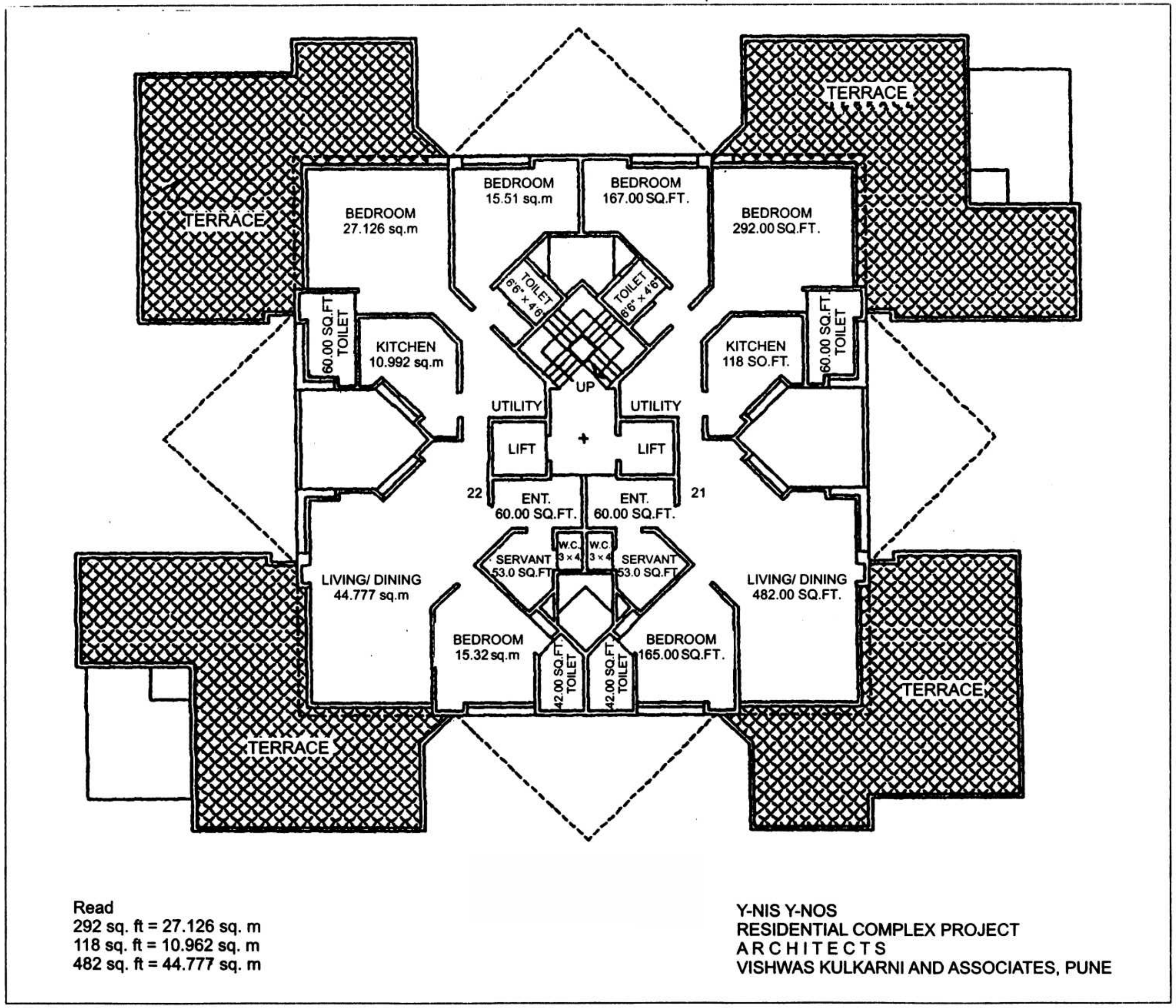


Figure 5.6 *Y-NIS Y-NOS Fifth Floor Plan*

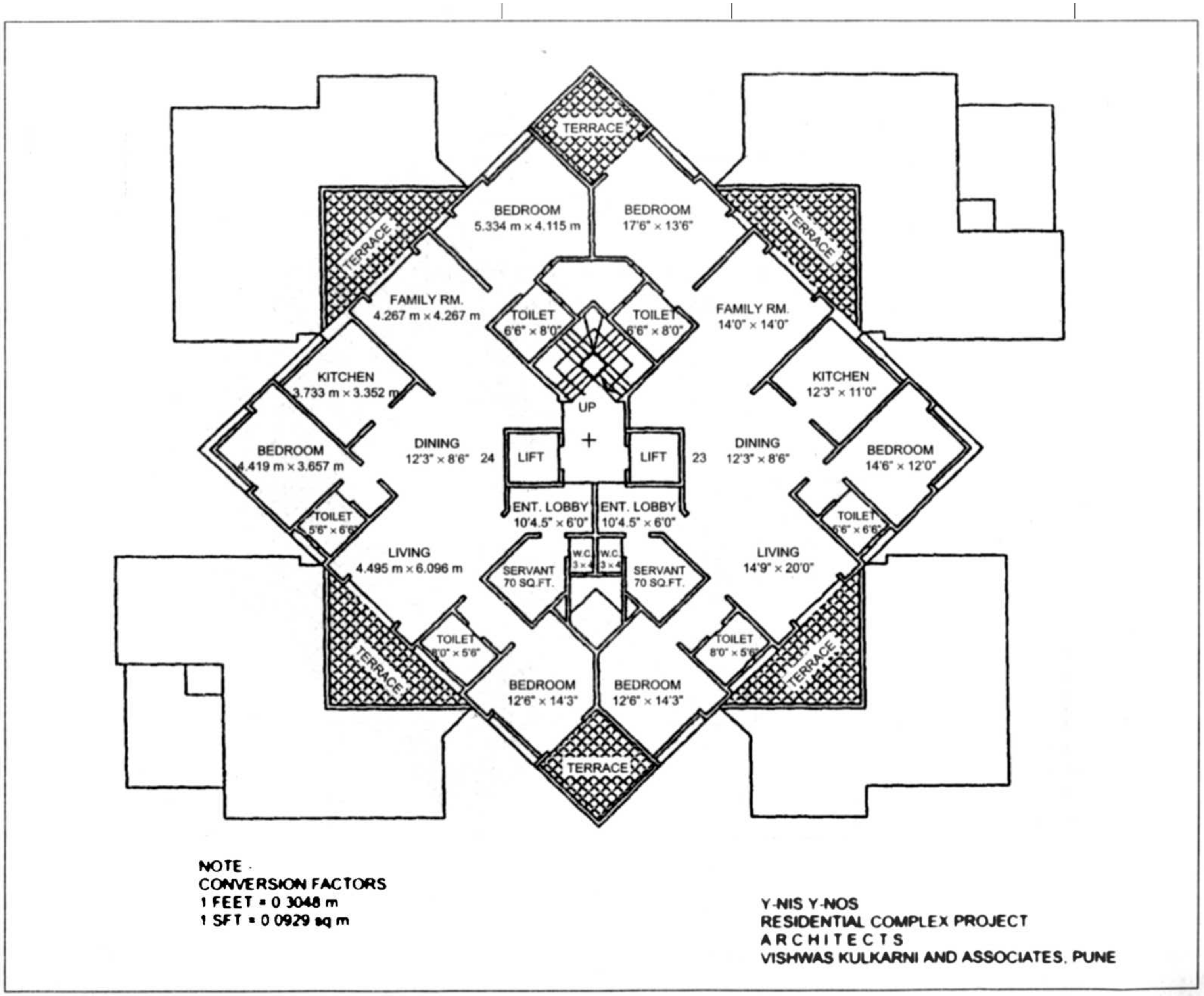


Figure 5.7 *Y-NIS Y-NOS Sixth Floor Plan*

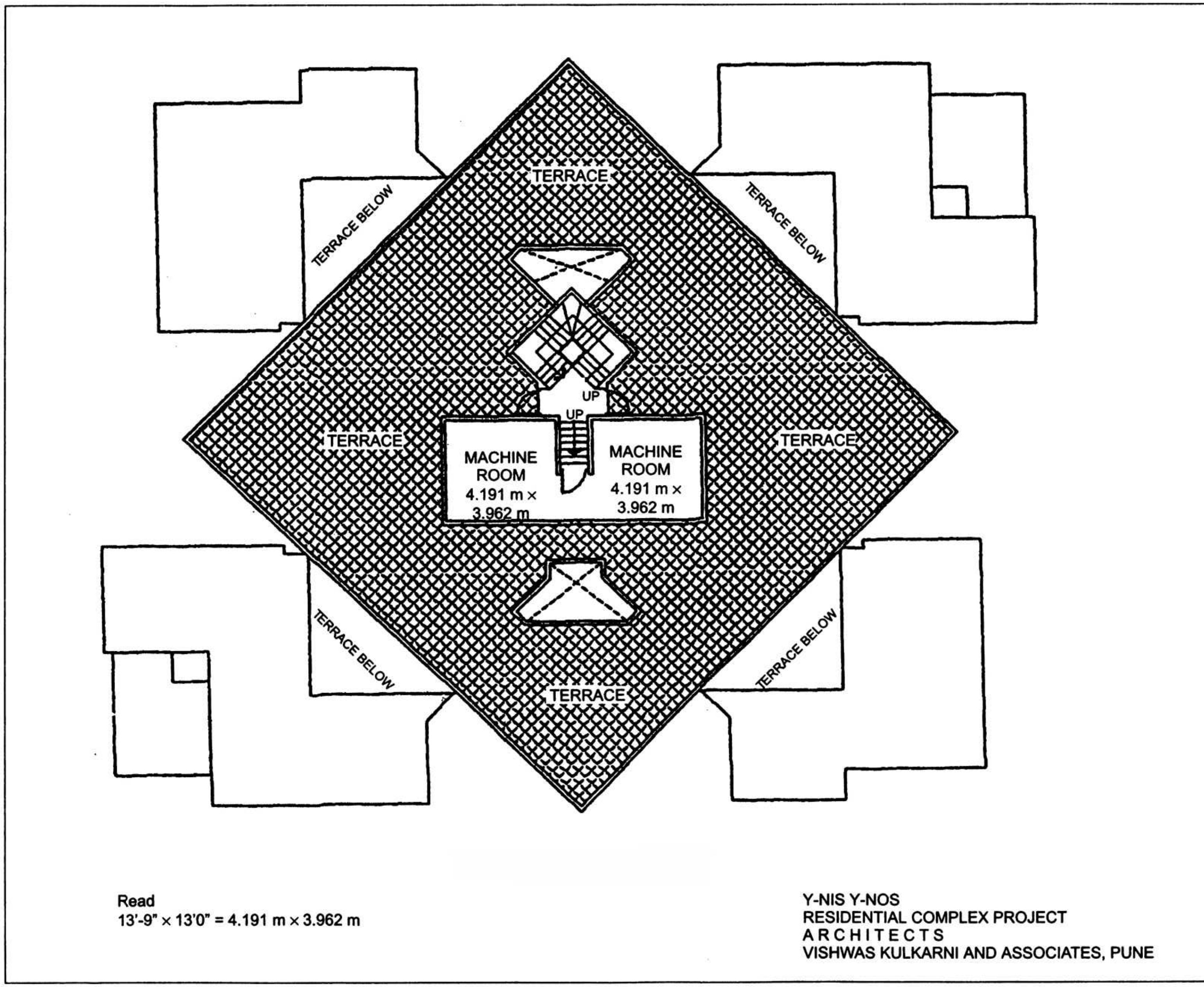


Figure 5.8 *Y-NIS Y-NOS Terrace Floor Plan*

Case Study

Apoorva Apartments, Pune (Figs. 5.9 and 5.10) Plate 5.2

The Brief Text by Architect Ravi Gadre, Pune

Since it was a builder's project, obvious requirement was to consume full FSI.Thus, maximum number of balconies and terraces for six luxurious flats of three and two bedrooms, full parking under stilts were to be provided.

The Design

The apartment block consists of only six tenements. This limited number enables to have three sides open for every block. For good light and ventilation, the central duct allows cross ventilation. Stilt and first floor flats have terraces, made available due to reduced number of bedrooms in each flat. The top two flats are of duplex type. Thus, the terrace to every flat is the main feature. This terracing and the volumetric composition surging towards the southern side gives a fragmented facade to the road on the northern side. The alternative placing of cupboards further reinforces and balances the symmetrical communisation. A space frame completes and includes sky in the composition, offers a sense of roof and also frames the distant view of the city and Parvati providing a seen from the upper duplex units.

The circular *chajjas* and watersheds soften down the overall cubic volumes, offering powerful composition, devoid of current populistic "treatment" oriented approaches usually taken as "requirements" by the builders. The composition further enhances with a matured colour scheme. The total area at the stilt level is concrete surfaced for minimum maintenance due to less number of units. Conventional construction materials and technology have been used.

Outcome

Compositional skill, Sciagraphy (Science of shades and shadows) as a design element, proportion and colour, power of inherent qualities of volumes, true meaning of beauty, are the real instruments and cause of good architecture.

Project Information

Architect	: Ravi Gadre, Pune
Design team	: P G Limaye, Ravi Gadre, Anu Tanksale
RCC consultant	: Mr. Kishor Jain
Promoters	: Khivnsara Associates
Contractor	: Mr. Girish Khivnsara
Area	: 510.96 Sq. mt.
Cost	: ₹ 27 lakhs (approx.)
Date of completion	: April 1997

Reading Exercise (Figs. 5.9 to 5.10)

1. Study all plans, circulation arrangement—vertical and horizontal, in a building, location of toilets, passage area, etc. Furniture arrangement is shown; check and justify windows and door locations. Give your comment on planning.
2. Prepare a list of working drawings and details essential for preparation of estimates and useful for site supervision.
3. Prepare a list of standard specifications for all essential items.
4. Think of 'fit and forget' type specifications for certain items for least maintenance.
5. State the advantages of aluminium windows. Collect details for powder coating of aluminium sections—procedure, different shades of colours, cost, etc.
6. A structural plan shows various members essential for the structural frame work. Study structural plan, location of columns, beams, etc. What is meant by HB? Note the numbering system for columns and beams. Study different systems for marking one way and two way slabs and cantilever projections. Why is a HC—(hanger column), provided in a stair case? Study details of reinforcement for stairs. Visit any site to study the RCC details for columns, beams, slabs and stairs. What are the advantages of tor steel bars? State the properties of reinforcing steel.
7. What is meant by a space frame? Why is it provided?
8. State the considerations in planning of an apartment building.
9. What are the essential documents and details of submission drawing to be submitted to the plan sanctioning authority such as the municipal corporation?
10. What is the procedure for plinth checking? Why is it necessary?
11. Study the role of an architect, structural designer, project engineer and promoter and builder.
12. Prepare a programme for maintenance of apartment buildings with reference to (i) essential record drawings of site and buildings, (ii) specifications for items, (iii) list and addresses of agencies involved in execution of the project, periodical, before monsoon and after monsoon maintenance schedules and agencies for maintenance, and (iv) special information for water supply, drainage system, electrical layout, water storage reservoir and pumps—their capacity, agencies for maintenance for soft and hard landscaping.
13. Prepare a check list for the following items: (i) layout for foundation work, (ii) checking of form work, and centering work, (iii) testing of concrete blocks procedure and record for testing, (iv) polishing for flooring (v) concealed wiring system, (vi) structural steel work, and (vii) fixtures and fastenings for doors.
14. Collect details for calculation of various materials: (i) brick work, (ii) concrete work, (iii) tiles, (iv) steel, and (v) fixtures and fastenings for doors.
15. Prepare check list for handing over apartments to the owners—various items, points to be checked, care to be taken while using apartment, instructions for maintenance.

Case Study

Sacred Heart Town, Wanawadi, Pune
(Figs. 5.11 to 5.23 and Plate 5.3)
Text by Architect-Laxman Thite

One of the meanings of the word Sacred, besides holy, is dedicated to some purpose. Similarly, the meaning of the word Heart, besides an important organ of the body, is the seat of one's innermost thoughts and secret feelings. So while designing the Sacred Heart, both the words were taken together for the efforts, feelings and skill dedicated to achieve the best results for the ultimate user of this housing project.

Introduction

The Sacred Heart town is an environment-friendly mini township, spread over about 15 acres of land, (6 ha) situated at Wanawadi, one of the fast growing parts of Pune city and in the vicinity of one of a historical heritage landmark 'Shinde Chhatri'. It comprises of residential accommodations of various sizes and commercial premises.

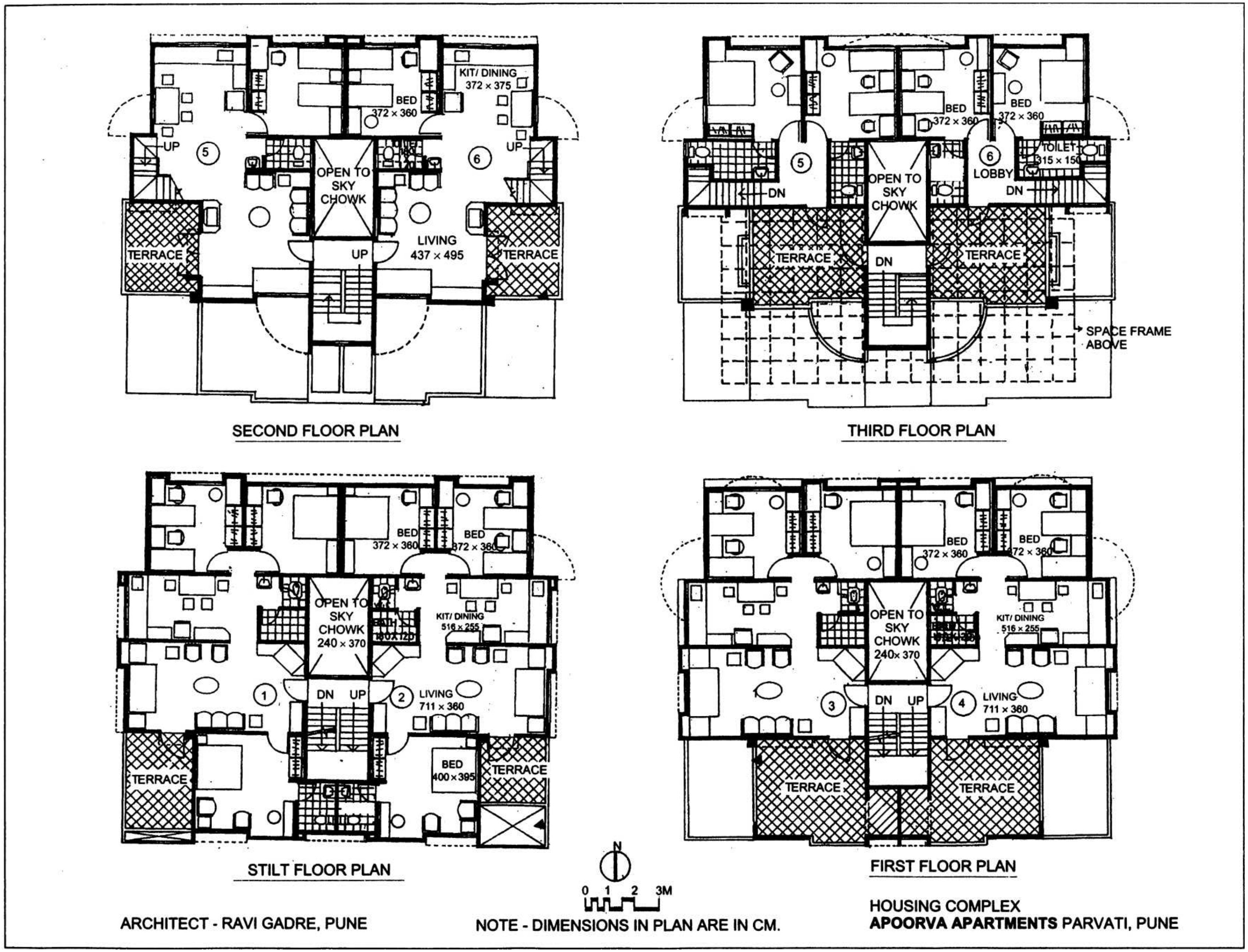


Figure 5.9 *Apoorva Apartments – Floor Plans*

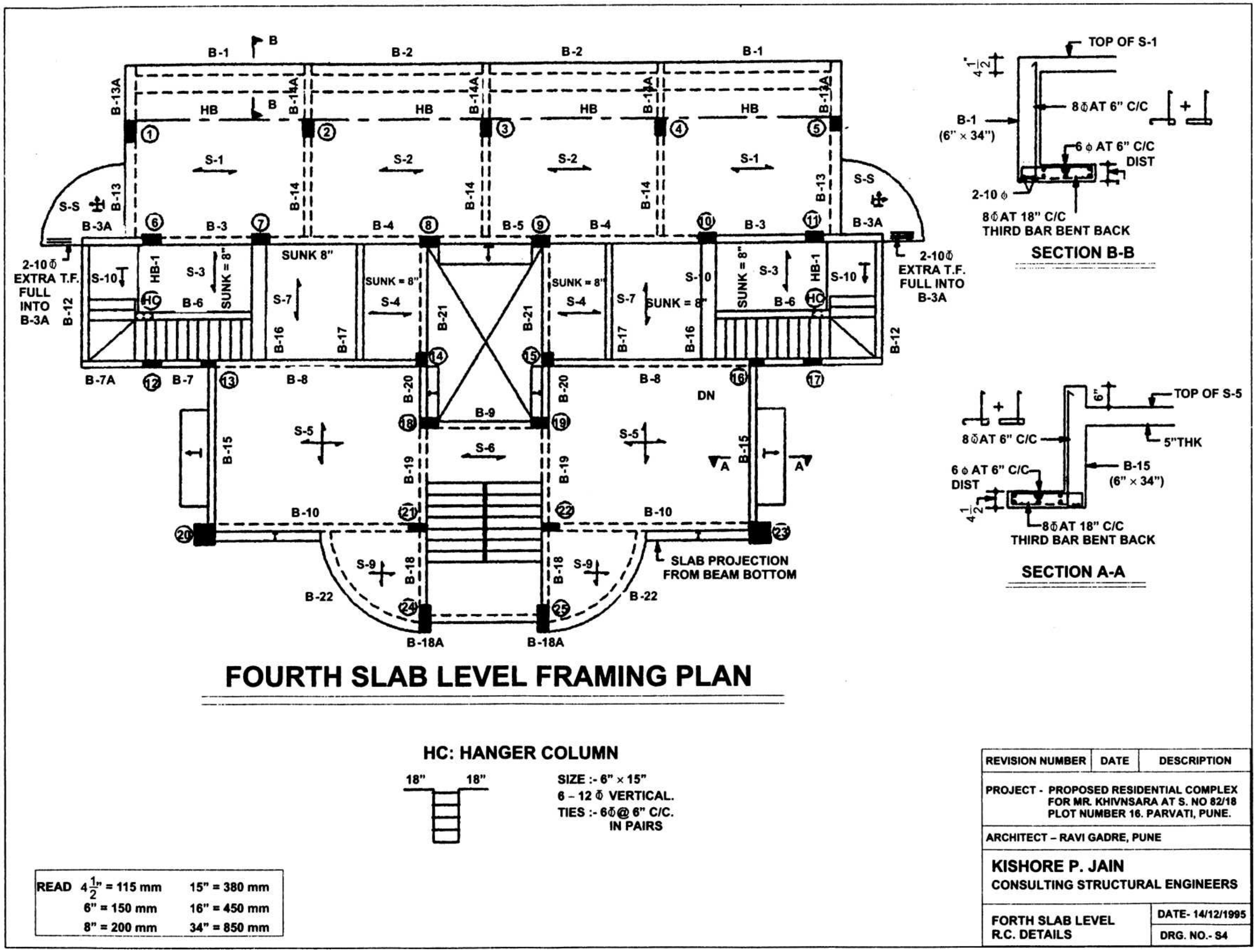


Figure 5.10 *Fourth Slab Level R C Details*

The project is divided into four phases, two of them have been completed, the third is under construction and the fourth is yet to be started.

The Team

Architect	:	***Mr. Laxman Thite and his staff***
Structural consultants:	:	***Mr. C E Godse and his staff***
Developers	:	***M/s Devi Construction Co.***
Landscape architect	:	***Mr. Vikas Bhosekar***

The Design Problem

To provide a group housing consisting of various sizes of residential as well as commercial premises for the residents of Pune.

The Planning Constraints

1. The natural subdivision of the site due to D P Road.
2. Some of the D C Rules and ever-changing policies of PMC about D C Rules.
3. Different zoning in the same site.
4. Restriction on areas of various accommodations.

The Site

(a) *Location*: S. No. 75/2/2B, Wanawadi, Pune. The site is fronting on 18.0 m. wide D P Road, Shivarkar Marg, leading to Pune Solapur Highway. The site is in the vicinity of Shinde Chhatri, Padma Vilas Palace, Wanawadi Gaothan, Wanawadi Bazar, S R P F. establishment. It is surrounded by other residential projects.

(b) The site is somewhat 'L' shaped, divided by 18.0 m wide D P road, running North-South. As per the development plan of Pune city, the West side falls in the residential zone and the Eastern side falls in a Public-semi-public zone. The topography of the land is generally plain, having normal gradient of slope, and with black cotton soil. The hard strata is available at an average of about 2.4 m except at some pockets.

The Brief Requirements

(a) Twin bungalows, with luxurious amenities and attached private garden. Built up area about 150 sq. m.
(b) One bedroom flats having carpet area of about 50 sq. m.
(c) Two bedroom flats having carpet area of about 80 sq. m, some with attached private terraces.
(d) Three bedroom flats having carpet area of about 100 sq. m, some with attached private terraces.
(e) Small shops having carpet area of about 25 sq. m.
(f) One big showroom.
(g) A recreation club house with swimming pool and facilities for lawn tennis.
(h) Common elevated water storage tank.
(i) Adequate parking space.
(j) Children's play area.
(k) Controlled entries to the complex.

Design Philosophy

The architect believes that simplicity is the mother of beauty and obviously, form follows function. The same principles have been adopted while designing the project.

The Planning Approach and Solutions

The Layout

The following aspects were primarily considered while designing the layout:

(a) The 'L' shape of the site controlled the placement of the various buildings. The concept was to provide buildings with open space, to avail the natural openness and the breeze. Separate block of flats were designed instead of one contiguous building to have maximum sides open to the flats.

Considering the direction of the evening breeze, twin bungalows having lowest height (G + a) were placed towards the far west side, then the multi-storeyed buildings were placed with the top two floors with private terraces. The buildings towards the far east, the side of the D P road were multi-storeyed buildings without any terraces, to avail the maximum possible breeze.

(b) D P road passing from north to south through the site. The shopping arcade was planned along side of the D P road, to add to the financial viability of the project. While designing the shopping arcade, the entries as well as other activities of residential and commercial users were segregated to have security from the commotion in the commercial areas. Additional front setback of 10 m, an average was left to accommodate the additional parking spaces for visitors and shop owners. These shops also provided the essential needs of the residents with minimum travel of time.

(c) The hierarchy of the open space was maintained to achieve maximum openness and provide pleasant views of the surrounding flora and fauna from within the flats. Open space for common gathering and private open space for children's play area and individual private gardens were provided with appropriate sizes in the following order:

1. ***Main open space***: includes jogging track, stage, and space provided for common gathering. This open space is surrounded by buildings—A, B, C, D, E, F, G, H, I, and J. At the northern end, stage and gathering space was designed. At the southern end, elevated water storage tank was planned as a focal point of the vast elongated open space.
2. ***Secondary open space***: In this area, a small club house, health club, tennis court and swimming pool have been provided for in-house health care and sports activities.
3. Small open spaces were provided surrounding the buildings M, N, O, P, Q, to accommodate children's play areas, wherein children play safely.
4. Private marginal open space was left around twin bungalows to have their own private garden, where they could spend their mornings for breakfast and/or relax in the evenings after a hectic day.

Internal Roads and Infrastructure

Due to the shape of the site, it was decided to provide two main entrances, one for each flange. While planning the internal roads, due care was taken to segregate the vehicular traffic and the pedestrians pathways, by providing foot paths. Additional open space was designed to have the parking space specially meant for visitors, alongside the internal roads and open spaces. These parking spaces were again segregated with open spaces either with landscaped barriers or difference in ground levels. The internal service lines such as drainage, water, telephone, and electrical lines were properly planned so that they would not overlap each other. All the service lines were laid outside the asphalted area of the demarcated roads to avoid the excavation of the roads in case of maintenance.

Buildings and Building Plans

All apartment blocks were designed on stilts to provide ample parking space. Brief specifications are:

(i) Ceramic tiles flooring
(ii) Marble mosaic tiles flooring
(iii) Marble top kitchen platform resting on M S angle, without vertical support to provide the trolleys and to ease the cleaning below.
(iv) Concealed plumbing
(v) Circuit breaker and concealed electrical wiring
(vi) Masonry walling
(vii) Cement plaster

For external facades, a family of earthen colours (cement paints) along with white body was chosen to give harmonious and decent aesthetical look to the buildings. A contrast in colour was avoided. Sloping roofs were provided with a brick red colour to have an impression of mangalore tiles, a rural element which blended perfectly with an urban structure.

1. ***Twin bungalows*****:** Independent lawns, private gardens and attached terraces for bedrooms, individual covered car parking, comfortable sizes of living, dining, and bed rooms.

2. ***Buildings A, B, and C*****:** Three bedroom flats with comfortable sizes of living, dining and bed rooms. Wider (2.0 m wide) internal passage of multi-purpose uses to accommodate essential commodities such as washing machine, *dhobi* box, ironing platform, common wash basin, etc.

3. ***Buildings F, G, H, I and J*****:** It is an interesting composition of buildings. Structurally, these five buildings were connected only on the ground floor so that they could have easy occess to the area of shopping, taking the advantage of the frontage of main D P road. On upper floors, each building stood apart. However, at the rear side, the wings were joined to have continuous rhythm in the elevation, when seen from the open space and jogging track, without affecting the space between each flat.

The ‘ Y’ shaped form of the block was derived to have maximum sides of each flat open to the surrounding atmosphere, and to avoid overlooking from one flat to another.

One flange was designed parallel to the D P road, to house the shopping units on the ground floor. It is important to note that each shop had its own toilet unit. The other two flanges being at the rear side drive way, provide additional space for manoeuvering of vehicles on the ground floor.

At the junction of buildings I and J, taking the advantage of the corner and the natural ground level, a big showroom had been designed with independent parking in the basement. To break the monotony of elevational features of shopping arcades, different features to this show room were added.

Each wing at the rear side had one bedroom flat and two bedrooms flat, designed in such a way that they could be combined into comfortable three or four bedroom flats. Thus, the flexibility of requirements was offered, if the need arose, keeping in mind the prospective market.

Wider balconies (1.8 m) were provided for comfort during leisure time.

These were provided with wider staircases and lift lobbies.

4. ***Buildings D and E*****:** These were similar to buildings F, G, H, I, J, except for the shopping area. No easy access to shopping was provided as these were inside the complex.

5. ***Buildings M, N, O, P, Q and U*****:** Three bedroom flats with separate dining rooms.

Wider staircases and common lobbies were also provided. One of the bedrooms was designed at the main entrance for multiple use. This bedroom could be used as a servant’s room, if required. It had direct separate entry so that it could be segregated from the main flat. The owner had another alternative to rent out this bed room with an attached toilet to the care taker in the event of not using the flat for a long period. This bedroom being little apart from the main flat, could be used as a guest bedroom also.

Virtually there was no internal passage. A dining space was provided from where the other two bedrooms were accessible.

Comfortably sized toilets (1.5 m x 2.4 m) were provided. Cross ventilation was provided into almost all rooms.

The upper two floors accommodated two bed room flats with attached private terraces.

6. ***Building*****:** Three bedrooms flats with separate dining, wider staircases and common lobbies, wider (2.4 m) covered sitouts attached to master bedroom and wider (2.0 m wide) internal passage for multi-purpose use to accommodate essential commodities such as washing machine, *dhobi* box, space for drying clothes, ironing platform, common wash basin, etc. It also avoided cramped feeling inside the flats. The upper two floors accommodated two bedroom flats with attached private terraces.

7. ***Club House*****:** With a view to provide sport facilities within the complex, and to offer facilities required for daily exercise and health care within the complex, the club house was provided. It had the following features:

(i) A swimming pool along with toddler pool.
(ii) Steam and sauna bath, gymnasium.
(iii) Adequate changing rooms, toilets and showers.
(iv) A multipurpose hall for small gatherings and yoga.
(v) Open air lawn for morning exercises.
(vi) Tennis court
(vii) Terrace over the club house for social gatherings and parties.

8. ***Entrance Gates*****:** Two massive and elegant entrance gates were provided with a watchman cabin to control the traffic and to provide security. Instead of providing a simple arch, a depth was given to form a canopy and shadow below, so that a visitor could pause for a while before entering the complex. Additionally, it provided a sort of grandeur and created an impression that one was about to enter a good and desirable, yet disciplined environment.

Theme of Elevation

The general theme had been basically evolved from the elements (later slightly modified) of Pune’s historical/heritage buildings such as Visharmbag Wada and Shinde Chhatri, in the context of today’s architecture easily and commonly executable in Pune.

The main elements were:

(i) Sloping weathersheds to balconies and sitouts and parapet walls.

(ii) Open type M S railings for balconies and sitouts with square modules.

(iii) Brick, plastered pillars with fragile corbelling, as if supporting the sloping roof above, also acted as stiffeners for railings as well as other projections.

(iv) Arched features for weathersheds, windows, balconies to provide a closer unobstructed view of the exterior, which also helped to break the monotony of horizontal bands or projections. Although different features were used, the composition of the same had created an unusual and pleasing rhythm in the overall complex,

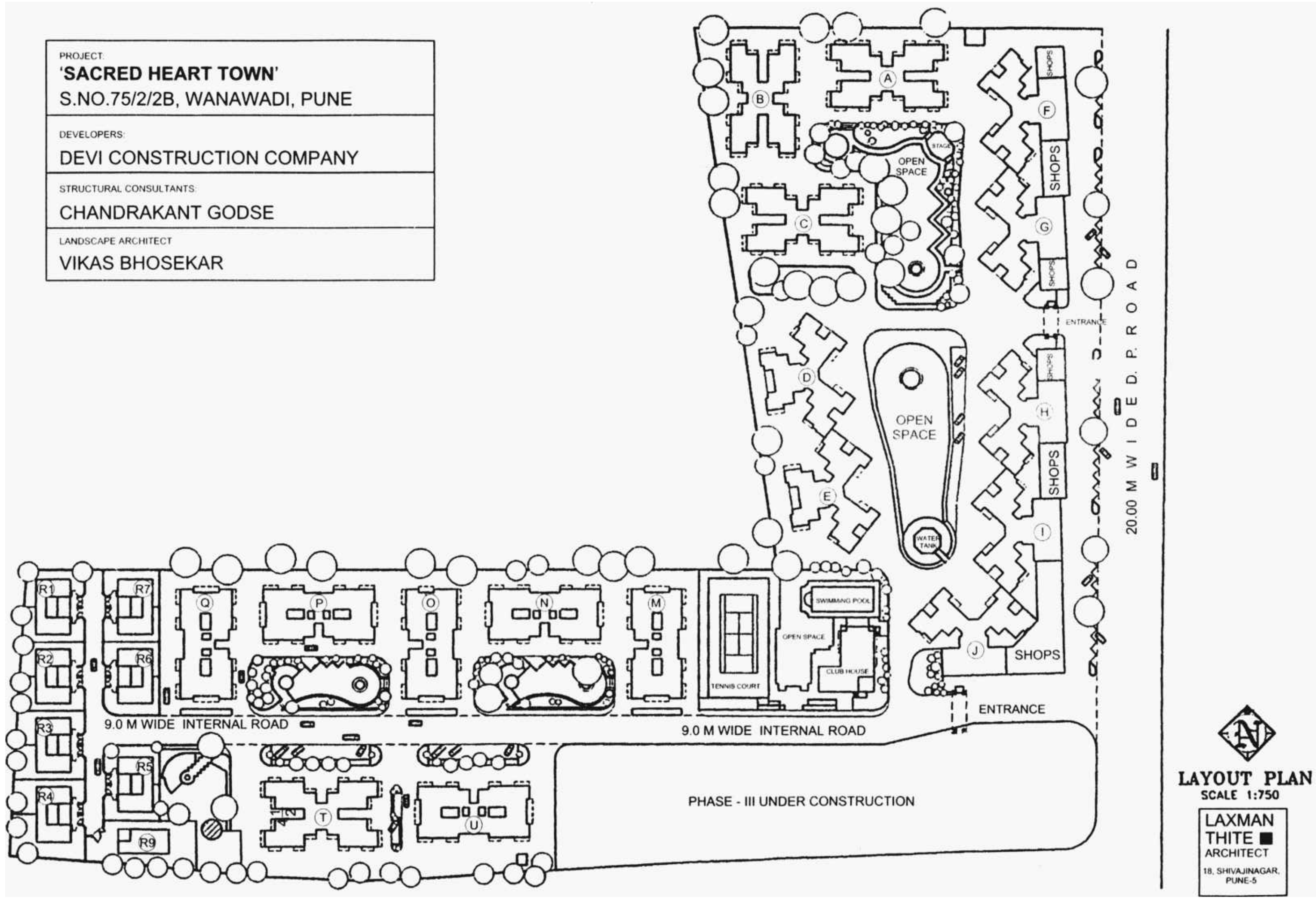


Figure 5.11 *Sacred Heart Town – Layout Plan*

without the monotony any where. The elevational features were purely functional to provide the protection from weather. Additionally, it enhanced the aesthetical look of the individual building as well as the whole complex. The sloping roof at the parapet of the top floor had been provided to protect the walls from rain water which prevented the leakage from the terrace into the room and created a sense of full stop to the rising structure.

The circular columns with pedestals in front of shops with sloping roofs over them provided protection to the shoppers, and created a feeling of separation of individual shops.

Few Green Words From Landscape Architect

The open space planning and the division created an impact of open planning. The open space in each building cluster acted and played an important role in the layout.

As the total planning rotated around these open spaces, an effort was made to make the landscape more functional, aesthetical and economical because of the scale of the project.

The major elements hence used in the landscape of these open spaces were with less civil work and more plantation work. Lighting in the garden was restricted to street lighting only.

The basic aroma of architectural planning of placing around the open spaces had been highlighted by introducing various activities in these spaces. Jogging track, stage for common gathering and fountains with seats around them, were introduced to achieve maximum utilisation of space for recreational purposes.

The club house and swimming pool were designed with a special boundary wall and on a slightly elevated ground to achieve privacy and seating around the deck. The plantation played an important role in the total landscaping. The internal

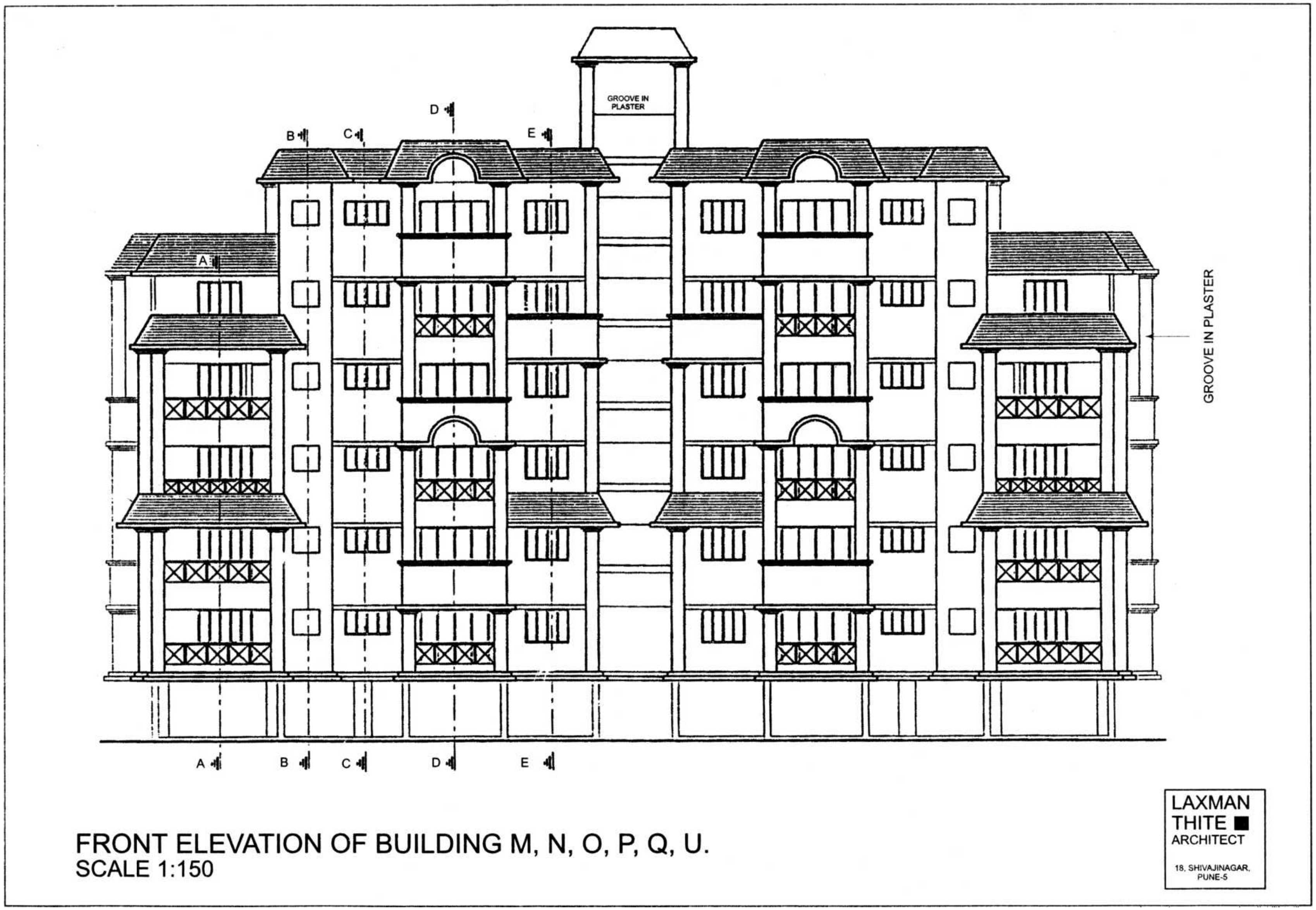


Figure 5.12 *Sacred Heart Town – Elevation*

roads were planted with avenue trees. Various evergreen shrubs have been planted in landscaped gardens to add more colour and variation which created an unique ambience in the total complex.

Few Concrete Words from the Structural Consultant

The buildings were with varied floor provisions ranging from G+1 for twin bungalows to P + 6 for apartment blocks. Some of the buildings had shopping podiums at the ground floor.

The structures were simple column beam RCC frames with M-20 grade of concrete. The quality of the concrete had been maintained significantly, under the guidance of Mr. Harish Baney of M/s Devi Construction Co. The layout of rooms, elevational features, and parking layout in stilts influenced the column positions and orientations.

Because of varied soil conditions some of the buildings were founded on bearing piles 500 mm dia, some were founded on pad footings on strata with safe bearing capacity ranging from 20 t/sq.m. to 40 t/sq.m.

Superstructure beams with preferred depth (730 mm) and width (150 mm) were generally used. This depth bridged the distance between the lintel level and floor level. Steel consumption to a fair level contributed to elevational projections.

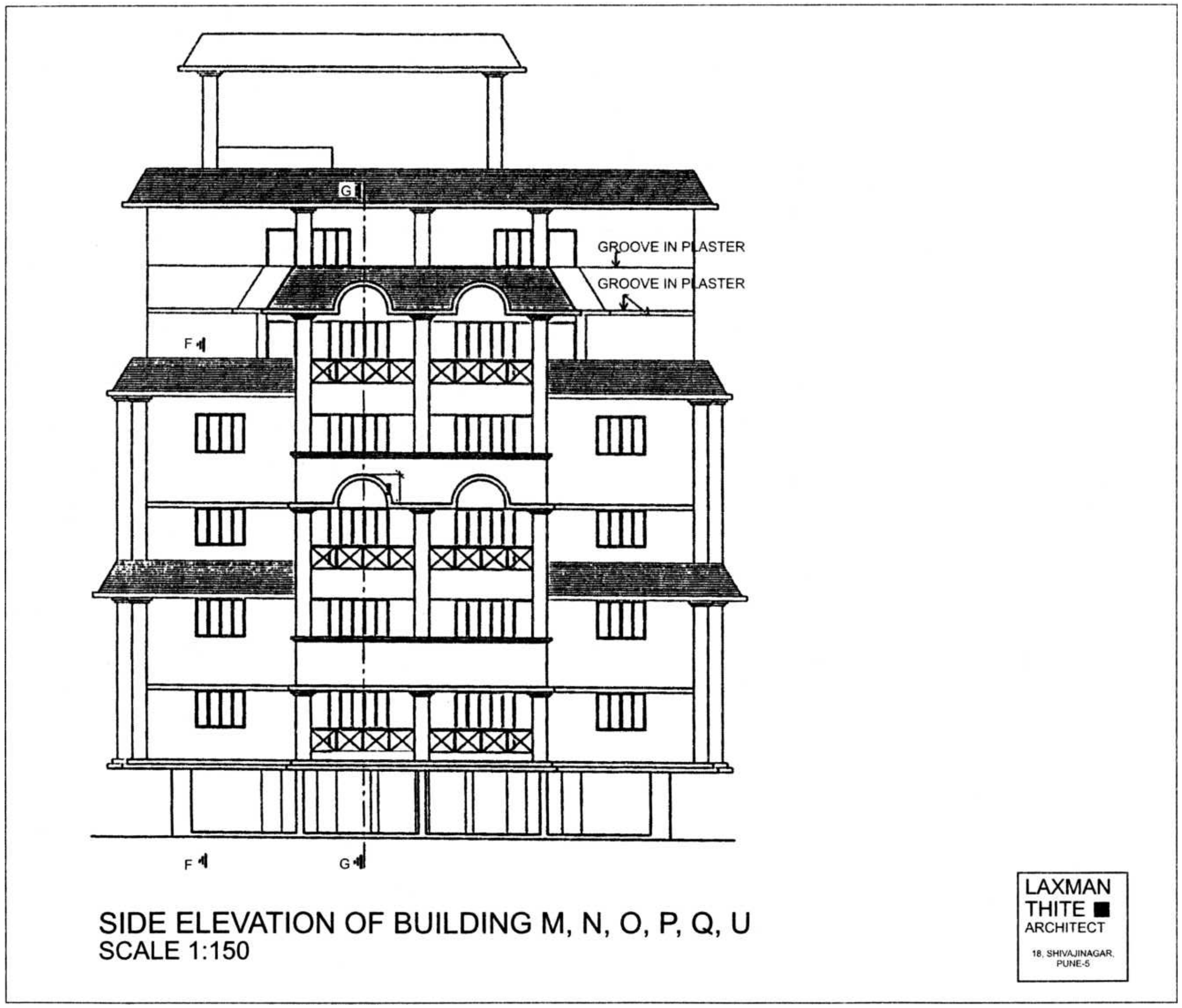


Figure 5.13 *Sacred Heart Town – Side Elevation*

The elevation demanded careful placement of beams on external walls. The position of the external beams were decided to keep the extra load due to elevational projections at the minimum level.

The Contractor and the Owner Promoters

Recently, the promoter and contractor company, one and the same in this case, M/s Devi Construction Co., run successfully under the guidance of Mr. K P Baney, was awarded ISO 9002. The architect, Laxman Thite, feels that M/s Devi Construction Co. deserves to be thanked for making this complex the best place to live in.

Synopsis

(i) Openness in layout
(ii) Designed to suit Pune's urban character
(iii) Environment-friendly design
(iv) Optimum utilisation of the space
(v) Segregation of commercial and residential areas, provision of essential shopping
(vi) Provision of day-to-day needs of health and sports activities
(vii) Useful elevational features to have protection from weather
(viii) Well-planned traffic circulation, wide driveways and parking facilities
(ix) Compact but comfortable sizes and designing of rooms, most comfortable for the user
(x) Planned at macro and micro levels
(xi) Quality construction

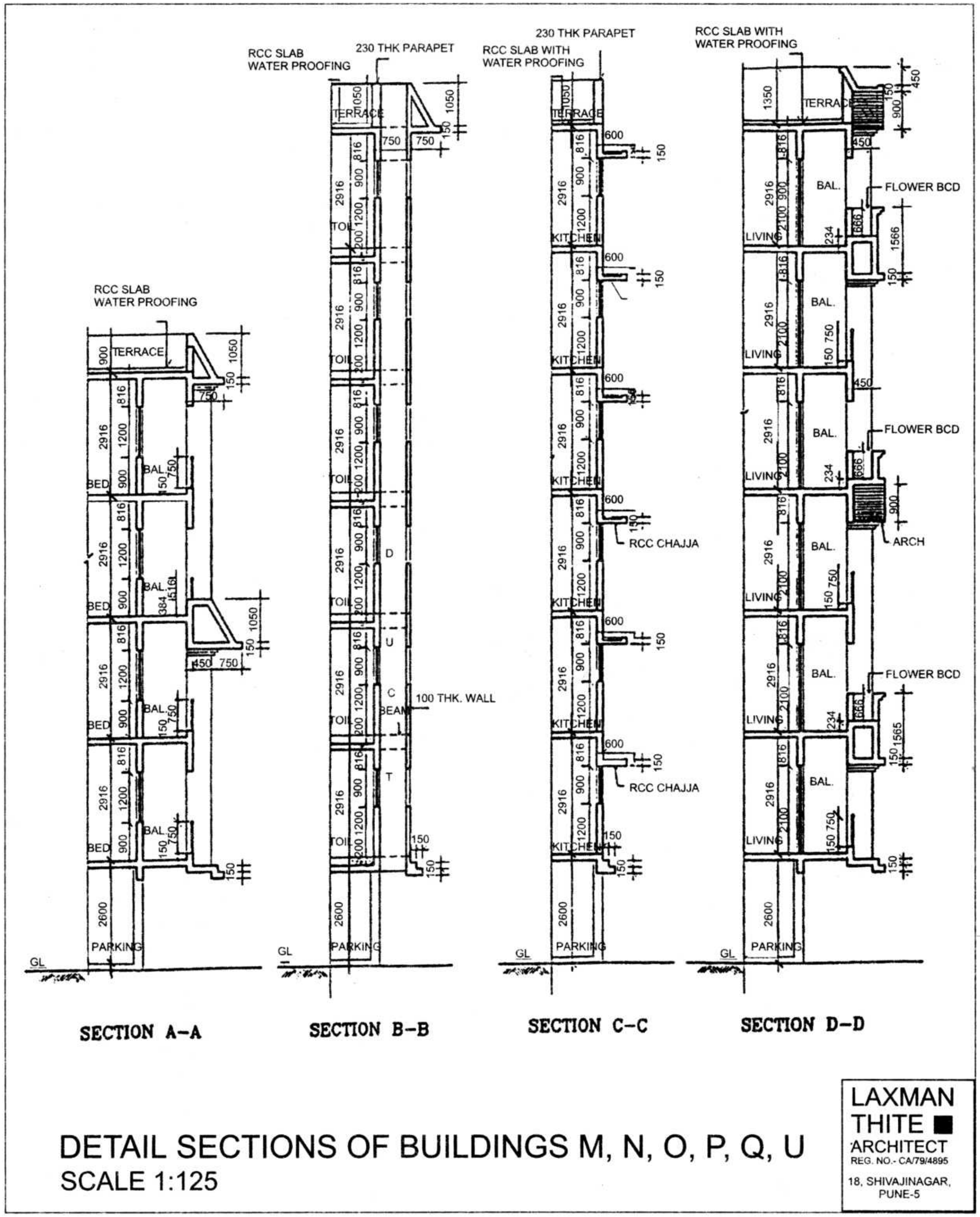


Figure 5.14 *Sacred Heart Town – Sections of Buildings*

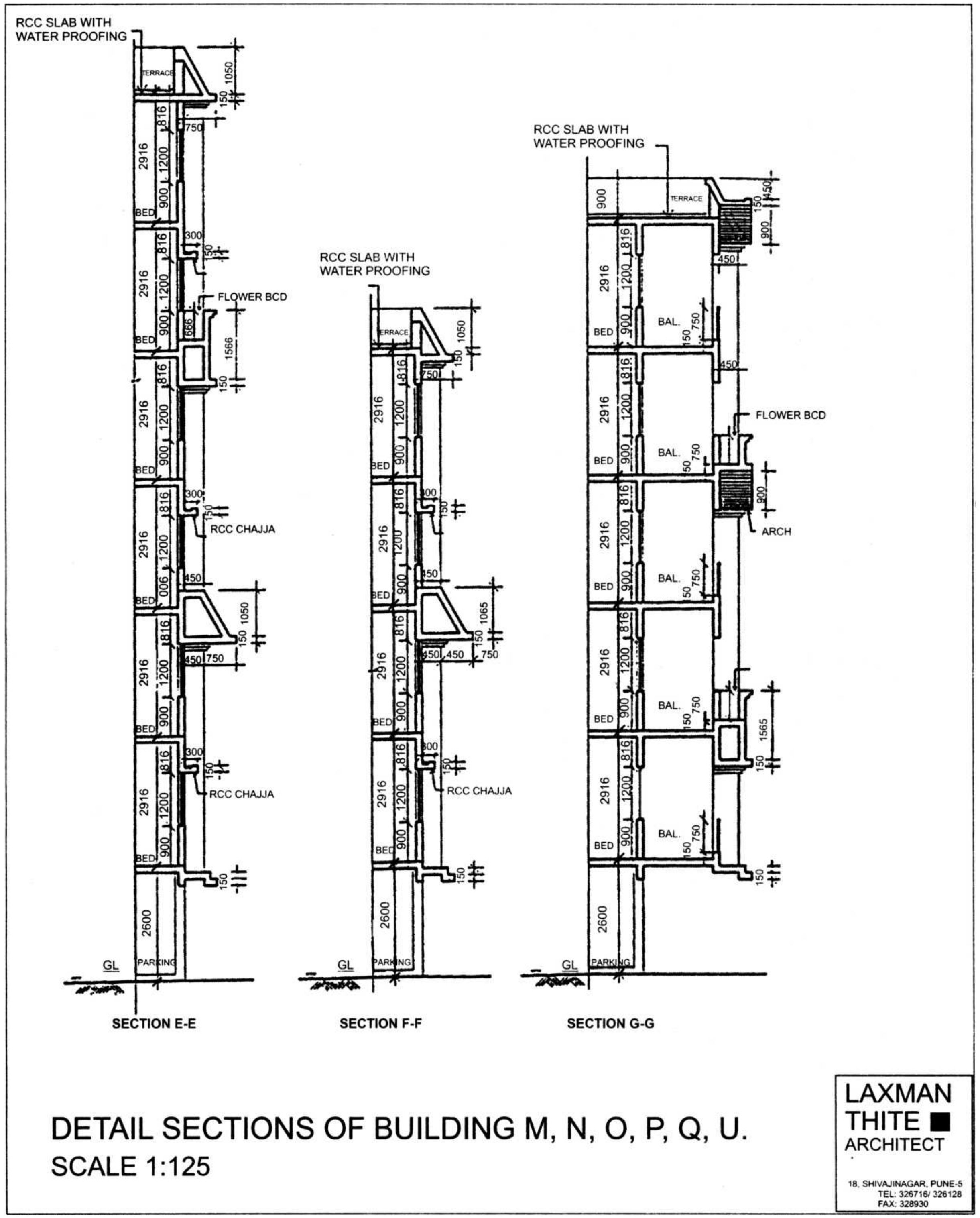


Figure 5.15 *Sacred Heart Town – Sections of Buildings*

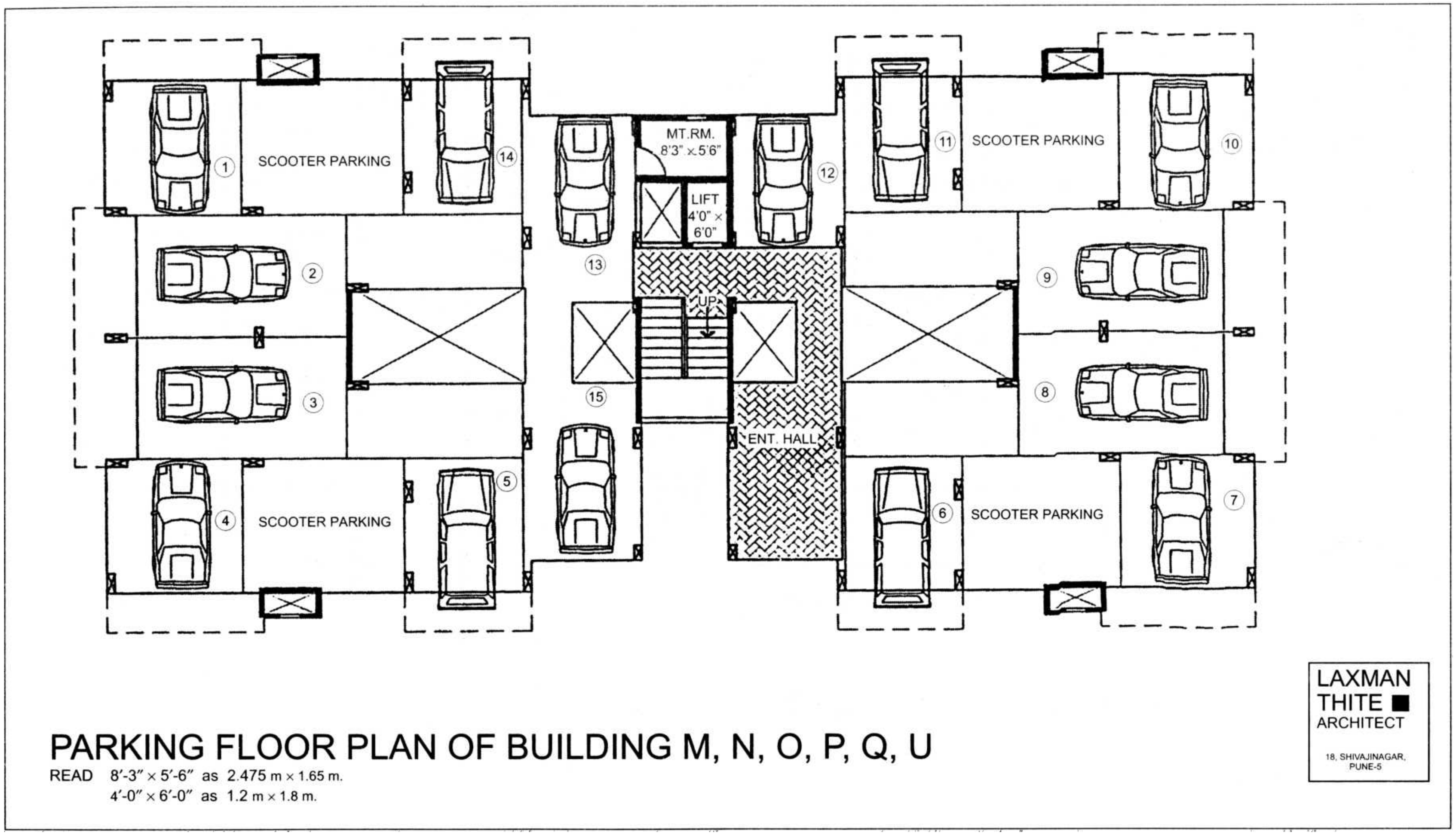


Figure 5.16 *Sacred Heart Town – Parking Floor Plan*

Reading Exercise (Figs. 5.11 to 5.23)

Study all drawings in detail and comments of the architect regarding the project site and requirements of the clients. Proposals for different flats of various areas, type of buildings, shopping and other amenities and finally the size and shape of plot which demands skills of a planner to plan within the rules regarding FAR, marginal distance from plot boundaries, distance between two buildings, area, length and width of road, open spaces, location of entrance gates, etc.

Water supply for drinking purpose and for fire fighting, drainage layout plan and electrical layout plan should be efficient, economical and with minimum maintenance expenditure.

Creation of an acceptable environment with livability inside and outside the building and in the complex is a challenge to the promoter and builder, architect and the team of consultants. This long-term investment of the client should give his family physical and psychological comfort, happiness and satisfaction.

1. How many different types of buildings are planned?
2. Study different plans with reference to orientation.
3. All drawings are computer aided.
4. Typical repetition in the design is essential for speedy construction. Study elevations and typical sections A, B, C, D, E, F, G. Note that masonry work is minimum because of RCC beam depth 730 mm and *chajja* above windows. What are the other advantages?
5. Study different floor plans, furniture arrangement, location of toilets and balconies in M, N, O, P, Q, U buildings.
6. Buildings F, G, H, I, J are with shops. Store and W C in every shop is a good consideration. Study parking area details and location of columns and division of parking areas.
7. How many flats are provided per floor in buildings F, G, H, I, J? How many are symmetrical per floor? Study 'voids'.

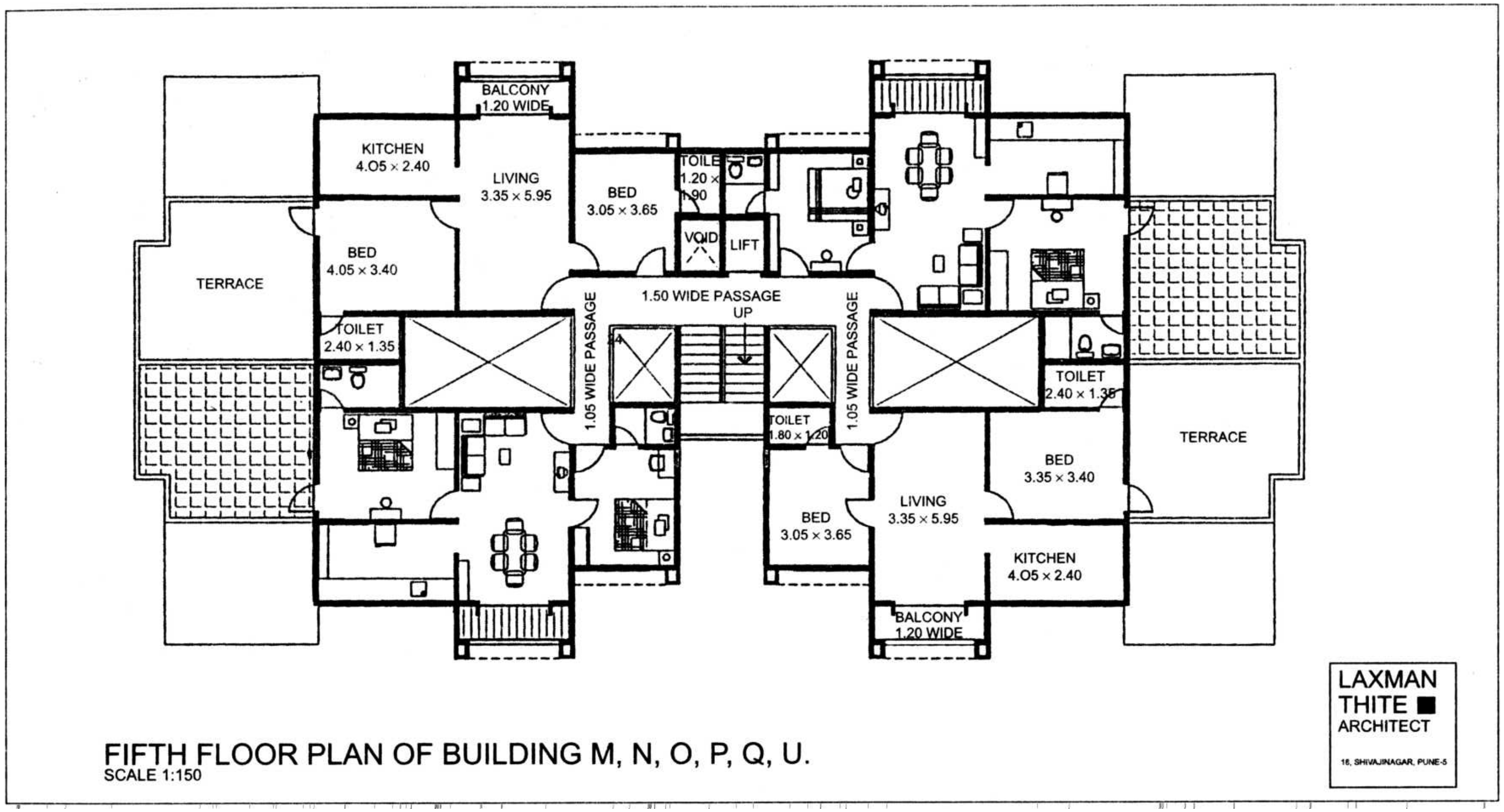


Figure 5.17 *Sacred Heart Town – Fifth Floor Plan*

8. Study floor plans, in the role of the structural designer, for location of RCC columns and beams for structural framing plan.
9. What is the minimum rate of water supply? Prepare a list of various plumbing fixtures for plumbing work. How will you decide the capacity of the elevated service reservoir? What are the essential specifications for the design of a swimming pool? A bore well in such complexes would be advantageous. Collect details for the cost of bore wells. How is the location selected for the same?
10. Study drainage layout plans. Location of two manholes on the road on right side shows the points where the drainage is connected. Self-cleansing velocity, diameter of pipe, grade for sewer line and discharge more than three times are all considerations of a design system for sewerage. Length of the drainage line should be minimum for quick discharge. Is it possible to treat total discharge so as to use this effluent for gardening? What are the different methods for treatment of sewage and sullage?
11. Electrical layout for the first, second and third floor for buildings M, N, O, P, Q shows various electrical installations. What is the difference in cost of open and concealed electrical wiring system? Collect brochures for all materials for electrical installations—wires, fixtures, etc. Study various symbols shown in the plan. Write a note on the procedure to obtain electrical power.
12. Collect brochures for (i) different types of tiles, (ii) water supply—taps, tub baths, showers, (iii) solar system for hot water, (iv) pumps for pumping of water, (v) colours—distempers, plastic emulsion, oil paints, (vi) aluminium windows, (vii) doors—commercial and other types, and (viii) different brands of cement. Study variations in their rates during a period of two years.
13. What is meant by ISO 9002? How can it be obtained? How is it useful for construction firms? Collect details for the same.
14. Collect details for (i) 'CONQUAS'—Construction Quality Assessment Scheme used in Singapore, and (ii) construction practice followed in countries in the Middle East to keep control over cost and quality.
15. Study the role of promoter and builder, procedure for preparation of the scheme, purchase of land, role of a legal consultant, documents for sale deed, agreement with the flat owner, formation of co-operative housing societies and registration for apartments and rules for the same.

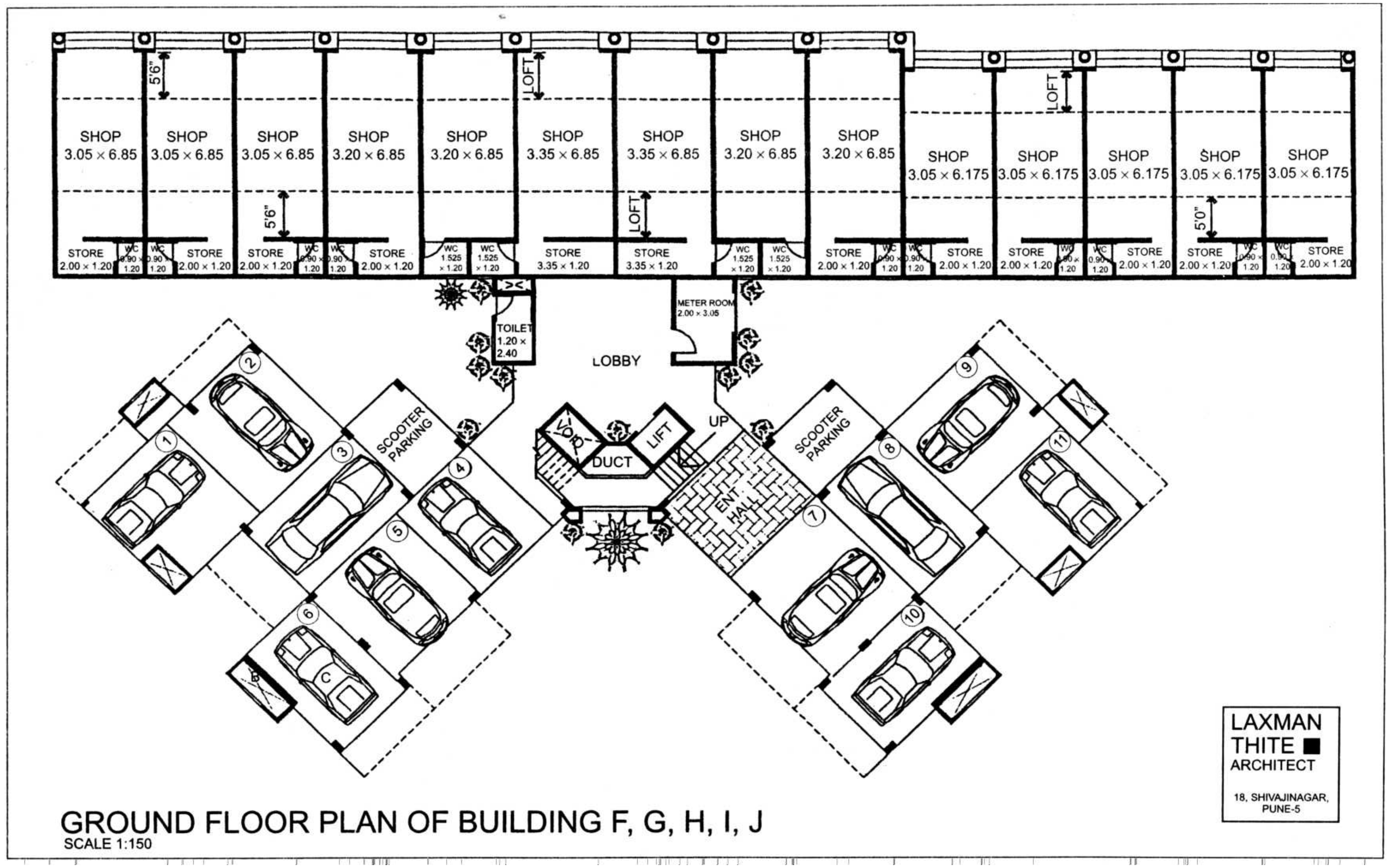


Figure 5.18 *Sacred Heart Town – Ground Floor Plan*

Case Study

Residential Complex at Paithan Road, Aurangabad Dakshin Vihar (Figs 5.24–5.26) Plates 5.4, 5.5

Text-Nagpal Consultants Pvt. Ltd.

The site is located four km from Aurangabad railway station.

Layout

Entry to the site is from the left, where the residential cum commercial complex is placed. The commercial complex is kept near the entrance so that the interior of the housing area is away from the commercial activities. The imposing watertank and the club house with its landscaped garden at the centre acts as the lungs of the entire housing complex flanked by independent and twin bungalows on three sides and apartments acting as a backdrop. The circulation of the site follows a rigid grid pattern and is functionally simple.

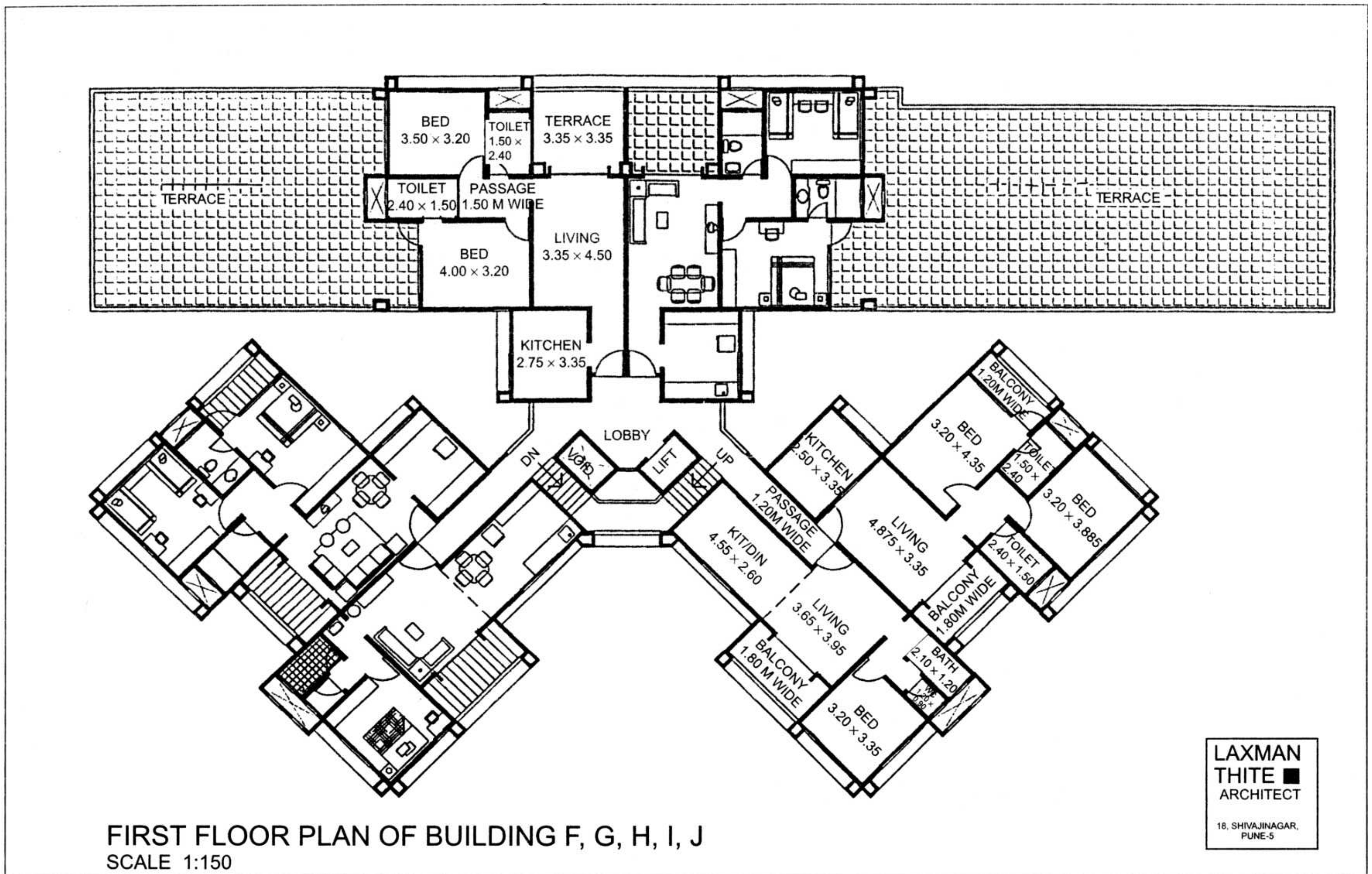


Figure 5.19 *Sacred Heart Town – First Floor Plan*

Reading Exercise (Figs. 5.24 to 5.26)

1. Study all drawings carefully.
2. Study plans, coloured prints–see the difference in coloured and black and white plans in visual communication.
3. Collect information about the procedure for colour prints with the help of CAD.

Work of a Promoter and Builder

Various modes of residential accommodation includes individual flats or individual duplex flats. In the latter case, the total unit consists of two or more floors with or without terraces with individual stairs, twin bungalows, row houses or sometimes combinations of these different types along with other amenities. The success of the scheme depends upon many factors. The needs of the client is also an important factor. His selection of the flat depends upon the layout of the scheme, location of the site, quality of construction, mode of payment, total cost, amenities and so on.

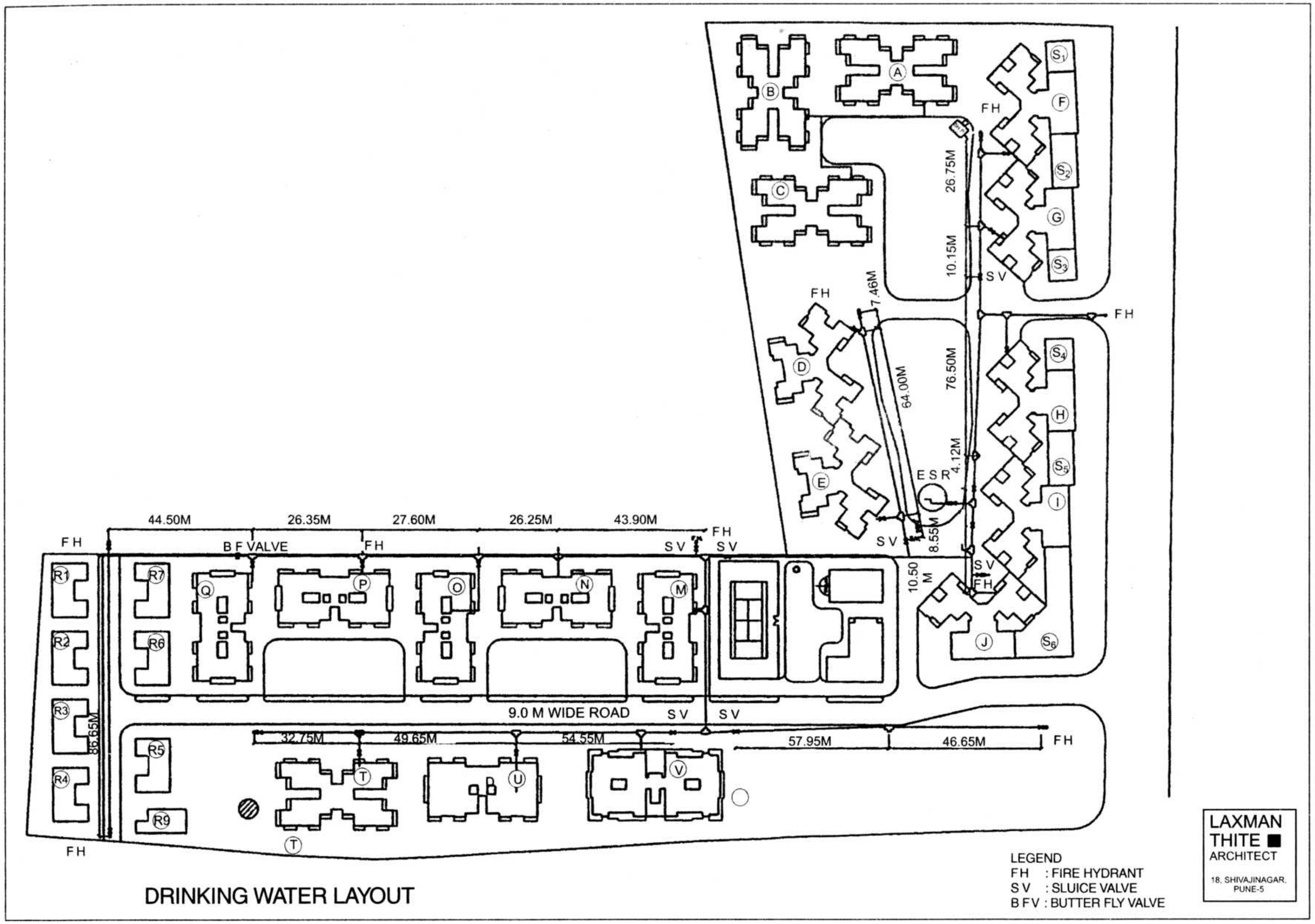


Figure 5.20 *Sacred Heart Town – Drinking Water Layout Plan*

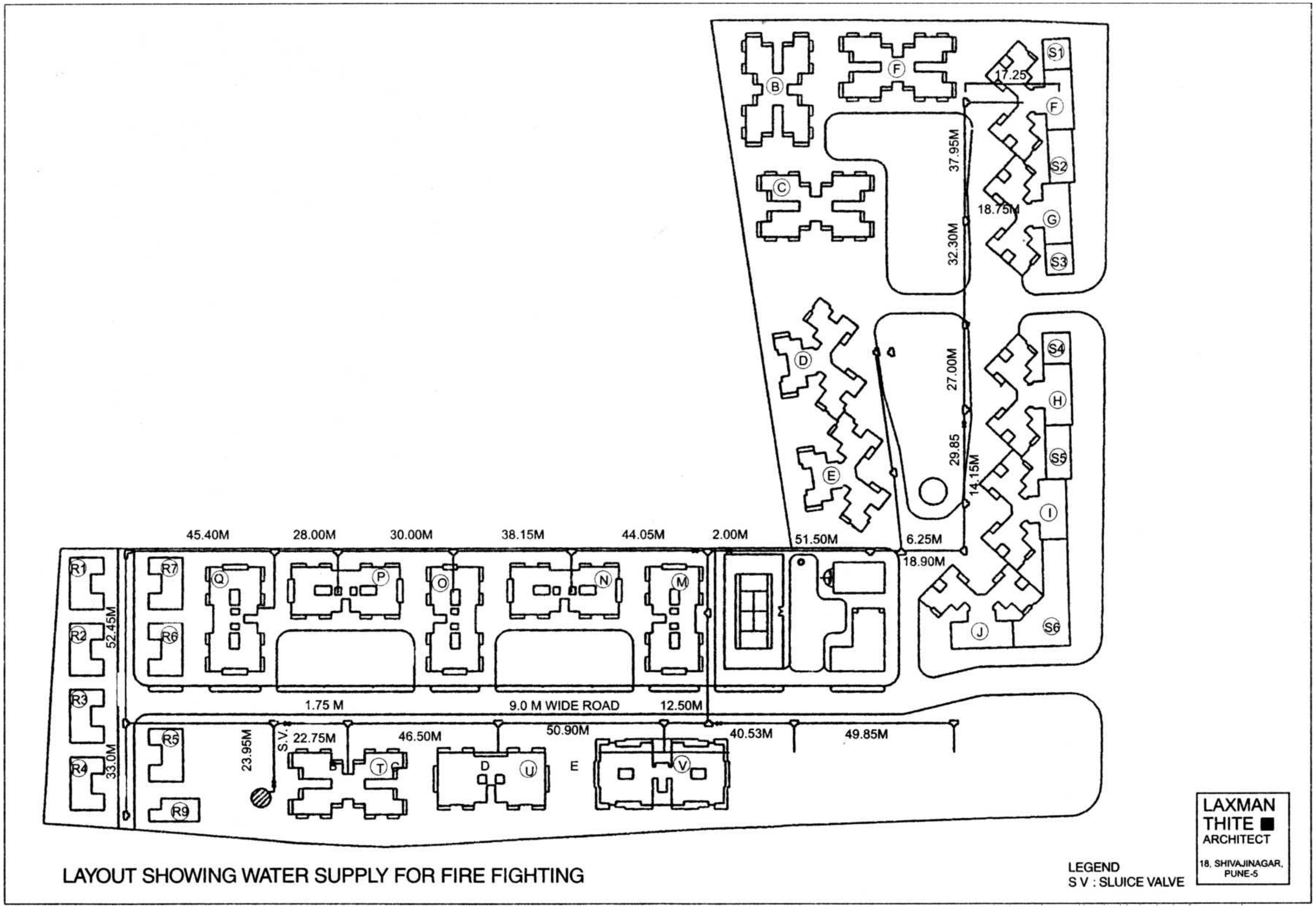


Figure 5.21 *Sacred Heart Town – Layout Showing Water Supply for Fire-fighting*

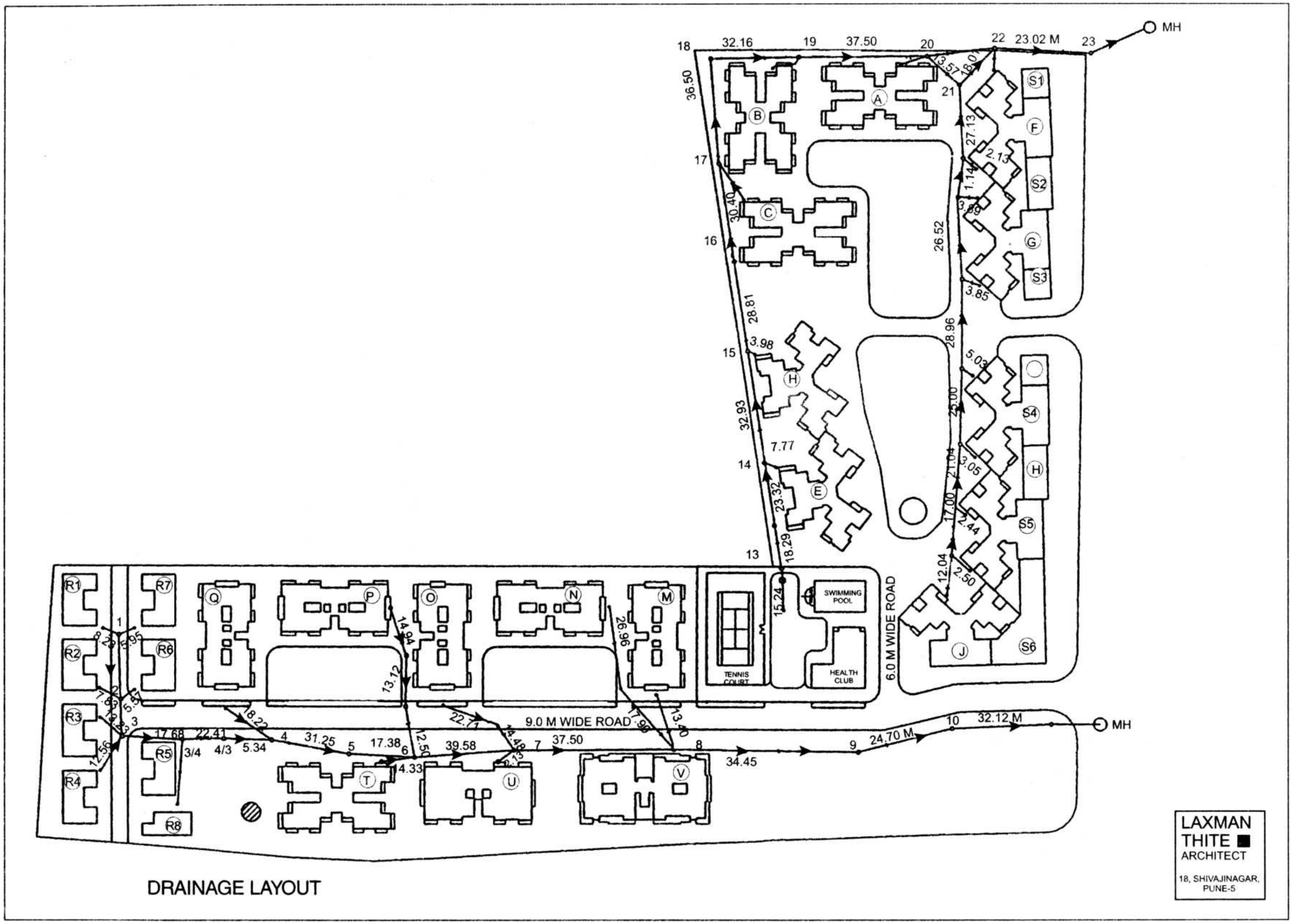


Figure 5.22 *Sacred Heart Town – Drainage Layout*

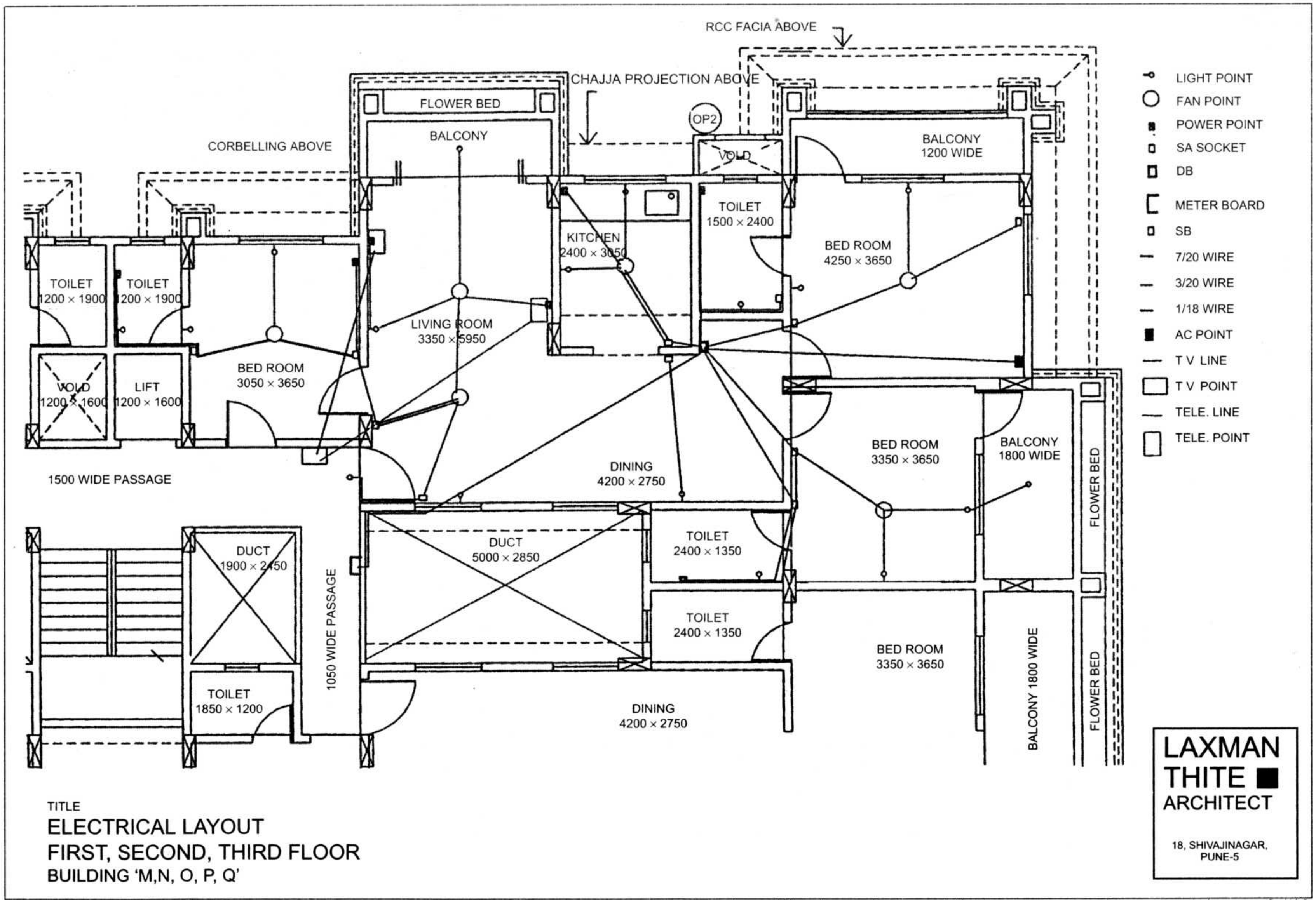


Figure 5.23 *Sacred Heart Town – Electrical Layout Plan*

The functions of a promoter and builder include the following details, right from the stage of purchasing the plot to the stage of completion of the scheme.

1. Location of the plot.
2. Infrastructural facilities—water supply, drainage, roads, electricity, other facilities in the surrounding area such as shopping centre, garden, entertainment centres, school and amenities for transportation.
3. Rules of plan sanctioning authority.
4. Finance for the scheme and provision of loan facilities to the client.
5. Appointment of professionals—architects, structural engineers, landscape architect, service engineers, legal consultants and others.
6. Execution of work—appointment of project engineer and supervisor to control the quality of work, to avoid delay and wastage of materials and co-ordinate all activities in the construction programme.
7. Procurement of good building materials and testing of materials as per specifications.

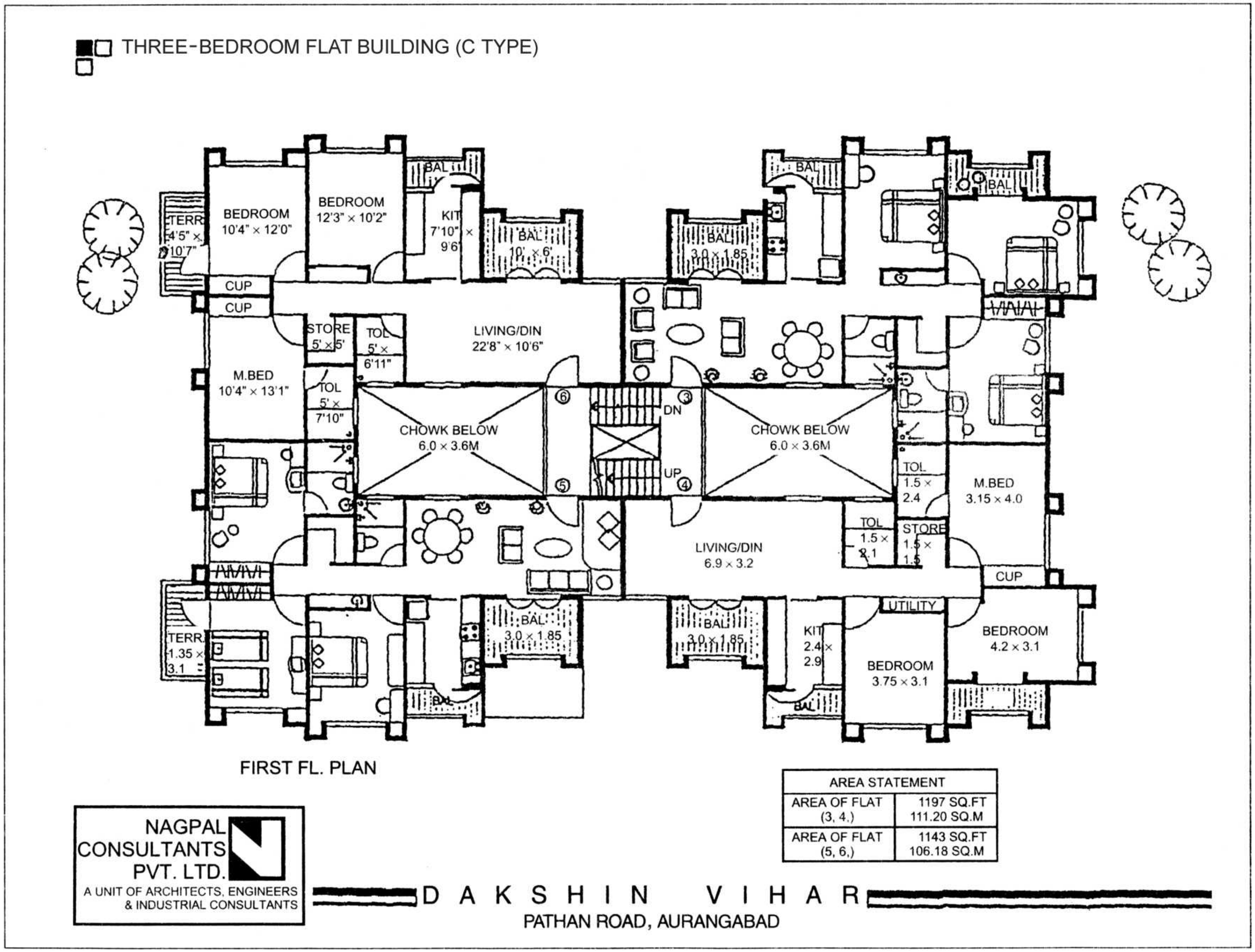


Fig. 5.24 *Dakshin Vihar – Plan C Type*

8. Provision of amenities—play area, common antenna for TV programmes, garden, swimming pool, club house, parking space, additional water supply through bore wells, internal communication system for safety and convenience, and so on.
9. Maintenance of the buildings—standard specifications, good supervision with quality execution reduces the problem of maintenance such as those due to development of cracks and leakages. Preparation of maintenance schedule to check leakages in water supply mains and drainage lines, and cleaning of drainage pipes and traps, and other works.
10. Climatic conditions of the locality.
11. Co-operation and faith of the clients during the construction stage and afterwards.

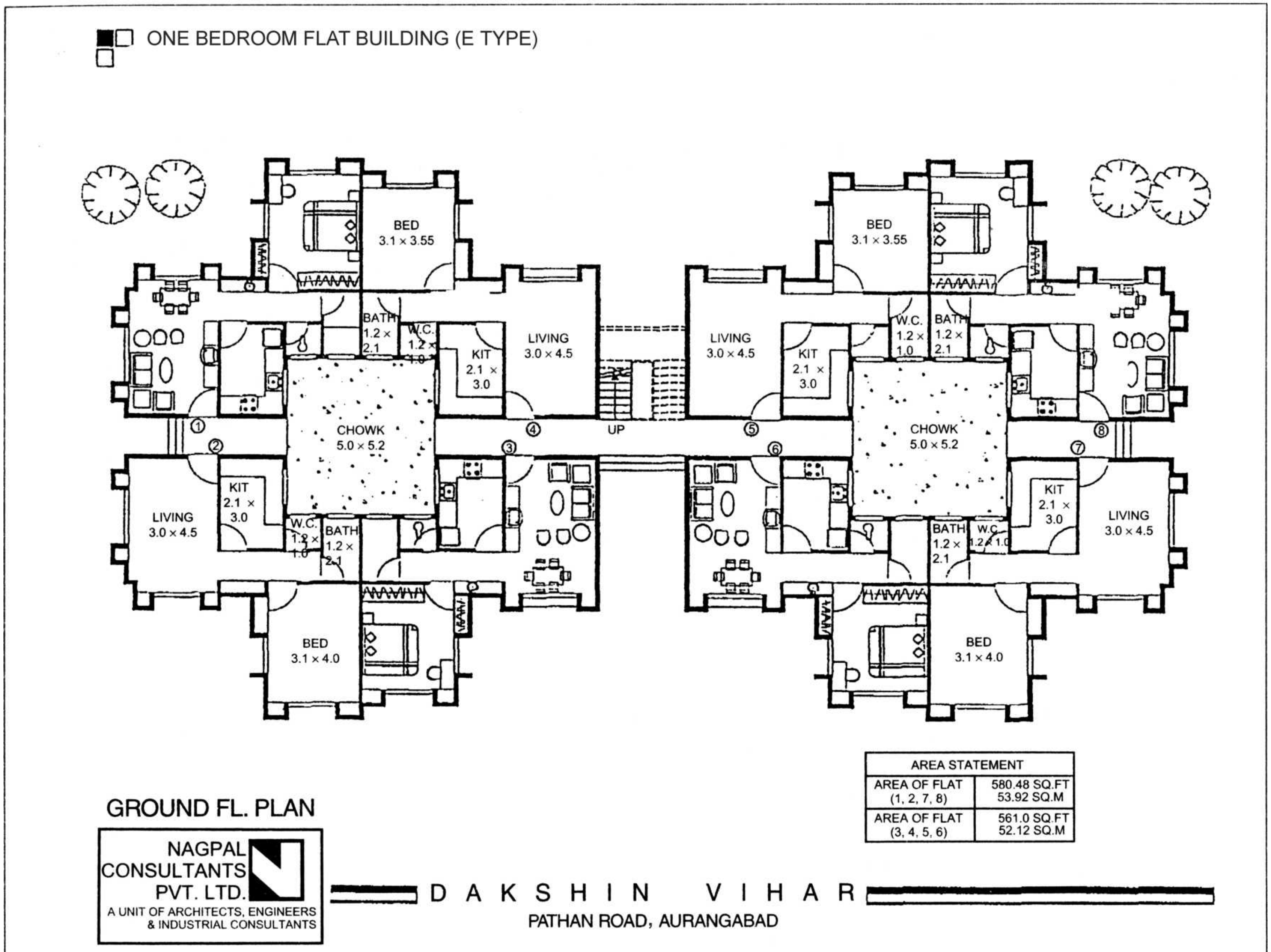


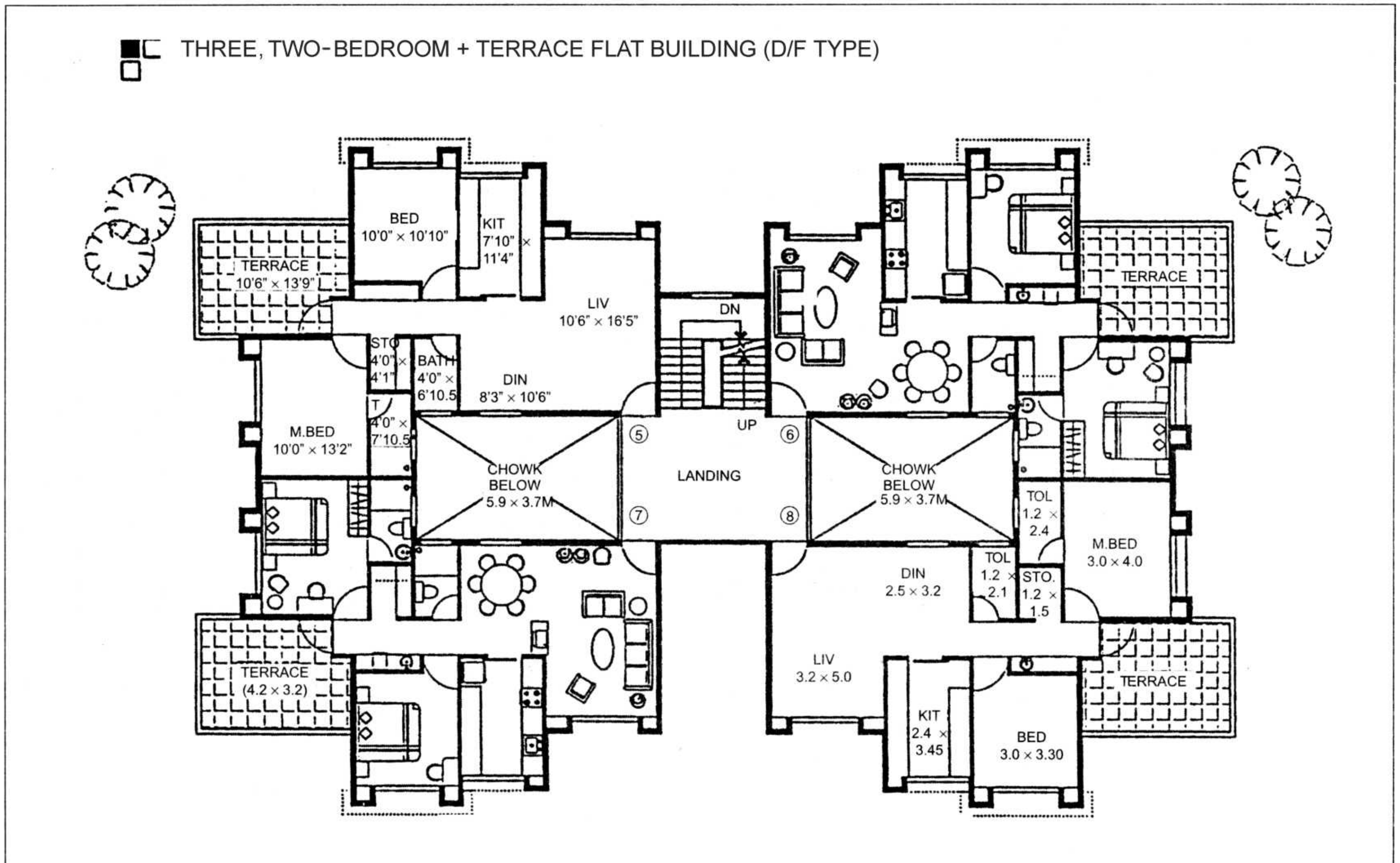
Figure 5.25 *Dakshin Vihar – Plan E Type*

12. General policy of the government about formation and working of co-operative housing society, ownership/apartment act, National Housing Policy, facilities for loans, concession in income tax, and so on.

A promoter gets the plan scheme approved by the plan sanctioning authority such as the municipality or municipal corporation and then floats an ownership or apartment scheme. He sells these units, before or during the construction itself to buyers who are in need of such apartments. The buyer normally pays the cost in installments.

Cost of the flat The cost or price per unit area is fixed as per:

1. Carpet area of the unit.
2. Built-up area of the unit.
3. Super built-up area which includes built-up area and proportional built-up area of common passage, staircase, etc.
4. Sometimes terrace/car parks are also sold to individual owners separately.



AREA STATEMENT	
AREA OF EACH FLAT (5, 6, 7, 8)	870 SQ.FT 80.82 SQ.M
TERRACE	152 SQ.FT 14.12 SQ.M

Figure 5.26 *Dakshin Vihar – Plan D/F Type*

The promoter/builder sells these units to others who in turn, become the tenant owners. The builder then helps these owners to form a co-operative society, if their number is eleven or more. If the number is less (five is the minimum), a partnership or an association is formed to pay taxes and look after the property and other matters of common interest such as payment of loans, maintenance, and so on.

Role of the Owner, Promoter and Builder

Role of a co-ordinator The owner/promoter and builder is supposed to perform the role of a co-ordinator. The architect becomes his representative. Sometimes the owner or promoter and builder may not have a technical background, yet he is supposed to perform the functions with the co-operation of various experts such as consultants and specialists. The requirements of the plan sanctioning authority, cooperative department, land survey and record department, loan sanctioning agencies, and last but not the least, the client or the purchaser of the flat have to be carefully evaluated as he invests a lot of money. Satisfaction of the client, efficient planning and completion of a project within minimum time without affecting the quality should be the main aim of the promoter and builder. Technical consultants should have liberty in planning, designing and construction.

Role of a legal consultant Nowadays, brokers or land agents help promoters or builders in the purchase and sale of land. A legal consultant is useful for verifying the title of the land with the further processing of the sale deed and registration. Hence, both the promoter and the owner of the land should take the help of common or separate competent and experienced lawyers known as legal consultants to look after all legal matters. The legal advice relates to transactions such as purchase of land, sale deed, registration of sale deed, power of attorney, agreement for sale of flats to buyers and formation of a co-operative society or association. Generally, model registration and conveyance deeds, bye laws, etc., prepared by the government are adopted by making changes to suit a particular project or different circumstances within the framework of the law.

5.1.3 Architect

Whatever may be the type of building, the owner or promoter and builder is in search of a person who will guide him and undertake the planning and supervision of the work. The architect is the proper person who will help him in executing his ideas. He is a man with imagination and executive capacity who can fulfill the requirements of the owner. He takes into consideration the owner's requirements, makes a list of them, visits the site and prepares preliminary correlated plans with estimates. The owner's requirements are transferred to and visualised on a drawing paper. After the approval of preliminary plans and estimates by the owner, the architect now becomes the representative of the owner. If required, he prepares a model of the proposed structure. Once the plan is approved by the owner, the architect obtains sanction for the same and executes the work with the help of a contractor and structural and/or consulting engineers. In some cases, the promoter and builder may have his own architectural department.

Role of the Architect

The scheme prepared by the architect is presented to the clients by preparing the following drawings and other documents:

1. Layout plan and perspective drawing.
2. Model of the scheme or buildings.
3. Brochures showing details—plan, perspective, layout plan, site plan, specifications, modes of payments, names of consultants and other details.
4. Submission drawings for submitting the scheme to the plan sanctioning authority.
5. Working drawings and architectural details.
6. Drawings and details from the structural engineer.
7. Landscaping, air-conditioning, electrical and other working drawings.
8. Agreements for sale of flats in case of a flat in an ownership scheme.
9. Record drawings after completion of the project to be handed over to the society or association for future reference along with guarantee certificates for pumps, lifts and/or other equipments.

All sets of drawings thus prepared for the construction are prepared after consulting all the professionals involved in the project.

Construction-Stages in the Construction Process and Role of Different Agencies

The task of the architect and his authority is clear from flowcharts 5.1, 5.2 and 5.3. To get quality work from all agencies concerned is the most difficult job. The success of the work depends upon selection of a proper experienced architect with a practical outlook. The owner's main job is to make payment of bills to the contractor, architect, and others from time to time, so that smooth progress of works is maintained. This insures completion of the job as per schedule and full return of the money invested in a desired period.

Students are advised to study the following charts carefully and meet different technical and nontechnical persons in order to get more details about their work.

Flowchart 5.1—Built environment—integrated approach—owner/promoter/architect, planning, designing, execution.

Flowchart 5.2—Role of different agencies in the construction process.

Flowchart 5.3—Stages in the process of construction.

Qualification and Qualities of an Architect

An architect should be a graduate in architecture (B Arch) or a Diploma (G D Arch) holder from a government recognised institute. He is required to get practising licence from the corporation or plan-sanctioning authority. In foreign countries, the planning work is mainly done by the architect. Civil engineers are mainly constructional or structural engineers. In our country, however, a license for preparing plans and supervision is granted to civil engineers as well.

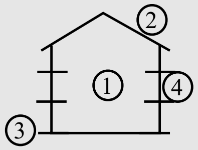
The architect plans the work and acts as a co-ordinator; hence he should have a deep insight in fulfiling the requirements of the owner. He should have a thorough knowledge of the factors affecting cost in particular sites due to foundation, subsoil water level, etc., as well as the knowledge about the latest materials for economical construction and human psychology. Draftsmen and junior architects help the architect of the firm in the completion of plans and drawings. All of them have to work in unison. A compromise on ideas is always required while bringing imagination into reality, the main factors being the rising costs and nonavailability of proper materials at the proper time. The main problem faced by the owner is the vast difference in the estimated amount and actual amount after completion of the work. The main problem of the contractor is the receipt of incorrect or insufficient drawings, late decisions by the owner or architect, and late payment of bills which may be due to delay in scrutiny of running and final bills. The architect is a planner, arbitrator, and lawyer. For ultimate success, he has to be practical minded and has to understand the role and difficulties of different persons with whom he has to correlate the work. He has to satisfy the owner and also do justice to the work and his profession.

The architect is a man supposed to be capable of thinking along the following lines:

1. Ability to think rationally about the nature of the site, the available resources and functional requirements of the building.
2. Creative thinking to decide building form as per rational thinking.
3. Value of judgement to judge the relative importance of various and sometimes conflicting factors related to planning.
4. To be able to make his design intentions known to the parties concerned.
5. Communication skills, to co-ordinate all agencies together from the planning to the completion stage.

Chart 5.1

Built Environment–Integrated Approach



1. SPACE
2. SHELL
3. LAND
4. SERVICES

Owner/promoter — **Legal Consultant**

Architect

Planning | **Designing** | **Execution**

Planning

- Plan sanctioning authority
- Code and bye-laws of municipal corporation
- Industrial development corporation
- Town planning department
- National building organisation
- Electricity board
- Pollution control authority
- Collectorate and land records
- Cooperative department—rules for ownership/apartment buildings

Designing

- Landscape architect
- Interior designer
  —Fumiture
  —Colour
  —Indoor plants
  —Lighting
- Internal communication consultant—telephone, etc.

- Civil engineer
- Quantity surveyor
- Structural engineer
- Service engineer
- Project manager
- Consultants
  —Foundation
  —Environment
  —Thermal
  —Ventilation
  —Acoustics/noise
  —Air conditioning
  —Fire
- Electrical engineer, lifts/escalators
- Layouts for electrical installations
- Mechanical engineer
  —Air conditioning, layouts for machinery
- Chemical engineer
  —Layout plans
- Other specialists

Execution

- Civil engineer
- Builder
- Project manager
- Site engineers
  —Tools
  —Materials
  —Labour
- Civil engineers and/or Architectes
  —Valuer
  —Arbitrator

Architecture—Object of an Architect—Built Environment

Object	Creation of an ideal built environment by providing well-designed and executed spaces for specific human activities and desirable environment for the efficient performance for those activities.
Building	A stable form or shape in the space, resting on the earth as we enclose the space upon the earth by walls and a roof.
Form	Product of the space requirements and flow pattern of the required space units for different activities. Form showing awareness of the relationship of architecture to the culture and climate is the expected creation.
Structure	Construction to create and maintain the desired form, to support the elements of space enclosure.
Space	Functional space, fulfilling the need of occupational comfort, and expected performance of human activities.
Ideal built environment	Optimum space with well-designed fumiture and essential building and plumbing services, giving sensation of physical and psychological well being, inside and outside the building.

Chart 5.2

ROLE OF DIFFERENT AGENCIES IN THE CONSTRUCTION PROCESS

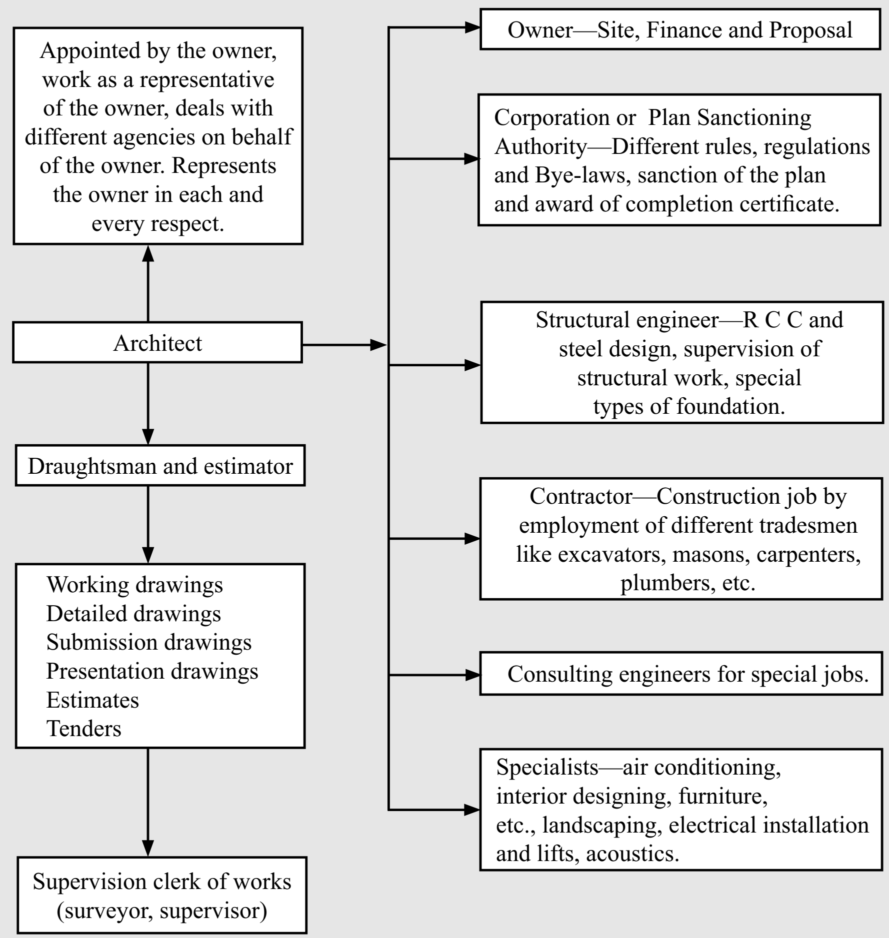
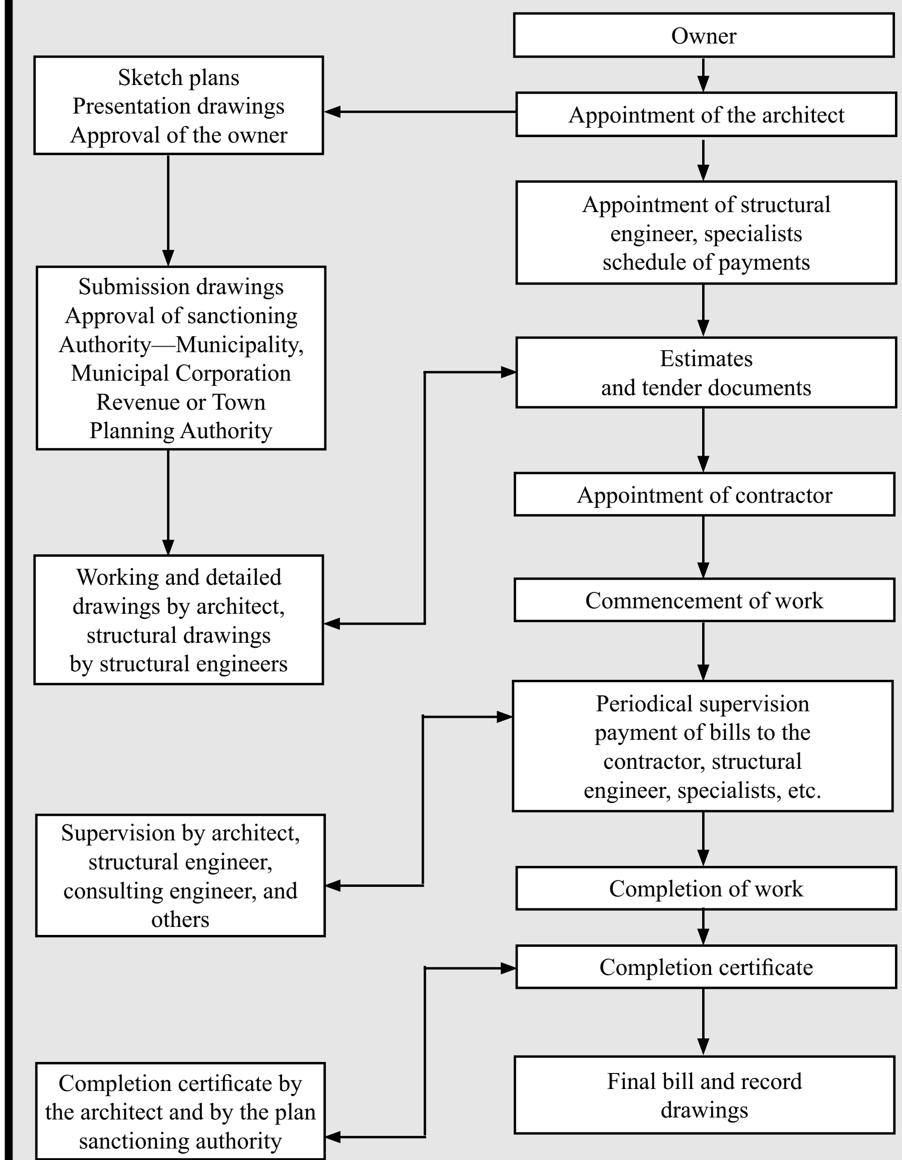


Chart 5.3

STAGES IN THE PROCESS OF CONSTRUCTION



Administration and co-ordination needs exceptional energy and foresight. Coordination in the design teams and with other agencies such as builders, plan sanctioning authority, town planning departments, land records, legal consultants and owner or promoter, etc. is essential. He has to be a co-ordinator *par excellence*.

5.2 SITE-CLIMATE AND MATERIALS OF CONSTRUCTION

5.2.1 Site

Site and Environment

Everybody likes to work or live in comfortable and pleasant surroundings. Selection of the site requires careful consideration and depends upon the type of buildings, residential or nonresidential. Now-a-days, town planning authorities divide towns into different zones, viz. residential, industrial and agricultural or green zones. Hence, the requirements regarding the width of roads, plot area, water supply, drainage, electricity, and other amenities are accordingly proposed for the desired development.

Whatever may be the type of landform and surrounding, sight, sound, skin and smell senses help us to create an overall integral opinion about the site and buildings. A building is first observed always in silhouette, in conjunction with the silhouette of environmental surroundings such as hills, trees and other landscape features along with or including other structures or buildings. It is necessary to decide the weight of the building mass at a particular location point to bring the system in equilibrium. One should also remember at this stage the consideration of its character, which implies its success of creating an impact on the mind about the functional design and harmony with its surroundings. It should be impossible to imagine the site without a particular characteristic of the building. It should be a perfect marriage of the site, buildings and surroundings. Landscaping helps us to achieve this impression.

Site Consideration for Selection

Geology helps us in deciding various merits regarding the site, its suitability for construction of buildings with reference to its shape, bearing capacity and the presence of geological features which restrict the options for proposed development. (*Ref. Chart 5.4*)

1. Topsoil and subsurface material and its bearing capacity, geological faults, i.e., lines of weakness caused by previous movements of the earth's crust, outcrop of rock, i.e., exposed rock faces are important features that determine the quality of a site.
2. Aquifers, i.e., underground source of water, become a valuable resource.
3. High and fluctuating water table may cause problems for development.
4. A site with impermeable materials, such as clay will require additional cost for suitable drainage.
5. A waste disposal site with unconsolidated materials will create problems with additional cost.

Geomorphological study of the site will throw light on the processes that have shaped the earth. The shape of every area of the earth is constantly changing due to erosion and deposition rocks breaking away from mountains due to landslips, etc.

A study of surface water, drainage system, flood line and nearness of river, quality of water, topography of surrounding area, slope analysis and so on will help in realising the exact nature of the site.

In selecting the site, following important factors should be kept in mind before finally deciding on the site:

1. ***Physical considerations***
   (a) The land and its surroundings should be fit for residential purpose. Peaceful environment, good landscape, and unobstructed flow of natural air are the considerations.
   (b) Soil conditions—The cost of foundation depends upon strata and the bearing capacity. Hard murum is ideal. It is necessary to test the bearing capacity of the soil. Enquiry regarding depth of foundation of surrounding buildings may help in justifying decisions.
   (c) Low lying areas, marshy areas, land located near rivers, reclaimed land, etc., are not suitable.
   (d) The water table level should not be too high or too low. A high water table would create permanent dampness and a very low water table would mean drawing water from wells and by pumps.
2. ***Health considerations***
   (a) Land near industrial areas would prove to be unhealthy because of noise and air pollution.
   (b) A good sewerage and efficient water supply system are desirable in order to avoid trouble from flies and mosquitoes.
3. ***Community facilities***
   The following places should be within easy reach of the site:
   (a) Primary and Secondary school
   (b) Primary health centre
   (c) Post office and bank
   (d) Shopping centre
   (e) Places of recreation
   (f) Public gardens
   (g) Playgrounds
4. ***Transportation facilities***
   (a) Proximity to the bus stand and railway station.
   (b) Good approach roads from the main road up to the colony.
   (c) Proximity to place of work and cheaper means of transportation to the same.
5. ***Economy***
   The total cost of the land includes the cost of land and the cost of development. It is necessary to ascertain the same in the beginning, along with clear ownership rights of the land.

Considerations for Development of Large Sites

Ecological considerations and site conservation measures are main considerations for the site planning team consisting of ecologists, horticulturists, conservation consultants along with landscape consultants. The study includes soils, their identification, soil water content, soil texture, soil salinity, plants, suitable plants, natural vegetation, and wild life, air quality in the area, plants as a source of delight which stimulate the senses, plants as a tool for erosion control, protection of vegetation on the site, methods to upgrade ecological value of the site.

Site Planning

Site planning needs collection of data, visit to the site, collection of maps, contour survey maps, study of topography, soil condition, drainage system, climatic consideration, vegetation. Help from the local people, foresters and farmers would be required to know the previous history of the site. On the basis of such information, site planning is finalised with the help of other consultants. Site planning is concerned with:

1. The environment around buildings.
2. Land use of areas—suitable locations.
3. Open areas within the proposed built environment and their treatment.
4. Development of appropriate landscape.

Site plans are essential for all types of change in land use. Projects related to housing, industrial, commercial, recreational and communicational development need detailed reports supplemented by surveys and plans.

5.2.2 Climate

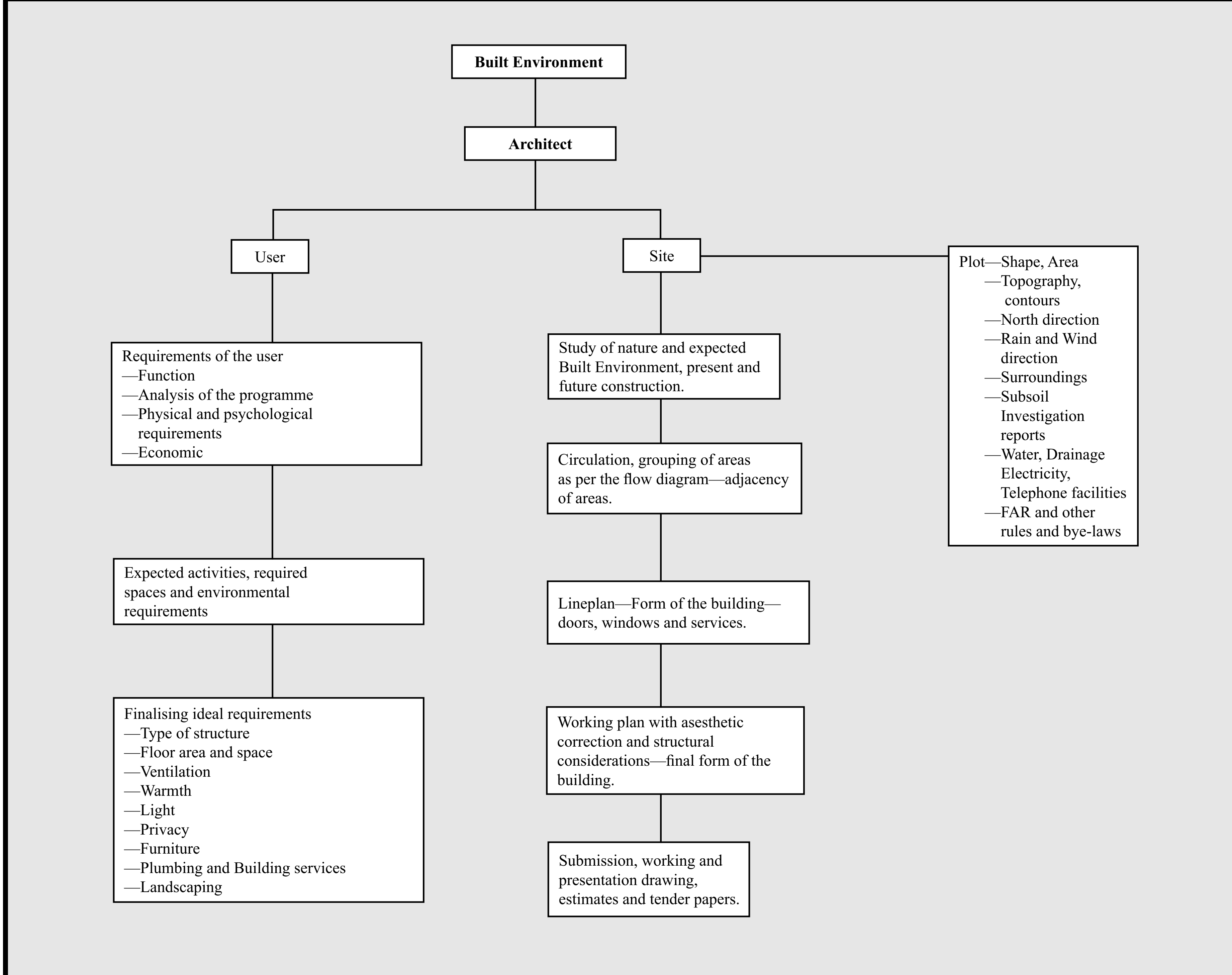
Livability of the Building

Our daily life cycle comprises of various activities, fatigue and recovery. It is essential that the mind and body recover, through recreation, rest and sleep, from the mental and physical fatigue resulting from the activities of the day. Finally, the question is of comfort, i.e., acceptable internal comfort conditions. The factors to be dealt by the designer include climatology or external environment. He also deals with the building fabric consisting of walls with openings for doors and windows as well as the fabric of the roof, i.e., the constructional barrier between the external environment and comfortable internal conditions. It is not feasible to regulate outdoor conditions or the external environment. Hence, the task of the designer is to create the best possible indoor climate and optimum total comfort. The latter may be defined as the sensation of complete physical and mental well being.

The subject Built Environment is important with reference to energy saving and efficiency improving designs. It is related to building science and building physics or in other words, to the livability of a building with controllable comfort conditions.

The effect of the climate on man is a factor of considerable importance.

Chart 5.4


Built Environment
Architect
User
Site
Plot—Shape, Area
—Topography, contours
—North direction
—Rain and Wind direction
—Surroundings
—Subsoil Investigation reports
—Water, Drainage Electricity, Telephone facilities
—FAR and other rules and bye-laws
Requirements of the user
—Function
—Analysis of the programme
—Physical and psychological requirements
—Economic
Expected activities, required spaces and environmental requirements
Finalising ideal requirements
—Type of structure
—Floor area and space
—Ventilation
—Warmth
—Light
—Privacy
—Furniture
—Plumbing and Building services
—Landscaping
Study of nature and expected Built Environment, present and future construction.
Circulation, grouping of areas as per the flow diagram—adjacency of areas.
Lineplan—Form of the building—doors, windows and services.
Working plan with asesthetic correction and structural considerations—final form of the building.
Submission, working and presentation drawing, estimates and tender papers.

Climatic Considerations

Climate is a combined effect of temperature, rainfall and wind (Fig. 5.27).

The sun's path from east to west changes from the tropic of Capricorn ($23\frac{1}{2}$°S) towards the equator and then towards the tropic of Cancer ($23\frac{1}{2}$°N) and back to the tropic of Capricorn in one year. As such, the sun crosses the equator twice in a year. June 21 experiences the longest day as the northern end of the earth's axis points towards the sun. December 21 is the shortest day of the year as the northern end of the earth's axis is away from the sun at its maximum. Hence, the altitude of the sun is the highest in the tropics and decreases beyond the tropic of cancer and the tropic of Capricorn. The total heat absorbed depends on the intensity and duration of the exposure of the earth's surface to the rays of the sun. In temperate zones, the sun's rays fall in a slanting direction and the temperature is below body temperature. Hence in temperate zones, only those houses are comfortable which shut out rain and cold and have large windows facing the south to admit maximum radiation from the sun. The situation in a tropical climate, on the other hand, is reverse, with a burning sun, rising and setting like a clock, dividing the day into equal parts of light and darkness. The sun also controls the distribution of the rain. Hence, the houses need protection from heat. They should be designed to act as environmental filter number two.

The Indian meteorological department recognises the following four seasons of the Indian Year.

1. Cool Dry Season : January and February; North East monsoon period.
2. Hot Dry Season : March to mid June; overhead sun moves towards the North and temperature rises appreciably; North East monsoon "breaking down".
3. General Rainy Season : Mid June to Mid September; the South West monsoon now fully establishes itself over the heavy rain. There is also a drop in temperature.
4. Season of the retreating South West monsoon. : Mid September to December; South West monsoon breaks down.

1. ***Tropical climate, its effects and remedies*:** Tropical climate can be classified into 'hot wet' or 'humid' and 'hot dry' climates (Fig. 5.28).

Humid or hot wet climate is characterised by high humidity throughout the year, and even in the dry seasons, there is only slight variation in the day and night temperature, viz. 25°–30°C in the hot seasons and 10°–22°C in the cold seasons. In a humid climate, air movement of any kind is a relief to the sweating skin (Fig. 5.28). In hot dry climate, the maximum day temperature in summer is, say, 27°–42°C and night temperature, 15°–25°C.

2. ***Latitude and temperature*:** There is a temperature gradient from the equator to the poles due to the path followed by the sun throughout the year. At the equator, the temperature is the highest and at the poles, the lowest.

3. ***Pressure belts and winds*:** There is a differential heating of the atmosphere on the earth due to its spherical shape. Large and distinct masses of cold and warm air are formed due to this differential heating. Cold air is dense and heavy as compared to warm air, hence, cold air sinks towards the earth while warm air rises towards the sky. This difference in the air pressure is measured by a barometer. The air pressure naturally tends to adjust inequalities within the system by movements from areas of high pressure to low pressure which finally results in creation of winds. The wind system accounts for some important long range climatic characteristics and is also responsible for daily changes in the weather.

4. ***Land-water relationship*:** It is found that the climate of areas close to the large masses of water is different from those away from them. Two major classifications are the coastal (or marine) and the continental climates.

5. ***Ocean currents*:** There is a movement of warm and cold currents along the continental shores. Warm currents somewhat heat the atmosphere while cold currents cool the air above.

6. ***Cyclonic system*:** The movement of masses of dense cold air and lighter warm air causes changes in the climate.

7. ***Mountain barriers and highlands*:** Mountains also serve as major barriers and affect the weather and climate of a region.

Main Climatic Regions of the World Table 5.1 shows the main climatic regions of the world from the equator towards the North and South poles. It should also be remembered that the climate of a region is reflected in its natural vegetation and one climate type usually merges into another very gradually, almost imperceptibly.

The data regarding the time of sunrise and sunset, temperature, rainfall, moisture, and direction of wind in different months are collected by the Meteorological Department in India. They are made available to architects, engineers and town planners through the Director General of Observatories, New Delhi. There is also an observatory at Pune with seismic records and computers.

Siting The process of planning that deals with placing the buildings on site is called *siting.* There may be many ways to do such planning. Each site has its own characteristics depending upon –

1. Topography
2. Slope
3. Existing trees
4. Roads—on both sides or on one side
5. Soil condition
6. Surroundings
7. Shape of the plot
8. Direction of the breeze and rain
9. Side margins as per rules
10. Expected view from the buildings
11. Garden planning
12. Internal roads and parking
13. Future expansion of buildings.

Orientation Orientation is an expression which refers to the position and direction of a building on site, with respect to the path of the sun. A sun diagram indicates the path of the sun at a particular place during the day and during the year. The problem of orientation may be considered in two stages; one, the orientation of building as a whole; and two, the orientation of internal spaces. Orientation also depends upon the function of the building. A building of a shopping complex must present an effective and inviting face to its potential clients, and thus its orientation with respect to main roads becomes more important and justified than with respect to the climate.

Orientation of buildings For orientation, the following points have to be considered:

1. A residential building provides space for the family. It has to provide privacy and comfort. It should be oriented according to the internal needs without much consideration for the road.
2. Walls facing the east, south and west are protected by *chajjas,* sun shades or vertical louvres to cut-off rays of the sun whenever not required and to regulate the flow of light and heat through openings in the wall. These projections cast shadows on the opening of the window area and also protect the walls from the rain (Fig. 5.29). Another alternative is to provide a setback for window openings with reference to the external face of the wall. In both cases, it is essential to take care of intercepting entry of rain water inside the room.

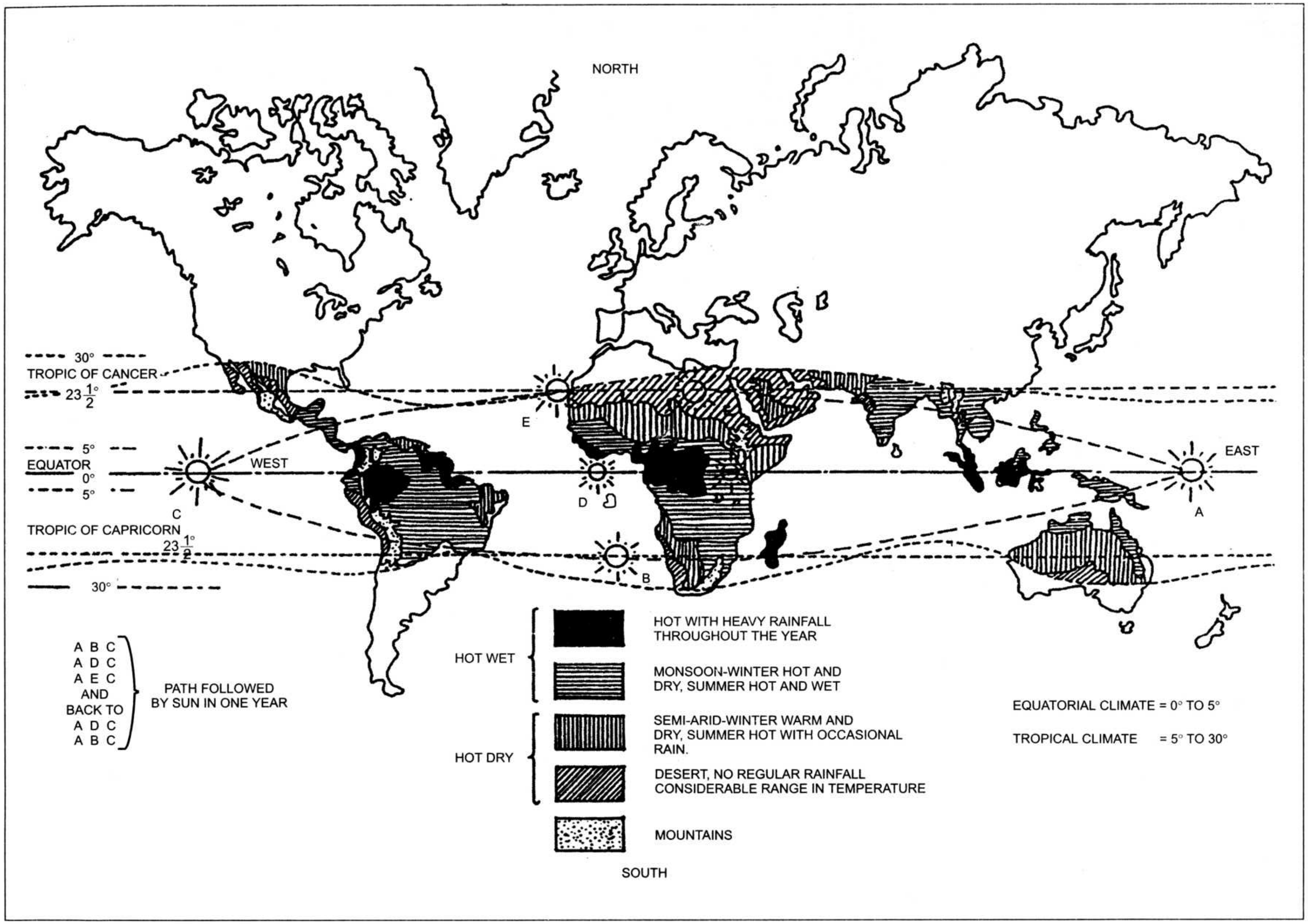


Figure 5.27 *Climatic Regions of the World*

3. Long walls of the buildings should be placed towards the north and south and short walls towards the east and west to minimise the area of the walls exposed to the sun, thus keeping the temperature inside the building comfortable.
4. A verandah and balcony facing the east and west, particularly the west, should be provided to keep the adjoining rooms cool.
5. If the front face of a structure is facing south, the sun breakers should be provided on the window on that side. Alternatively, a double faced wall construction is made, in which instead of vertical louvres, concrete blocks are used. Additional walls are constructed by keeping a clear space of about 750 to 1000 mm between the main wall and concrete blocks. Vertical louvres may be separated from the main wall by a distance of 150 mm. This helps in maintaining air circulation. A sun breaker is an element of construction projecting on the external face of the wall. It is provided on the west and south face of the building to protect it from the sun and rain. Sun breakers may be fixed or movable. Sometimes a combination of vertical and horizontal louvres is made. The maximum permissible projection for *chajjas* and louvres is 750 mm according to bye-laws.

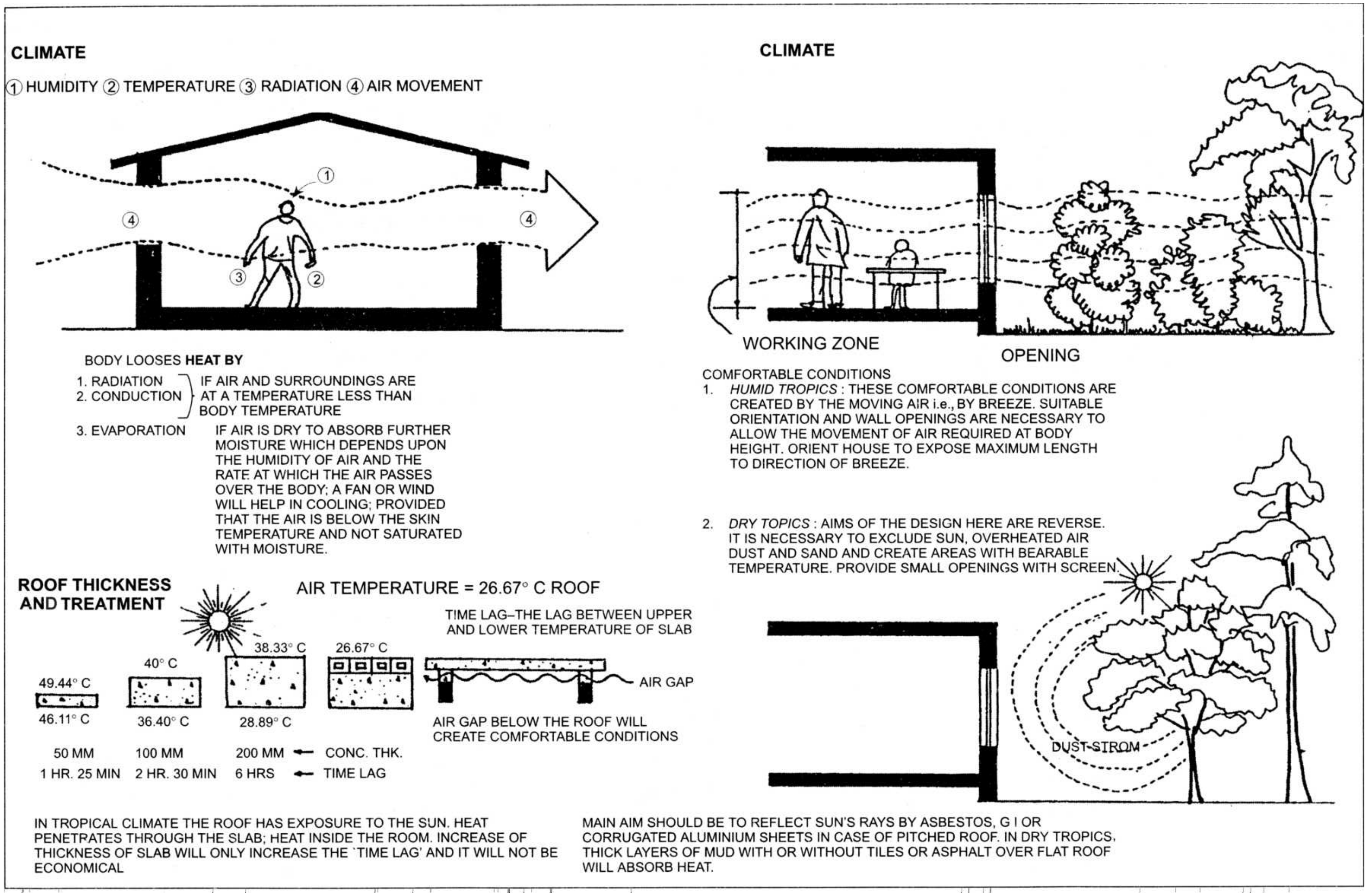


Figure 5.28 *Climate – Design Considerations*

6. In order to protect walls from damp, it is necessary to make them damp proof. Brick walls should be cement plastered and stone masonry cement pointed. More overhang of the roof on the southern and western sides protect walls from rain.
7. The roof is a part that is most exposed to the sun. Tropical rain can be sudden, heavy and wind borne. Roofs should be of flat type or pitched type depending upon rainfall. Well constructed valley gutters, overhanging eaves, etc., are useful for draining water in case of pitch roofs. An overhang will also protect walls from being heated up by the sun's rays. RCC flat roofs should be treated with water proofing material. In hot zone localities, the upper surface of RCC flat roofs should have a fair reflecting quality. It has been seen that by increasing the thickness of the slab from 50 mm to 200 mm, protection from penetration of rain water and insulation against heat are achieved at an increased time lag. In the case of sloping roof with asbestos or GI sheets, the slope should be given on one side. This will effect saving in the cost of the ridge, and all rain water will be collected on one side. Another advantage is that the accumulated hot air will be let out at the higher side of the roof.
8. It is found that if the temperature inside the house is 32°–22°C, the temperature around the house will be about 43°–33°C. This is due to the radiation of heat absorbed by the ground. If the ground is provided with grass and vegetation, there will be shade around the house. Air which would be cooled through vegetation due to presence of water will circulate in the house.

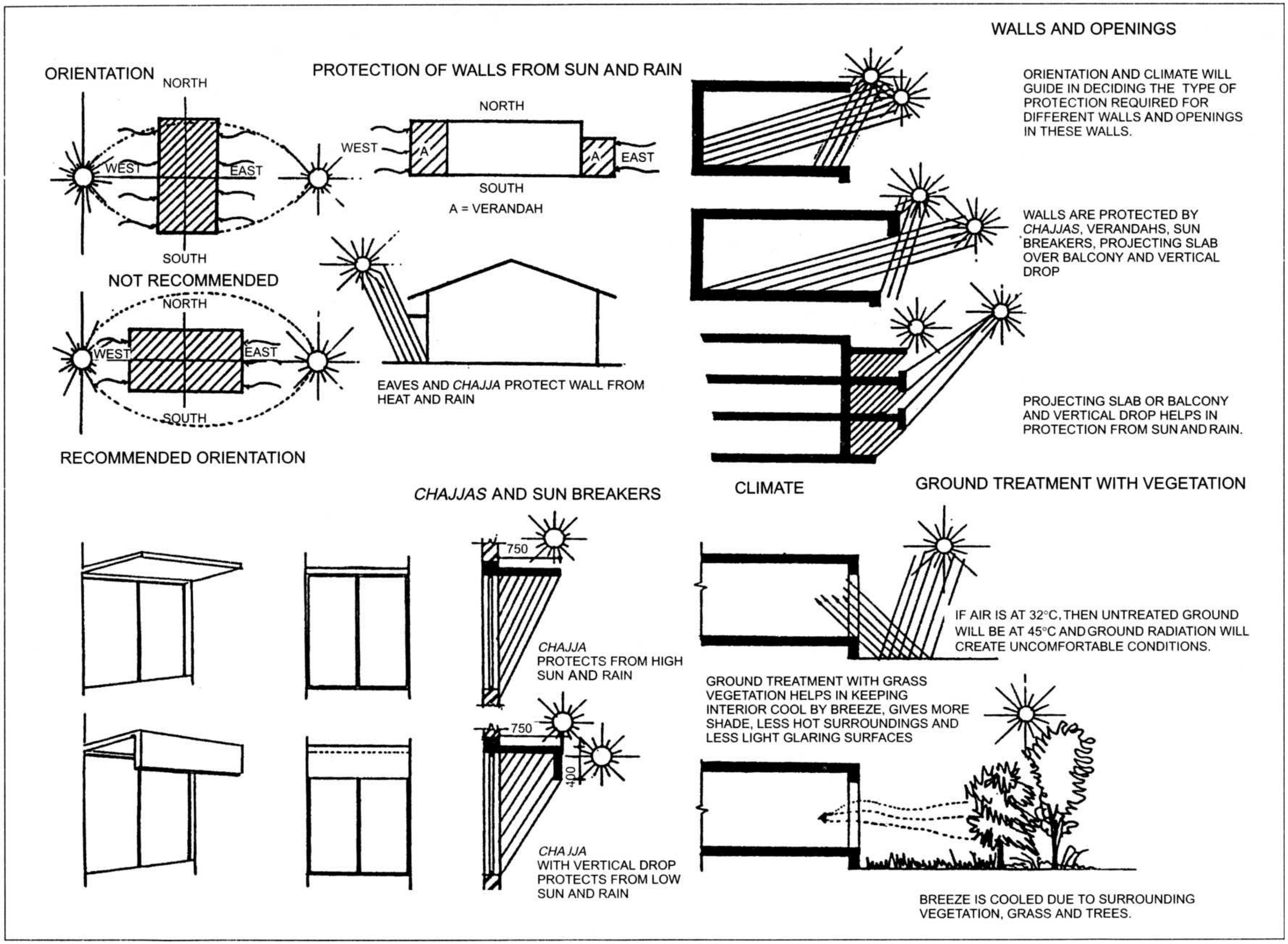


Figure 5.29 *Design Considerations for Orientation, Walls and Openings*

9. In the hot humid tropics, movement of air is important to create comfortable conditions. Window openings with ventilators should be placed at proper positions in the outside walls. Provision of ventilators over the doors opposite the window openings solves this problem to some extent. Movement of air should be at 2.5 m above the floor level which is the working zone, and in case of public buildings, arrangement for artificial ventilation should be provided.

10. Location of the kitchen and toilet needs consideration with reference to their placing. Discomfort due to smell, clatter and refuse need careful planning. In public buildings such as restaurants, schools and hospitals, the placement of kitchens should be done in such a manner that they are not seen. In residential buildings, bungalows and flats, use of exhaust fans becomes essential in kitchens and toilets.

Orientation has to be viewed both in its individual and overall aspects in placing of the block on site and particular aspects of individual areas.

Table 5.1 Zone-wise Design Considerations

Zone	Temperature and humidity	Design considerations
Very Hot	Temperature above 38°C from April to June, hot evenings	Protection of buildings from too hot and too bright sun; shading of building roof; facilities for sleeping outdoors at night. Heat radiation and glare from ground to be reduced by grass and hedges.
	Low humidity 90% hours in a year with the above condition	Permanent ventilation not desirable. Thick wall (400 mm) with reflective surfaces and having thermal capacity and time lag to make indoor living cool during daytime. The roof should be white or of any light shade to reflect the outside heat. For flat roofs, there should be sufficient thermal capacity. By providing 120 mm thick RCC slab with 100–120 mm mud phaska or lime concrete; 8–10 hrs time lag is achieved. For pitch roofs, ventilation is provided at eaves and ridge levels.
Hot	Temperature between 27°–38°C from March to September and ftom July to October. Temperature is combined with high humidity, during 51% hours in a year with the above condition.	Same is applicable to very hot zones.
Warm	Temperature falls between 15° and 27°C in February and March and November and December, during 23% hours in a year.	Open and outdoor living with more ventilation.
Cool	Temperature falls below 15°C in January, February, November and December; during 17% hours of the year.	Ventilation is to be restricted. Adjustable awning or shades over courtyards to retain heat for evening comforts. Provide gutter and drainage as per maximum rainfall. Leakage through RCC slabs depends upon variation in day and night temperature. Provide water proofing arrangements. Surface exposed to sun will have to stand variations in temperature and must be selected suitably.

Zone-Wise Design Considerations

Climatically, India can be roughly divided into the following zones:

1. Very hot
2. Hot
3. Warm, and
4. Cool

5.2.3 Materials of Construction

The form, the structure to be created, and to maintain that desired form, materials available for the erection of the structure and the architectural expression, are all interconnected factors. The most important and powerful principle of all arts or artistic sciences is a perfect natural agreement between the materials and the form.

An architect uses all varieties of building materials. The choice of materials is to be made, keeping in mind the principle of unity, which is affected by different types of materials, eskimos are lucky to have only one material for their igloo. Similarly, people in cool temperate zone use only timber for roof, walls and floors. The problem arises where materials of different types are available and a judicious choice is to be made keeping in mind the form. While considering the materials for the roof, wall and floors, we find that each material is characterised by three qualities; (i) structure (ii) texture, and (iii) aspect. Structure determines the particular way the material reacts under stress. This quality decides the place where the material will be best suited. Texture is related to the internal structure and directs the choice of tools to be used. The aspect is concerned with the colour and exterior skin after tooling. The intrinsic qualities of each must be known before selection of the materials. Depending upon the molecular organisation of each material, materials can be grouped under five different groups or families:

1. Rock family — Natural stone and clay (bricks)
2. Organic family — Wood/timber
   Natural materials having a cellular organisation
3. Metal family — A refined product from the natural material-most compact molecular organisation
4. Synthetic family — Glass, plastic, laminated and decorative sheets, etc.
5. Hybrid family Mixture of two or more types of materials (e.g. plywood, concrete, RCC and other composite materials).

1. ***Rock family, stone and brick masonry*:** Stone, which is obtained from natural rock, is the most durable and the least expensive of all materials of construction, as far as maintenance is concerned. The choice of stone masonry depends upon availability of stone and time available for construction. Stone requires more time for dressing, lifting and placing in position to make it fit in the wall perfectly. The thickness of plaster, if required, is more for stone structures, including mortar for joints. The minimum thickness of walls should be 400 mm. The different types of stone masonry are:

(a) Ashlar masonry It is of carefully dressed stones with narrow or fine joints. The main types include:

(i) *Ashlar fine or coursed ashlar*: In this class of stone masonry, stone blocks of the same height are used in each course and each stone is fine-tooled on all beds, joints and faces. The thickness of the mortar does not exceed 3 mm, while stones are usually over 300 mm in depth. The effect depends upon the size and proportion of the blocks of stone used. The sizes must confirm to the general scale of the building. For a pleasing effect, the length of each block should be twice or thrice its height. Public buildings in order to appear imposing, require ashlar masonry.

(ii) *Block-in-course masonry or hammer-dressed ashlar*: This type of masonry occupies an intermediate place between ashlar and rubble masonry. The stones are squared and brought to good, fair joints. The faces are then hammer dressed. The thickness of the mortar joint is 6 mm. The courses are usually 150 to 180 mm high. Block-in-course closely resembles coursed rubble masonry in its refined form. This type of masonry is usually associated with heavy engineering works such as railway stations, bridges, etc.

(iii) *Ashlar facing*: The heavy expense of ashlar masonry prevents its use throughout the whole thickness or depth of a wall, except in works of great public importance. Hence, the usual practice is to construct walls faced with blocks of ashlar, having a minimum thickness and backed by brick work or rubble. Such walls are also known as *composite walls*. This type of masonry is suitable for public buildings and heavy structures where expenses are to be kept to the minimum.

(iv) *Brick masonry*: Brick masonry is suitable for buildings and is easy to construct as compared to stone masonry. It affords proper bonding and requires less mortar. The minimum thickness is 100 mm. If the bricks are of good quality, different types of pointing enhances the appearance of the structure. If plastered, construction requires less amount of mortar than stone.

It should be noted that since the introduction of RCC framed structure, many materials have been tried for outside walling, such as solid concrete and hollow concrete blocks, concrete combined with cork, tiles, or with both, finishes applied on metal lath with a cement gun, or walls of asbestos, of compressed straw of plywood, aluminium, glass or steel plates. As compared to these materials, it is found that bricks and stones are more durable and economical as far as the capital cost and maintenance is concerned.

2. ***Organic family*:** The most common material from this family is wood or timber. It can be easily worked with tools of any size. Structural connections are easily made by joints. It is stronger than other materials of construction in proportion to weight. It is useful for decorative and attractive interior fittings. Buildings built of timber remain cool in summers and warm in winters. Timber constructions are well-known for their lightness, strength and durability. Post and beam type constructions designed with timber serve as skeletons for construction.

3. ***Metal family*:** Metals are able to stand a great amount of stress on account of their higher grade of molecular structure and organisation. The qualities of density, purity and elasticity are controllable and controlled while manufacturing. In case of stone or wood, one does not know the exact internal structure. Hence, the size used is naturally oversize for safety. That is why timber structures look heavier. In the case of metallic structures, lightness is possible due to its known strength. Steel frames give a perfect and economical solution for multi-storied and factory buildings.

4. ***Synthetic family*:** Glass for glazing windows, partitions, glass blocks and glass tiles help the utility of functional designs. Plastic is used for a variety of purposes, such as building materials for flooring, floor finish tiles, and heat insulation. Foamed polystyrene, which is available in the form of light-weight slabs with low thermal conductivity, is suited for thermal insulation. Slabs of foamed polystyrene can be readily fixed to the walls and can also be plastered. Phenolic resin-bonded paper laminates are available for roofing in the form of corrugated sheets. They are light and yet have a high strength and very good corrosion resisting property. Plastic pipes are also used as they are light and flexible.

5. ***Hybrid family*:** Hybrid materials have been created by man using two materials so as to create a new material, e.g., plywood, laminated wood, RCC, and so on.

Thin sheets of wood known as *veneers* are produced by rotary cutters and the same are bonded by synthetic adhesives, thus creating plywood. Teak, sisoo and toon are some of the Indian timbers capable of producing high grade figured veneers of approved quality. All types of veneers—decorative and commercial, highly specialised qualities of plywood, blockboards, flush doors and particle boards are useful for different purposes for the desired effect. Concrete shuttering plywood is extremely strong, durable, dimensionally stable, weather and water proof, and rot, termite, insect and fire resistant. It is widely used for centering, shuttering and formwork. It is ideally suitable for curved formwork. Plywood is suitable for ceilings for trussed roof with corrugated asbestos, GI sheets or tiles. Plywood ceiling tiles are also available. They come in plain, half perforated or fully perforated forms, and are suitable for false ceilings in commercial offices, factories, godowns, banks, showrooms, hotels, auditoria and wall panellings of auditoria.

Laminated wood stems from the same process as plywood. It is used for beams of any curvature and thickness and is profiled to withstand any specified stress. Fibre glass made of acrylic plastic and fibres to reinforce it, is a new hybrid material.

Reinforced concrete is the most useful and convenient material and has revolutionised the construction world. It is the association of steel, a tensile material and concrete, a compressive material. Thin profiled cantilevers, curved shells, roof to span wide spans, and quick monolithic and rigid constructions have become possible because of the combination of these two materials. Steel constructions are articulated and assembled, while RCC constructions are monolithic and rigid. Countries having steel, cement and cheap labour find RCC as an ideal material. The continuous use of RCC and the unending research in its varieties has unfolded before us its possible use as thin slabs, shells, membranes, folded structures and prestressed varieties. Further research and intensive use will show the way in which it can be used for light and less expensive structures.

Use of Materials as Veneer or for a Structural Purpose The details regarding materials for construction will give a new vision to students while studying properties of different materials. It should be remembered that materials are used either for structural purpose or for veneer. When materials are used for a structural purpose, one is interested in their inherent strength. This is because the role of a material under consideration is to hold the structure together and to span openings by beams supported on columns. When the material is used as a veneer, it is applied as a skin over an already existing structural system, and as such it is only supporting its own weight. Vacuum bonding relieves the main structure from the dead weight of the veneer elements. Stone, bricks, tiles, etc., are used as veneer materials and expression in a design changes due to its texture. Texture can be rough or smooth polished, glazed or grained. The effect of texture is to bring out the dramatic expression of the material itself due to tooling and its natural colour. Hence, what is important from the design point of view is the selection of the material and its desired texture which is to be seen with other materials, so as not to affect the unity in design.

Colour schemes and visual effect dictate the place and the area to be covered by the veneer material. It is obvious that natural materials match all other kinds of materials in their natural state. Rough stone matches with nonpolished metal, while polished metal goes well with wood or timber. In olden days, transportation was the main problem. Hence designers used materials available in the region; but nowadays different types of materials are available and hence their careful and judicious selection is very important.

In design also, perfect harmony becomes boring by excess of immobility, while dissonance, i.e., lack of harmony, brings interest and movements. Too much dissonance however shows disorder, confusion and chaos. The architect and the structural engineer are supposed to study different types of materials, their behaviour under stress, and the effect of climate on their texture and colour. Constructions should be sound and economical with the judicious selection of suitable materials available locally.

New material entrants in the postmodern period Polymer and plastics are two materials which are being frequently used in the postmodern period.

A polymer is a big molecule made by joining together of several simpler molecules of the same kind. A plastic is a substance like bakelite. It is a polymerised substance, which at a certain stage in its making, can be moulded into any shape.

Case Study

Structural Framing Plan for RCC Structure

Structural designers work involves:

1. Preparation of structural framing plan.
2. Estimation of loads, load transfer system—vertical as well as lateral loads.
3. Analysis of structure for shear, bending moments, axial loads and deflection, etc.
4. Design of different members.
5. Drawing, detailing and preparation of schedules.
6. Structural supervision work.

The study of architect's plans, elevations, sections, site investigation report, current IS codes for design, constructability, economy, safety, experience and the expected speed of construction play an important role in preparing structural design. Hence, a discussion with the architect related to all the points at the very initial stage before finalising the design helps in many ways to avoid waste of time later.

The first stage of preparation of structural framing plan, and various considerations along with some structural framing plans is discussed in case studies in Chapter 3 (Ref. Fig. 3.50, 3.50A, 3.50B, 3.51).

Structural framing plan is a plan showing structural system consisting of columns, floor beams, slabs with their respective numbers, span for slabs and beams and indications showing one way, two way or cantilever slabs and other details as per requirements of the plan.

The work of deciding positions of columns, followed by positioning of beams and spanning of slabs is done by some guiding principles and experience to achieve economy.

Once the positions of columns are decided most of the locations of beams get automatically fixed from the positions of columns and walls. Spanning of slabs is also possible in different ways, taking into consideration end conditions, supporting beams and their effective spans.

1. *Positioning of Columns*

(a) The load coming from the slab is transferred to beams, then from beams to columns and then to foundation through column footings in case of framed structure.

(b) The columns are usually carrying axial compressive loads. In addition, they carry some moments, due to gravity loads, wind loads and earthquake loads.

(c) The shape of the column may be square, rectangular, circular, octagonal, hexagonal or 'L' or 'T' type depending upon the functional and architectural requirements.

(d) Reinforcement: A column contains longitudinal and transverse reinforcements —transverse tie or helical reinforcement.

(e) The function of the column is to support the beams which also supports walls. Hence, columns should preferably be located at or near the corners of the building and at the intersections of walls.

(f) For walls along property line, columns are shifted inside along a cross wall to make room for accommodating the footing within the property line.

(g) Spacing between columns decides the span of the beam. Increase in span of beam increases the depth of beam, self-weight and hence total load. Therefore, larger spans of beams should be avoided to control the deflection and cracking. In the case of columns, the increase in the total load and hence increase in the size due to increase in span is negligible as long as the column is short.

(h) For big halls, grid system is used to avoid columns.

(i) As far as possible, width of column should not exceed the thickness of the wall to avoid offsets. This necessitates the depth of column to be larger for the desired load carrying capacity. However, for buildings other than residential, this consideration may not be strictly adhered to.

(j) The column should be so oriented that the depth of the column is perpendicular to the major axis of bending so as to get larger moment resisting capacity. In this case, the depth of the column is kept in the plane of bending.

2. *Positioning of Beams*

(a) Beams are normally provided under the walls or below a heavy concentrated load with a view to transfer heavy loads to the foundation along the shortest path.

(b) Spacing of the beams is decided by the maximum span of slabs. Maximum and minimum spans of slabs are governed by loading, and limiting thickness of the slab.

Maximum practical thickness of a slab is 200 mm while the minimum thickness is 100 mm for residential/office/public building.

(c) Beam should rest on column fully or it should be connected to another beam.

(d) Depth of the beams should be 1/12 to 1/15 of span. Depth includes thickness of slab.

3. *Spanning of Slabs*

Spanning of slabs is decided by the positioning of supporting beams or walls.

(a) One-way slab—supports are only on opposite sides or only in one direction. Major load is transferred along short span.

(b) Two-way slab—(i) Supports are in two perpendicular direction, i.e., supported on all four sides or supports, (ii) Two-way action of slab also depends upon L_y/L_x (the ratio of long span L_y to short span L_x), the ratio of reinforcement in the two directions (Astx/Asty) and the boundary conditions.

(c) In two-way slabs, steel along both the spans act as the main steel and transfers the load to all the four supports. In one-way slab, main steel is provided along the short span only and the load is transferred to the opposite supports only.

(d) A slab acts as a two-way slab when the aspect ratio $L_y/L_x < 2$. However, in practice, slab with $L_y/L_x < 1.5$ is designed as two-way slab. Slab with $L_y/L_x > 2$ is designed as one-way slab. Spanning of slab is also decided by the necessity of continuity of adjacent slabs.

4. *Layout of Stairs*

The type of stair and its layout is governed essentially by the available size of staircase room and the positions of the beams and columns along the boundary of the staircase.

5. *Numbering and Nomenclature for Members*

Columns are numbered serially starting from top left corner and proceeding rightwards and then downwards. Beams are marked serially as Bl, B2, etc., starting from first column and moving rightwards first and then downwards. Beams of similar type are designated by the same number. Slabs are marked according to their categories. Economy depends upon uniformity in dimensions of the columns and depth of beams, reinforcement can be changed according to the design by keeping outer dimensions uniform.

We all know that natural materials such as wood and rubber are getting scarce. Similarly, there is a problem of versatile utility. Wood or steel cannot always be moulded as per our desires and requirements. This led to the invention and utilisation of synthetics. Plastic is a synthetic organic material. It is a polymer, so is synthetic rubber or an adhesive. Polymer has high molecular weight. The world consumption of polymers was 1.5 million tonnes in 1950. It will be about 90 million tonnes by the year 2000. At present, the worldwide polymer usage exceeds the use of nonferrous metals on a weight basis. This limit was crossed in 1985. Now, this usage also exceeds the use of steel on a volume basis from 1990.

Polymers or plastics are light weight and energy saving in manufacturing capital cost. They can also be recycled. If the energy consumption of plastic is 1 unit, that of steel is 5.3, of zinc 6.1 and of aluminium it is 7.7 units. If the density of steel is 8 units, of polymer or plastic is 1 unit, in spite of its being a giant micro-molecule formed by thousands of molecules and with a high molecular weight.

Timber doors and windows were replaced by steel, aluminium and glass, and these in turn are now being replaced by plastics. Sintex doors and window frames are presently in the market. Jute bags are being replaced by ones made of polymers. Milk bottles have been replaced by light weight polythene bags. A bottling plant requires a basic investment of ₹ 190 lakh, whereas a plastic or polythene bag plant requires an investment of ₹ 86 lakh only.

Plastics have been replacing metals in structural applications as well. Steel, RCC and aluminium are being replaced by polymer composites. Steel ball-bearings in bridge construction are replaced by polymer ball-bearings. Its advantages are:

1. Light in weight
2. Low in thermal expansion
3. High stiffening capacity
4. High strength

Soon, we will make use of plastic floors, partitions, walls, doors and windows, roofs, plastic water tanks and water supply and drainage pipes in building activities. Waterproof synthetic materials are already available in the market. Plastic chairs are now of everyday use in hotels, theatres and most public places.

Soon, there may be plastic high-strength and low-weight stiffened bridges and plastic railway bogies.

Ferrocrete Technology Today, ferrocrete is well known due to its application for precast or cast in-situ overhead water tanks or septic tanks, gobar gas digesters, etc. It is a versatile material of construction, a composite formed with closely knit wire mesh, mild steel angles or bars used for forming skeleton with chicken mesh and squaremesh impregnated with rich cement mortar mix with a ratio of 1 : 2 or 1 : 3.

It is possible to fabricate a variety of structural elements. They are thin, light and durable with a high degree of impermeability. It needs no formwork for casting. It is found to be suitable for tanks, storage bins, pipes, roofing and walling elements. Its structural strength is achieved through its shape and the integrity of casting and stiffening members.

Overhead water tanks of capacity from 500 to 5000 litres on the terrace, ground service reservoirs of 10,000 to 50,000 litres capacity, septic tanks as per requirement, gobar gas digesters, pressure pipes, precast *chhajja*, lintel units, sewer chambers, are some of the products. Attempts are also made for water proofing of terrace slabs and use of ferrocrete for providing formwork which becomes an integral part of the member, i.e. beams, columns and slabs.

5.3 BUILDING RULES AND BYE-LAWS

5.3.1 Development of Land and Construction of Buildings

Development of land and construction of buildings is done according to the development control rules of the municipality, corporation, town planning authority or plan sanctioning authority of the area. Architects, contractors, civil engineers, draftsmen, promoters and builders are supposed to keep a copy of these bye-laws with them for ready reference along with the amendments thereto. Regional Town Planning Act, 1966 and Town Planning Act controls the construction and developmental procedures. For some areas, the industrial development authority and revenue department act as plan sanctioning authorities.

These regulations give detailed requirements for the following:

1. Layout plans, sizes of plots, width of the road, and open spaces
2. Lines of building frontages or setbacks
3. Built up areas and floor area ratio (FAR)
4. Marginal distances around buildings for open space
5. Height of the building
6. Maximum number of storeys
7. Maximum number of tenements
8. Plinth heights
9. Room areas, i.e., minimum room dimensions
10. Ventilation, i.e., minimum areas of window openings
11. Staircases and lifts
12. Water supply and sanitary arrangements
13. Balconies, *chajjas*, other overhangings and porches
14. Basement
15. Group housing schemes
16. Co-operative housing schemes
17. Industrial or public buildings
18. Shops
19. Parking spaces and garages
20. Compound wall
21. Outhouses.

5.3.2 Calculation of Plinth, Floor and Carpet Area

Plinth Area This is built-up covered area measured at the floor level of the basement or of any storey.

The following shall be included in the plinth area:

1. Area of the walls at the floor level excluding plinth offsets, if any, when the building consists of columns projections beyond cladding.
2. Internal shafts of sanitary installations, provided these do not exceed 2 m^2 in area, air-conditioning ducts, lifts, etc.
3. Porches and other cantilevers provided.
4. The area of *barsati* and the mumty at terrace level.

The following shall not be included in the plinth area:

1. Area of lofts.
2. Internal sanitary shafts, provided these are more than 2 m^2 in area.
3. Unclosed balconies.
4. Unless they form a storey at the terrace level, towers, turrets, domes projecting above the terrace level at terrace.
5. Architectural bands, cornices, etc.
6. Vertical sun breakers or box louvres projecting out.

Floor Area This is the usable covered area of the building at any floor level.

To get floor area, the area of walls shall be deducted from the plinth area to arrive at the floor area.

The following shall be included in the wall area:

1. Door and other openings in the wall.
2. Internal pillars and supports.
3. Plaster along walls exceeding 300 cm^2 in area.
4. Flues which are within the walls.

The following shall be excluded from the wall area:

1. Plaster along walls each not exceeding 300 cm^2 in areas.
2. Fire place projecting beyond the face of the wall in living or bedrooms.
3. *Chullah* platforms projecting beyond the wall of kitchen.

Carpet Area This is the floor area of the usable rooms at any floor level.

The carpet area of any floor shall be the floor area worked as per floor area and exclude the following portions of the building:

1. Sanitary accommodations
2. Verandahs
3. Corridors and passages
4. Kitchen and pantries
5. Stores in domestic buildings
6. Entrance hall and porches
7. Staircases and mumties
8. Shafts for lifts
9. *Barsaties**
10. Garages
11. Canteens
12. Air-conditioning ducts and air-conditioning plant rooms.

Floor Area Ratio (FAR) (Fig. 5.30) In town planning schemes, one of the important factors to be controlled is the density of population. It is a measure of the intensity of land use and is expressed as the number of persons living on a unit of land. Earlier, the method employed to control the density was indirect, i.e., by controlling widths of open spaces around buildings and their heights in relation to the widths of roads or by limiting the percentage of built-up area to the plot area or by restricting the number of floors that could be built on the plot.

Floor Area Ratio (FAR) is a new concept to regulate population density and to control overcrowding in dwelling units. It limits the total floor area of a building in relation to the plot area. A Floor Area Ratio of 1.6 means that the total area of all the floors in a building cannot be greater than 1.6 times the area of the plot. If the FAR is one, it means that the total area of the floors in a building is equal to the area of the plot, and each floor, if equal, will be of l/*n* the area of the plot, where *n* is the number of floors. It should be remembered that adequate front, rear and side open spaces have to be provided in relation to the height of the building to ensure good lighting and ventilation. The system of FAR gives full freedom to the architect to choose the number of floors that suit the project, provided the total area of all the floors does not exceed the built up area available for the plot as per the floor area ratio.

The FAR is therefore, the total area of all floors including the ground floor. It does not include the basement area. The following is also excluded from the total area, viz. staircase hall, balcony, water tanks on the roofs or terrace, garage, mezzanine floor (provided it covers not more than 40% of the area of room and height not more than 2.6 m).

Procedure of Submitting Plans for Sanctions For any type of building, two sets of drawings are prepared, (i) Submission drawings, and (ii) Working drawings and details.

The basic set includes drawings required for obtaining sanction from the sanctioning authority. After obtaining the sanction, detailed drawings are prepared.They help in pre-planning of detailed constructional work and supplying sufficient details to the contractor who can quote rates at the time of calling tenders.

Drawings for submission to the corporation or a sanctioning authority should contain:

1. Site plan—block plan and area statement.
2. Ground floor plan, first floor plan, basement floor plan, terrace plan, and car park plan; scale : RF 1/100, i.e., 10 mm = 1m.
3. Elevation—scale RF 1/100, i.e., 10 mm = 1m.
4. Sections passing through staircase, WC, bath, etc., giving details up to the foundation.
5. Schedule of doors, windows, and grill work.
6. Schedule giving notes for type of construction, foundation work, RCC work, etc.

Along with the plan, the following documents are required to be submitted:

1. Notice to execute the proposed work in the standard form.
2. Undertaking from the architect in the standard form.

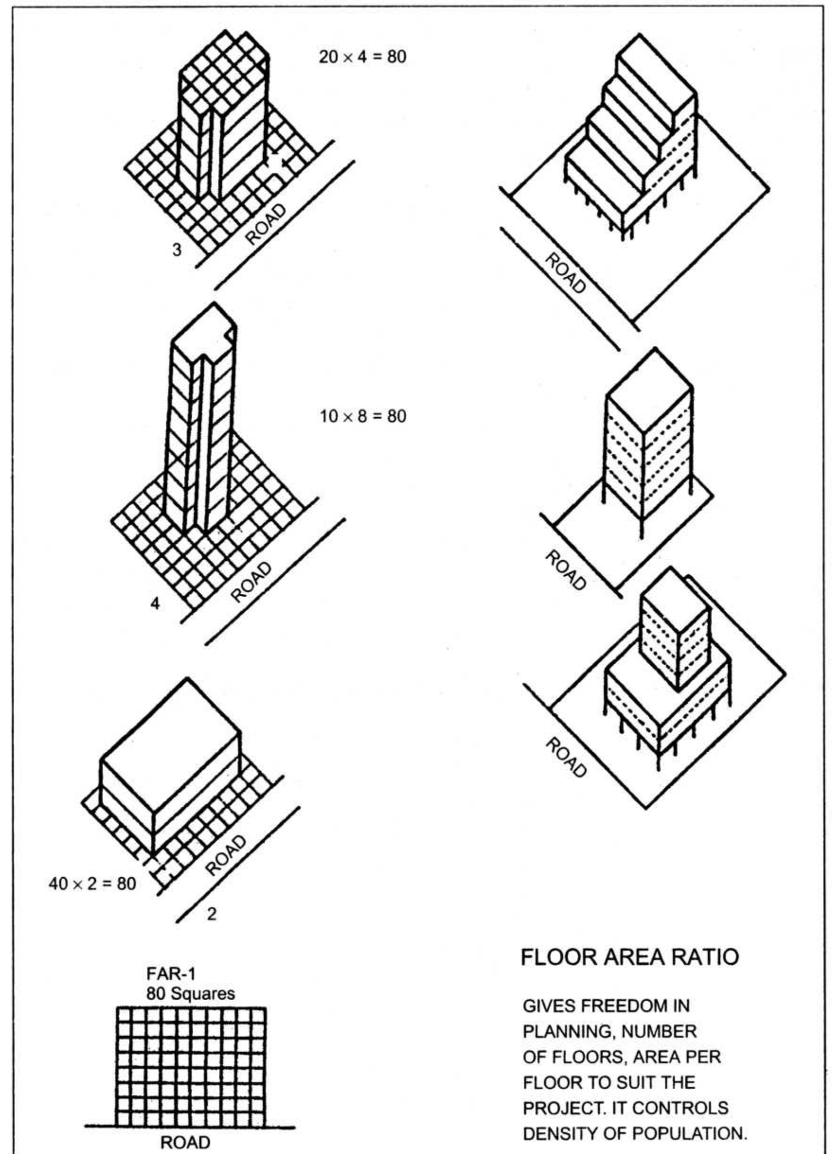


Figure 5.30 *Floor Area Ratio*

* *Barasati* is a covered space open at least on one side—constructed on a terraced roof used for shelter during rains.

3. Extract from property register stating the details regarding the owner and land.
4. Plan from the city survey office showing boundaries of the plot and adjoining survey numbers.
5. Certificate regarding area of the plot given by a corporation or town planning department.

If the plans comply with the requirements of the rules and bye-laws of the sanctioning authority and the code of town planning scheme, they may be sanctioned in due course, otherwise they may have to be resubmitted as per instructions of the authorities after complying with the same.

5.3.3 Extracts from Building Rules and Bye-Laws

The following information will throw light on the general requirements regarding plans, notice, certificates, undertakings, qualifications, and so on by different plan sanctioning authorities such as corporations, municipalities and others. It is likely that some modifications may take place in the future. As such, an architect or engineer should be in touch with such modifications, if any, in connection with the following:

1. Documents and plans
2. Number of copies
3. Owner's notice to execute the work
4. Undertaking from the supervisor
5. Building completion certificate
6. Qualifications and the experience for licensed surveyors, architects, engineers, clerks of works, structural designers, and plumbers
7. Extracts from the property register card.

1. ***Documents and Plans***: The following is an extract from building rules and bye-laws of municipal corporations, regarding the documents and plans to be furnished along with the notice.

The person intending to carry out the work shall send, along with the notice to be given, the following documents and plans:

(a) Correct plans and sections of every floor of the building intended to be erected which shall be drawn to a scale of not less than (10 mm = 1 m) and shall show the position, form, dimensions and means of ventilation of and access to the several parts of such a building and its appurtenances and the particular part or parts thereof, which are and those which are not intended to be used for human habitation and in the case of a building intended to be used as a dwelling house for two or more families or for carrying on any trade or business in which a number of people not exceeding twenty maximum be employed or as a place of public resort, the means of ingress and egress. Such plans and sections shall also show the depth and nature of the foundation and the proposed dimensions of all the walls, posts, columns, beams, joints, all girders, and scantling to be used in the walls, staircases, floors, and roof.

(b) A specification of each description of work proposed to be executed and of the materials to be used. Such specification shall include a description of the proposed method of drainage of the building intended to be erected and of the sanitary fittings to be used and also of the means of water supply and shall, if necessary, by the commissioner, be supplemented, by detailed calculations showing the sufficiency of the strength of any part of such a building.

(c) A block plan of such a building which shall be drawn to the scale of the largest revenue survey map at the time being in existence for the locality in which the building is, or is to be situated and shall show the positions and appurtenances of the properties, if any, immediately adjoining the width and level of the street, if any, in front and side of the street, if any, at the rear of such buildings, the levels of the foundations, and the lowest floor of such buildings, and of any yard or ground belonging thereto and the means of access to such buildings.

(d) A plan showing the intended line of drainage of such a building and the intended size, depth and inclination of each drain, and the details of the arrangement proposed for the ventilation of the drains.

(e) Undertaking from the person who is appointed to supervise the execution of the work (see Extract D).

Plans and sections to be submitted to the corporation under the provisions of the act and the building bye-laws and rules should be drawn and signed by the surveyor, engineer, architect or structural designer licensed by the municipal commissioner.

The description of the works set out in the plans must comply with the requirements of the building bye-laws.

The structural drawings and the structural calculations which are to accompany the plans shall be prepared and signed by the structural designer licensed by the municipal commissioner.

2. ***Number of Copies***:

(a) Three copies of plans for buildings in "gaothan" areas.
(b) Four copies of plans for buildings in agricultural lands.
(c) Five copies of plans for buildings in town planning scheme areas.

One of the above plans shall be signed by the Municipal Commissioner when signifying his approval or otherwise, of the plan and shall be returned to the person by whom the same was furnished.

(i) If found necessary by the commissioner, it shall be incumbent on every person whose plans have been approved or otherwise, to submit amended plans for any deviations he proposes to make during the construction of his building work and the procedure laid down for plans heretofore, shall apply to all such amended plans.

(ii) Every plan or amended plan mentioned above shall be coloured with fixed colours as follows:

Block Plan The proposed work is in red; the existing work is in black grey or neutral tint and the open spaces are uncoloured. Work to be removed is to be clearly shown on the plan.

Plans and Sections Proposed work in white lines if shown on blue ferro prints and in red lines if on white coloured prints.

Deviations In red, if shown on blue prints and in black, if on white prints. Brick work, wood work, RCC work, or steel work shall each be differently specified.

(iii) All the drainage work and drainage lines shall be shown on original and amended plans in distinguishing colours together with the location of the sewer trap chamber and the depth of street connections.

3. ***Owner's Notice to Execute the Work***:

Typical Notice
XXX Municipal Corporation

Notice under Section _____ of the XXX Provincial Municipal Corporation Act, 1949.

To

The Municipal Commissioner, No.
XXX Municipal Corporation, XXX Date

Sir,

Pursuant to the provisions of ________ of the XXX Municipal Corporation Act, ________, I hereby give you notice that I intend within the meaning of that section to execute the following work:

1. Description of the proposed work.
2. The purpose for which the work is intended.
3. Dimensions of the work.
4. The name and address of the person intended to be employed to supervise the work.

5. Name and address of the contractor, if any.
6. The description of walls, whether stone or brick masonry, the nature of mortar to be used.
7. The depth of the foundation and whether it is to be taken up to murum or hard rock strata.
8. Information about the projection of the balcony, whether it is on the municipal land.
9. How is the disposal of sewage water provided for?
10. Whether the land on which the proposed work is to be erected is owned by the person giving the notice.

I hereby acknowledge to have perused the building regulations contained in Chapter XV and schedule Chapter XII of the XXX provincial Municipal Corporation Act, ________, and the bye-laws made under the said Act.

Yours faithfully,

Signature and address of the owner of the proposed work
XXX (Name of the town)

4. ***Undertaking from the Supervisor*:** The following undertaking from the person who is appointed to supervise the execution of the work should be submitted to the Municipal Commissioner along with the notice.

To
The City Engineer, Date
XXX Municipal Corporation, XXX.
Sir,

With reference to the notice under Section ________ of the XXX Provincial Municipal Corporation Act, ________ , submitted to you by Shri ________________for the execution of the work ________________________, I wish to inform you that I have agreed to supervise the execution of the work mentioned therein.

Yours faithfully,

Licensed Surveyor L S No. ________________________
Licensed Engineer L S No. ________________________
Licensed Architect L S No. ________________________
Licensed Structural Designer L S No. ________________________

5. ***Building Completion Certificate*:**

(a) ***Certificate from the architect to the Corporation/Municipality***

XXX Municipal Corporation
Building Completion Certificate

I do hereby certify that the following work ________________________ has been (insert full particulars of the work) supervised by me and has been completed to my satisfaction, that the workmanship and the whole of the material used are good; and that no provision of the Act or the bye-laws and no requisition made, condition prescribed or order issued thereunder has been transgressed in execution of the work.

The drainage works in relation to the construction work mentioned above have been completed in accordance with your drainage rules and bye-laws and a certificate prescribed under rule ________ of schedule from Shri XXX, a licensed plumber is sent herewith.

Signature

(Date)
License No. ________________________

(b) ***Certificate from the Corporation to the Owner***

XXX Corporation,
____
No. ________________________ ________________________
Dated

Occupancy Certificate
(According to XXX Municipal Corporation Act of 1949)

From
The Assistant Engineer,
________________________ Corporation,
____

To
Shri ________________________
Address ________________________

With reference to your application, dated ________________________ for permission to construct a building ________________________ at plot No. ________________________ the Commencement Certificate No. ________________________ dated ________________ was issued to you.

With reference to the completion certificate, dated ________________________ issued by your architect and submitted to this office, permission required to occupy the same building is hereby granted as per ________________________ Provincial Municipal Act ________.

XXX Sd/-
Assistant Engineer
________________________ Corporation

6. ***Qualifications and Experience*:**

Bye-laws under Section ______ of the Provincial Municipal Corporation Act ______ prescribing the qualifications and the experience for licensed surveyors, architects, engineers, clerks of works, structural designers and plumbers.

Definitions

1. Words and phrases which are used but not defined herein shall have the same meanings as are assigned to them in the XXX Municipal Corporation Act, ________ referred to in these bye-laws as the "Act".

Qualifications of a Licensed Surveyor:

1. No surveyor shall be granted a license by the Commissioner as required by Section ________ unless the said person possesses the qualifications and experience as prescribed:

(a) A degree in civil engineering of any University or a diploma or a degree in architecture of any University or Institution recognised by the Commissioner.

OR

(b) Associate membership or membership of any institution which is considered by the Commissioner to be equivalent to a University Degree in civil engineering or architecture.

OR

(c) A diploma in civil engineering of any University or institution which is recognised by the Commissioner with practical experience of at least one year of work connected with the survey and building construction.

2. Any surveyor who has been granted continuously for a period of five years immediately preceding the date on which these bye-laws come into force, a surveyor's license by the Municipal Corporation of the city of XXX or who has at least five years practical experience of work connected with the survey and building construction work, may be granted a surveyor

license by the Commissioner, provided he passes the practical examination held by the city engineer for testing the merit.

3. No architect or engineer shall be granted a license by the Commissioner as required by section ________ unless the said person possesses the qualifications as prescribed:

(a) A degree in civil engineering or a diploma in architecture of any University or Institution recognised by the Commissioner on this behalf.

OR

(b) Associate membership or membership of any institution which is considered by the Commissioner to-be equivalent to a University Degree in civil engineering or architecture.

(c) A diploma holder in civil engineering or equivalent, holding surveyor's license for at least 10 years before these bye-laws came into force, if he is able to produce sufficient evidence of his having done structural engineering work for the ten years.

4. No person will be granted a license by the Commissioner to work as a structural designer for carrying out the works of design and execution of RCC or steel structures under ______ of the Act unless he possesses the following qualifications:

(a) A degree in civil engineering or structural engineering of any University recognised by the Commissioner in this behalf.

(b) Associate Membership of AMI Struct. E or AMIE (India) with structural engineering as a special subject.

(c) A diploma holder in civil engineering or equivalent who is already holding surveyor's license continuously for the last seven years previous to the passing of these bye-laws.

Qualifications of a clerk of works:

5. Any person who intends to work as a clerk of works may obtain a license from the Commissioner under section ______ if he produces a certificate from a licensed surveyor of having worked under him for a period of five years to the satisfaction of the licensed surveyor.

Qualifications of a Licensed Plumber:

6. (1) No plumber shall be granted a license by the Commissioner as required by ______ unless the said person holds a Degree or a Diploma in Civil Engineering or Sanitary Engineering of any University or Institution recognised by the Commissioner.

(2) Notwithstanding anything contained in clause (1), any person who does not possess the qualifications prescribed in clause (1) may be given a plumber's license by the Commissioner, if:

(a) He was granted a Plumber's License by the Municipal Corporation of the City of XXX continuously for a period of five years immediately preceding the date on which these bye-laws come into force.

OR

(b) He has extensive practical experience of not less than five years.

Provided that the Commissioner may, before granting a license to such a person, require him to pass a theoretical and practical examination.

5.3.4 The Architects Act, 1972 (No. 20 of 1972)

An act to provide for the registration of architects and for matters connected therewith was passed by the Parliament in 1972. The objects and reasons stated were, "Since independence and more particularly, with the implementation of the five year plans, building construction activity in our country has expanded almost on a phenomenal scale. A large variety of buildings, many of an extremely complex nature and magnitude, like multistoreyed office buildings, factory buildings and residential houses, are being constructed each year. With this increase in building activity, many unqualified persons calling themselves as architects are undertaking the construction of buildings which are uneconomical and quite frequently, unsafe, thus bringing into disrepute the profession of architects. Various organisations, including the Indian Institute of Architects, have repeatedly emphasised the need for statutory regulation to protect the general public from unqualified persons working as architects. With the passing of this legislation, it will be unlawful for any person to designate himself as an "architect" unless he has the requisite qualifications and experience and is registered under the Act."

Although this legislation protects the title "architect", it does not make the design, supervision and construction of buildings an exclusive responsibility of architects. Other professionals like engineers will be free to engage themselves in their normal vocation in respect of building construction work, provided that they do not style themselves as architects.

Application for Registration According to this act, "Every architect who desires to have his name entered in the register shall submit an application in form No. XI, together with documentary evidence about his eligibility for registration accompanied by a draft of ₹ 50/- (Present situation) in favour of the Secretary, Council of Architecture, New Delhi, for issue of a certificate of registration and the certificate of registration shall be issued in Form XII.

Form No. XI

Application for Registration of Architects

The Secretary

Council of Architecture

New Delhi

1. Name in full (in block letters)
2. Father's name
3. Nationality
4. Date of Birth
5. Residential address
6. Professional address
7. Particulars of qualification (supported by attested copies)
8. Date of commencement of profession/service.
9. Whether practising independently/as a partner/or employed
10. Period of residence in India
11. Present address on which communication will be made
12. Any other particulars.

I hereby undertake that if admitted as a registered architect, I will be bound by the provision of the Architect's Act, 1972 and the rules and regulations framed thereunder or that may hereafter from time to time be made pursuant to the said Act.

I also enclose a draft of ₹ 50/- as registration fee for the year ____________.

Yours faithfully,

Encl. List of particulars endorsed.

Form No. XII

Council of Architecture of India

Certificate of Registration under sub-section (7) of Section 24 and sub-section (4) of Section 26 of the Architects Act, 1972.

Certificate of Registration

This is to certify that the name of Shri/Shrimati ________________ has been entered in the register and his/her Registration No. is ________________. This certificate is valid from the ________________ day of ________________ 20________ to the ________________ day of 20 ________________ inclusive.

Renewals

Signature of Registrar

List of additional qualifications.

Given under the common seal of the Council of Architecture, this ________________ day of 20 ________________

President

Secretary (Seal)

Extracts from the Property Register Card

City Survey: Poona-Taluka: Poona-District: Poona			
Survey No. (Shivajinagar) 560	Area (ha.) (0.34)	Tenure (final plot) 26	Particulars of assessment or rent paid to the Govt. and when due for revision
Basements —			
Holder in 19 origin of the title (so far as traced)			
Lessee —	City Survey Office SEAL		
Other encumbrances— Other Remarks			

Date	Transaction	Vol. No.	New Holder (H), Lessee (L) or Encumbrances (E)	Attestation
12.4.44	As per Partition deed	120	H Shriram Govind Naik	Sd/- Tahsildar
5.11.68	As per sale deed amount ₹ 4,32,450/- From: Shriram Govind Naik	S(2) 4350 – 9.4.67	H Anand Cooperative Housing Society	Sd/- Tahsildar

5.4 ARCHITECTURAL PLANNING OF BUILDINGS-PRINCIPLES

5.4.1 Role of an Architect and a Civil Engineer

Just as one enjoys music, derives pleasure out of looking at sculptures and paintings and loves taking a stroll in the moonlight, in the same manner, an architectural creation also has an appealing quality. Architectural forms may be lines, surfaces or volumes. While walking, our angle of vision changes constantly with every step. We observe different aspects of a building, the interplay of light and shade, its colour and texture, openings for doors and windows and its surroundings. Some buildings please the observer, while others do not. Every building is constructed with more or less the same material. Each one has doors, windows and a roof. In spite of this, every building cannot be a piece of architecture which will please every observer. The beauty of a building is in its design. The common man constructs his shelter with the help of masons and carpenters. The basic purpose of the construction is thus served, because for him the purpose of construction is to make things hold together. For him, homogeneous construction with heterogenous materials is good. But, the purpose of architecture is different altogether. Utility, form and aesthetics are an architect's main consideration and these are related to the proper utilisation of space according to the function or programme. Architecture is the art and science of planning and construction in which art has its own say. Art is both static and dynamic. Architecture is a static art which delights in order and proportion, just as painting and sculpture. Dynamic art delights in movements and rhythm. Architectural forms possess the dimension of time which signifies movement and life. There is some quality in architectural design which creates a liveliness in few buildings, but which is not materialised in the vast bulk of the remaining buildings. A drawing or photograph can never completely express the living value of space which is essentially fluid. It can only serve as a base or support for our imagination. No work of architecture can be truly appreciated for its total worth until it is visited.

A house is not constructed merely as a shelter, it is expected to create a happy environment inside as well as outside. The same is valid for buildings for education, health and entertainment. The creation of a desired environment inside as well as outside the building is the job of the architect. Hence, site relationships, planning of gardens, trees, pathways and harmony of form, colour and texture so that it is pleasing to the observer are the main considerations. The design should not separate the building from its surroundings. It should integrate both. It should be impossible to think of the site without the building. This is the real test of the success of the programme "planning and construction".

Modern buildings are constructed with a new vision, employing new methods and new materials. They reflect the fact that the exterior of a building is deter-mined by its plan and every little part or projection of the building justifies its existence.

Symmetrical fronts which were typical of traditional architecture are not commonly seen in present-day buildings. A building should suit its site and surroundings. Even asymmetry and contrast are appreciated if the building merges with its surroundings. Hence, one should realise the importance of landscape architecture, and of selection of materials and a form suitable to the function and the site.

With the high cost of living today, ownership flats have become very popular. Therefore, one has very high expectations from the architects who design them. An architect should design houses which are both functional and pleasing to look at. The same is true of public buildings.

Le Corbusier has commented on the work of engineers and architects in the following words:

An engineer employs geometrical forms ________ his work is on the direct line of good art.

The architect by his arrangement of forms, realises an order which is a pure creation of his spirit. The purpose of construction is to make things hold together, and of architecture, to move us.

Thus, architecture demands a different talent and vision while dealing with its basic necessity, i.e., utility, form and aesthetics. A person trained in planning and possessing the urge and natural vision for aesthetics should deal with planning and aesthetics. At the same time, he should have a sufficient background for structural design and construction. A person possessing an analytical vision, knowledge of the methods of construction, materials and their properties, and sufficient background of structural design should deal with sound and economic construction. Planning, co-ordination and execution is thus the job of the architect. Estimation and measurements, structural design, contract, and supervision is the job of the civil engineer. This division automatically stresses the need for a civil engineer to have the background of the work of an architect and a knowledge of the principles of architecture, so as to enable him to read the drawings with the vision of an architect.

5.4.2 An Approach to Planning

With the expectations explained above, there will be a number of questions in the mind of the student. What should be the main considerations when one starts to plan a building? How to develop the plan step-by-step? etc.

Chart 5.5 shows the various considerations regarding the function, i.e., utility (usefulness), form and feeling for aesthetics and utility. While planning, one has to consider each requirement separately, but one should remember that all considerations are inter-related and integrated.

Another to be kept in mind throughout the whole process of planning is the three-dimensional aspect of the structure. Ultimately, the total pleasing effect depends upon many components. The first impression regarding the building rests in the architectural composition and treatment of the surroundings. As one approaches a particular building, the location of the building with reference to its surroundings, the proportion of solids and voids in the elevation, projections of *chajjas* and sunbreakers, shades and shadows, colour scheme, texture of the construction material, etc., all create a visual impact on the observer.

The next impression is imprinted as one enters the building. While walking across the different rooms, passages, and the staircase, one immediately gets a feel of the size of the room, light, ventilation and spatial arrangements. However, the success of a design is not only dependent on these major details but also on minor details, such as the height of windows and material of the window sill, fixtures for the doors and windows, location of switches, etc. Hence, it is essential to study the principles of planning to create the desired environment inside as well as outside the building.

5.4.3 Function-Utility-People and Their Requirements

A building can be a public or a private building, or residential or nonresidential. Functional requirements vary from building to building. Hence, it is essential to finalise the programme with reference to the people who will be living there and their requirements. The time spent in this initial stage is really worthwhile from the point of view of the correct approach to planning and construction.

Proposal A house should provide all comforts. Yet it should be constructed economically. It may be a one or two-room tenement in a *chawl* or a three to four room flat in an apartment house or it may be a separate bungalow constructed on a small or big plot. The owner may wish to invest in a theatre or shopping centre.

Site A visit to the site will give a clear idea about the surroundings and the nature of the plot. If necessary, the architect may do a contour survey of the area. The size, dimensions, shape and nature of the ground surface—level or sloping, the rate and direction of slope with reference to the front road, etc., are important considerations while preparing the layout plan. Trial pit results help to know about the nature of the soil, foundation conditions of the site and its geology, i.e., the depth of the surface soil, the various strata which may be met with, and so on. Hard murum, i.e., noncohesive soil having a safe bearing capacity of 450 kN/m^2, within a depth of one to two metres may be considered as the best geological condition. The type of construction depends upon the depth at which hard strata are available. Availability of water, electricity and drainage facilities are favourable points.

The position of the ground water table should be predetermined as it affects the cost of excavation and foundation. Exposed rocks near the site of construction are not favourable as they get heated up during the day and radiate the same heat during the night creating uncomfortable conditions in summer.

Finance The estimation for the work to be executed can now be carried out. The present rates of construction whether (i) on the plinth area rate basis, or (ii) on the carpet area rate basis are available with architects for different types of residential and nonresidential buildings.

The financial implications consist of:

1. Cost of civil construction including compound wall, water supply and drainage
2. Cost of electrical work
3. Cost of interior design
4. Cost of furniture
5. Cost of acoustics
6. Cost of air conditioning
7. Cost of landscaping—development of premises, filling and levelling, etc.
8. Fee of the architect
9. Fee of the structural designer (engineer)
10. Consulating engineer's fee for the foundation of any special work (Many times this is covered under item 9).
11. Supervisor's and watchman's wages
12. Fees of the specialists, for instance, the interior designer, furniture designer, acoustic consultant, air conditioning consultant, landscape consultant, etc. Lawyer's fee for legal advice, if any, for purchase of the plot, etc.

The cost due to the above mentioned items will vary as per the type and requirements of the building—residential or nonresidential and its specifications.

The owner expects to get optimum returns for his investment. The architect and owner thus have to decide upon the mode of getting the work done in the shortest period of time at the minimum cost. This is done on the following basis: (i) by contract on item rate basis, (ii) by cost plus percentage, and (iii) on lumpsum basis. Efficiency is brought into play in huge constructional works by the scientific systems, such as CPM and PERT for project management.

Analysis of the Programme Discussions with the owner will supply the basic data to the architect about his requirements. A theatre for cinema, for instance, requires a main auditorium with or without a balcony, a stage with a screen, projection room, booking and manager's office, sanitary units, canteen, air conditioning units, etc. A theatre for drama requires a big stage with ample space for stage material and other properties, a green room, room for the control of light and sound, etc. A school building requires classrooms, drawing halls, an exhibition hall, laboratories, a principal's room, an office and sanitary arrangements for students and the staff. Even residential buildings have got different requirements as per the type, viz. two-room flats, three-room flats or a separate bungalow for an owner.

Once the architect is clear about the general scope of the proposed building with reference to the site plan as given by the owner, the next question to finalise with the owner is the space requirement.

Case Study

Reading Exercise (Figs. 5.31 to 5.35)

Architects—"Kimaya" Residence for Mukund and Netra Sonpatki at Talegaon Dabhade

1. Study the five drawings showing various considerations in planning— study of the site, nature of the ground, slope, views, bubble diagram for the lower ground floor, ground and first floor. Analysis of the programme, visit to the site and discussions with the owner about total requirements is essential before finalising planning and construction details.
2. Details about the climate and surroundings would be useful while deciding structural and landscaping details. Prepare a check list for essential data for the same.
3. What is meant by cavity walls? How are they useful? What will be the increase in the cost? Think of an alternative for cavity wall construction.
4. Study constructional details for stair, handrail, parapet, etc.
5. A landscape plan shows names of different trees and plants. Collect their local names, study in detail about their plantation, maintenance etc. Collect details for any other project with reference to:
   (a) Cost of the plot
   (b) Cost of construction
   (c) Cost for landscaping
   (d) Cost for fees of consultants.

Space Requirement The space requirement for every individual unit in a building depends upon its function. A building consists of different units or rooms having specific functions, and these units have a definite relation with their adjoining and other units with regard to function and convenience. These units may be connected with each other by means of a passage, lobby, verandah or staircase. Hence, the next stage in the analysis of the programme is to make a list of the different units, and scrutinise their functional requirements, along with their sizes. For example, in the case of an auditorium, the size of the chair, number of rows, etc., will decide the seating capacity, size and shape of the auditorium. The size of a classroom, on the other hand, will depend upon the size of the teacher's platform, number of students in the class, type of benches, number of students per bench, area required for each bench, distance between two rows, and also the distance between the first row and the blackboard. Space requirement finalises the area (length, width and then height), suitable to the function and ventilation. Rules and regulations regarding building construction should be referred to at this stage. For example, the minimum area for a living room should be 12 m^2 while for an auditorium, area per chair should be 0.8 m^2–l m^2 with a volume of 3.5–4.3 m^3 per chair. The space requirement should be checked even for the smallest unit, such as wash basins, etc. Hence, the points to be considered for space requirement are:

1. Regulations and bye-laws of the plan sanctioning authority.
2. Establishment of areas for different units (a) function (b) number of persons (c) furniture requirement, etc.
3. Roominess
4. Flexibility
5. Sanitation
6. Requirements for air conditioning/central heating, acoustics-equipment and other provisions
7. Cubical requirements for ventilation.

An architect should study the regulations and bye-laws laid down by the corporation, municipal authority, town planning department, and industrial development corporation or revenue department as per its jurisdiction. The plan of any type of building must fulfil the requirements mentioned in the code, Architects, contractors, civil engineers and draftsmen are supposed to keep a copy of these bye-laws with them for ready reference along with the amendments thereto.

Determining Areas for Different Units The success of functional planning can be judged immediately by observing the plan which details furniture arrangement of sofas, chairs, tables, carpets, television, and other decorative pieces in the living room, chairs and dining table in the dining room; cupboards and refrigerator in the kitchen; and beds, easy chairs, and dressing tables in the bedrooms. The furniture should be arranged to give maximum area for movement and convenience regarding opening of doors and cupboards and opening and closing of window shutters.The position of beds should give privacy with reference to the direction of opening of shutters for the door, sufficient light for reading and for getting cool breeze during night. The whole set of arrangements must be comfortable. Built-up furniture units are provided in bedrooms by providing a loft above the projecting walls. The cupboard width should be 600 mm in bedrooms and 200 mm in the kitchen.

Furniture requirement plans are essential in the case of library buildings, hotels, schools, theatres, health centres, etc., in order to fix the size with reference to the number of persons to be accommodated.

Analysis of the programme gives details regarding the exact requirements of the health centre. Rooms for doctors and nurses, a labour room, waiting hall, maternity ward and special rooms along with toilets are necessary. Finalisation of the number of units, their areas and grouping of units, taking into consideration circulation, are the various stages in planning.

The area of a particular unit is dependent upon the function, number of persons that will be using the unit, furniture, space, and area required for circulation. Another condition is the minimum area required for circulation. Yet another condition is the minimum area requirement of a particular unit as per rules, e.g., kitchen—8 m^2, bedroom—12 m^2, W C —1 × 1.2 m, i.e., 1.2 m^2, and so on. Use of space-saving furniture, e.g., sofa-cum-bed, dining table of a folding type, etc., and their convenient arrangement will naturally increase the utilisation of space in a room.

A plan showing the furniture arrangement and location of doors and windows showing the direction of opening of the shutters would be useful to the owner to judge comfort, convenience, circulation, privacy as achieved through the plan, along with the direction of breeze and natural light. It also helps in the preparation of the plan for electrical installations—switch boards, points for lights, fans, heater, air conditioner or cooler, and so on.

The area for a toilet attached to the bedroom should be sufficient to accommodate a W C pan (Indian or European), a wash basin, a tub, etc., with due thought for plumbing installation.

Roominess After establishing the area for a particular unit, the next job is to check, and if required, modify the dimensions—length, width and height of a unit with reference to the consideration of roominess.

In planning a building, an architect deals with length, width and height. In short, he deals with space. The height of man is the real measure. His eye level, the height up to which he can raise his hands, the length of his bed, etc., are some measures by which we can compare different levels, viz. the window-sill level, top level of doors and windows, loft level, etc. The feeling of space, i.e., whether it is sufficient, less, more or cramped, depends upon suitable and adequate proportions of the minimum dimensions required for the functions expected to be achieved from the space. If the length of the room exceeds one-and-a-half times its width, the result will be a cramped effect. A square room is found to be inconvenient as compared to a rectangular room of the same area from the utility point of view. Hence, the length to width ratio should be between 1.2 : 1 and 1.5 : 1. Less width with more length will cause a tunnel effect. Positions of doors, windows, cupboards, lofts and their level, and the colour treatment of the flooring, walls, ceilings, etc., are all responsible for creating the effect of space. Light colours create the effect of more space whereas dark colours make the room look smaller. Hence, a combination of light and dark colours for different walls of the same room will apparently reduce the effect of less width and more length.

For buildings such as clubs, the ceiling height is generally kept low to create an impression of closeness. However, for buildings like district or high courts or public buildings of monumental nature, the ceiling is kept at a higher level to create a feeling of grandeur and solemnity.

The imagination of the architect leads him to project the look of a particular room or area with reference to furniture pieces and their location, sizes of doors and windows, areas interrupted and uninterrupted by openings, and the effect to be achieved while deciding the colour scheme for the walls.

Flexibility The requirements of a family change as the family expands. The kitchen and dining space have to be combined in most houses. There may not be any separate guest room and it may become necessary to convert the living room into a guest room when required. Three and four-roomed flats should be designed with special regard to this flexibility. Furniture like sofa-cum-beds easily help in achieving this. The most important requirement in planning is to provide independent access to sanitary units from all rooms.

In the case of public buildings like schools, hostels, etc., the plan should provide flexibility from the point of future expansion.

Sanitation Sufficient light, cleanliness, ventilation and sanitary convenience are the main considerations in sanitation.

Lighting Lighting is important from the point of view of illumination and hygiene. Lighting is of two types, natural lighting and artificial lighting. In some cases, both natural and artificial lighting may be required to give sufficient light.

The source of natural lighting is the sun. Sunlight is a source for illumination and it also destroys certain germs. The intensity of natural light is affected by pollutants like smoke, dirt, dust, gases and clouds. The minimum window area for buildings located in a hot-humid climate

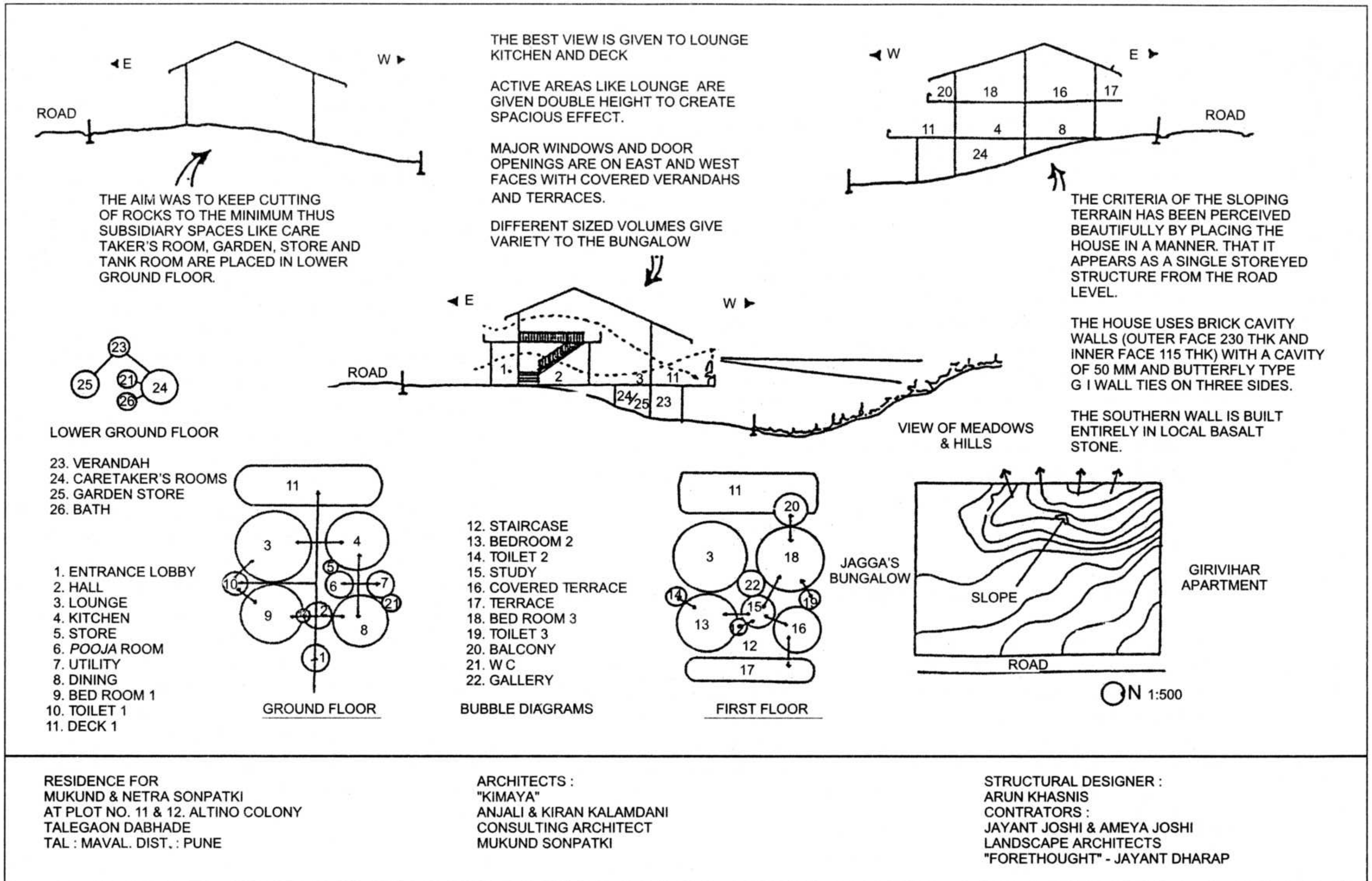


Figure 5.31 *Planning and Design of Residence – Considerations*

is one-seventh of the floor area, and for dry climates, one-tenth of the floor area. For buildings like *chawls*, dormitories, factories, schools, etc., it should be one-fifth of the floor area. Vertical windows are more effective than horizontal windows. Walls of a soft shade increase light by reflection, while dark shades reduce light by absorption. Use of white colour for ceilings and white or soft shades of colour for walls in passages and rooms will improve the lighting and impart a pleasing look.

Artificial lighting is required to supplement or replace natural illumination. Proper illumination increases the efficiency of workers in a factory or office by reducing fatigue. Light glares should be avoided as they damage the eyes.

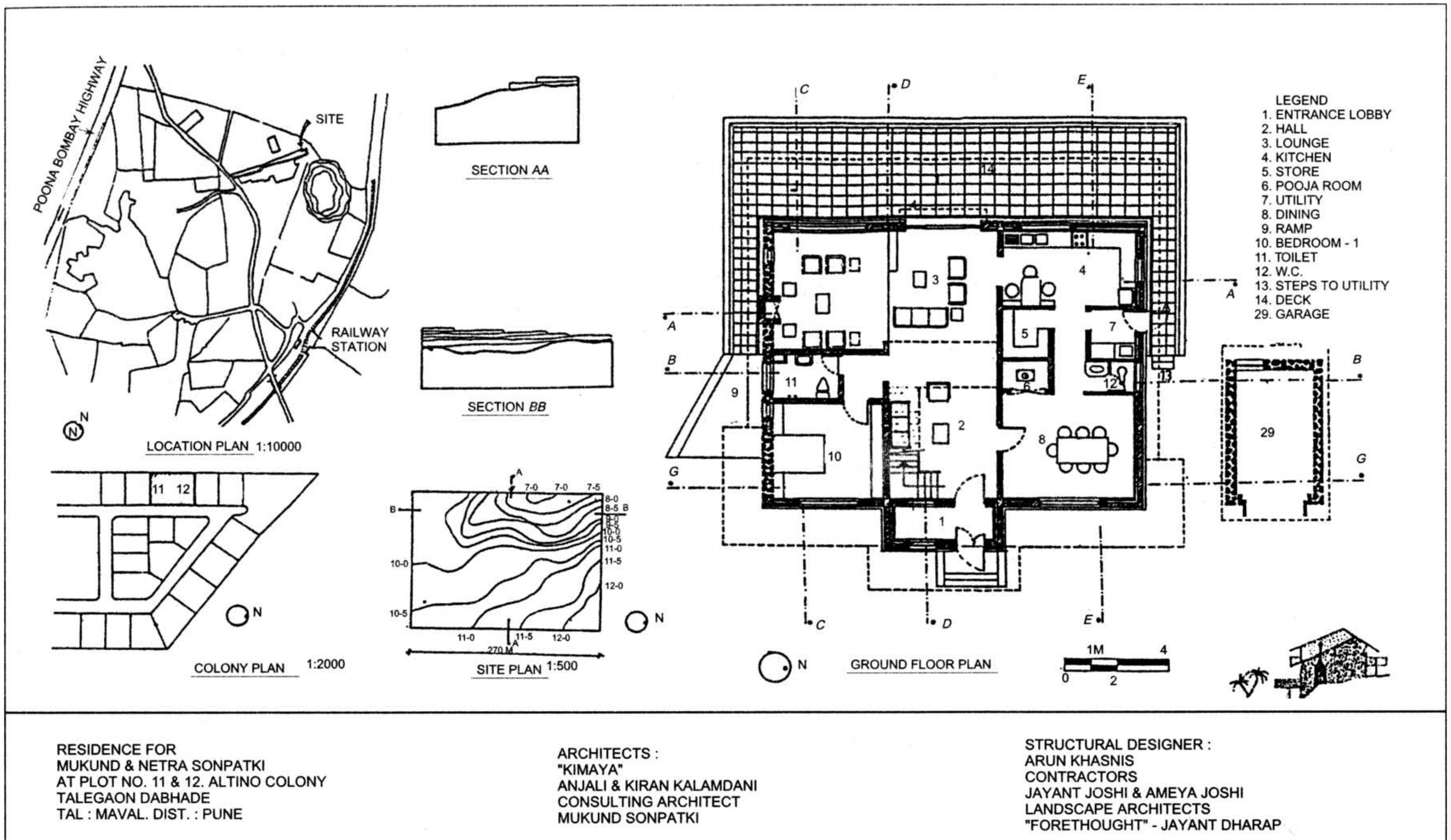


Figure 5.32 *Planning and Design of Residence – Considerations – Site Plan and Plan*

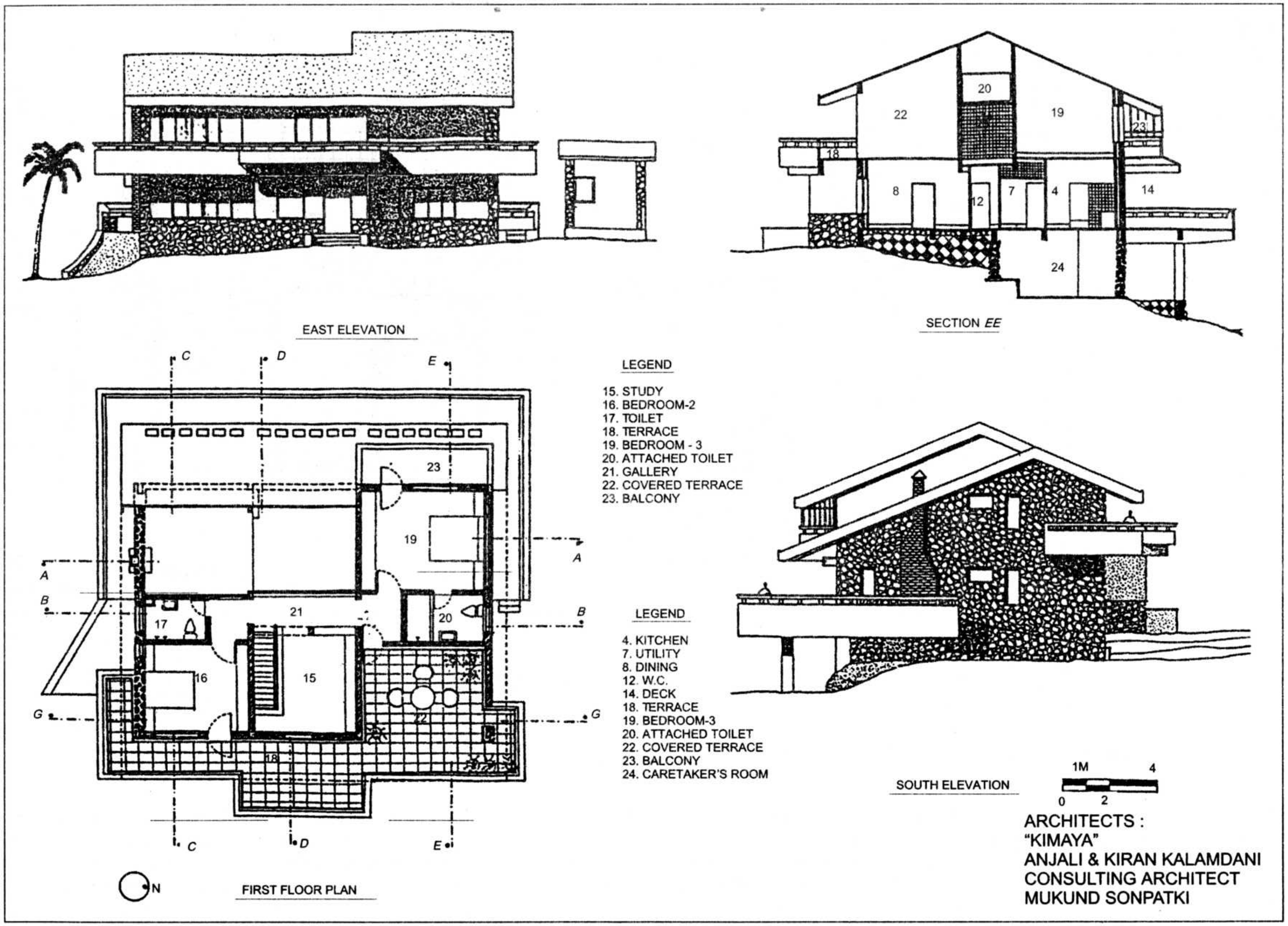


Figure 5.33 *Elevations and Sections*

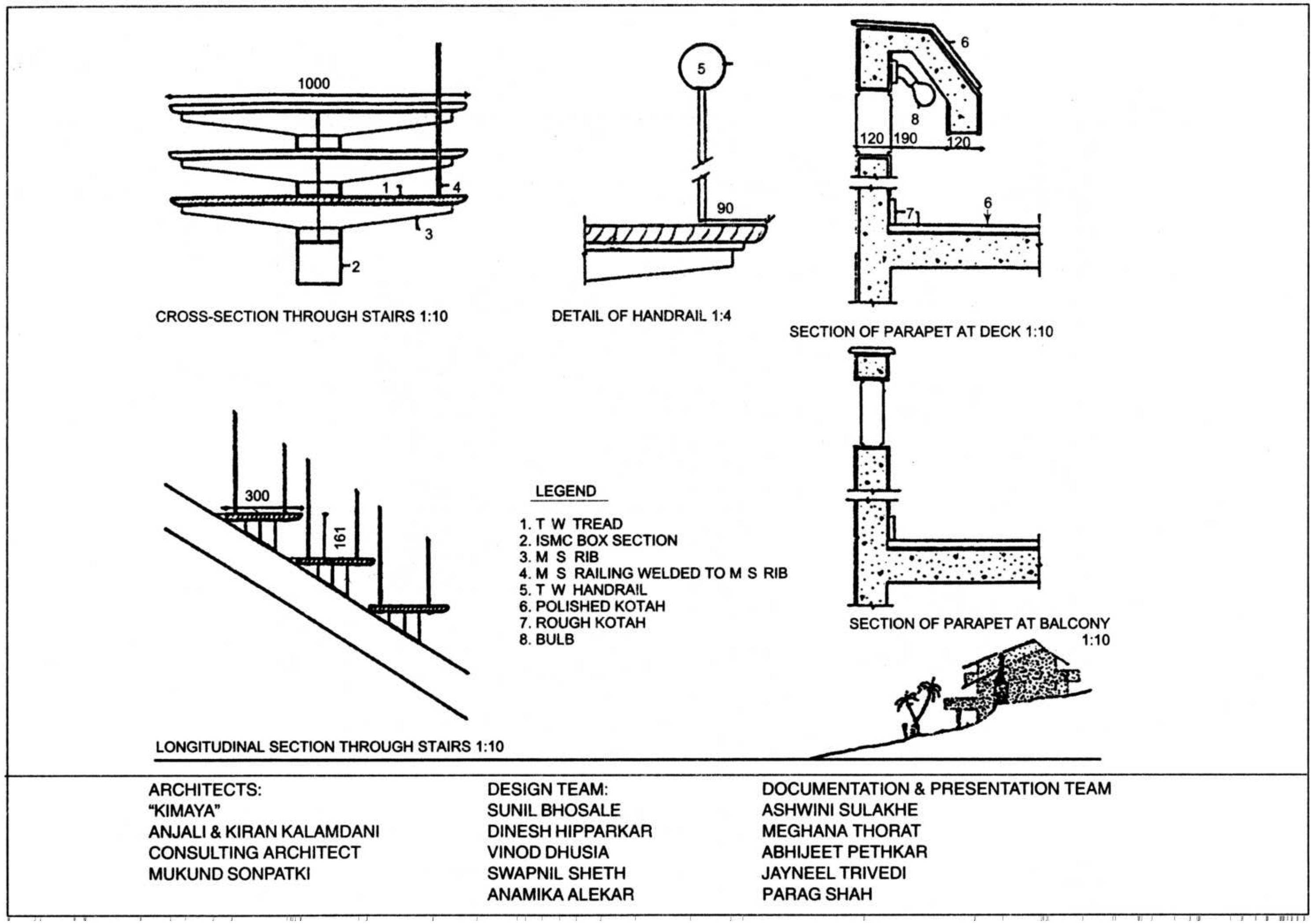


Figure 5.34 *Details – Stair*

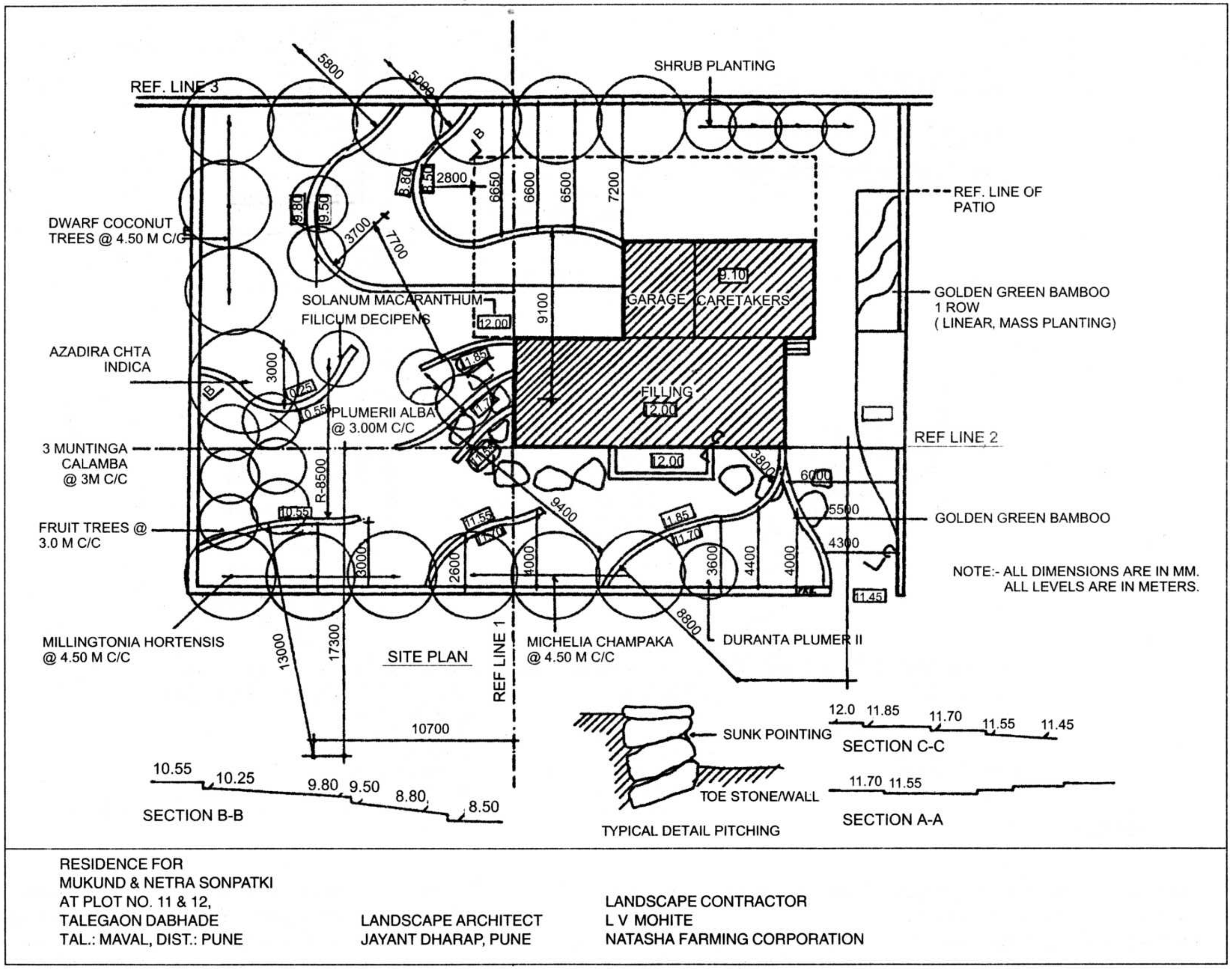


Figure 5.35 *Landscaping Details*

Table 5.2 Recommended Value of Illumination

Sr No.	Visual tasks	Illumination (lux)
	(A) Industrial Buildings and Processes	
1.	Canteens	150
2.	Entrances, corridors, stairs	100
3.	Assembly shops	
	(a) Rough work (heavy machinery)	150
	(b) Medium work (engine assembly)	300
	(c) Fine work (radio and telephone equipment)	700
	(d) Very fine work (precision mechanisms and instruments)	1500
	(B) Office, School and Public Buildings	
1.	Airport buildings	
	(a) Reception areas (desks)	300
	(b) Customs and immigration halls	300
	(c) Circulation area and lounges	150
2.	Banks	
	(a) Counter, typing and accounting book areas	300
	(b) Public areas	150
3.	Cinemas	
	(a) Foyers	150
	(b) Auditoria	50
	(c) Corridors	70
	(d) Staircase	100
4.	Libraries	
	(a) Shelves (stacks)	70 to 150
	(b) Reading-room	150 to 300
	(c) Reading tables	300 to 700
5.	Offices	
	(a) General offices	300
	(b) Conference rooms and executive offices	300
	(c) Drawing offices	
	(i) General	300
	(ii) Boards and tracings	450
6.	Schools	
	(a) Class and lecture rooms	
	(i) Desks	300
	(ii) Blackboards	200 to 300
	(b) Laboratories	300
7.	Hospitals	
	(a) Reception and Waiting Rooms	150
	(b) Wards	
	(i) General	100
	(ii) Beds	150
8.	Hotels, Restaurants, Shops and Homes	
1.	Hotels	
	(a) Entrance hall	150
	(b) Dining rooms (tables)	100
	(c) Bedrooms	100
2.	Restaurants	
	(a) Dining rooms	
	(i) Tables	100
	(ii) Cash desks	300
	(b) Kitchens	200
3.	Shops and stores	
	General area	150 to 300
9.	Homes	
	(a) Kitchen	200
	(b) Bathrooms	100
	(c) Bathrooms	100

Table 5.2 gives recommended values of illumination for some locations and tasks. These values are valid under most of the conditions whether the illumination is by natural lighting, artificial lighting or a combination of both. Refer to National Building Code of India, 1970 (part VIII)—Building Services—Lighting, for additional details in case of (i) industrial buildings and processes, (ii) offices, schools and public buildings (iii) nursing home and hospitals, and (iv) hotels, restaurants, shops and homes.

Illumination is the density of luminous flux incident upon a surface. The unit of illumination is lumen per square metre (lm/m^2) which is known as *lux* (lx).

Luminous Flux is the light given out by a source or received by a surface or transmitted by a medium irrespective of the manner in which it is distributed spatially as regards direction. The unit of luminous flux is lumen (lm).

Good daylighting means not too much light but sufficient light free from glare. It should come from the right direction. Good daylighting is essential to promote the activities carried out within the buildings, particularly industrial buildings, to promote the safety of people using the buildings, and to create a pleasant environment. In the case of residential buildings, this requirement is met by admitting daylight through windows on the basis of daylight factors. The efficiency of a window as far as lighting is concerend is judged by means of the percentage of external sunshine that is admitted into the rooms.

100 lux is equal to a daylight factor of value 1.25 per cent based on 8000 lux as the external design illumination for India.

The number and size of windows can now be adjusted to meet the above requirements. In actual practice, sizes of windows and openings depend upon the climatic condition, and lighting requirement.

The light may be distributed in three ways; (i) directly, (ii) indirectly, or (iii) semi-indirectly. Direct lighting brings the light direct from the source to the surface to be illuminated. It is more economical. Indirect lighting brings the light by reflection or redirection to the surface to be illuminated; the light source itself is hidden from view by some reflecting device. Semi-indirect lighting is a combination of both direct and indirect lighting.

Location	*Daylight factors for dwelling (%)*
Kitchen	2.5
Living room	0.625
Bedroom	0.313
Study	1.9
Circulation	0.313

Cleanliness Dust is injurious to health. It allows the growth of bacteria and spread of diseases. Mouldings, skirting, cornices and corners are the places of dust accumulation. The design of the room should be such that it can be cleaned easily.

Ventilation Ventilation may be defined as the system of supplying or removing air by natural or mechanical means to or from any enclosed space to create and maintain comfortable conditions.

Orientation of the building and location of windows help in providing proper ventilation. Window areas are specified according to the rules. Placement of windows and ventilators should be in such a manner that it facilitates the flow of fresh air into the house. Louvres in doors and windows are useful for ventilation. A sensation of comfort, reduction in humidity, removal of heat, and proper supply of oxygen are the basic requirements in ventilation apart from reduction of dust.

There are two methods of ventilation; (i) natural ventilation, and (ii) artificial or mechanical ventilation.

Natural ventilation It is suitable for houses and flats. It is achieved by designing windows and ventilators opposite to each other. Window openings should not be less than one-fourth the superficial area of that side of the room which faces an open space. Natural ventilation is due to air movement induced by wind and/ or temperature difference.

Artificial ventilation It is necessary if the room is to be occupied by more than 50 persons or where the space per occupant is less than 3 m^3. It is achieved in three different ways (i) exhaust or extract system, (ii) supply or plenum system, and (iii) balanced system.

Table 5.3 Space Requirement Per Head

Nature of building	Cubic space per head (m^3)	Floor area per head (m^2)
Residential houses and *chawls*	9	2.5 to 9.0
Dormitories	12.0 to 15.0	3.0 to 4.0
Factories	7.50	2.0 to 2.5
Educational establishments	4.5 to 7.5	1 to 2
Hospital wards	30	8 to 10
Auditoria	3.5 to 4.3	–

Sanitary facilities Water closets and bathrooms should be provided with dadoes, so that they can be cleaned regularly. The flooring and side walls should be finished with water-proofing material before fixing the tiles for the floor and dadoes. A water-carriage system is good for cleaning. If this system is not possible, properly designed septic tanks or *acqua privies* (in villages) should be used. Provision of an overhead reservoir, storage at ground level with the rate at 135 litres/head/day or maximum available rate and pumping arrangement will provide continuous water supply to these units. The requirement regarding number of WCs, wash basins, urinals for male and female users, etc., is given under "Data for public buildings".

Provision of water supply, drainage, rain water and ventilation pipes, and their connection to the wall and various units require careful thought to avoid leakage on walls. A plan showing gully traps, inspection chambers, man holes, gradient to pipes, flow direction, etc., should also be prepared.

Air conditioning When an enclosed space is occupied by human beings, the effects observed are; reduction in the oxygen content and increase in the carbon dioxide content, odour and organic matters given off from the skin, clothing and mouth, dry bulb temperature and humidity. The ultimate effect is discomfort. Complete air conditioning must include heating, cooling, humidifying, ventilating, and filtering of air. Winter treatment of air for comfort includes heating, humidification, cleaning, i.e., the removal of dust, dirt, smoke, fog and bacteria by various means, sterilisation, absorption of odourous materials, and dilution with clean, fresh, air either to reduce odour intensities or to minimise the danger from toxic gases. The distribution of air must be uniform with a gentle motion in all parts of the enclosed space, to maintain uniformity in temperature and humidity. In summers, air is cooled and dehumidified, while in winters, air is heated and humidified for comfort.

The equipments provided in a complete air conditioning system have to perform the following functions:

1. Heating and humidification of air for winter conditioning only.
2. Cooling and dehumidification of air for summer conditioning only.
3. Air filtering and proper ventilation for both winter and summer conditioning.

In central air conditioning systems, all the machinery is kept at one place. The duct line is provided to supply the conditioned air. The area required for the air conditioning plant and the information regarding the duct system and the cost may be obtained from a specialist.

Depending upon the type of the building—auditorium, hospital, or factory, it is necessary to know the specific requirements for machinery, pipes and sizes for air conditioning or air cooling equipments. Before finalising the shape of an auditorium, it is necessary to consult an acoustician to get a natural audio effect.

For large jobs, architects commonly employ the services of specialists to design the layout and furnish drawings dealing with mechanical and electrical systems. Separate drawings such as an "air conditioning plan", an "electrical plan", a "plumbing plan", etc., are necessary. The same are then combined with the architect's set of working drawings. However, the architect is supposed to know the general space requirements for these installations in the initial stage of planning and also the total cost of equipments and installation.

Finalising of space requirements for different units, as also the length and width of individual units, provide sufficient data to prepare a flow diagram. The architect has by now complete data ready on his table. What is necessary now is to arrange the units in a logical sequence. The main principle to be remembered is, "Everything, however small, must fall into its proper place—not only in a suitable place, but in an aesthetically acceptable place."

The architect should imagine that he is moving through the various units of the building, and check mentally for length, width and height provided. The considerations regarding grouping, circulation, privacy, orientation, aspect and prospect, elegance and economy will help in preparing a practical, comfortable, convenient and economical plan (Fig. 5.36).

Grouping Grouping implies an arrangement of various rooms with reference to their functions. As most people like to sit in the verandah, the living room should naturally be next to it. The kitchen and dining room must be close to each other. Sanitary arrangements must be adjacent to the bedrooms. There should be independent access to sanitary units. The staircase must be approachable from the maximum number of rooms. The passage area must be minimum, well ventilated, and sufficiently well lit.

Grouping varies according to the type of the building. Hospitals, libraries, schools, and cinema halls should be designed taking into consideration the movement of persons from one unit to another, without causing disturbance to the other units. Location of the main and subsidiary entrances, staircases and toilet units, units on the ground floor and other floors require careful consideration.

If some buildings form parts of a large complex, the grouping of the buildings itself should be considered. For this, consultation is necessary with specialists and administrators of different streams, such as education, medicine, industry, etc.

The shape of a building is determined by the shape of the plot. It is also dependent upon the grouping of various individual units. The area of the plot, the permissible built-up area, the area proposed to be built, area for future expansion, etc., are the points which are considered while judging the efficiency of the plan.

Circulation Circulation in a building is of two types, horizontal and vertical. Horizontal circulation is between the rooms of the same floor. It should be achieved by the provision of passages, corridors, halls and lobbies. Vertical circulation is between different floors, and can be achieved by the judicious provision of staircases and lifts. Sometimes, ramps are provided in public buildings such as theatres, bus stands, truck depots or office buildings. Multi-storeyed buildings should be provided with emergency exits in the event of a fire.

Minimum area with sufficient light and ventilation is the basic requirement of both types of circulation units. They should add to the convenience, comfort and privacy of the users. Staircase planning requires consideration in the selection of rise, tread, width of stairs and landing and design of the handrail. In the case of public buildings, suitable location of staircases, their appearance, etc., help to create a cheerful atmosphere.

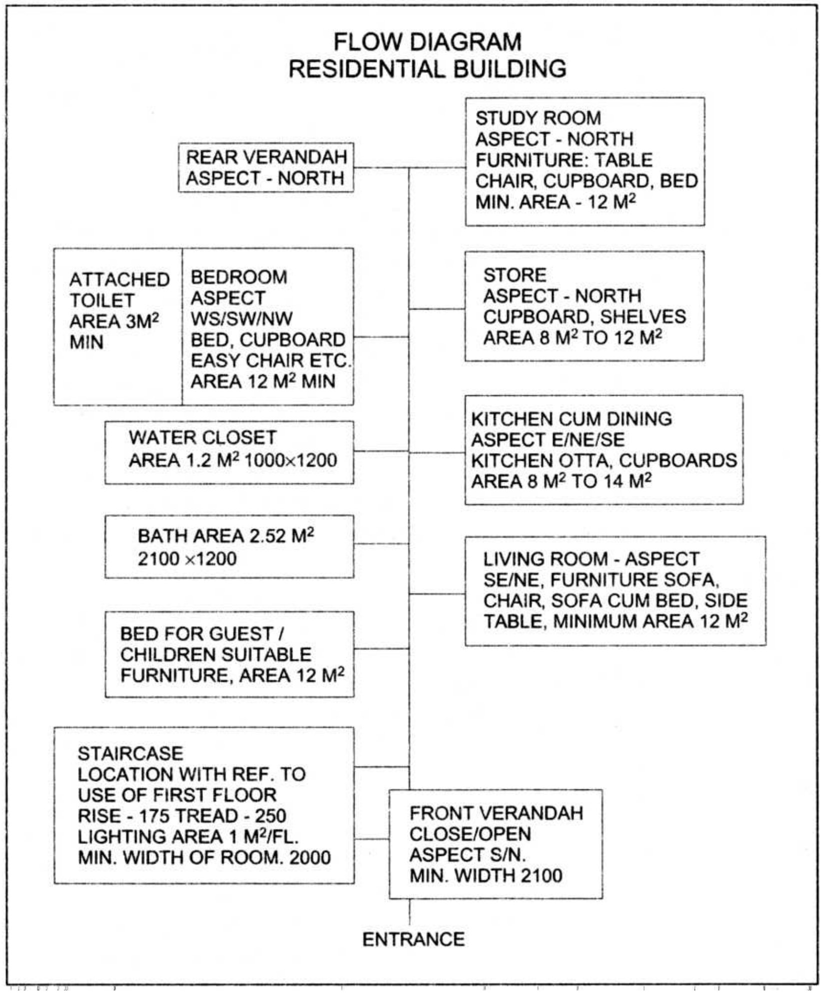


Figure 5.36 *Flow Diagram – Residential Building*

Orientation-Aspect and Prospect Good orientation means proper placement of plan units of the building in relation to the sun, wind, topography and outlook and at the same time providing convenient access both to the street and backyard. The position of a building in relation to the prevailing wind or to the sun is an important consideration. Different rooms have different functions. Activities in different rooms take place at different times of the day. Early in the morning we would like sunshine to enter the rooms and hence, the bedroom should face east in places having cold climate. The kitchen should be planned in such a way that the main windows face eastwards and the others towards north. This is because most women use the kitchen for more than six hours a day. The living room should have one opening towards the north and another towards the east. This will make the room comfortable throughout the day. A living room facing south will get maximum sunlight in winter. The final choice depends upon the climate of the place. If the direction of the breeze is south-west or west, bedrooms which are always used after evenings should face the west, south-west, or north-west. The verandah should face either the east or west, and if required, the south. This is to protect the kitchen, living room or bedroom from intense heat.

Orientation helps to create comfortable conditions in the case of public buildings, such as schools, colleges, office buildings, industrial structures, etc., by placement of long walls towards the north and south and short walls towards the east and west. Orientation in the case of nonsquare buildings is stated by the direction of the normal to the long axis. If the length of the building is east-west, the long axis will be east-west and normal to the long axis will be north-south, hence its orientation is stated as north-south.

Aspect and prospect *Aspect* is connected to the placement of different rooms of the house in accordance with our activities at different hours of the day. The kitchen should have an eastern or north-east aspect and bedrooms a south-west or north-west aspect. The rooms should get enough sunlight and air, as this apart from creating a cheerful atmosphere, is also good from the hygienic point of view. Windows are provided to fulfil these requirements. The minimum area of a window should be as per usual rules, viz. one-tenth of the floor area of the room for hot-dry climates (hot-arid) and one-seventh of the floor area for hot-wet climates (hot-humid). Windows should be provided on at least one side of the room and if possible, on two or even three sides. They should be of the same height as far as possible but their width can vary.

Prospect refers to the view as seen of the outside from the windows in general and doors in external walls. It is determined by the view as desired from certain rooms of the house, viz. view of the garden or a nearby hill. At the same time, it is naturally intended to conceal some undesirable views. It will be observed that sometimes aspect and prospect considerations may be at variance with each other, and herein lies the skill and imagination of the architect.

Window locations are useful to keep visual control on the plot, i.e., the main entrance gate or the back side. It is a protection against intruders. The design of the grill should be checked from the security point of view.

Privacy By privacy, we mean the following:

1. Privacy of the whole building with reference to the surrounding buildings and roads. This can be achieved by screening the entrances (front and back), planting of trees and creepers, etc.
2. Privacy in different rooms, i.e., bedrooms, bathrooms, kitchen, etc. This is achieved by correct positioning of the doors and openings of shutters. The shutters should open in such a way that a person entering the room will get minimum view. A large portion of the details of the room (such as beds in a bedroom) should not be visible at a glance. For maximum privacy, single shutters are better than double shutters. Provision of frosted glass for windows provide more privacy than plain glass. Louvres for shutters provide ventilation as well as privacy.

Elegance The principles mentioned above are for general guidance. Certain compromises have to be made while preparing a particular plan. Site conditions and marginal distances *restrict ideas* to some extent. Elegance is related to the effect produced by elevation, which depends upon the proportion of width, height, doors and windows and the choice of materials.The visualisation of elevation should always be kept in mind while preparing a plan. Utility is the main consideration, keeping in mind the cost. An architectural design and composition should be studied in detail for achieving success in creating an elegant structure.

Economy Economy inhibits the freedom of an architect in planning. At the very outset, he should discuss with the client the aspect of current costs. A false idea of economy should not be given. Scope should be kept for future expansion. Economy can be achieved by providing rooms of minimum necessary dimensions, minimum door and window areas, simple design for windows, plain tiles and fixtures and fastenings of a simple type for internal doors, and so on.

Line Plan-Sketch Plan and Layout Plan While drawing the sketch plan, the elevation of all the four sides as well as the perspective view from the road should be kept in mind. The real test of a design is the economy of area and economy of space. An effect of spaciousness within comparatively limited dimensions can be achieved by skillful treatment of form, colour, natural and artificial lighting and all the elements of furnishing. Space production is a skill. Small areas and lower floor heights necessitate a careful study of wall surfaces and sizes with skillful proportions of windows and doors. Wall surfaces should not be unnecessarily broken by the placing of doors. Doors and windows located in corners provide an unbroken wall surface.

One should remember that for a best thought-out plan, there are not many solutions for a given programme. The line plan with reference to the site plan, shape of the plot, north direction, wind and rain directions, main road and surrounding views, etc., should be kept in mind while preparing the sketch plan. The decision regarding the type of structure, i.e., load bearing or framed structure, with reference to the depth of foundation, economy, number of storeys and future expansion decides the thickness of the internal and external walls. For example, RCC framed structures will have external walls of 230 mm thickness, while internal walls will normally be 115 mm thick (thickness includes plaster on both sides and thickness of skirting, tiles, etc.). In the case of load bearing structures, the thickness of walls will depend upon the number of storeys and materials of construction. A normal structure will have walls of 400 mm thickness.

The sketch plan should be prepared on a tracing paper. Beginners may keep a graph paper below the tracing paper. This will help to save a lot of time. The sketch plan is generally a free-hand drawing. After plotting the site plan, the north direction, marginal distances, and the area for parking, the plan is sketched/ drawn with reference to the main entrance or focal point of interest. Sometimes, the plan is developed by making major and minor axes which are suitable for buildings like hospitals or educational institutions having different wings. A plan may be symmetrical, balanced or asymmetrical depending upon the nature of the building and the shape of the plot. A symmetrical plan is divided into two equal parts by the principal axis on each side. Elements equal in general mass are placed or grouped on each side of the principal axis. In the case of a balanced plan, the masses on either side of the main axis are equal in weight, but their character and disposition may be considerably different. In the asymmetrical plan, the axis is brought to one side of the composition. Hence this plan allows free grouping of various units of different sizes.

The checking stage At this stage, the cost of the total project can be worked out, which includes the cost of the land, cost of development, cost of buildings, and also the cost of other amenities and the surrounding garden. In the case of small buildings, it is necessary to check the area of the proposed construction with the area allowed for construction as per the floor area ratio and marginal distances. Sometimes, it may become necessary to reduce the dimensions so as to meet the various rules and bye-laws. Cost of the buildings can be calculated from the present rates of construction, plinth or carpet—cost/m2 or cost/m3. The area statement showing the area of the plot, area allowed to be built and area proposed to be built is necessary for discussion and approval.

Approval of the owner The owner may be an individual or a public body. At this stage, it is necessary for the architect to get the owner's approval of the scheme proposed by him. Sketch plans for the layout, perspective drawing or a model serves the purpose. Once the owner has given his approval, the next stage is to finalise details of the structural requirements as per the form of the building which is a product of the space requirements and flow pattern of different units. The architect now leaves the work of structural design to the structural engineer so as to devote maximum time to the architectural details of the project. The first stage has given a solution within the limitation of time, expense and restrictions. The second stage is related to the architect, to his aspirations which is a challenge to the spirit of the artist in the architect, the aspiration to add some quality in the architectural design to make the building "live".

5.4.4 Checklist for planning

Data for planning and organising the work must be collected in a systematic way. The following checklist will guide the architect in collecting the data. After knowing the requirements of the owner and inspection of the site, the data are to be recorded systematically as follows:

Job number ____________________

Name of the work ____________________

Name of the owner ____________________

Address ____________________

(a) ***Site and site plan***
- (i) Size of the plot
- (ii) Shape of the plot
- (iii) Frontage and depth
- (iv) Nature of the ground-level or sloping, contour details with plan
- (v) Existence of ditches, nallas, etc.

(b) ***Utilities available and other data***
- (i) Water
- (ii) Electricity
- (iii) Drainage
- (iv) Trees
- (v) North direction
- (vi) Desirable view
- (vii) Trial pit results
- (viii) Hard murum depth
- (ix) Level of the road and plot
- (x) Invert level of the drainage where it is to be connected
- (xi) Rainfall and maximum-minimum temperature in summer and winter
- (xii) Local materials for construction
- (xiii) Type of locality
- (xiv) Sub-soil water level
- (xv) Access roads
- (xvi) Types and details of adjoining structures
- (xvii) Overhead high tension lines
- (xviii) Telephone lines crossing the plot

(c) ***Rules and documents***
- (i) Corporation or sanctioning authority; rules for the construction and built-up area; building line, marginal distance and floor area ratio (FAR).
- (ii) Proof regarding ownership of the plot; an extract of the record of rights, i.e., property register card, 7/12 extract or any other relevant documents, copy of sale deed or *sathe khat*.
- (iii) Copy of plan from city survey office or land records department regarding measurements of plot boundaries.
- (iv) Certificate regarding area of the plot from the town planning office or corporation.
- (v) Certificate from the corporation or town planning authorities incorporating the permission for residential or industrial construction.
- (vi) NA certificate from the revenue authorities.

(d) ***Requirements of the owner (residential buildings like bungalows)***
- (i) Number of persons and age
- (ii) Profession of the owner
- (iii) Accommodation required
- (iv) Servant's accommodation attached or in outhouse
- (v) Kitchen—separate dining or combined
- (vi) Separate accommodation for "*Pooja*".
- (vii) Hobby of the owner
- (viii) Car park for garage
- (ix) Ground floor accommodation
- (x) First floor accommodation
- (xi) Basement, store-room

(xii) Storage tank for water—type and capacity, solar water heating system
(xiii) Roof type
(xiv) Location of entrance
(xv) Verandahs and ottas
(xvi) Porch
(xvii) Study, dressing room, office, etc.
(xviii) Staircase—internal, external, or common
(xix) Accommodation to be rented
(xx) Floor finish
(xxi) Provision for future construction
(xii) Bath rooms—number, attached or separate
(xiii) Water closets—Indian, Western
(xxiv) Instructions for finish in bathroom, WC, kitchen, etc.
(xxv) Electrical fittings—open or concealed

(e) ***Building restrictions***

(i) Maximum permissible built-up area
(ii) Maximum cost
(iii) Stages in construction, if any
(iv) Method of finance
(v) Time limit for construction
(vi) Correlation of supply of funds with progress of works
(vii) Owner's requirements as regards to the type of construction.

The architect prepares the line-plan, develops the plan, and shows it to the owner along with perspective drawings, if required. Sometimes, this plan is shown to the sanctioning authority to ensure that all the basic requirements regarding rules and bye-laws are fulfiled. If it is approved, the architect proceeds further. The following structural data are taken into consideration and instructions are given to the draftsman for preparing the final submission drawings as required to obtain sanction from the authorities concerned.

Structural data

- Method of Construction
  Load bearing
- Framed Structure
  RCC, Steel, Timber
- Modular construction
  Hollow solid concrete block construction
  Siporex blocks having predetermined width, length and height
- Site
  Depth of foundation as per trial pit results
  Height of plinth with reference to the level of the centre of the road and the invert level of drainage
  Filling in of plot, if required, for levelling
  Advantage of low ground level by providing basement or car park or split-level contruction
- Foundation
  Type of masonry, wall thickness, size of footing, water proofing for the basement, etc.
- Plinth and superstructure masonry.
  Thickness of wall, type of masonry, finishing—external and internal
- Doors
  Types, size, finishing, fixtures and fastenings
- Windows
  Type-steel or timber; size, finish, method of opening; ventilators; fixtures and fastenings; sills for windows—types; *chajjas*—types and shape
- Rooms
  Floor finish, colour finish to different walls, skirting to walls, ceiling finish; or false ceiling
- Staircase
  Type—timber or RCC; finish; grill design; handrail—type, details.
- Roof
  Type—flat or sloping, RCC or pitched, roofing—asbestos or Mangalore tiles; ceiling, treatment for waterproofing over RCC slab
- Garage
  Requirement—floor finish, loft, type of door, inspection pit, etc.
- Grill Work
  RCC—-precast jali or blocks or steel; design for verandah, staircase, balcony, window
- Entrance Details
  Special type of door with side window; steps, canopy, flower bed, otta for sitting
- Bathroom, WC
  Finish of floor and walls, height of glazed tiles for dado, wash basin, WC pans, commode; flushing tank type, tubs, plumbing requirements— concealed or open; taps—types and number; shower—hot and cold water.
- Kitchen
  Otta details, finish, data of glazed tiles, or other finish, sink, lofts for storage and built-in cupboards
- Compound wall or fencing
  Type; gate—size and number
  The above list gives details for residential buildings. Similar details will be required with slight variation in each case for a public building like a hostel, hotel, hospital, school, etc.

Extract from Development Control Rules

1. Maximum permissible built up area is 1/3 to l/4th of the plot area.
2. Maximum number of storeys permissible is three plus one car park.
3. Maximum height permissible is 16 m.
4. FAR-1
5. Tenament density should be 120 tenements per ha. for net plot area.
6. Minimum setback from the road in front should be 4.5 m.
7. Minimum rear open space is to be 3 m.
8. Minimum side open space should be 3 m.
9. Interior open spaces (*chowk*)—minimum area 4.5 m^2, minimum, side of shaft 1.8 m for 18 m height of the building.
10. The parking space should be enough to accommodate at least two scooters and two cycles.
11. Plinth height for the car park floor should be 150 mm.
12. Habitable rooms:
    (a) The minimum size should be 9.5 m^2; minimum width of the room has to be 2.4 m.
    (b) One full side of a habitable room in which windows for minimum light and ventilation are provided shall abut on the required open space.
    (c) The height has to be 2.75 m minimum, measured from the surface of the floor to the lowest point or ceiling (bottom of the slab).

13. For the kitchen, minimum area is 5.5 m^2, minimum width is to be 1.8 m. For kitchen cum dining, minimum area should be 9.5 m^2 and minimum width 2.4 m.
14. For the bathroom, minimum area and minimum width required is 1.8 m^2 and 1.2 m, respectively. For WC—minimum area 1.1 m^2, minimum width 0.9 m; combined bathroom and WC, minimum area is 2.8 m^2 and minimum width, 1.2 m.
    Height of the bath room—surface of floor to the lowest point in the ceiling (bottom of slab) is to be 2.2 m minimum. Window opening in bathroom and WC is to be 0.3 m^2 minimum and side not less than 0.3 m.
15. Loft in kitchen, over WC and bath, clear head room 2.2 m.
16. For lighting and ventilation of rooms, the minimum aggregate area of openings of habitable rooms and kitchens excluding doors should be l/8th of the floor area.
17. Parapet—minimum height 1.05 m, maximum—1.2 m.
18. Compound wall—maximum height 1.05 m above the centre line of the front street.
19. The compound gate should open entirely inside the property.
20. Office cum letter box room—area 2 m x 3 m, under stilts.
21. Staircase-stair width—1000 mm, rise 175 mm, tread—250 mm, maximum height of riser 190 mm. Handrails—minimum height is 900 mm, from the centre of the tread. Minimum head room in a passage under the landing should be 2200 mm.
22. Water supply—basis—5 persons/tenement, 135 lit/heed/day

Site plan:

Plot boundary	:	Thick black
Existing Street	:	Green
Proposed work	:	Red filled in
Drainage and Sewerage work	:	Red dotted
Water supply work	:	Black dotted thin

24. Balcony—1200 mm wide, total permissible length—l/3rd of the periphery of the building.

Note: Students are advised to refer rules and regulations of municipalities/corporations, etc., according to the place, as there are variations in certain rules as per area and location of the plot.

5.4.5 Planning of Residential Buildings

A residential building such as a bungalow or a flat can be divided into three major areas, viz. living area, sleeping area and service area.

Living area The living area is the area for general use. Hence, the living and drawing rooms should be planned near the entrance. It should be planned taking into view the following considerations:

1. It should not provide direct passage or access to the bedrooms and W C or bath.
2. It should be adjacent to the dining room.
3. It should be comfortable and spacious in order to accommodate furniture and also allow proper circulation area.
4. It should be sufficiently lighted and offer an attractive view of the surrounding landscape, garden, etc.
5. It should have a southern or northern aspect.

Sleeping area This area provides bedrooms for sleeping and relaxing. Bedrooms may be with attached toilets, i.e., bath and WC. Their size depends upon the number of beds. They should accommodate beds, easy chairs, cupboards and such other pieces of furniture. They should have a north-west or south-west aspect.

Service area This area includes the kitchen, dining room, bathroom and WC.

Kitchen The kitchen may be adjacent to the dining room or separate. It consists of a cooking area, i.e. kitchen, otta, sink, and cupboards. It should have an eastern or north-eastern aspect.

Dining room The dining room as hall may be attached to the living room or to the kitchen. It is a room in which meals are served. Kitchen activities should be screened from the dining area by means of cupboards or a screen. A service window may be provided between the kitchen and the dining room.

Bath and WC They should be approachable from all rooms. Dadoes or glazed tiles should be provided or otherwise walls should be finished with smooth water-proof cement coat. They should also be provided with the necessary fixtures. Size and type of WC pans, wash basins, electrical installations for hot water, plumbing fixtures, washing machine etc., control the size of the bathroom and WC.

Other areas like the office, *pooja* room, study, etc., may be suitably located near the living room, bedroom or kitchen.

5.4.6 Functional Planning and Circulation

All these areas and rooms are designed taking into consideration the purpose for which they will be used. This purpose decides the size, placing and the size of windows, furniture, etc.

The rooms mentioned there are grouped together by means of a passage, lobby, staircase, etc. The area for these should be as small as possible and at the same time, it should be well-ventilated and lighted. Planning is more of an art than a perfect science. Hence, the ideal conditions mentioned above are not always possible, but an architect is supposed to use his judgement in fulfiling the needs of the owner, with due considerations for economy, rules and regulations, customs, type of family, profession and their needs.

Doors and Windows Doors in a building provide access, privacy, and safety for different rooms. Windows and ventilators provide ventilation and light in different rooms. Doors are normally made of timber and windows of timber, steel or aluminium.

The different types of doors classified on the basis of types of shutters are:

Ledged and braced, single or double shutters (timber)	For economical construction
Framed and panelled, single or double shutters (timber)	For entrance doors
Fully glazed (timber and glass), single or double shutters Partly glazed and partly panelled, single or double shutters	Where light is to be admitted inside the room and where the view of the landscape is to be enjoyed. Fully glazed panels are provided for shops and for showcases
Flush door (pressed wood), single or double shutters	For interior doors
Rolling shutters (steel)	For garage, shops for more safety and for large openings
Collapsible doors (iron)	Staircase entrance for ventilation
Steel shutters with angle iron frames	Staircase entrance, entrance gate Shops,
Sliding shutters (timber, iron or aluminium)	public buildings
Revolving shutters (timber, aluminium)	Shops

Windows are classified on the basis of material and type of shutters that are provided, which is similar to that of doors.

Fan lights (ventilators) are generally provided on doors and windows. They admit light and provide ventilation in rooms. The normal size of a door is 0.90 m × 2.1 m including the frame, for all rooms, and 0.75 m × 2.1 m for WCs and bathrooms. The window sill is kept at a height of 750 mm above floor level. Door and window tops are kept at the same level, i.e., 2.1 m above the floor level. Various fixtures and fastenings include hinges, tower bolts, handles, hooks, eyes and aldrops. Details of the fixtures and fastenings for different types of doors and windows are necessary.

Table 5.4 Minimum Dimensions (Refer local rules, if any)

Description	Minimum requirement
Plinth height	More than 300 mm 450 mm in general 150 mm for garages
Habitable rooms—area:	
Only one room	9.5 m^2 2.4 m—Minimum width
Two rooms	9.5 m^2—Minimum area for one room 7.5 m^2 for the other room (with a minimum width of 2.4 m)
Kitchen:	
Kitchen-cum-store	5.5 m^2 with a minimum width of kitchen – 1.8 m
Kitchen having a separate store	4.5 m^2
Kitchen cum dining	9.5 m^2 with a minimum width = 2.4 m
Bathrooms:	
Combined bathroom and WC	2.8 m^2 minimum floor area with a width 1.2 m
Water closet Mezzanine floor area Habitable rooms—height	1.1 m^2 9.5 m^2 if it is to be used as a living room
(a) for habitable rooms	2.75 m
(b) habitable rooms if air conditioned	2.4 m
(c) for habitable rooms under row housing scheme	2.6 m
(d) for kitchen	2.75 m
(e) for bathrooms or water closets	2.2 m
Lighting and ventilation of rooms Window openings, excluding doors and including frames	1/10 of the area for hot dry climates; 1/7 of the floor areas for hot wet climates 1/7 aggregate area of doors and windows, in addition to above means of ventilation of 0.3 m near the top of each room; preferably placed opposite to each other for thorough ventilation
Bathrooms and WC window openings *Depth of foundation:*	10% of floor area
(a) For single storeyed buildings	0.75 m to 1.0 m below finished G L,
(b) For double storeyed buildings	1.0 m to 1.30 m below finished 1.0 m to 1.30 m below finished GL maximum as per soil condition and formula
Staircase: Width	1 m for residential buildings 1.5 m for public buildings
Rise and Tread	For residential buildings— Rise—175 to 185 mm. Tread—250 mm For public buildings: Rise—150 mm. Tread—300 mm
Pitch	40° maximum 25° minimum
Lighting area	1 m^2 per floor height
Head room	2.2 m

5.5 PLANNING OF PUBLIC BUILDINGS

The design of a public building depends upon the nature of the building. Every building has a special character of its own. The function of the building is to be ascertained first. Then different blocks or units are to be planned. The units are then joined together to form the whole building. The sizes of various units depend upon the number of persons working, furniture required, space necessary for movements, etc. As such, no hard and fast dimensions can be given. However, some average dimensions are given for the guidance of students.

Some common arrangements required in all types of public buildings are:

1. Sanitary blocks
2. Circulation
3. Entrance or reception
4. Parking space, garages, and cycle stands
5. Watchman's room
6. Public telephone

Sanitary block The sanitary block includes bathirooms, WC, wash hand basins, and urinals. The number required for each building varies according to the requirements. Sizes adopted are:

Bathroom	1.2 m × 2.1 m 1.5 m × 2.4 m 1.9 m × 2.7 m
WC	0.9 m × 1.2 m 1.0 m × 1.2 m
Urinals	0.9 m × 0.75 m
Passage	width 0.9 – 1.5 m

Circulation Various units are joined together horizontally by passages, corridors, and verandahs. Vertical circulation can be effected by stairs and lifts. Sizes adopted are:

Passage/corridor	1–2.5 m
Verandahs	Width : 1.8–3.5 m
Stairs	Width : 1.2 m (minimum) Riser: 150–170 mm Tread : 300–325 mm Landing : 1–1.8 m wide Headroom : 1.8 m (minimum)
Floor height	2.75 m–6 m

Lifts Lifts are provided for quick and efficient vertical circulation. Types of lifts and number of lifts depend upon the character of one building, extent and duration of peak periods, frequency of service required, and type and method of control.

In the following details, different types of lifts are described.

(a) Lifts used in low and medium class flats (to carry five persons)
Car (lift) speed—0.5 m/s
Doors for lift-sliding
Landing doors—closed type
Method of control—automatic push button.

(b) Lifts used in office buildings, hotels, and high class flats (to carry 10–20 persons).

Table 5.5

No. of floors	Lift (car) speed in m/s
upto 2	0.5
3–4	0.5–0.75
5–6	0.75–1.5
7–9	1.5–2
10–12	2–2.5
Over 12	2–5.3

For car speeds exceeding 1.75 m/s, gearless machines should be provided. Car door—automatic type

(c) Method of control—car switch control, automatic push button.
Lifts used in shops and departmental stores:
Load—12–20 persons
Car speed—2–2.5 m/s
Doors for lift—automatic opening
Method of control—car switch control.

(d) Hospital and passenger lifts:
Passenger lifts—for goods and persons
Car speed—0.25–0.5 m/s
Gates for car—collapsible
Control method—depends upon local conditions
Hospital bed lifts
Car speed—0.25 m/s – 0.5 m/s
Car door—solid sliding.

To facilitate the wheeling beds or stretcher-trolleys in and out of the lift car, an automatic car levelling device is included.

Entrance or reception For every public building, some space is required at the entrance. The area of this entrance shall vary slightly with the number of persons entering at one time. In any case, width of an entrance shall not be less than 2.75 m.

General sizes of the entrance or reception are 3 m × 6 m, 3.5 m × 7 m; 3.75 m × 8 m; 4 m × 5 m; 4.5 m × 6 m; 6 m × 7.5 m; 7 m × 8.0 m; and 8 m × 10.0 m.

Parking space, garages and cycle stands Open parking space is essential around any type of a public building. The area required will depend upon the nature of the building and number of persons visiting the building. Cycle stands are essential for every public building. Provision of the garages shall be made according to the requirement of the building.

Table 5.6 Area required

Vehicle	Area required
Cars	20 m^2/vehicle
Scooters and Motorcycles	3m^2/vehicle
Cycles	1.2 m^2/vehicle

Driving aisles (passage between two blocks) for cars: 1–2 m wide

Garages: 3 m × 4 m
3.3 m × 4.2 m
4.0 m × 4.5 m

Watchman's room This is a small enclosure generally provided at the entrance gate. A minimum size of 2 m × 2 m is required. Larger sizes may be adopted as per requirements.

Public telephone Public telephones are usually provided in the public buildings. A small booth of size 1 m × 1 m may be installed in the entrance space. Sometimes telephones are hung on walls and columns. As such, no separate space is required. Only the position of phones is to be marked on a plan.

Data for Public Buildings Data regarding some public buildings are given below. The data provide units or blocks with their dimensions, wherever possible. The dimensions given are for guidance and suitable changes may be made as per requirement.

Buildings for education This includes primary and secondary schools, arts, science, commerce, and law colleges; technical, medical, and agricultural colleges or institutes. The units required are:

(a) Entrance or reception
(b) Office and administrative block
(c) Classrooms
Students below 10 years — Area 1 – 1.2 m^2/student
Students above 10 years — Area 1.2 – 1.5 m^2/student
General sizes — 4.5 m × 6 m
5.5 m × 6.5 m
6.0 m × 7.2 m
6.0 m × 7.8 m
7.0 m × 10.0 m
(d) Teachers room — 14 m^2
(e) Drawing halls — Area 3 – 4 m^2/student
(f) Laboratories — Area 3 – 4 m^2/student
(g) Assembly hall — Area 0.5 – 0.6 m^2/student
(h) Circulation — 1.0 m – 2.0 m
(i) Library — Area 80 – 95 m^2 for 1500 students
(j) Parking space and cycle stand
(k) Sanitary block

Description	Male	Female
WC	1 for 40 students	1 for 25 students
Urinals	1 for 20 students	
Wash Basin	1 for 40 students	1 for 40 students
Water taps	1 for 50 students	1 for 50 students

Library

(a) Entrance and moving space around delivery counter — 1.8 m wide (minimum)
(b) Delivery counter — Height 1.6 m – 1.8 m
(c) Librarian's Room — 9 m^2 (minimum)
(d) Sections in Library
Reference Books — Area 20 m^2 – 60 m^2
Book section — Area 20 m^2 – 60 m^2
Magazines and newspapers — 3 m wide (minimum)
Stacking space — 20 m^2
(e) Circulation
(f) Parking space and cycle stand
(g) Sanitary block

Description	**Male**	**Female**
WC	1 for 200 up to 400 Above 400, 1 for every 250	1 for 100 up to 200 Above 200, 1 for every 150
Urinals	1 for 50	
Wash Basins	1 for 200 up to 400 Above 400, 1 for every 250	1 for 200 up to 400 Above 400, 1 for every 250

Banks

(a)	Entrance and moving space by the side of counters		2 m wide minimum
(b)	Counters	Height	1.6 m – 1.8 m
		Width	0.4 m – 0.8 m
(c)	Working space behind the counters		3 m wide
(d)	Agent's room		9 m^2
(e)	Cashier's cabin		1.5 m × 1.5 m
(f)	Safe deposit lockers		
(g)	Sanitary block for office staff/officers		

Post Office

(a)	Entrance and moving space by the side of counters		2 m wide
(b)	Counters	Height	1.6 m – 1.8 m
		Width	0.7 m – 0.95 m
(c)	Post master's room		9 m^2
(d)	Working space behind counters		3 m wide
(e)	Sorting space		2 – 3 m^2 per postman
(f)	Telephone booth		
(g)	Parking space and cycle stand		
(h)	Sanitary block for office staff/officers		

Hostels

(a)	Entrance		3 m wide
(b)	Rooms		
	Single seated	Area	9.3 m^2/head
		Size	3 m × 3.1 m
	Two seated	Area	7.5 m^2/head
		Size	3.5 m × 4 m
	Three seated	Area	7 m^2/head
		Size	4.2 m × 5 m
(c)	Circulation		1.0 to 2.0 m width
(d)	Recreation hall		2 – 3 m^2/head
(e)	Dining hall		3 – 4 m^2/head
(f)	Kitchen		2.75 m × 3 m
	Pantry		2 m × 3 m
	Store		2.75 m × 3 m
(g)	Parking space and cycle stand		
(h)	Public telephone		
(i)	Sanitary block		

Description	**Male**	**Female**
WC	1 for 10	1 for 8
Bath	1 for 10	1 for 10
Urinals	1 for 25	
Wash basins	1 for 10	1 for 10

Hotels

(a)	Entrance and reception	
(b)	Waiting hall	
(c)	Dining	2 – 3 m^2/head
	Kitchen	10 m^2
	Store	10 m^2
	Pantry	6 m^2
(d)	Circulation	1.5 m to 2.0 m
(e)	Bedrooms	
	General purpose	2.75 × 4.5 m
	Good size double bed	
	(refer rules for rooms as per	3.4 m × 4.5 m
	(standards of tourisum department)	3.6 m × 5.5 m
		4.2 m × 5.5 m
(f)	Laundry,	3 m × 4.5 m
(g)	Servant's room	3 m × 3.9 m
(h)	Sanitary block	for servants; near dining and entrance hall; and for every bedroom
(i)	Parking space, garages, cycle stand	

Rest houses These are provided for transit residence of Government servants on duty.

(a)	Bedrooms with attached toilet	3.4 m × 4.5 m
		3.6 m × 5.5 m
		4.2 m × 5.5 m
	Toilet	1.5 m × 2.4 m
(b)	Circulation space verandah	2 m wide
(c)	Dining hall	3.6 m × 5.4 m
(d)	Kitchen	2.75 m × 3.5 m
	Store	2.75 m × 3 m
(e)	Office room	3.0 × 3.5 m
(f)	Parking space and garages	

Markets

(a)	Entrance	Generally open space
(b)	Stalls	2.5 m × 4 m
		2 m × 5 m
		2.5 m × 5 m
(c)	Cold room	3 m × 4.5 m
(d)	Circulation space	corridors, staircase, lift, etc.
(e)	Parking space and cycle stand for public	
(f)	Parking space for trucks	
(g)	Space for collecting garbage	
(h)	Office	
(i)	Sanitary block	

Buildings for entertainment

	Cinema Theatres	
(a)	Entrance for foyer	3 m wide
(b)	Auditorium	Area 0.8 – 1 m^2 chair Volume 3.5 – 4.3 m^3/chair
	One door for 200 persons	
	Slope of floor	1 : 20 – 1 : 10
	Distance between chairs	450 mm
	Stage height	0.9 m – 1.2 m
(c)	Office and booking window	4.6 m^2
(d)	Projection room	18.5 m^2
(e)	Snack bar, tea stall	12 m^2 – 15 m^2

(f) Parking space and cycle stand
(g) Manager's office 12 m² – 15 m²
(h) Sanitary blocks

Description	Male	Female
WC	1 for 100 up to 400 Above 400, 1 for every additional 250	1 for 100 up to 200 Above 200, 1 for every additional 100
Urinals	1 for 50	
Wash basins	1 for 200	1 for 200

(i) Air conditioning room on each floor
(j) Store 12 m²

Drama Theatre

(a)	Entrance for foyer	3 m wide
(b)	Ticket office	4.6 m^2
(c)	Management office	32–40 m^2
(d)	Auditorium	Same as for cinema theatre
(e)	Stage	290 m^2 (minimum)
(f)	Screen storage	32–40 m^2
(g)	Costume storage	18.5–22 m^2
(h)	Dressing room	18.5–22 m^2
(i)	Make-up room	37–42 m^2
(j)	Stage manager	11 m^2
(k)	Circulation	1.2 to 2.0 m
(l)	Sanitary block	Same as for cinema theatre
(m)	Parking space and cycle stand	
(n)	Store	12 m^2
(o)	Snack bar, tea stall	12 m^2 – 15 m^2
(p)	Air conditioning room	

Buildings for health services This includes dispensaries, health centres and hospitals.

Dispensary

(a)	Entrance and waiting space	2 m wide (minimum)
(b)	Doctor's room	2.75 m × 4 m
(c)	Examination or dressing room	3 m × 4 m
(d)	Operation room or dressing room	3 m × 4 m
(e)	Sanitary block	
(f)	Store room	2.75 m × 3 m
(g)	Compounder's window and compounding space	2 m wide (minimum)
(h)	Circulation space	

Health Centre

(a)	Entrance and waiting space		
(b)	Doctors room		3 m × 3.6 m
(c)	Examination room		3 m × 4 m
(d)	Operation theatre		4 m × 5.5 m
(e)	Circulation space		
(f)	Wards : Maternity, General		8 × 10 m^2/bed
(g)	Medical store		3.5 m × 4.75 m
(h)	Office		12 m^2
(i)	Laboratory		15 m^2
(j)	Parking space		
(k)	Family planning unit		
(l)	Residence	Doctor	60–90 m^2/head
		Servants	40–60 m^2/head

Hospital

Out Patient Department (OPD)

(a) Entrance and waiting space 1 to 2 m^2/person
(b) Consulting rooms
Operation
Medicine
ENT
Eye
Dentistry
Gynaecology Each 3 m × 4 m
Pediatric
Orthopaedic
Mental
Family planning
Venereal diseases
Skin
(c) Office 3 m × 4 m
(d) Emergency 4 m × 5.5 m
(e) Dispensary 4 m × 5 m
(f) Sanitary block

Description	Male	Female
WC	1 for 100	2 for 100
Urinals	1 for 50	
Wash basins	1 for 100	1 for 100

Operation Theatre

Operation theatre	4.2 m × 5.5 m
Sterilisation room	2.75 × 3.6 m
Doctor's room	3 m × 4 m
Nurse's room	3 m × 3 m
Waiting space	3 m wide
Circulation space	
Sanitary block	

Wards

The different wards are medicine, operation, gynaecology, female, children, and infectious diseases.

(a) Ward 8–10 m^2/bed
(b) Circulation space
(c) Nurse's room joining dispensing room 3 m × 4 m
(d) Sanitary block
WC 1 for 8 beds
Bath room 2 for 1 ward
Wash basins 1 for 30 beds
(4) Radiological department
(5) Laundry
(6) Pathology laboratory
(7) Circulation space
(8) Parking space, cycle stand and garages

Other buildings

Museum

Entrance	3 m wide
Halls	4.2 m × 7 m each
Office	3 m × 3 m
Sanitary block	
Circulation space	

Shops		
Counter		1.2 m–1.6 m high
Space for storing articles		
Moving space for customers		1.8 m (minimum)
Display windows		
Clubs		
Entrance		1.2 m wide
Hall		5 m × 6.5 m
Changing room		3 m × 3 m
Billiards, Table Tennis, Cards		4 m × 5 m each
Store		2.75 m × 3 m
Sanitary block		
Government or commercial offices		
Entrance		1.2 m wide
Cubicles		4–6 m^2
Restaurant		
Rest and recreation room		
Sanitary block		
Description	**Male**	**Female**
WC	1 for 25	1 for 15
Urinals	1 for 6 to 20 2 for 21 to 45 3 for 46 to 70 4 for 71 to 100 (add 3% for every 100 to 200)	
Wash basin	1 for 25	1 for 25
Village Panchayat Office		
Hall for meeting		4.75 m × 5.5 m
Office room		2.75 × 3 m
Other rooms		3 m × 4 m
Varandah		2 m wide
Sanitary block		
Bus station		
Entrance verandah		
Waiting hall		
Enquiry office, retiring room for drivers, and conductors		
Newspaper, fruit and other stalls		
Control room		
Restaurant		
Sanitary block		Same as for cinema theatre
Platform		Height 150 mm–200 mm
Parking area required for bus 2.5 m × 10 m		
Parking space for buses		
Parking space for private vehicles		
Cycle stand		
Industrial buildings		
Main factory		
Office and administration, Library		
Store for raw materials		
Store for finished goods		
Laboratory		
Research and Development		
Restaurant		
Parking space and cycle stand		
Circulation space		
Sanitary block		

Case Study

St. Ursula School, Sindhudurg district, Pune
Architect-Vikas Bhandari, Pune (Figs. 5.37 to 5.40)

"The real issue in education is to see that when the child leaves the school, he is well established in goodness, both outwardly and inwardly. He should be a total human being, not only someone with an inward understanding.... but also someone who is good in what he does outwardly. The two must go together".

J. Krishnamurthi Philosopher—India

Environment for Teaching and Learning, School Architecture

"A creative, stimulating and interactive environment is absolutely necessary for the development of young minds. A good built environment gives children the freedom, space and flexibility to understand the world they live in. The school building is probably their first exposure to design, materials and textures outside their home environment"

Magazine—Inside-Outside March 1999

A school needs an architectural style which is sympathetic, cheerful and colourful. A good site or location is one of the prime necessities of a good school. It must be central to the area it serves and must have plenty of open space for a playground and for future expansion. Trees planted in groups, lawns, fountains, walkways, benches on the side of roads, play areas and benches to watch games are also required. Provision of residential units for the headmaster, teaching and administrative staff, chowkidar, gardener and auxiliary services is also necessary.

The basic unit of a school is a classroom. Rectangular classrooms attached to a long corridor in one or more blocks where classroom doors open straight into the corridor, i.e., into the traffic flow is a common design which has been used since many years.

Study carefully the plans, elevation and section for a school building constructed at Phanaswadi, in Sindhudurg district, Maharashtra which is in an area having maximum rainfall.

Reading Exercise (Figs. 5.37 to 5.40)

1. Study horizontal and vertical circulation patterns.
2. Study section and advantage taken of the sloping ground in locating the stage and auditorium.
3. Think of a colour scheme for the internal walls of a classroom. Will it be better to have different shades of colours for different classrooms, or change in colour per floor?

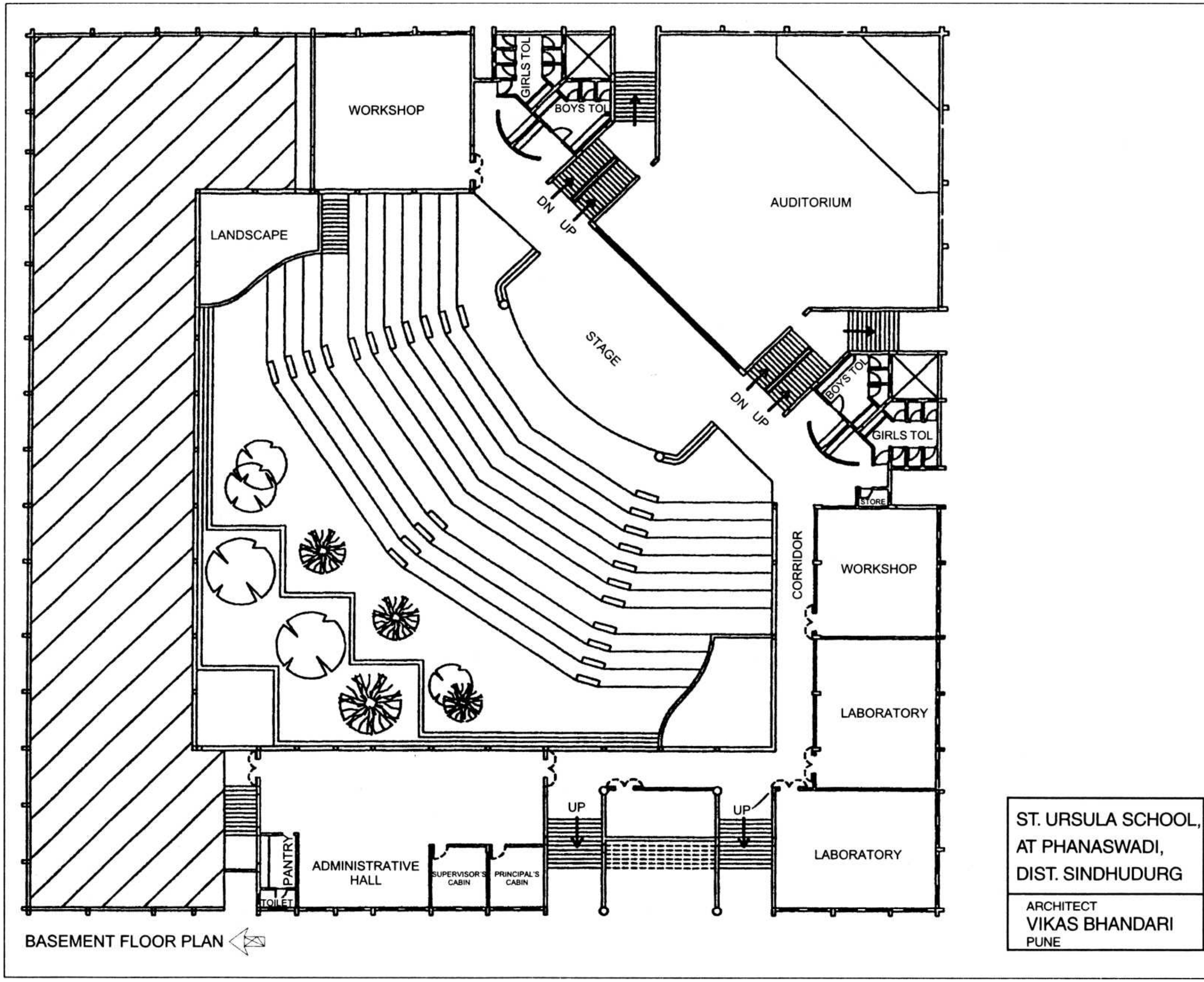


Figure 5.37 *School Building – Basement Floor Plan*

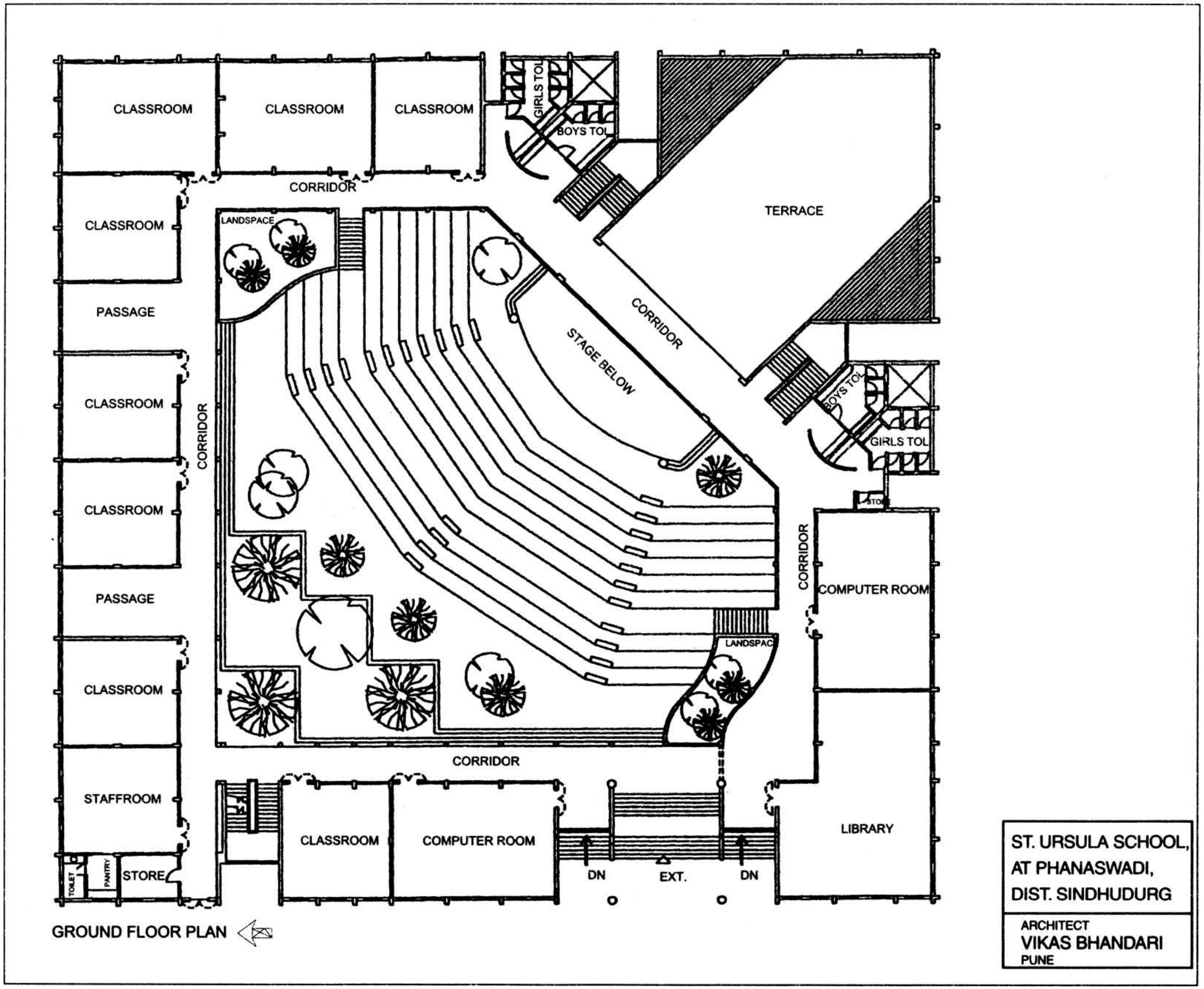


Figure 5.38 *School Building – Ground Floor Plan*

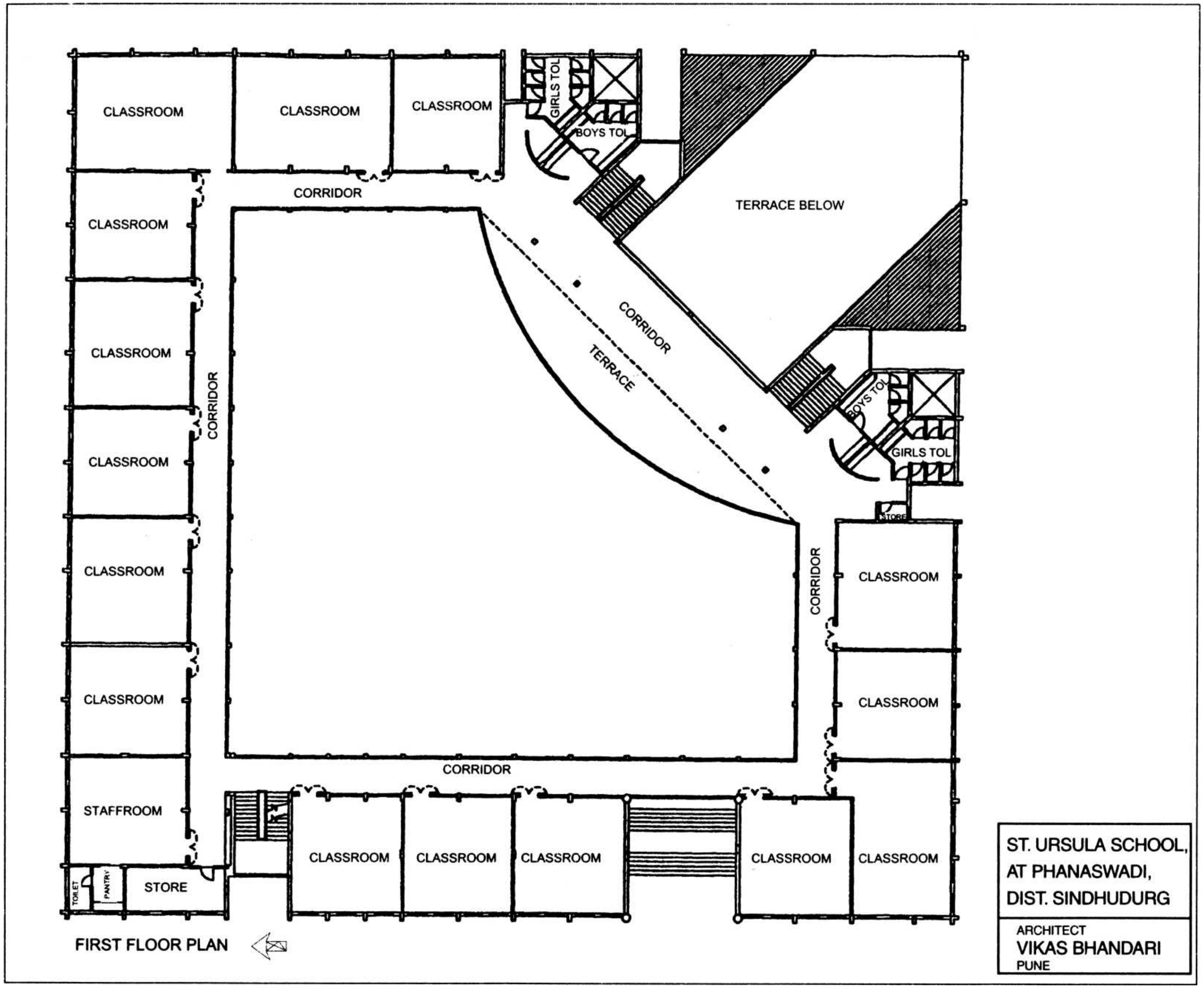


Figure 5.39 *School Building – First Floor Plan*

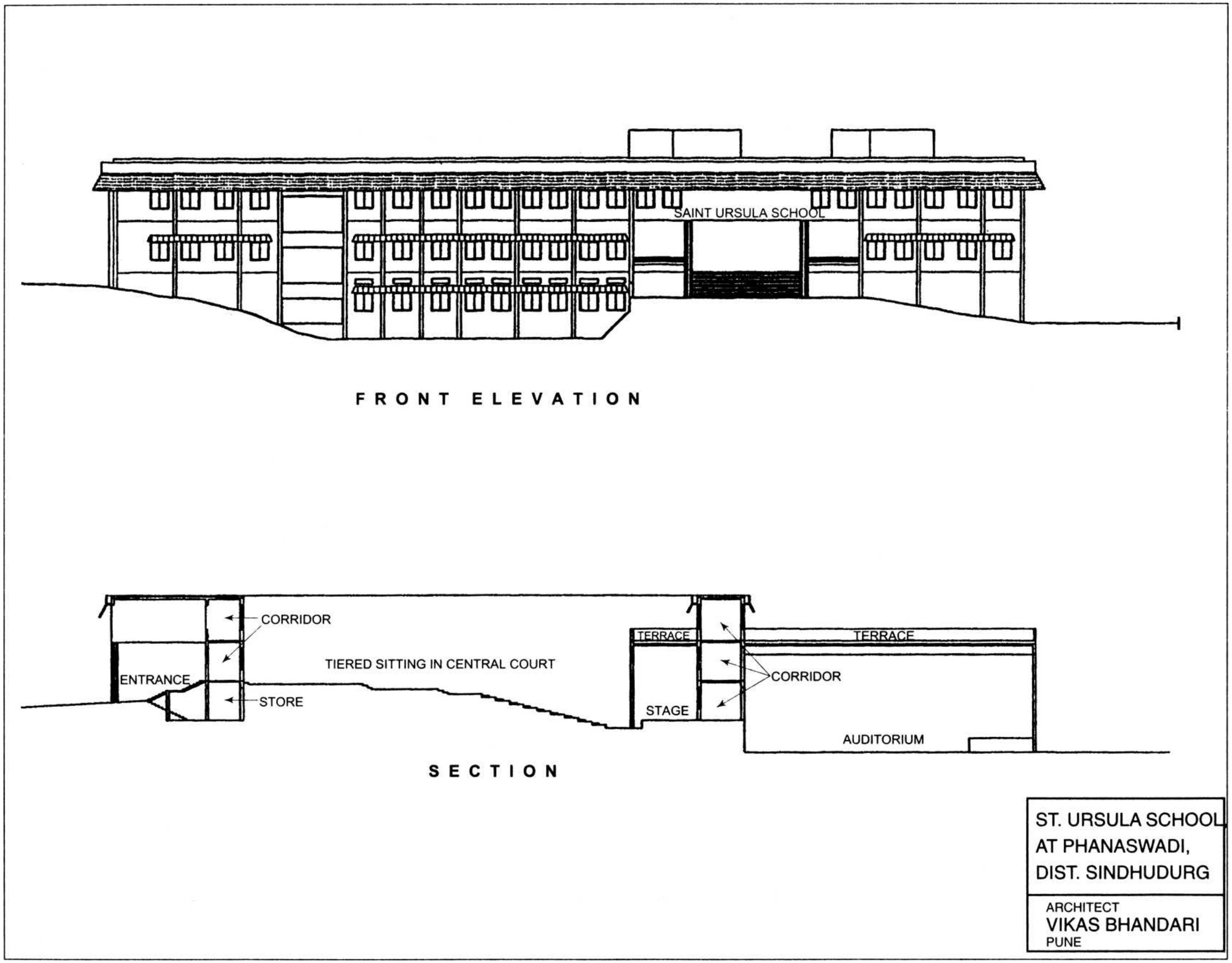


Figure 5.40 *School Building – Elevation and Section*

4. Furniture of different materials is now available—CC teakwood, steel base with laminated top, PVC, etc. Collect details for the same and suggest colourful, easy to clean furniture for the classroom.
5. Notice boards for displays are necessary. Suggest suitable locations for the same in the classroom, in the passage and elsewhere.
6. Value engineering is a branch of engineering which specifies appropriate specifications for different items and materials, suitable to the climate and helps to have an economical construction. Write all construction notes.
7. Prepare a plan for one classroom and auditorium with audio-visual aids such as a slide projector and overhead projector. Show the arrangement of chairs, arrangement for using audio-visual aids, exhaust fans, curtains, etc.

Case Study

Auto Unit, Baramati
Architect-Nagpal Consultants Pvt. Ltd. Aurangabad, Pune
(Fig. 5.41, Plate 5.5)

Greaves Limited proposed to have an automobile manufacturing factory in MIDC area of Baramati. Initially when this project started, there were not much infrastructural facilities available at Baramati, but gradually the pace started building up with the introduction of new projects and industries.

The factory assembled imported parts. The assembled body was finished, tested and finally dispatched.

Site Context

There were thirty two acres of sloping land with many undulations. The land was levelled by cutting and filling without bringing earth from outside. Two constraints were laid before the architect at the initial stage:

1. Time period of twelve months.
2. The client wanted a well-organised and functionally effective setup. The whole site was an essence of an intelligent campus planning.

The campus was designed using a fixed grid of 14 × 7 m. All buildings designed were in multiples of the grid.

The size of the grid was decided keeping in mind the structural compatibility, size of truss, probable spanning between trusses, size of openings, machinery layout, etc. Even the road network and other movement patterns followed the gird. This grid was also used in elevations.

5.5.1 Design Approach

Planning The whole layout was conceived in two zones, manufacturing + administrative zone and staff + service zone. The manufacturing zone was completely segregated from the staff and service zones.

Staff facilities included changing rooms and lockers, canteen, and parking space. These facilities followed a uniform pattern from the entrance to the security check, the parking area, changing rooms, canteen and finally to the respective work areas.

The services comprised of sub-station, transformer, water tank, pump room and effluent disposal, all located on the south east side of the property.

An existing level difference of 2.4 m between two zones was maintained. To retain the earth, dry stone pitching was done. This level difference was exploited as a demarcation between two zones. There was a spine running from south-west to north-east direction of the site which served both the manufacturing area and service area. The main spine from the entrance of the site bifurcated itself into two ancillary roads of which one ran along the peripheral to the manufacturing area and the other along the service area. Officers and visitors parking was provided right in front of the zone. Two security checks were provided, one at the service entry area and the other at the main entry.

Other services like L D O tank and compressor generator which were directly linked to manufacturing processes were placed in between both shops resulting in a smoother manufacturing process.

Manufacturing Process Manufacturing was carried mainly in two shops where the following functions took place:

The material brought in after the security check was unloaded and received in shop 1 where the chassis frame, wind shield assembly, floor panels and steering columns were fabricated.

All fabricated components were then brought in for painting. Direct procured components like body painting was also being done. All painted components were then transferred to the assembly shop where first, sub-assembly parts such as gear box, wheel tyres, engine box, etc., were bolted to the chassis and bodies. Finally, the finished body is tested and inspected. A test track from this shop lead to the loading platform from where the vehicles were dispatched.

To make the process of assembling much more modern and fast and to facilitate efficient handling, cable conveyers were used. These conveyers carried the assembled vehicle from the paint shop to the assembly shop. A connecting passage was given between both shops for which the tie level was maintained at 3 m higher than the tie level of both the shops.

The trusses provided over the shops were designed to support the power driven conveyor system. As functionally required, the buildings were placed oblong in the plan. Throughout the project, the building width was standardized.

Designing of such structures required careful planning so that a conducive indoor environment was created with adequate light, ventilation and proper power supply which was achieved by providing windows at the working level and at tie level. Lighting was also provided through north light trusses.

Other Infrastructure Amongst other buildings, was a remarkable standing overhead water tank. The architect had made efforts to introduce a water tank in this project as an architectural feature. Thus, the location of the tank was in front of the main campus entrance so that it could be visible from a longer vicinity. It has now become the landmark of that area. The total structure was a self finish (form finish) concrete with M 20 grade of concrete. Plastering work had been avoided for economical purpose. A fabricated spiral staircase was provided at the core of the tank.

Conclusion The overall building was combination of solids with intermittent punctuation of voids. At the corners, the mass had been corbelled in steps. The parapet was kept high to avoid the vicinity of the truss, thus giving the building a consistent look. The structural framework was done in such a way that it achieved a sculptural outlook. One of the characteristic features of this design was its pursuit of maximum flexibility to accommodate future expansion.

5.5.2 Project Data

Cost of construction	:	500 lacs
Period of construction	:	10 Months (92-93)
Area of land	:	32 Ha.
Built up area	:	13000 sq. m

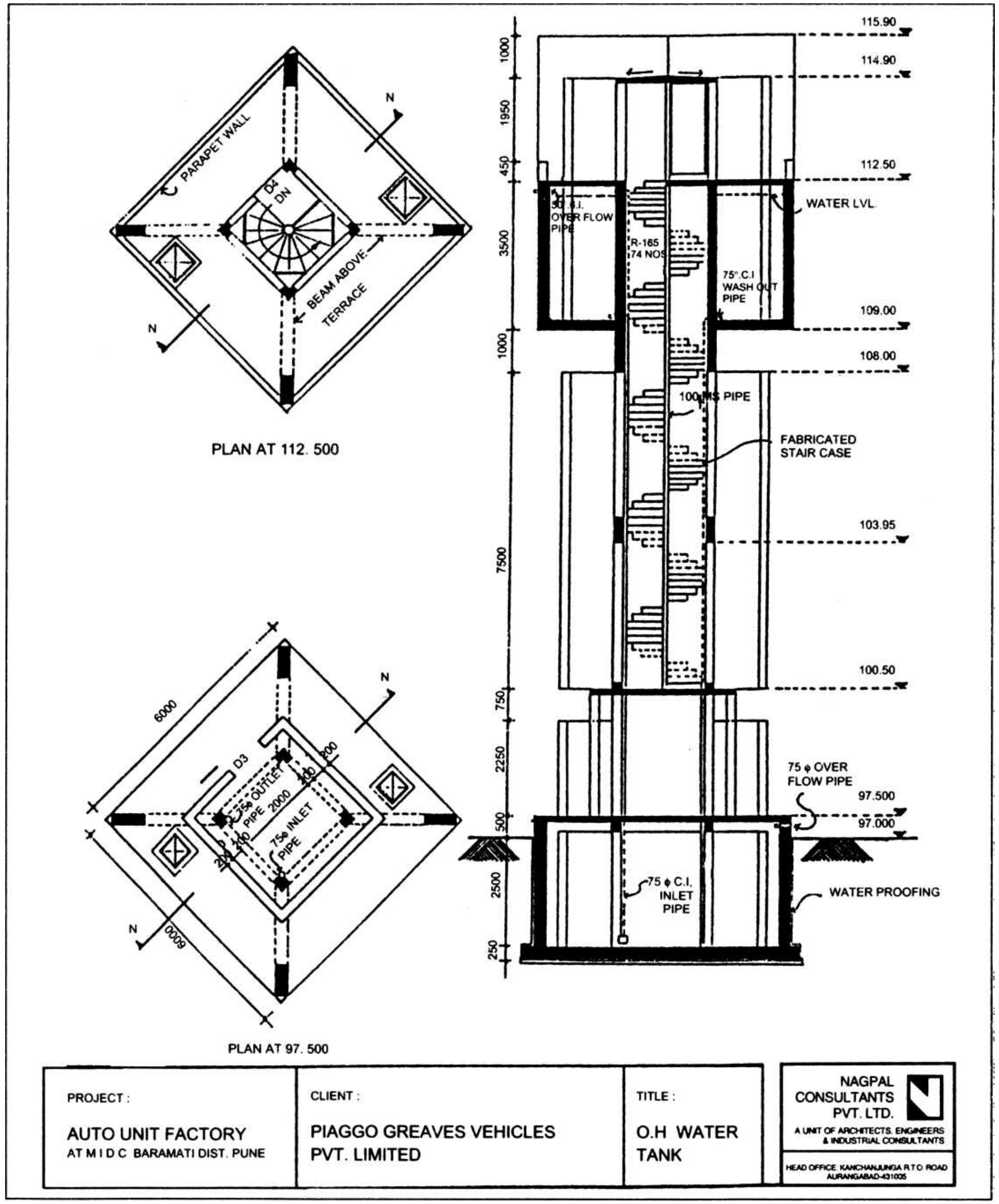


Figure 5.41 *Details – Over Head Water Tank*

Architectural consultancy		Nagpal Consultants Pvt. Ltd.
Structural consultancy	:	(Project Team)
Aircondition and electrical	:	R B Nagpal (Project Director)
Consultancy	:	Mirza Azhar (Civil Engineer)
Contractor	:	Ashoka Builders Pvt. Ltd. 1/2, River View, Ashoka Stambha, Nasik-422 002

Case Study

Bank of Maharashtra, Cidco, Aurangabad
Architect—Nagpal Consultants Pvt. Ltd. Aurangabad, Pune
Site Figs. 5.42 to 5.45 Plate 5.6

Bank of Maharashtra invited applications from selected architects for their project of Marathwada zonal office in Aurangabad. The plot, admeasuring 3366 sq. m was situated in town centre, Cidco at New Aurangabad.

The Project

1. The project was the construction of an administrative cum residential complex. The basic requirements were: (i) a composite office (including computer section, telex, Pbx, reception area, canteen, etc.) plus future expansion, (ii) branch premises, (iii) residential block for the assistant general manager and (iv) four residential flats of which three flats were for regional managers and one for the chief manager.

Few architects were shortlisted amongst whom architect R B Nagpal was given the job.

5.5.3 Design Approach-Form, Function and Circulation

The building stood back from the main line of buildings, giving relief to passing pedestrians and its sleek, triangular, double height column and the elevation in grid drew attention from a distance.

The basic plan actually consisted of two squares (large square on the left and small square on the right) with services at the juncture of the two "master" spaces. The "service" spaces consisted of the staircase, lift and toilet block at the back. The two squares were aligned at an angle of 45° at the ground floor and first floor, and became a complete rectangle at the second floor and the angular alignment got repeated in the third floor.

The entire planning in the X-Yplane was done on a modular concept based on a grid of 5 × 5 m. The further breakup of the grid was in the series of 2.5, 1.25 and 0.625. The concept was carried out in Z axis also, as reflected in the elevation. The windows were square, of size 1.25 m × 1.25 m and the vertical and horizontal projections were of 0.625 m.

The entry to the site was aligned at an angle of 45°, giving a sceptical view of the entrance. Rounding off the island at the centre, towards the right, one went down the ramp to the parking area allotted for the staff. A separate area for two wheelers and four wheeler parking was given. Towards left was the parking area allotted for visitors. Service entry was from the back of the site and the circulation was planned in such a way that the service vehicles encircled around the island and unloaded on the loading platform of the store and could even exit straight. The entire layout was well conceived, keeping vehicular and pedestrian circulation in mind. The entire landscaping encompassed stepped landscape courtyards, carried out at different levels and exquisite circular courtyards encircled the double height triangular column which virtually took the second floor of the building as its capital. The serenity and spaciousness of these landscape courtyards created a restful environment away from the bustle of the busy main street. The entire circulation and landscaping was planned in such a way that it established constant visual contact with the rest of the complex.

Internal Layout The entrance was clad in polished granite with polished kota flooring so as to engulf the visitor in a reflective, subdued atmosphere. At the entrance itself, a full glass door provided a view of the interior. As you entered through the entrance foyer, on the left, was the stores department with white marble mosaic flooring which constituted the stationery department, ladies room, enquiry cell, CM inspections cabin. On the right was the bank with locker facility in the basement.

At the first floor level, the big square plan on the left constituted the recovery cell, reconciliation, general administration and planning departments with complete low height partitions demarcating each section. The right small square plan constituted the personnel department and cabins for credit/advances, each provided with low height partitions. The individual cabins of AGM and CM administration were also located here. At the centre, two square columns defined the waiting area.

On the second floor, the floor plan became a complete rectangle which constituted the union office, computer cell, battery room, printer room, stored room in the left wing, and discussion room, office area, library, lecture hall, dining room, etc., in the right wing. The areas allotted for different activities were separated by partitions. The height of partitions in different floors varied from 1.2 m to 4 m. The colour schemes also varied from floor to floor.

On the third floor, the floor plan again transformed into two squares with a conference hall on the left and an open terrace on the right. A small area for the pantry was also provided on this floor.

The interior layout was carried out according to the functional requirements of each of the departments, with careful signage, appropriate colour schemes, detailing of fixed elements, furniture design and lighting, choice of materials, etc.

In the electrical layout, concealed wiring was carried out at the sill level covered by a laminated facia which could be opened and operated whenever required (as shown in the drawings).

Structure The four exposed columns took the load of triangular projected portions of the second floor while the entire load distribution was done by the peripheral columns, the L-shaped columns at the corners and square columns at the centre.

5.5.4 Project Data

Period of construction	:	15 months (1997–98)
Contractor		NBCC
Architectural consultants	:	Nagpal Consultants Pvt. Ltd.
Structure consultants	:	(Project team)
lectrical consultant	:	R B Nagpal (Project Director)
Landscape consultant	:	Mirza Azhar (Civil engineer)
Interior consultant	:	Ujjwala Sinha (Architect) Subhashini Moorthy (Interior designer)
Total expenditure	:	3 crores

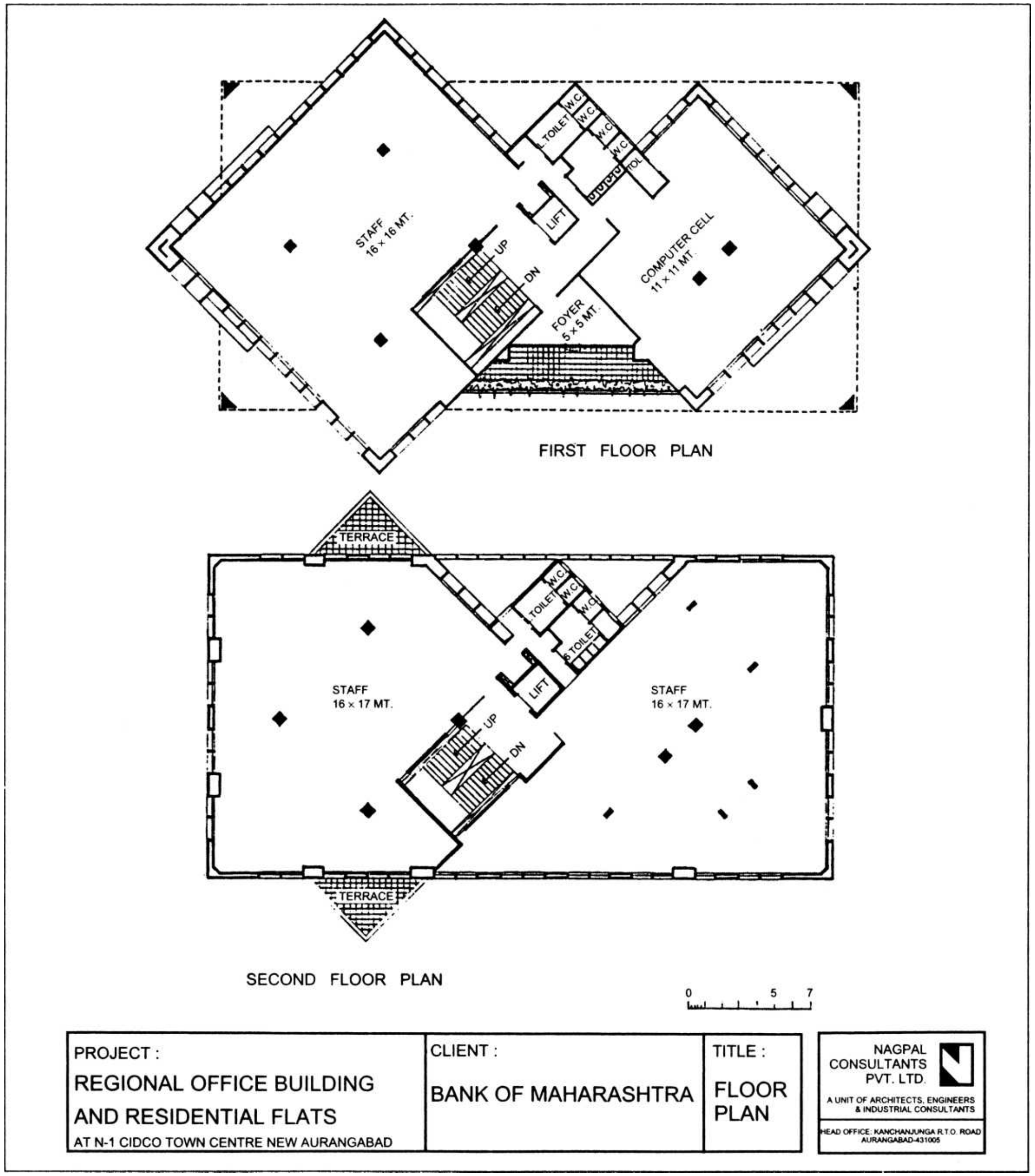
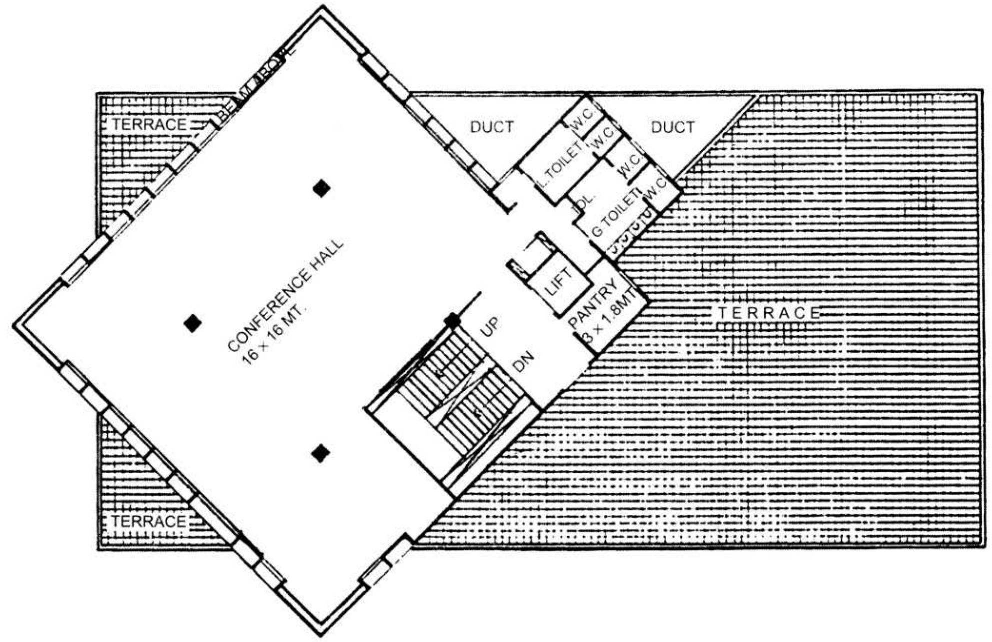


Figure 5.42 *Bank – Details-First and Second Floor Plan*



THIRD FLOOR PLAN

PROJECT : REGIONAL OFFICE BUILDING AND RESIDENTIAL FLATS AT N-1 CIDCO TOWN CENTRE, NEW AURANGABAD	CLIENT : BANK OF MAHARASHTRA	TITLE : FLOOR PLAN	NAGPAL CONSULTANTS PVT. LTD. A UNIT OF ARCHITECTS, ENGINEERS & INDUSTRIAL CONSULTANTS HEAD OFFICE KANCHANJUNGA R.T.O. ROAD AURANGABAD-431005

Figure 5.43 *Bank – Third Floor Plan*

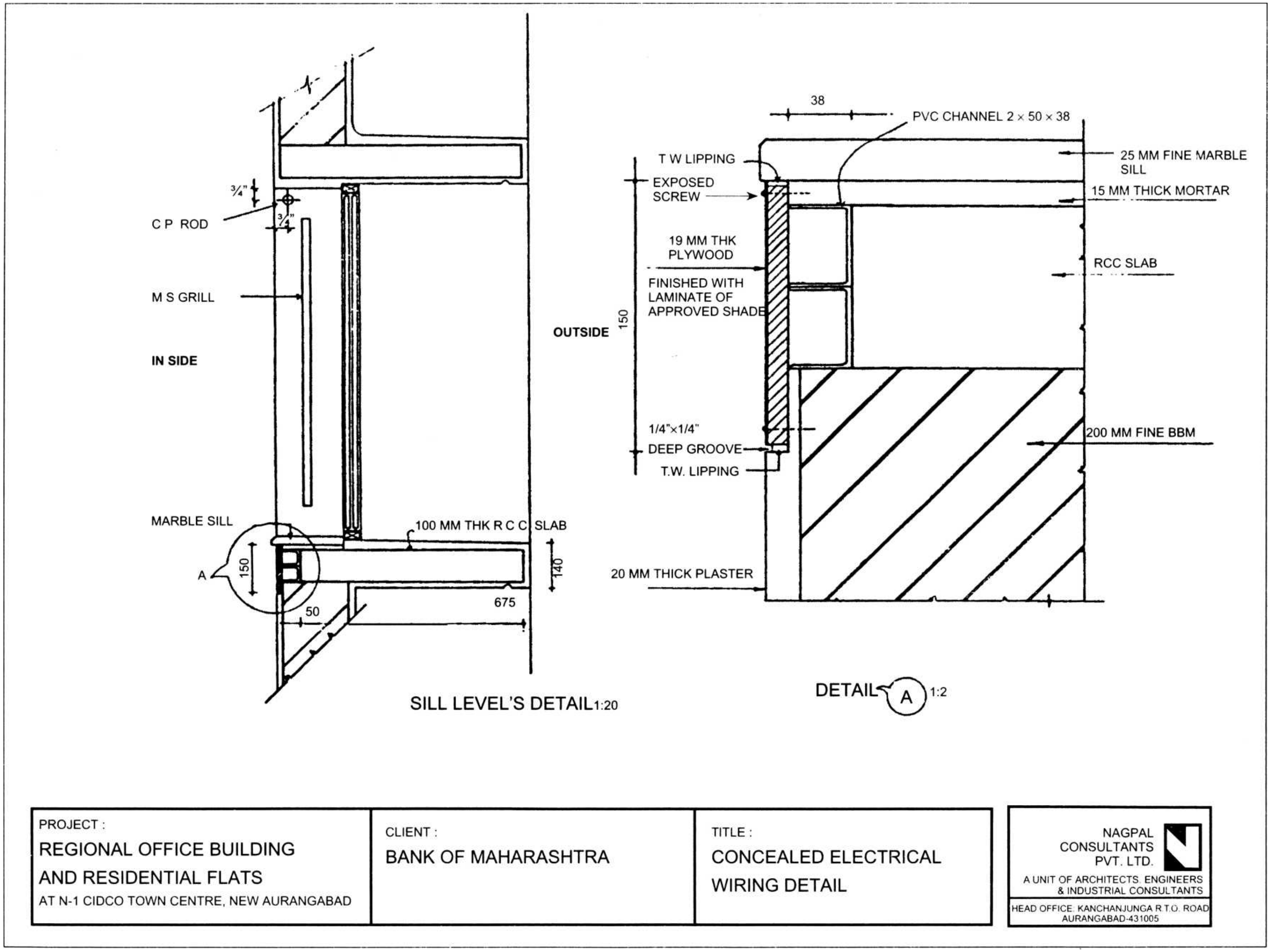


Figure 5.44 *Bank – Concealed Electrical Wiring Details*

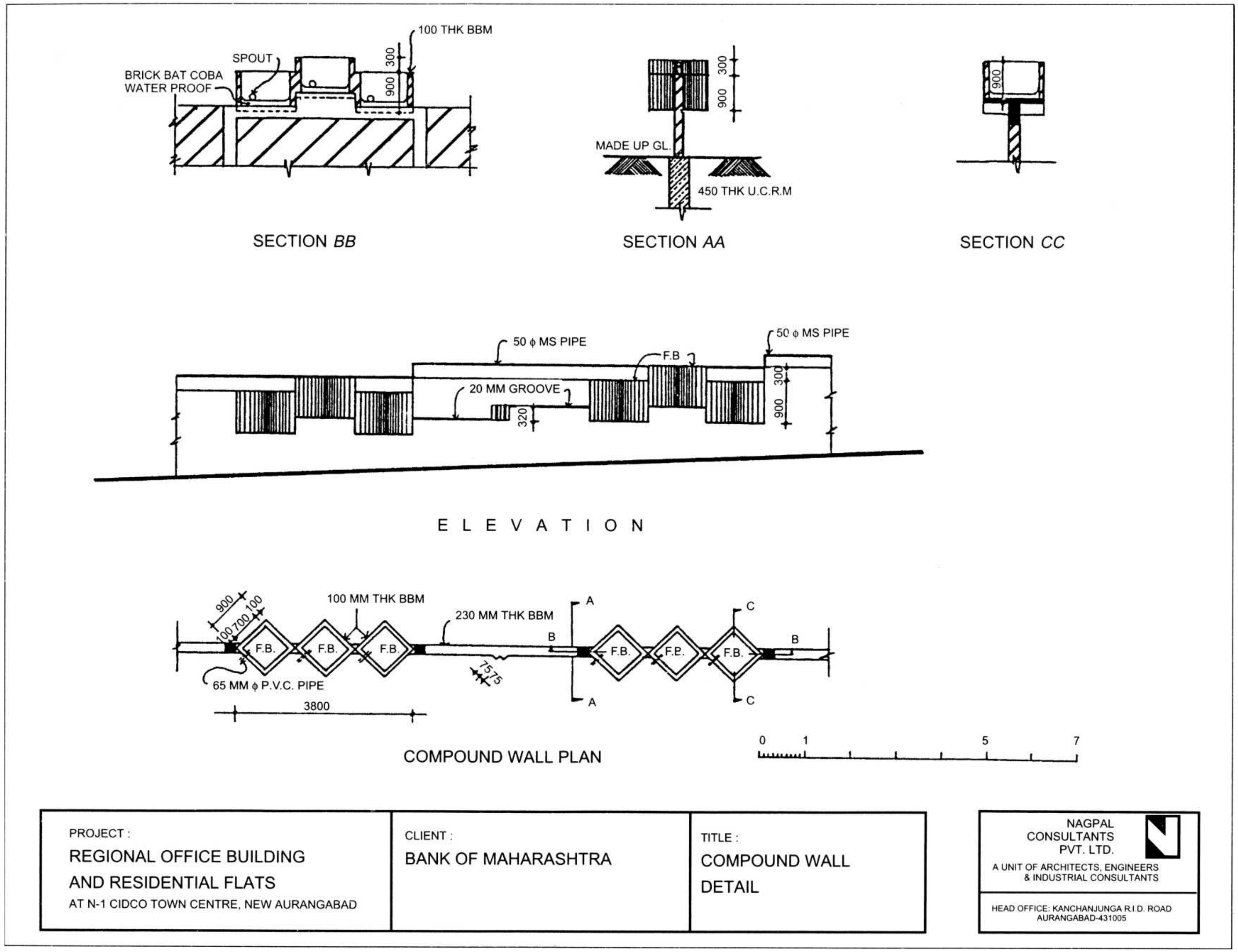


Figure 5.45 *Bank – Compound Wall Detail*

5.6 DESIGNING OF BUILDINGS

"Designing—The performing of a very complicated act of faith".

Author: Gorden Nelson
Book: *The Architecture of Building Services*

"Design-An art with a purpose."

Architect: Frank Lloyd Wright

All design work transferred to working drawings, provides data for construction. Specifications, notes, dimensions, levels and details on the drawings are the essential needs of designing. Traditional designs were prepared with a respect or a consideration for climate, availability of a limited range of materials and their use with traditional workmanship. Today, with the development of technology, knowledge of new materials and their properties, facilities for testing, use of computers to provide data for designing, computer aided drawings, project management, estimation and rate analysis, planning, designing and quality control in construction, etc., are integrated tools to reduce total time and use of resources.

The designing process stated by the designer Bruce Archer is, (a) training, (b) brief programming experience, (c) data collection, (d) analysis, (e) synthesis, (f) development, (g) communication, and (h) solution.

The real success of the design depends upon its solution in relation to the site, climate, the needs—present and future and use of natural resources economically, i.e., eco-friendly materials and techniques, innovative use of natural resources, causing least environmental damage, and lastly, satisfying functional needs as well as imparting aesthetic appeal. An integrated approach of all consultants in design and on the site is the only way. Periodical maintenance of a building gives it expected life.

5.6.1 Systems for Served Spaces

"Systems to create acceptable environment conditions which are maintained in a public building throughout the shifts and as per changes in the external climate. System needs space in the design. Building and the system must work together in harmony."

Architect: Louis Kahn

A building should be designed to act as environmental filter number two, hence its design is done with reference to some important considerations, namely safety and livability.

1. Safety- Design stage 1

There are four aspects of safety namely,

(a) Structural safety, (b) Health safety, (c) Fire safety, and (d) Constructional safety.

(a) ***Structural safety*** The main aim of the structure is to create and maintain the desired form and to support the elements of space enclosure as per expected life of the building. Study of the architect's drawings about enclosure of the building, shape and height of the structure and nature of plumbing and building services, throws light on the expected type of structure—load bearing, framed, surface or composite type. The important decisions related to the structural design are taken by studying site data and holding discussion with the architect, client and other consultants with reference to:

1. Site, site investigation report, site contours and features, soil and its bearing capacity, water table, foundation problems of the structures in the vicinity, earthquake, availability of materials and type of labour.

Chart 5.5

DESIGN OF BUILDINGS

1. Environmental Approach has replaced the structural approach. Built environment is a multidisciplinary subject.
2. Architecture is an act of creation which brings into existence—a design, a form, a function and a structure.
3. Housing—Regional, Urban and Rural Development. Town Planning Architecture and Landscaping is very essential.

1. Stage 1 Design for Safety	(a) Structural Safety (b) Health Safety (c) Fire Safety (d) Constructional Safety	To achieve safe life of the building through design and quality control in construction, to get return on investment with minimum maintenance.
2. Stage 2 A Design for Comforts to achieve Livability	Thermal, Ventilation, Lighting, Air Conditioning, Noise and Acoustics, Moisture Control, Electrical and Building Services	To achieve acceptable, controllable comfort levels for expected performance as per sensory needs.
Stage 2 B Interior Designing	For fulfilling, Spatial Needs Sensory Needs Social Needs Furniture and Furnishing Colour of Walls, Ceilings, Pattern for flooring and lighting.	To achieve visual textural pleasure, to create desired mood, with acceptable environment for function
Stage 2 C Landscaping and Indoor Plants	Design for surroundings, hard and soft landscape for visual pleasure.	To achieve pleasing relationship with nature to refresh all.
3. Stage 3 Final Check by Architect	Co-ordination of all drawings of consultants to finalise constructional programme.	To keep control at various stages in construction, to achieve economy and quality.

2. Building acts and regulations for the structural design and safety, standards and codes of practice.
3. Building type and function—specific structural requirements, life of the building, use of space, change of use of space in future to have knowledge of the change in loading, imposed floor loading, static and dynamic loadings, plumbing and building services, loading pattern, flexibility of loading pattern, movements in buildings, preference of the client for materials/use/life/cost/maintenance, etc., period of construction, selection of building materials with reference to the climate, windspeed, possibility of flooding, availability of skilled and unskilled labour, environmental requirements of the building—thermal,

ventilation, fire, air conditioning, lighting, noise and acoustics, moisture control, water proofing, grade of concrete, integral finish, use of admixtures, chemical grout, prevention of failure through design, testing, etc.

(b) ***Health safety*** Potable water supply, garbage removal system, drainage system, provision to avoid contamination and stagnation of water, mosquito control, dust control, soft and hard landscape, measures for noise control, (Ref: sp : 35 (S and T) 1987, Bureau of Indian Standards).

(c) ***Fire safety*** Study of safety codes related to fire safety, selection of construction materials as per classes of fire—A, B, C, and D. Fire resistance construction, provision of fire detectors, fire prevention and protection programmes. Fire safety plan, instructions and training, access for fire fighting equipment vehicles.

(d) ***Constructional safety*** Safety during the construction work and foundation work below ground level—pumping and dewatering, effect on adjacent structures, nature of soil, care during blasting, protection of excavated area, foundation level proposed and change if any, prevention of accidents by constant observation and related actions for various points mentioned above. Provision of a permanent bench mark to check levels, and settlements if any. Study of contractor's method of construction, imposed loading during construction, centering work for safety during construction of RCC work, removal of centering procedure, damp proofing treatment to foundation basement, floors and walls. Anti-termite treatment for soil and foundation, testing and approval of materials, testing of concrete cubes, check on soundness of construction, safety of workers and first aid. Reports on accidents, if any. Insurance scheme for workers.

"Built form can seldom escape the climatic conditions in which it is constructed and, by inference, that architecture which ignores local and immediate realities might be doomed to failure. Mumbai's high rise apartment blocks for all their white concrete and glass glory—cave in before the weather. Their facades crack, their metal fittings rust away, their open balconies can barely keep away monsoon gales. It should be sensitive to the weather patterns, the topographical profile and the material constraints of the sites."

Architect: Kazi Khaleed Ashraf.
Bangla Desh, settled in U S A
Ref: *Times of India, 22-12-97*

2. Livability-Design Stage 2A Essential factors in the creation of a building are physical and psychological factors related to an acceptable building environment. A building is basically for a human being, his activities and his expected performance. Thus, a human environment is the need. It is hence, the design for 'livability' through which we have to achieve and satisfy the client and fulfil functional requirements in all types of buildings. Providing space requirement for different activities and enriching the space with the expected comfort levels are two considerations for 'livability'. The subject of building physics/building science consider these considerations of Building Environment 'livability'.

The climate controls the external environment which depends upon geographical location, movement of the sun, wind direction, rainfall, humidity, etc. Physical and psychological study of man, as per human sciences, in case of different climatic and working conditions have stated different comfort levels. Construction of a building requires different materials. Thermal and other physical properties of materials help in selecting the suitable material for a building fabric.

Design for livability with minimum use of electrical energy for ventilation, air conditioning; provision of openings to admit maximum daylight, to avoid glare and for ventilation, selection of suitable materials to achieve thermal comfort economically and control of moisture should be the aim of today's designers. The shape of the building, its orientation, and mass tree plantation around the building play important roles in saving electrical energy.

Design for livability is done for:

(a) Design for thermal comfort
(b) Design for ventilation comfort
(c) Design for air conditioning
(d) Design for lighting
(e) Design for noise and acoustics
(f) Design for protection against moisture
(g) Design for building services—electrical, vertical circulation, i.e., lifts, escalators, telecommunication, information, entertainment, etc.

Planning with space and constructional requirements for various activities and services and proper sizes and directions of openings and shape of the building are all finalised with reference to these designs. They become part of the final working drawings.

5.6.2 Design of Fenestration

Fenestration means openings in the building. Its design, mainly of windows in buildings, their shapes, sizes and placement depend upon the type, shape and location of the building. It is a complex process related to many environmental and functional factors which conflict with each other. It should satisfy several building codes and regulations. An appropriate solution demands a detailed study of several factors.

Earlier, window openings were essential for ventilation and light. Today with the availability of glass, windows with glass and glass for roof light are common. Wooden, steel and aluminium windows have changed the facade. Fixed, openable, sliding windows are the common types. Their size depends upon sizes of rooms, number of users, etc. Louvred shutters were found useful for more ventilation. The radiation from the sun and the rain was also obstructed. Double and triple glazed windows with air gaps for insulation changed the design of windows. Decorative glass, safety glass, tempered glass, laminated glass, heat absorbing, heat reflecting low emissivity glasses and tinted glass are recent developments. Curtain walling is a system which encloses the building with large continuous areas of glass and panels from the floor to the ceiling. Prevention of rain water and air leakage are important aspects of designing. *Neoprene*, a synthetic rubber gasket, is found to be useful to provide a cushion against expansion and vibration. This was found useful in cold climates. A tropical climate needs an all together different approach, with warm-humid and warm-dry climate characteristics.

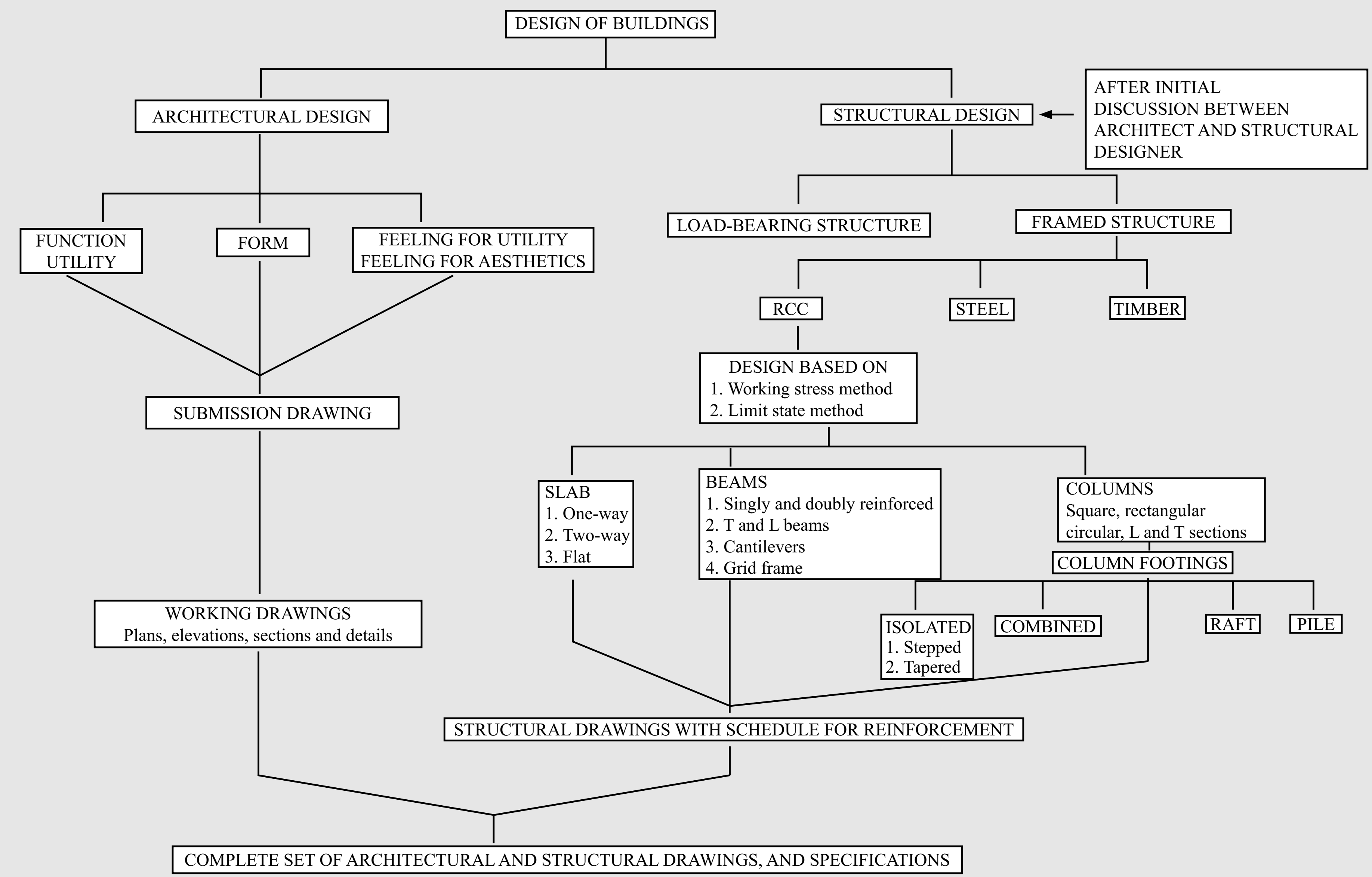
Functional Aspects of Windows Windows are concerned with the thermal, visual and aural comfort of the occupants of non air-conditioned buildings and energy consumption of air conditioned buildings. Windows are expected to provide of outward view in residential buildings. In office buildings, floor area and column free maximum area is important while in residential buildings, the view is more important. It should become a part of the room. From the psychological aspect, this visual contact with the outside world along with privacy, is essential. Windows play an important role in architectural appearance, both from inside and outside. Consideration of wind load is important in tall buildings. Ventilation, day lighting, heat gain and hot air leakage through glass, need for glare free visual environment, poor sound insulation as compared to the wall, nuisance of noise are different considerations related to the design of windows. Thus, it is difficult to get a single best solution for design of windows. Hence in each type of building, different degrees of weightages are to be given to the visual, thermal, acoustical and energy performance of the windows.

Design of Windows

Design of windows includes the determination of:

(a) Area and number of openings and their distribution in the facades
(b) Type—wooden, metal, i.e., steel, aluminium, PVC.
(c) Fixed and openable type of glass panes and shutters and their proportion
(d) Type of glass
(e) Single or double glazed
(f) Sun shading devices—their type, fixed or adjustable, louvres, etc.
(g) Location and environmental factors.

Chart 5.6



Working Stress Method

In this method, ultimate stresses are divided by a factor of safety to arrive at permissible stresses. Factor of safety for concrete is 3 and steel 1.5. The theory is based on elastic analysis using modular ratio concept; the sections are designed in such a way that the permissible stresses are within permissible limits. However, this method does not utilise full strength of the member, resulting in heavy sections. The economic aspect cannot be fully utilised in this method even by using high-grade mix of concrete and high tensile twisted bars.

Limit State Method

This is an entirely new method based on the probability concept. The structure is analysed at the failure. The strength of concrete and steel is worked by probability concept to ensure the correct available strength. Partial safety factors are introduced to reduce the probability of failure to almost zero. For concrete, factor is 1.5 and for steel 1.15. The factor for loading is 1.5. Limit state for serviceability and cracking are also considered. Limit state method is more logical to the actual behaviour of the structure under various loads. Indian Standard IS: 456-1978 has introduced the use of this method from 1979.

Computerised study is helpful for all complex calculations related to the requirements for ventilation, air changes, comfort standards, daylight requirements, acoustic behaviour, effect of wind, wind load, energy considerations, which is done with reference to Hand Book on functional requirement of buildings (other than industrial buildings), Bureau of Indian standards, New Delhi, 1988.

5.6.3 Interior Designing and Landscape Architecture-Design Stage 2B and 2C

'Livability' is finally achieved through the interior designer's work which decides the colour, texture, pattern for flooring, ceiling, wall surface, and all visible objects such as various equipments like electrical fans, fittings and accessories, curtains for windows, decorative glass work, furniture. Landscaping, indoor plants for achieving unity in the total design and giving aesthetic pleasure; all is done by the landscape architect.

5.6.4 Energy Conscious Architecture

The challenge faced by today's designers is to create a design that will provide a comfortable and productive environment with minimum cost of energy and maintenance throughout the life of the building. Energy consumption is to be reduced by different alternative sources than electrical energy and by economical design of the building fabric, to reduce heating and cooling loads for the whole building and through use of more efficient equipments for heating, ventilation and air conditioning (HAVC) systems, carefully sized and operated with efficient control systems. This needs correct installation and set-up of equipment, better maintenance through routine inspection and servicing and a constant check on the expected performance standard. The real achievement of the planner is due to appropriate form and orientation of the building, openings to take advantage of maximum day light and natural ventilation, solar heat gain and design and operation of the environment control system of the building.

A building is designed to utilise daylighting, natural ventilation and passive solar heating while a climate-rejecting building is supposed to depend on artificial lighting, heating, ventilation and air conditioning, as per the function of the building. Humidity control is a requirement of art galleries and libraries. Industrial manufacturing have different requirements such as water bodies around the building and within the campus, dust control, noise reduction and protection from glare and wind. Hence, what is important in the initial stage is the study of the site, surroundings, details about temperature, humidity, wind intensity, rainfall, etc., study of suitable form for the function and site. One takes decisions related to the four safeties and livability with comfort standards, at the planning level only. This energy/electric consumption can be reduced. Computer simulation techniques can help us to evaluate the comparative merits of different building plans, deep plan forms or otherwise. This is essential to eliminate or reduce the energy waste. This can be done by reducing the size of plants, through compact fluorescent lights, optical lighting systems and automated control systems, shade trees, gardens/lawn on terrace and light coloured external walls with sun-shading devices. The climate on the earth varies as per climatic zones. The study of climates done by Indian Meteorological Department, New Delhi and Central Building Research Institute, Roorkee (UP) for climatological and solar data (ASHARE Fundamentals, 1981, American Society for Heating Refrigeration and Air Conditioning Engineers, USA) would be useful in getting to know design developments in the field of machinery for air conditioning, different types of air conditioners, electrical appliances with safety devices and films to control heating of glass. Materials for insulation are also helpful in designs.

Sustainable architecture includes energy conscious architecture and use of renewable energy resources. Bioclimatic, passive, active, hybrid, solar or environment friendly, energy conserving architecture are different names for energy conscious architecture. We should note that the sun, sky, air, earth and water are the ancient elements of 'climatology'.

Chart 5.7 shows different steps related to the achievement of a physically and psychologically acceptable environment, through design for safety and livability. Energy conscious architecture achieves this through planning and designing with minimum energy. That should be the aim of the planner and designer. He should study various forms of buildings given in case studies. Important considerations for the design for livability are given in the following lines, which will help to understand the design procedures, with reference to Bureau of Indian Standards, New Delhi.

Design for Thermal Comfort The source of heat of the earth is the Sun which is at a distance of approximately 150 million km from our earth. Heat is transferred through radiation, conduction and convection from the external environment to the interior of a building through walls, openings and the roof. It heats up the building fabric and raises the temperature creating uncomfortable conditions. Hence the design requirement for thermal comfort is to reduce heat absorbing and heat radiating capacities of walls and the roof, to minimise openings and use of sun-shading devices to prevent direct penetration of the sun's rays inside buildings. A large part of India lies between 8°N to 29°N latitudes. Suitable orientation would be useful for areas between the tropics to reduce the effects of summer solar radiation. In colder climates, i.e., above the tropic of cancer ($23\frac{1}{2}$° Latitude N), buildings should receive maximum solar radiation in winter and minimum in summer. Absorption and radiation of heat depends on the types of materials used in walls and roofs. In order to reduce the effect of solar radiation on buildings, the absorptivity for the building material must be low. White walls and light cream bricks or tiles have low absorptivity.

Comfort factors of heat It is found that our body temperature is maintained within a normal range of 37°C to 39°C. When the external temperature is higher than the normal body temperature, the skin perspires and evaporative cooling starts. However, if loss of heat is too rapid, it produces shivering in order to restore the heat loss. An environment which controls these two extreme conditions is known as a comfortable environment. For various climatic zones in India, the effective room temperature for comfort is between 21°C to 24°C with +/-3°C on either side.

Two distinct climatic types in the tropics are warm humid, i.e., places near the see shore like Mumbai and Chennai, and warm dry, i.e., places away from the sea shore like Nagpur and Hyderabad. Apart from humidity considerations, the main difference between them is the magnitude of the diurnal variation of air temperature. In a warm humid climate, there are relatively small daily fluctuations in air temperature, but in warm dry climates there can be large fluctuations. We should also note that the thermal performance design of the buildings is not only a function of air temperature, but depends upon air temperature, solar radiation, longwave radiation, moisture content of the air and wind. Topography, height above sea level, proximity to the sea or other large water masses, vegetation, etc., are also related factors for the local variation of thermal effect.

Solar radiation is affected by the degree of cloud cover, cloud type, and extent of pollution of the atmosphere. Weather stations usually record solar radiation intensities on horizontal surfaces. It is the radiation incident on the vertical surface of the building that affects its thermal response. There is a need to apply designs with reference to weather data judiciously and with great caution, as there are many variations at different places.

Thermal performance of buildings and its control The three main factors determining the thermal response of a building are:

(a) Net heat gains through the different elements
(b) Heat produced internally, number of persons and activities
(c) Extent to which the building is ventilated.

The heat gains or losses through the building depend upon the heat storing capacity and insulating properties of the building elements, the external air to internal air temperature differences across the elements and the solar radiations absorbed by the various surfaces.

Chart 5.7

BASE BUILDING MODULE AND SIMULATION CONDITIONS

1. Location—Singapore	: 1.3° N Latitude
2. Core zone—Dimensions and Floor Area	: 25 m × 25 m; 625 m^2
3. Perimeter Zone—Dimensions and floor area	: 25 m × 5 m; 125 m^2
floor to ceiling height	: 3.15 m
4. Glazing—Single glazing	: 6 mm tinted heat absorbing glass
U Value	: 5.88 W/m^2 K°
Shading co-efficients (SC)	: 0.53
Visual Transmittance (TV)	: 0.30
Glass area	: 25 m × 1.5 m; 37.5 m^2
Window area/wall area	: 0.476 (47.6 per cent)
Window area/floor area	: 0.25 (25 per cent)
5. External walls	: 2.54 cm plaster + 10.16 cm dense concrete + 1.9 cm plaster U-3.32 W/m^2K° Solar absorptivity 0.70
6. Floor	: 15.2 cm dense concrete U = 3.03 W/m^2K°
7. Internal partition walls	: 1.6 cm gypsum plaster board + 10 cm air space + 1.6 cm gypsum plaster board U = 2.57 W/m^2K°
8. Occupants	: 1 person per 10 m^2
9. Infiltration rate	: 0.6 air changes per hour
10. Fresh air supply for ventilation	: 24.5 m^3 per minute
11. Cooling system	: Variable air volume (VAV) system with centrifugal chiller plant
Co-efficient of performance of the chiller.	: 45
Overall co-efficient of performance of the cooling system including fans and pumps	: 3.0
System operating hours	
Monday-Friday	: 08 Hrs to 18 Hrs
Saturday	: 08 Hrs to 13 Hrs
Annual total number of working hours	: 2750
12. Indoor conditions : Air temperature set point	: 25°C
Relative humidity	: 50%
Illuminance on working plant	: 500 lux
Lighting Power Density	: 20 W/m^2

Data given in the winter school on "Functional Design of Buildings" organised by IIT Madras (Nov 15-28, 1989).

In warm dry climates, heavy weight buildings are superior to those of light weight, while the light weight building is superior in a warm humid climate because the light weight structure cools down further during the night, creating comfortable sleeping conditions. A combination of thick and thin walls as per orientation is also found suitable for certain climates.

Darker surfaces absorb more solar heat, while large white painted surfaces may give rise to glare problems. Hence, slightly tinted surfaces would be more appropriate.

Window glass transmits solar radiations directly in varying degrees depending on the nature and colour of the glass, but it is opaque to low temperature radiation emitted from an internal heat source. Hence, shading of windows is essential by the use of special glasses and glazing materials, double glazing, internal shading, and external shading.

Out of the above four methods, external shading is found to be most effective as it intercepts solar heat before it reaches the glass. In general, north/south orientation for buildings have short east and west walls. Roof overhangs for single storey buildings and horizontal projections for multi-storey buildings create comfortable conditions. Effective ventilation removes excess heat, promotes air movement for body cooling purposes, and cools or heats the structure during periods of either high or low outdoor air temperatures, as per the conditions.

Design of building envelop/fabric Design of the building fabric, i.e., wall is found to be useful for improving thermal performance of the building. Selection of wall elements with high performance, increasing the thickness of the brick wall, cellular concrete wall, plastering on both sides of the wall, cavity walls and expanded polystrene are some methods for thermal design of walls. For the roof, RCC slabs plastered on both sides, or RCC slabs with insulation and finished with tiles, roof with mud phuska or roof with lime concrete, i.e., lime concrete over an RCC slab with plaster finish at the bottom is found to be effective. The following terms and definitions are used in the thermal design.

(a) ***Thermal Transmittance: U-Unit-Watts/m2°C*** It is the quantity of heat flow (q) per unit time through unit area of the element or structure, for one degree temperature difference of outside and inside air. It includes the surface conductance (f) on both sides. U values for walls with different materials and thickness and for the roof are:

1. Brick wall 190 mm thick	U = 2.371 W/m^2°C
2. Brick wall 190 mm thick with plaster 10 mm thick on one side	U = 2.295 W/m^2°C
3. Brick wall 190 mm thick with cement plaster 10 mm thick on both sides	U = 2.225 W/m^2°C
4. Brick wall 90 mm thick with air cavity, 100 mm thick and cement plaster 10 mm thick on both sides	U = 2.204 W/m^2°C
5. Brick wall 190 mm thick with plaster 10 mm thick on both sides with insulation of expanded polystrene 25 mm thick	U = 0.903 W/m^2°C
6. Cellular concrete wall 190 mm thick, cement plaster on both sides, 10 mm thick	U = 0.816 W/m^2°C (Compare this with brick wall) U = 2.25 W/m^2°C
7. GI sheet, 0.5 cm thick	U = 5.331 W/m^2°C
8. Asbestoes cement sheet 0.6 cm thick	U = 4.717 W/m^2°C
9. RCC roof slab 100 mm thick with plaster on both sides, thickness 10 mm each	U = 3.5903 W/m^2°C
10. RCC slab with insulation and finished with tiles	U = 0.6229 W/m^2°C (Polystyrene 50 mm thick

Brick tile = 20 mm thick	has given U value 0.6229
Polystyrene = 50 mm thick for insulation	W/m^2°C as compared to 3.5903 W/m^2°C
RCC slab = 100 mm thick	(9) above
Cement Plaster =10 mm thick	80% contribution
11. Madras terrace roof	U = 0.6678 W/m^2°C
Clay tile = 20 mm thick	
Lime concrete =100 mm thick	U will be more in the
Terrace Brick = 75 mm thick	section without the joist
Cement plaster =10 mm thick	
Timber = 75 mm thick	
12. Roof with Mud phuska	U = 1.704 W/m^2°C
Clay tile = 20 mm thick	
Mud mortar =10 mm thick	
Mud phuska = 150 mm thick	
RCC slab = 100 mm thick	
Cement plaster =10 mm thick	
13. Roof with lime concrete over RCC slab	U = 2.49 W/m^2°C
Lime concrete =100 mm thick	
RCC slab = 100 mm thick	
Cement plaster =10 mm thick	
14. Roof with bitumen felt	U = 3.149 W/m^2°C
Clay tiles = 20 mm thick	
Bitumen felt = 20 mm thick	
RCC slab = 100 mm thick	

For thermal transmittance, the U value should be less for the walls and roof. The details giving U values for different designs will suggest suitable solutions as per climate, type of building, availability of materials and workmanship as the cost of insulating materials is very high. Reduction of thermal transmittance should be the main aim.

Madras terrace and mud phuska are suitable roofs for hot and dry regions.

Details for design procedure for thermal transmittance are given in IS code and in the book *Building Environment* by D Ajitha Simha, Tata McGraw-Hill Publishing Co, New Delhi, which is referred here.

(b) ***Surface Conductance (f)*** It is the quantity of heat exchanged by radiation, conduction and convection of a unit area of surface with the surroundings or surrounding air per unit time. Its value is expressed in watts per square metre kelvin. Surface resistance is the reciprocal of surface conductance.

(c) ***Thermal Conductance (c)*** It is the quantity of heat transmitted by a single layer of an element per unit area due to a temperature difference between the hot (outside) and cold (inside) faces. Its value is expressed in watts per square metre kelvin.

(d) ***Thermal Conductance of Air Space (a)*** It is the quantity of heat flow through a unit area of air space per unit temperature difference between the boundary surfaces. It is determined by test.

(e) ***Thermal Conductivity (k)*** It is the quantity of heat flow per unit time in a steady state through unit area of an infinite piece of uniform material per unit temperature difference between the two planes normal to thermal flux per unit thickness. It is expressed as watts per metre kelvin.

(f) ***Thermal resistance (R)*** It is the reciprocal of the heat transfer co-efficient as expressed by U, C, K, F or a. If the U value is 0.25, the thermal resistance R = 1/U = 1/0.25 = 4.

Design for Ventilation Comfort A supply of fresh air is essential for dilution of inside air for the control of odours, to remove products of combustion and to maintain a satisfactory thermal environment. This depends upon the number of persons living or working indoors and the air space available per person.

In non-conditioned spaces, removal of body odour through ventilation is essential while in conditioned spaces, it is essential to remove body odours, smoke and heat. Number of air changes per hour are specified by IS: 3362-1977. There are three air changes per hour for living rooms and bedrooms and at least six air changes per hour in kitchens, bathrooms and water closets. In factories, along with natural ventilation, mechanical means are adopted to remove contaminants released during the manufacturing processes.

Design for Air Conditioning Comfort In air conditioning, temperature, humidity, purity and distribution of air is controlled according to the necessity of conditioned space, number of persons, and nature of occupancy. Hence, the requirement of an outdoor supply of fresh air is different and higher for conditioned spaces. Movement of air is also essential with velocities not exceeding 30 m/minute in the zone between the floor level and a height of 1500 mm above the floor, 15 m/minute for comfort air conditioning.

The comfort conditions in an air conditioned space for summer and winter seasons are different.

Table 5.6 Comfort Conditions for Air Conditioning

Seasons	Optimum Conditions		Maximum Conditions	
	Dry bulb temp. °C	Wet bulb temp. °C	Dry bulb temp. °C	Wet bulb temp. °C
Summer	23.3	19.4	25.9	21.8
Winter	21.4	17.8	18.3	15.0

Table 5.7 Minimum Fresh Air Requirements for Conditioned Occupancies

Occupancy	Smoking	Cubic Metre/hour/person	
For residential occupancy		Recommended	Minimum
(a) Apartments	Some	33.6	16.8
(b) Hotels	Heavy	50.4	42.0

Design for Lighting Comfort The lighting should be good, related to its quantity and quality. This depends upon illumination levels (quantity) and glare (quality). The primary source of daylight is the sun. It is received by solar illumination and sky radiation. Direct solar illumination brings heat and glare; hence it is not considered in the design. Only natural radiation is useful for illumination of building interiors during the day. The design sky, is based on clear sky at 15° altitude for tropical climate. Daylight is related to the sky component, external reflected component, and internal reflected component. Artificial illumination is necessary both during day or night as per the nature of occupancy, the size of the building, climatic seasons, the visual task, etc. The glare reduces the efficiency of vision and also hurts the eyes. The glare index is related to the quality of light. Illumination levels are expressed in lux, i.e., for residential general purposes 100–200, and for offices, 300.

Design for Noise and Acoustics—Comfort Levels Noise, i.e., unwanted sound, airborne or from some impact can be controlled in different ways. Zoning or planning of town areas and orientation of buildings help in reducing nuisance due to airborne noise. Sound insulating materials are useful for reducing the effects of impact noise. Acceptable noise levels for different occupancies are specified by Indian standards. Attempts should be made through suitable design by using sound absorbent materials such as porous materials, glass, fibre, resonant panels and cavity resonators. The sound level is measured by a sound level meter. For acoustic purposes, an octave band analyser is used along with a sound level meter.

Design for Moisture Control Building materials and entire buildings are affected by moisture. The effect is seen in the uncomfortable condition due to dampness which affects walls, the ground floor, roofs and construction joints. It is highly essential to prevent ingress of moisture through constructional means and applied finishes. A dampproof course is one remedy. Materials like wood and wood products are affected by moisture. Efflorescence and spalling of masonry, rusting of steel causing damage to RCC work, etc., are due to moisture penetration. Leakages through the roof and ingress of moisture through windows and other openings cause uncomfortable conditions.

Specifications and testing of materials, workmanship, quality control and periodical maintenance help in controlling moisture.

Design for Building Services Safety and effective functioning of services is the long-term need from all types of services. Safety in electrical work is an essential need. Selection of equipments, machinery, provision of space, levels and erection and tests as per the manufacturers instructions is essential. All details about different equipments should be studied at the time of planning in order to finalise space requirements and for provisions in the budget.

5.7 CONSTRUCTION OF BUILDINGS

"Building construction is engineering in action"

Author: Vinita Shah
Book: Human Resources Development in the Building Industry—A Study in Bombay

Construction is an action which converts two dimensional drawings into three dimensional structures and fulfills functional and aesthetic needs, economically, within the time frame. Taking into consideration the participation of different teams for planning, designing and construction, construction requires management of uni-directional actions of all concerned.

The use of newer building materials, mechanised operations, sophisticated plants and instrumentation, superior construction techniques with minimum maintenance expenses are essential factors. This required higher level of skills and sincerity of the work force, supervisors and skilled and unskilled persons. Construction is a real opportunity to show the creative urge of planners, designers and constructors. In the age of computer aided drawings, design and management, the urge for quality in the mind of all concerned should create built environment to give satisfaction and joy of achievement of a desired social transformation for the welfare of mankind.

Details about materials, labour, machinery and quality control are given in the following lines with reference to related points. Students are advised to refer to different books, Handbooks published by National Building Organisation, New Delhi, IS Codes for materials and testing, etc., in order to prepare check lists for different items in construction, (study cost analysis diagram, Fig. 5.46)

Materials Different materials are required for construction. Specifications are related to the use of materials, workmanship expected and care, till full strength is achieved by the elements of construction, walls, lintels, arches, RCC slab, etc.

Properties of materials are studied as physical properties and mechanical/strength properties.

1. ***Physical Properties*** Physical property depends upon specific gravity, density, bulk density, porosity, water absorption, hygrosopicity, permeability, fire resistance, thermal capacity, sound transmission properties, corrosion, durability and soundness.

These properties depend upon the type of material—organic or inorganic, natural or manufactured or solid building materials/binding materials/finishing materials or insulating materials.

2. ***Mechanical Properties*** These are elasticity, plasticity, toughness, resilience, hardness, brittleness, ductility, fatigue, creep, abrasive resistance, impact strength, tensile, compressive and shear strengths. Knowledge of mechanical properties helps in the selection of suitable materials.

Sampling and testing are done as per various codes of practice for the same. It is highly essential to maintain standard procedures and conditions like temperature, rate of loading, etc., for a particular test. It also requires standardised and specified testing equipments.

A study of Indian standard codes published by the Bureau of Indian Standards, manufacturers' catalogues, various journals and market surveys give knowledge of commercial firms, brand names and the price structure.

Labour-Skilled/Unskilled

Skilled Mason, carpenter, plasterer, painter, tiler, plumber, steel fixer/bar bender, electrical wireman, carpenter for centering and formwork, stone cutter and dresser, carpenter for furniture work, construction supervisor, machine operator, auto/heavy duty vehicle's mechanic, earth moving equipment mechanic, crawler operator, motorised grader operator and hydraulic excavator, all are skilled labourers. Study the work of skilled workers, their training as per requirement of the job, their job description, i.e., expected work quality, responsibility, construction drawings, and prepare checklist of expected items in order to complete the specific job as per specification within the given time period.

Semiskilled, skilled and highly skilled classification helps in the assignment of jobs. One should also know the inter-relation of different trades and their inter dependence to achieve specifications with expected quality.

Machinery and Construction Equipment The machinery for construction include concrete mixers, vibrators, cranes, floor polishing machines, stone polishing and cutting machines, survey equipments, pumps, generators, earth excavating and moving equipments, as also vehicles and equipments for different trades and workers.

Project Management Project management is done through the resident engineer, the chief responsible person on the site, appointed by the employer/owner to control the total construction programme as per the planning and design of the architect and his team of consultants. His main job includes site meetings, reporting the progress of work to architect and passing on architect's instructions to the contractor's representative on site. Co-ordinating the entire work process is his job. His skill, experience, knowledge in taking quick-on-the-spot decisions to avoid delay and mistakes, and making prompt payments are important factors which keep the progress schedule as per expectation.

The project manager is a representative of the contractor. His team includes the site manager, supervisors, site office staff, and labourers. Good organising administrative quality is an essential quality of the project manager. Project control needs site meetings and co-ordination with all concerned. Labour welfare, anticipation of difficulties, material supply, quality control as per specifications and progress depend upon his experience and decisions. Critical path method (CPM) is used for interlinking and determination of interdependency of various activities involved in a project. Today, computers are used to keep control on the project work, by keeping ready, all information related to the project. It is highly essential to keep all drawings, documents and reports for ready reference. Maintenance of the site, laboratory, safety of labour and staff are, allied responsibilities. Different softwares are now available to control construction work.

Quality Control A check list for handing over a completed flat is given in Chart 5.8 which helps in knowing the expected quality from different items.

The present practice is related to the preparation of various check lists for different items starting from job layout, line out for foundation, excavation, etc., upto the final site clearance.

Chart 5.8

CHECK LIST FOR HANDING OVER POSSESSION OF FLAT

Item Inspected	Yes	No
I. Walls:		
1. Are there any cracks in walls?		✓
2. Are there any signs of dampness/leakage on walls?		✓
3. Are all Walls examined?	✓	
II. Tiling		
1. Are there any Cracks in the flooring?		✓
2. Is there any settlement in floors?		✓
3. Is the floor laid to proper slope?	✓	
4. Is the floor properly finished, polished and cleaned?	✓	
5. Are the joints filled properly?	✓	
6. Are all floors/dado examined?	✓	
7. Is the kitchen platform finished properly?	✓	
III. Terrace/Roof		
1. Are there any cracks on the terrace?		✓
2. Are any leaks visible?		✓
3. Has the waterproofing treatment been laid to proper slope and correctly?	✓	
4. Are Rainwater pipes/spouts properly fitted and free of chocking?	✓	
5. Have all roofs and ceiling examined?	✓	
IV. Doors and Windows:		
1. Are all doors/windows opening and closing smoothly?	✓	
2. Are all doors/windows properly painted/polished?	✓	
3. Are all fittings like locks, tower bolts, stoppers, hinges, etc., working smoothly?	✓	
4. Are all glass panes properly fitted, cleaned and crack free?	✓	
5. Have you received all the keys?	✓	
V. Finishing:		
1. Are all rooms properly painted?	✓	
2. Is the main door polished well?	✓	
3. Are there any cracks visible?		✓
4. Is there any gap anywhere?		✓
VI. Plumbing and Sanitation:		
1. Are all pipes properly fixed?	✓	
2. Are there any leakages outside?		✓
3. Are all taps, valves, showers, wash basins, sinks, tubes, geysers, etc. working properly and is there any choking/leakage?	✓	
4. Are all flushing cistems and valves working properly?	✓	

Item Inspected	Yes	No
5. Are all WC Pans, wash basins and sinks free of cracks/breakages?	✓	
VII. Electrical:		
1. Are the following items working properly?		
(a) Switches	✓	
(b) Plug points	✓	
(c) Fan points	✓	
(d) AC points	✓	
(e) Fridge points	✓	
(f) Bells	✓	
(g) Geysers	✓	
(h) Exhaust fan points	✓	
(i) Main switch	✓	
(j) Meters	✓	
2. Are all fuses wired properly?	✓	
3. Is the earthing connection tested?	✓	
4. Is initial reading of meter noted?	✓	
VIII. Building Exterior and Compound:		
1. Is the building *chajjas*, terraces, lofts, and compound cleaned of debris?	✓	
2. Is the approach road, laid properly?	✓	
3. Do the compound wall and gate ensure security?	✓	
4. Is the building painted properly?	✓	
5. Is the compound finishing completed?	✓	
6. Is the compound, staircase, terrace, passage and common area well lit up?	✓	
IX. General:		
1. Is the lift working properly?	✓	
2. Are the steps and staircases provided properly?	✓	
3. Is the entrance hall cleaned well?	✓	
4. Are the water pumps in working order?	✓	
5. Are the overhead and underground tanks free of leakages and cleaned?	✓	
6. Is there sufficient green area?	✓	

Signature of the Builder’s representative
Date:
Siddharth Builders, Pune.

Signature of the Flat Owner
Date:

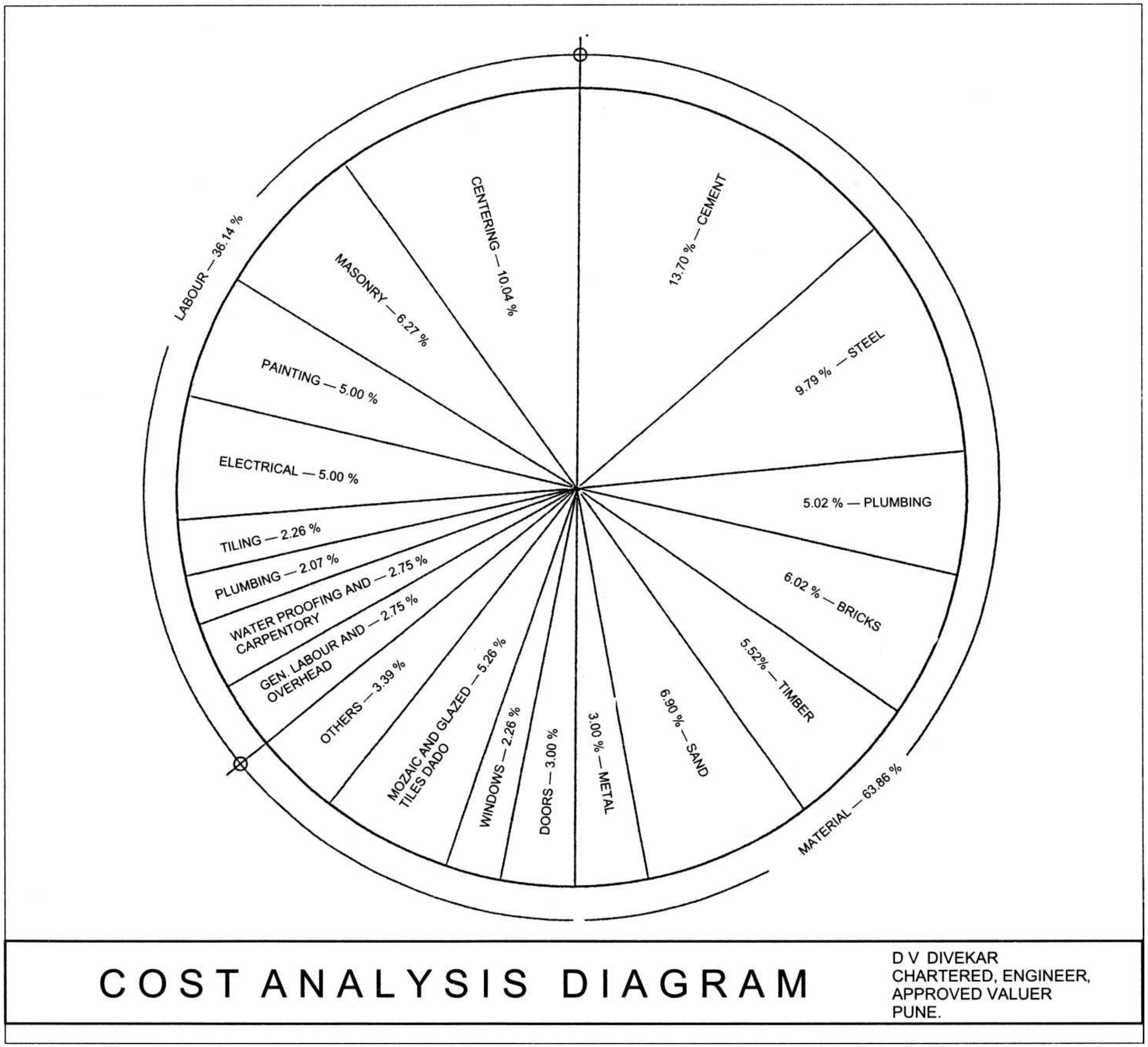


Figure 5.46 *Cost Analysis Diagram*

It pinpoints the details to be checked, i.e., approval and testing of materials, equipments, instructions to carry out work as per drawings, specifications, etc. Such check lists are prepared by different contractors/ architects/structural designers and other consultants.

Case Study

Siddharth Builders have completed projects viz. Siddharth Palace, Siddarth Regal Homes, Siddharth Royal Homes, Siddharth Castle, and Siddarth Mansion in Pune. Houses good enough to suit every budget, with the best amenities, taking care of comforts, in short, 'Better Homes' is their motto.

Their check list for handing over possession of flat is shown here. The flat owner is supposed to check all items by inspection in the presence of the builder's representative. This also shows the builder's confidence in strict quality control during construction.

Reading Exercise (Chart 5.8)

Students should study carefully the check list of all items. Then think and prepare your own check list for quality control during supervision.

(i) How to achieve the expected quality in different items?

(ii) What control is necessary in selecting and testing of materials and maintaining workmanship?

(iii) How to achieve quality with economy of time, money and materials?

Is it not a good attempt to develop an awareness about the quality in the mind of the owner of the flat? This also shows the concern of the builder to give full returns on the investment of the owner.

Construction Quality Assessment Scheme (CONQUAS) Assessment of the quality of construction other than project's architect, and structural designer is followed in some countries, by appointing a separate agency of Architects, Engineers and other Consultants, the main assumption is, "Even quality is measurable". The procedure to check quality is prescribed along with different standards for checking, acceptable standards or tolerances. The assessment system followed in Singapore consists of the following details.

The total work is divided in three parts:

(a) Structural works: 40% points for checking of formworks, reinforcement, quality of concrete and finished work. It is done in two stages, i.e., to check formwork and reinforcement as per drawings before concreting and then quality of concrete, honeycombing, etc., after concreting. Number of elements are decided as per the size/storeys of the building. Quality is checked by different professionals.

(b) Architectural works: 50% points for workmanship and finishes of floors, internal and external work, ceilings, doors and windows, plumbing and sanitary fittings, roof, etc.

(c) External Works: 10% points for walkways and drains, compound wall, car park, footpaths, turfing and gates.

The detailed procedure for different types of building, elements to be checked per floor as per areas of the floor and prescribed forms to give points per element and relevant points to be checked is all prescribed. For example,

Structural work—Total 40 points—Formwork 5 points
Reinforcement 10 points
Finished concrete 15 points
Concrete quality 10 points
Total 40 points

In the same way, details about points to be given for architectural work and external work are prescribed. Finally, the total points received for the building are stated out of 100 points. Checking is also done during the defects liability period. 1 defect per 1000 square metres is allowed. For every subsequent defect per 1000 sq. metres, 2 points are deducted from CONQUAS score for architectural work and 1 point for external works.

The list prescribed for various standards to be achieved is in detail; hence workers carry out the work to eliminate maximum defects. Quality of materials is checked by testing. Assessment is done throughout the construction process for the structural work and on the completed buildings for architectural and construction work.

Training of workers with reference to different standards, checking by different professional teams and response from different building contractors is the reason for the success of CONQUAS.

5.7.1 Assessment of the Total Cost of the Project after Completion (Fig. 5.46)

Softwares for building, designs and drawings have reduced total time for the preparation of the project. Estimates of quantities per floor, cost of development, etc. give the estimated total cost of construction. The laborious analysis, drafting and estimation cycle is now replaced by a few keystrokes on the computer. Entering the single line floor plan is the only work one is supposed to do. User friendly software requires only a basic knowledge of computers. The complex functions of the package are driven by simple menu commands. Tedious calculations of carpet area, built up area, etc., are done by the software. Accurate quantities of RCC and non RCC items are available from the plan drawings. Bar bending schedules can be sent to sites directly for further action by fitters and bar benders. The measurements at site can be cross checked easily at the office before billing. Modified revised estimates are available with the office before billing. Modified revised estimates are available with changes in the rate/rates of materials.

Hence, it is now possible to check the actual cost and estimated cost of the completed project. Built up area and carpet area, concrete, and brickwork volume, plaster, flooring and formwork areas, excavations and filling quantities, bar bending schedule of reinforcement, diameter wise break up of steel, cost estimate for provided rates, and quantities in length, breadth, depth LBD form. Cost analysis diagram (Fig. 5.46) is useful to know the cost of material and labour.

5.7.2 Construction Report

It is essential to prepare a construction report of the completed project. Set of working drawings with changes, lists and addresses of sub-contractors, details about pumps, of consultants with their address, total cost, cost/m^2, administrative expenses, etc., would be useful for other projects.

5.8 PROJECT WORK

Architectural Planning

1. Collect brochures for different housing schemes, study layout plans, width of roads, areas of plots, open spaces and shapes of plots. Compare different plans for buildings, area statements and specifications. Study rules and Bye-laws for layouts.
2. Hold interviews with the architect—discuss profession of an architect, rules for planning of buildings and role of an architect, procedure for submission of plans for approval.
3. Study bye-laws and development rules of corporations.
4. Study vernacular and designed architecture. Collect photographs and drawings. Comment on planning, construction, after interview of the user.

Chart 5.9

BUILT ENVIRONEMENT

BUILDING

It is a stable shape in the space resting on the terra firma.

Building is not only a **SHELTER** but it is:
⇒ 'Built Environment for Human Beings'
⇒ 'Container of Activities'
⇒ 'Environmental Filter for Human Performance'
⇒ 'Energy Saving, Efficiency Improving Design
⇒ 'Land Value Changer'
⇒ For Improving 'Living, Working and Health Conditions of Masses'

PLANNING

FUNCTION — FORM — FEELING FOR UTILITY AND AESTHETICS

Functionally well-planned, grouped with desired flow pattern and constructed spaces, suitable for the site and climate for occupational comfort and expected performance of human activities in internal and external space.

DESIGNING

DESIGN PARAMETERS

⇒ Aesthetic Sensitivity
⇒ Free creativity of the Artist
⇒ Scientific knowledge
⇒ Intellectual discipline of the technician for a socially useful purpose.
⇒ Welfare of mankind by economical design is the aim of Engineering.
⇒ Social Engineering deals with quality of life for all.
⇒ Design for safety and livability for physical and psychological acceptance as per expected controllable comfort standards for performance.

DRAWING

TOOL FOR CONSTRUCTION

⇒ It is a Graphical Language of the planner and designer for construction through drawings.
⇒ Drawing is a convenient tool to develop the power of imagination, attention and accuracy—basis for creativity. Dimensions, notes, levels, colour, detailing and skill of reading a drawing is essential for safe, speedy and economical construction.
⇒ Orthographic and pictorial views help for estimating, supervision and visual communication.
⇒ Colours are essential for easy, quick visual communication.

CONSTRUCTION

ENGINEERING IN ACTION

⇒ It is the conversion of two dimensional drawings into three dimensional structures.
⇒ Construction is for:
⇒ Enclosing of the spaces.
⇒ Spanning of the spaces.
⇒ Enriching of the spaces.
⇒ Creation of a desired designed form of the building by use of money, men, material and machinery through construction management.

MAINTENANCE

SAFETY AND LIVABILITY

To keep the building safe with livability throughout the life of the building for:
1. Satisfaction
2. Happiness
3. Return on Investment

Through periodical maintenance of building fabric, plumbing and building services and landscaped surroundings.

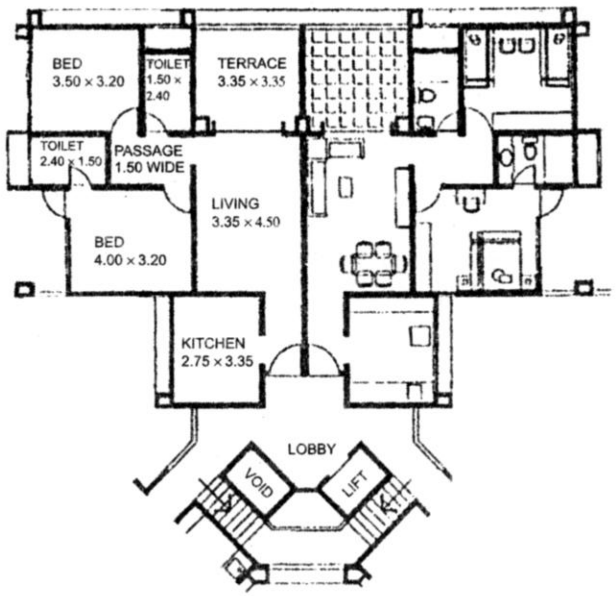
Use of computer for all activities—Planning, Designing, Drawing, Construction and Maintenance
Computer Aided Architectural Design (CAAD), Compute Aided Design (CAD), Computer Aided Design and Draughting (CADD), Computer for Accounts, Administration and Records

5. Hold on interviews with owners, architects and users with reference to environment friendly designs. Comment on maintenance procedures.
6. Study works of different architects in India and abroad with reference to case studies published in magazines, interviews, etc.
7. Collect brouchers for different materials for architectural construction and collect advertisements in newspapers and magazines.
8. Write essays on (i) Users friendly architecture, (ii) Energy conscious architecture, (iii) Solar energy, (iv) Designs for Earthquake zones, and (v) Housing schemes for slums.
9. Study the role of a civil engineer as structural designer, project consultant, resident engineer, valuer, arbitrator, quantity surveyor, building services consultant, fire safety consultant and social worker.
10. Compare different theatres in your town and give your opinion about their planning, parking facilities, acoustical design and give your ideas on essential amenities, specifications, etc.
11. Study different shopping complexes in your city and state your opinion for the total planning, specifications, problems of shop owners and the common man.
12. Prepare a maintenance programme for theatres and shopping and commercial complexes. Collect information related to the construction and different agencies—architect, structural designer, contractor and other agencies, who have supplied equipment and machinery.
13. Read architectural magazines, journals related to interior designs, construction, valuation, design, built environment and landscaping.
14. Study publications of National Building Organisation, New Delhi.
15. Study IS code for architectural drawing.
16. Collect working drawings for different types of buildings, plans, elevations, sections, details and structural drawings.
17. Study Human Sciences and design considerations for efficiency.
18. Write an essay on “Architecture is a performing art” with examples from different architectural constructions.
19. Collect information on use of computer aided drawings, softwares for estimation, rate analysis and project management.
20. “Optical lighting system-A design alternative for lighting”. Collect information on the design procedure and economy.
21. Study bio-climatic architecture with reference to thermal performance, computer simulation, design criteria and methodology.
22. Study building automation systems for regulating air conditioning, heating, lighting, and other energy consuming functions and designs of intelligent buildings.
23. Study designs of biogas plants—family biogas plants, community and institutional biogas plants.
24. Study designs of wind mills for water pumping, wind power projects and connection of wind power projects with state electricity grids for distribution of power.
25. Collect information on Bio mass power for fast growing species of trees and plants to meet the requirements of fuel, fodder, and power generation.
26. Study fit and forget type fixtures, fastenings and specifications for normal maintenance for flooring, painting and powder coated items (aluminium windows, etc).
27. Collect documents like sale deeds for lands, and sale of ownership flats. Study the procedure for converting agricultural land to non-agricultural purposes and rules and procedurs of construction of farm houses.

5.8.1 Architectural Construction

1. Collect advertisements, brochures for different types of construction materials, construction machinery and study specifications, rates, names of suppliers, etc.
2. Collect current labour and material rates regarding different items.
3. Study the manufacturing process of bricks, cement, AC sheets, hume pipes, mosaic tiles, ferrocrete work, steel fabrication procedure for steel windows, trusses, railings and marble/granite polishing work.
4. Pay visits to stone quarries to see crushing of stone by stone crusher, dressing of stones and manufacturing of commercial door shutters.
5. Visit construction sites to study line out for foundation, site office, stores, testing of materials, safety precautions and site layout plans.
6. Study standard specifications for different items, government and private works.
7. Study standard tests for different materials, different agencies for tests, rates for testing and requirements of samples.
8. Visit construction sites to study construction work in different stages, study of working drawings, work and time study, check list for supervision work, procedure for submission, scrutiny and payment of bills.
9. Study RCC work, structural drawings, placement of reinforcement, concreting, removal of centering work, curing, cement, sand and metal requirements for concrete work.
10. Collect information about cement manufacturing companies, rates of cement bags and types of cements, as also rates of steel for reinforcement.
11. Study plumbing works with reference to fixing of wash hand basin, washers for taps, Indian and European pans, tub baths, gully traps, inspection chambers, man holes, various plumbing fixtures and pipes, testing of pipes and specifications for hot water pipes.
12. Study use of ferrocrete for different items.
13. Study the construction quality assessment scheme (CONQUAS) in Singapore. Also, study the detailed procedure for assessment.
14. Study working drawings showing:
    (a) Air conditioning work—layout of duct, machinery, specifications.
    (b) Details of acoustical treatment.
    (c) Details of fire safety equipment.
    (d) Details of constructional requirements for lift, waterproofing of basement, bath W C, and terrace.
    (e) Solar water heating system and hot water pipe and their requirements.
    (f) Plumbing and drainage system for housing schemes, hospitals, theatres, industrial units, commercial complexes.
    (g) Electrical work, safety precautions, maintenance procedure, water pumps, etc.
16. Study different types of foundations—pile foundation work, raft foundation, column and footing foundation and the procedure for concreting foundation and layout plans.
17. Write an essay on “Building Construction is Engineering in Action”.
18. Prepare check lists for different items such as (a) masonry, (b) brick laying, (c) plaster work, (d) polishing of floor, (e) RCC work, (f) plumbing work, (g) waterproofing, (h) dado work, (i) wood work-polishing, (j) Glazing work, etc.
19. Study integrated planning and design of residential or public buildings.

6 COMPUTER TECHNOLOGY FOR ENGINEERS AND ARCHITECTS



Design Organisation

Design Organisation can become the organisation of a process of collaboration between individual designers. For example, all project co-designers, linked CAD-related integrating systems for a cooperative design process and agreed solution-design for production and design for operation, through continuous consultancy.

Author: Tim Cornick
Book: *Computer Integrated Building Design*
(E&FN SPON, London)

Creativity

"Lateral thinking" is contrary to the logical, sequential pattern of thinking. It is, put simply, a different way of looking at things."

Author: Gordon/Nelson
Book: *The Architecture of Building Services*

Topics covered in this chapter

6.1 The Computer

6.2 Computer Software—Feedback from Software Professionals, about Software for Drawings, Designs, Estimates and Projects Management

6.1 THE COMPUTER

A computer is an automatic stored programme, reprogrammable, electronic, digital data processor."

Author: Brian Gooch
Book: *The Computer Guide for Architects*

The industrial revolution of the eighteenth century brought about major changes through mechanisation of the industrial process, causing reduction in manual labour. The computer revolution of the twentieth century has drastically changed the process of planning, designing and related administration. Computers are now being extensively used by architects and engineers, which has made creation of integrated building designs a much easier task.

Computer technology is said to be the fastest developing technology and the most complex system man has so far invented.

It would be interesting to know the various stages in computer technology.

6.1.1 History of Computers

1833 : First mechanical computer was invented by Charles Babbage in Totnes, Devon.

1940 : An electronic computing machine was invented by a British Logician, Alan Turing.

1946 : The first electronic computer "ENIAC" consisting of 18,000 vacuum tubes was built in USA.

1950 : Computers were used initially for scientific calculations and for business applications such as pay roll and production.

1963 : Ivan Sutherland at the Massachusetts Institute of Technology announced the famous SKETCH PAD SYSTEM.

1966 : William Newman at Imperial college in London developed similar system specifically for architectural applications.

1968 : Architects started working on computer screens rather than on drawing boards for the entire design process, heat loss and gain calculations, site usage and capital cost and production documentation.

1970 : There was a boom in attempts to use computer by architects, structural engineers, consultants and contractors to reduce the dependence on manual effort for laborious calculations, testing of alternative solutions and to schedule the optimum use of men and machinery on site and to organise the ordering of materials as per the scheduled time.

Numerous conferences were held on computer aided architectural design and many books on development of new computers, economical in size and cost, were published.

1977 : The first microcomputer and the IBM Personal Computer (PC) was developed. There was a drop in prices due to large scale production and usage.

1985 : A more powerful microprocessor was developed to drive the PC which helped in preparing small drawings at an acceptable speed. Early systems were expensive because of the cost of hardware and software. There have been numerous developments in computer softwares which are used as tools in designing and drawing. (CAD, CAAD and CADD)

CAD—Computer Aided Design

CAAD—Computer Aided Architectural Design

CADD—Computer Aided Design and Draughting

It has helped to extend the designers, range of expertise for computer integrated building design, estimation, project work including accounts and administration and 3-D animation of projects for marketing purposes.

Now, it is a challenge to learn how to use computers and how to get the best from them by selecting the right type of software and gaining expertise in planning, designing and construction and other related areas.

Today, high level of investment in large buildings requires speedy construction. Buildings are not getting bigger but are becoming more complex with large number of plumbing services and building services for better lighting, fire safety, air conditioning and thermal comfort. It is also essential to keep design and construction team as small as possible for effective coordination and increasing productivity. This reduces overhead charges and provides better control and communication.

Computer education needs to be introduced right from the first year of architecture and engineering. The education and training systems need to be modified.

Brian Gooch in *The Computer Guide for Architects* has said that education is the act of making people aware of the facts, of extending knowledge and vision, and *training* is the process by which people are instructed in acquiring the necessary skills which they have to practise in order to become proficient in carrying out the requisite tasks.

It is now time to get acquainted with computers. Information regarding softwares developed by different companies and used by various professionals for planning, designing and construction is given as guidance from professionals to the technical education system and details regarding the use of CAD, CAAD and CADD is given with reference to different areas. This will bring students closer to the world of computers. The following points will reveal how computer technology is used by architects and engineers for various processes in designing and construction:

1. Product documents, working drawing details, estimates, tender documents, rate analysis, resource control, check lists for quality control, schedules, CPM charts, etc., can now be prepared in less time.
2. It is possible and convenient to carry out long sequences of well-defined operations involving complex calculations at high speed and in a short time with great accuracy.
3. It is easier to test different building layouts, plans, elevations, etc., at an early stage in the design process, with reference to building laws, FAR, open space requirements, etc.
4. Services of specialist consultants for air conditioning, lifts, design for fenestration, day-lighting and artificial lighting, kitchen design, acoustical design, etc., can now be used right from the beginning to finalise space and constructional requirements with the latest available products in the market.
5. Previous information, design data and drawings are now readily available as a feedback for new designs.
6. Computer drawings, design work, etc., require precise instructions and complete accurate data. Hence, it is essential to mould and update all members of the office, design and construction team. This is a continuous process.
7. There have been improvements in draughting techniques and speed. A visit to an architect's office is essential to know about the total procedure and sequence of operations.

   The final finished appearance of a computer drawing is always clean, as per required size AO to A4, because of quick changes in scale. Standard elements in buildings such as different types of doors, windows, furniture pieces, staircases, toilet details, kitchen details, etc., can be drawn once and then placed on the drawings as per the requirement. It is also possible to change a left hand swing door into a right hand swing, different components can be mirrored in the plan as per the requirement, a line or whole area can be erased in seconds.
8. It is a well-known fact that energy will be more expensive in the future. Environmental preference designs need compact buildings with suitable orientation, less glazing, effec-

tive lighting system and fire safety as per expected environmental performance. Today, many packages are available for achieving different comfort standards in summer and winter. This makes it possible to spend more time for the design of four safeties—structural, health, fire and constructional, and finally, livability.

9. Today the control and reliability of the electronic system helps to integrate environmental control in a single system. This is done with the help of external sensors which detect temperature, wind speed, daylight and artificial light requirements, i.e., lighting levels, humidity and smoke levels. The computer is aware of the total environmental requirements during every hour of the day, and every day of the week as per thermal lag of the structure. A sophisticated controlling system in such intelligent buildings controls lifts, security system, fire detection and controls even automatic flushing of urinals. Total control is achieved through a centralised system with a single master computer or distributed system with certain areas of the building having a local intelligence and autonomous system where the areas are provided with full computing capability. An autonomous system is found suitable for a large factory and big campus area. It is essential to study the basic cost of such construction.
10. The administration in architect's/construction company is made much easier with the use of computers. Time related to office administration, co-ordination work, accounting work, storage of information and documentation is reduced. Quality management, taking quick decisions and planning and scheduling is possible for the engineering department which is known as the backbone of a building organisation.
11. Today, efficient, easy-to-use softwares with latest technology are available along with manuals for planning, structural designing, landscaping work, roadwork, etc. Computer graphics and animation for presentation, and marketing requirements have changed presentation systems. Virtual simulators to provide rendering work, light effects and different types of motions are useful while finalising designs.
12. Two-dimensional building drawings are usually sufficient as working drawings but the client is not totally satisfied with 2-D drawings, hence colourful brochures of promoters and builders, which show floor plans, elevations and perspective views are used. Today 3-D animation helps architectural visualisation and walkthrough techniques to show exterior and interior views of commercial complexes, bungalows, and housing complexes. One will know how his flat/bungalow will look. You can suggest and see changes in wall paints, placement of furniture, choice of elevation, etc. No line drawing, ammonia print or model can make up for such 3-D visualisation, hence, it is gaining popularity. It is a tool used for marketing purpose so that a future client gets an opportunity to see the interior, exterior, etc., before the commencement of the work. Hence, it is considered as a value added service to the client. Details about surroundings of the site, hotels, markets, gardens etc., are also shown along with proposed building/s. Creation of videos close to reality are possible. It also helps designers to give finishing touches with required changes in the design.

    In order to show a walkthrough view of the interior or exterior, it is essential to generate hundreds or even more than that, different views in a pre-determined sequence, and then record them with the help of a video recorder. Each view is slightly different than the previous view. Then they are shown in sequence at the rate of 25 frames per second, which results in the impression of movement.
13. 2-D modelling has flat two-dimensional plans. 2.5-D modelling is done by adding a floor height to the plan. It shows three dimensions but it is not considered as 3-D modelling. 3-D modelling is done in three-dimensions, interior and exterior views.
14. Computer systems are used for land surveying and to collect data to create models of the terrain. Different systems for the same are:
    (a) Theodolite survey results are recorded in the field book. As usual, they are then transferred or fed, by input via. the keyboard, to the computer in the office.
    (b) Electronic theodolite station and an electronic data logger is used for traversing work, then the data are transferred to the computer back at the office.
    (c) The data is stored directly onto the field computer. It is possible to process and check data before leaving the site.

Information available from aerial photographs or other survey maps and digitised video records is also used alongwith survey details for creating a model of the site. Graphical and numerical data are referred to as *databases.* A digital map is a picture made up of a mesh of fine dots, finer mesh and smaller dots giving better quality of the map. This is referred to as *cartography.*

6.1.2 Design in Buildings-A New Approach in the Computer Era

Architectural design is related to the aesthetic, social and spatial criteria for buildings. Engineering design is related to the structural and environmental performance.

Structural designers are also concerned with aesthetic appearance as the structure also becomes an essential architectural feature of the proposed building.

Today, we have to look towards a design from different angles, i.e., 'Designing for production' and 'Designing for operation'. Production design for construction and operation necessitates that all the participants involved in a building are designers. Designing for operation includes all considerations related to the use, purpose, processes and facilities essential in the building. Hence, one will agree that the design of a building for all purposes is a knowledge sharing process, and information exchange process of all co-designers for the collective conceptualisation of an agreed building solution to fulfil the client's and site requirements. It is the skill of the co-ordinator, i.e., the architect to utilise and exchange each designers information and knowledge with reference to his knowledge regarding building design legislation, good practice design guidance and information about latest building materials/products which need constant updating. Depending upon the purpose of the project, the architect or engineer will have to work as the co-ordinator.

(a) Client—Building operation designer—Function/processes, performance standards.
(b) Architects and engineers—Form, structure and environment
(c) Specialist trade—Building Production Designers
(d) Contractors, Construction Managers—Technical production requirements for the building, assembling all structural elements, building elements, site requirements, cost and time programmes.

Computer Application

The generation, alteration and presentation of graphical data by all designers is now more convenient and possible at a far greater speed than by previous manual methods. It is easier to meet the client's requirements. All designers should think in parallel through CAD-related computer-based applications so that an integrated design will serve the intended purpose.

The architect working on his or her CAD station and electronically linked to other co-designer client engineers, interior designers, construction managers, etc., generates alternative building forms and material concepts, schedules so as to know the cost, time and performance standards, and the architect's design becomes known and understood by every one. The final result is a commonly agreed solution to the client's building problem. Continuous consultancy is possible through use of computer based technology.

References:

1. *Computing for Architects,* R A Reynolds, Butterworth Publication
2. *The Computer Guide for Architects,* Brian Gooch, The Computer Guides Ltd.
3. *Computer Integrated Building Design,* Tim Cornick, E and FN Spon
4. Brochures related to various softwares.

6.2 COMPUTER SOFTWARES—FEEDBACK AND GUIDANCE FROM SOFTWARE PROFESSIONALS

Information regarding the latest developments in the softwares given in this chapter will create interest about the world of software professionals. Constant developments, updating of the softwares as per new requirements related to Built Environment is a great assset to planners and executors. Today, users of software are also benifitted by the constant guidance of technical support engineers of software companies. Contact with all such professionals is easily possible through website details.

It is also observed that advertisements for various jobs of civil engineers and architects include conditions regarding necessity of knowledge/skill for using specific softwares related to design/drawings/estimating, etc. It is essential to collect such information from various advertisements from time to time so as to arrange lectures of software professionals to reduce the gap between education and the world of software professionals.

With this constant updating completion of projects with the expected quality, economy and schedule should be the aim of all professionals.

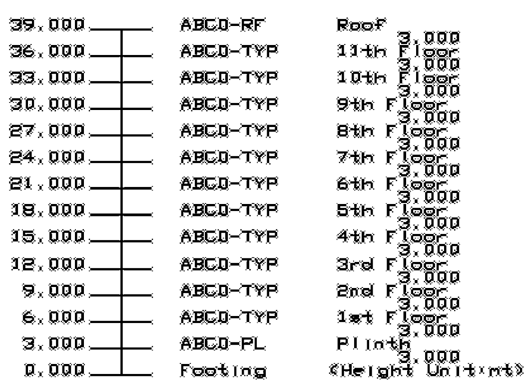
ENSOFT SYSTEMS PVT. LTD.
Website: *www.ensoft.co.in.*

A COMPLETE PACKAGE FOR BUILDING ANALYSIS, DESIGN & DRAWINGS

SALIENT FEATURES

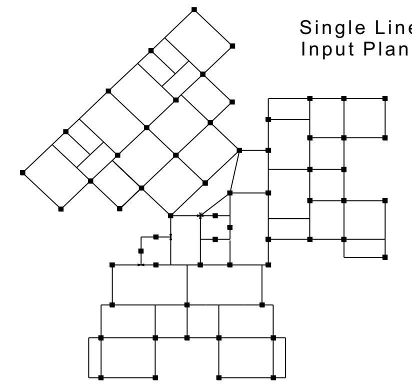
Defining Building Project

A Building Project in **Build-Master** is defined by drawing **single line floor plans** graphically at different levels. With **Build-Master** the space frame data need not be entered with 3D nodal co-ordinates and member connectivity. **Space Frame Model** of building gets generated from these plans automatically.



Automatic Numbering of Beams and Slabs

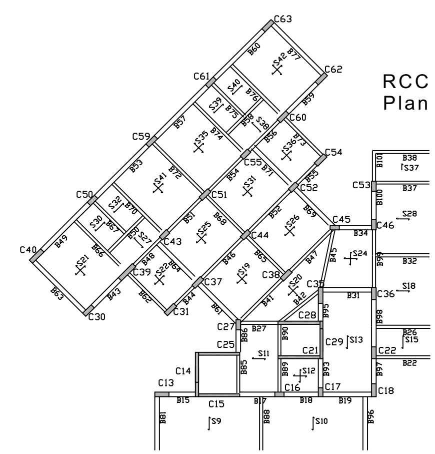
The main feature of Build-Master is that it detects the Beams and Slabs from line sketch drawn for each plan. Line sketch will include only beam lines and columns. Slabs also are detected from the closed boundaries. Inbuilt graphical editor is not only equipped with powerful commands to draw any complicated shape, but it can also read plans drawn with a CAD package.



Concept of Beams and Members

Build-Master has a unique concept of distinguishing beams and members. A beam can have multiple nodes when it is divided by cross beams. Each part is called as a member with two nodes. Analysis is done in terms of members. While designing a beam critical forces of all the members of that beam are brought together and it is designed as a single entity. Design, drawing and estimation is in terms of beams.

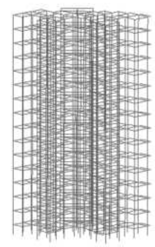
Support top steel of beams is designed for lesser of the adjacent beam depths. T or L flange action is also considered when designing a beam at mid-span.



Distribution of Slab Loads and Wall Loads

Build-Master has a facility of defining the spanning of each slab panel as **one-way, two-way** or **cantilever**. Slab loading is exactly transferred on the adjacent beams as **triangular** or **trapezoidal loads**. Slabs can be of any irregular shapes. **Cutouts and ducts** can be defined by defining the openings. Slabs can be marked as **Sunk** to make them discontinuous from adjacent ones. Wall Loads are worked out after deducting beam depths from the floor heights.

Space Frame Analysis



3D Space Frame Model of building is generated from floor plans automatically. Generation starts from the top most level. Horizontal members in space frame are added for Beams and Vertical members are added at the column positions in plan. This procedure is repeated for all levels and the 3D model is ready. Shear walls and be C Shape Lift Walls can also incorporated in model.

Earthquake and Wind Loads

Build-Master calculates earthquake and wind loads using the floor plan data. **Base shear** is first calculated using DL and LL reactions of columns at each level and the earthquake zone for that region. It then distributes it along the height. **C G of each floor** is worked out and the horizontal loads are applied at C G. Wind loads are calculated from the widths of the plans at each level. **Rigidity and eccentricity** of floor slabs is considered. Program generates 19 load cases & 205 combinations. Loading, BMD, SFD and deflection diagrams can be plotted for any desired combination.

Floor-wise RCC Design

Space frame analysis results are read and **automatic design** of all RCC components like beams and slabs is done floor wise. Design output is stored in a **database**. Any component can then be redesigned individually with **interactive design** procedure.

Beams are designed as singly reinforced or doubly reinforced sections. Availability of flange effect is detected from the plan data. Bottom bars can be bent-up or curtailed type. Bar Combinations are selected from the user-defined file for required area of steel. Depth of adjacent beams is considered while designing support top steel.

SCHEDULE OF BEAMS

BEAM NOS.	O/ALL SIZE		BOT. REINF.	TOP REINF.			STIRRUP SPACING		REMARKS
	WIDTH	DEPTH	STR. + CURT.	ANCHOR	L. SUPP.	R. SUPP.	NEAR SUPPORT	REST OF BEAM	
B 1,4	230	750	2 Φ 12 + 1 Φ 10 Curt	2 Φ 16 + 1 Φ 12	2 Φ 16 +1 12	2 Φ 16 +1 12	Φ 8 @ 100 c/c	Φ 8 @ 130 c/c	
B 2,3	230	550	2 Φ 12 + 1 Φ 10 Curt	2 Φ 8	2 Φ 10	3 Φ 12 + 3 Φ 12	Ø6 @ 130 c/c	Ø6 @ 150 c/c	
B 5,10	150	450	2 Φ 10	2 Φ 12 + 1 Φ 16	2 Φ 12 +1 16	2 Φ 12 +1 16	Φ 8 @ 150 c/c	Φ 8 @ 260 c/c	
B 6,9	150	450	2 Φ 12 + 2 Φ 12 Curt	2 Φ 8	2 Φ 12 + 1 Φ 16	3 Φ 12 + 2 Φ 12	Φ 8 @ 150 c/c	Ø6 @ 230 c/c	

Slabs are designed as per their spanning. Continuity of slabs is detected from plan data itself. Design outputs are stored in calculation sheet as well as schedule form.

SCHEDULE OF SLABS

SLAB NOS.	THICK.	MAIN SPAN STEEL	OTHER SPAN STEEL	REMARKS
S 1,4	100	Φ 8 @ 150 c/c Alt. Bent	Ø 6 @ 150 c/c Distr.	Cantilever (Steel@ Top)
S 2,3,12,16,17,19,22,24,25 26,33,34,35,36,41	100	Φ 8 @ 200 c/c Alt. Bent	Φ 8 @ 200 c/c Alt. Bent	Two Way Slab
S 5,8	100	Φ 8 @ 200 c/c Alt. Bent	Ø 6 @ 180 c/c Distr.	
S 6,7,23,29	100	Φ 8 @ 200 c/c Alt. Bent	Φ 8 @ 200 c/c Alt. Bent	Sunk Slab
S 9,10	115	Φ 8 @ 160 c/c Alt. Bent	Ø 6 @ 160 c/c Distr.	

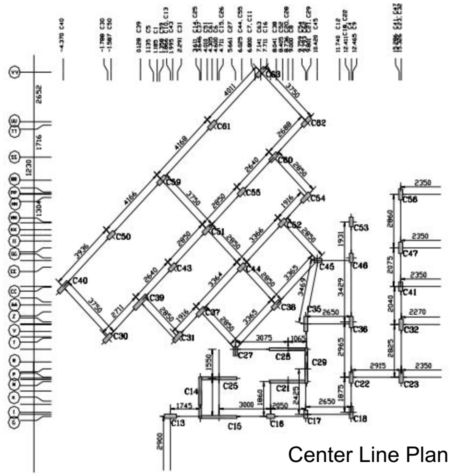
Each column is designed from top to bottom as one entity. Slenderness and minimum eccentricity is checked automatically. Footings can be of sloping pyramidal shape or constant depth. They are designed for all possible worst loading combinations. Loss of contact for biaxial moments and unequal pressure distribution is considered for optimum size of footings.

RCC Working Drawings

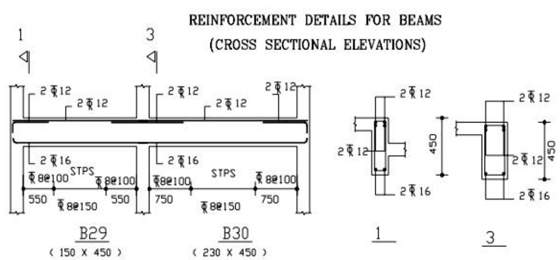
Build-Master creates detail RCC plan **Drawings** with column centerlines in **DXF** formats. External beam lines are drawn continuous and internal dotted. Lines around sunken slabs are continuous. Columns are drawn as per their sizes and flush position data.

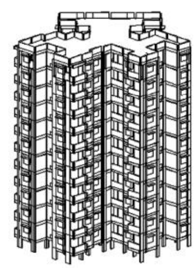
Design schedules can be edited and stored in drawing form in DXF files. Multiple DXF drawings can be read in a **CAD** package and assembled. Title blocks can be added and working drawings are ready for printing.

Beam longitudinal reinforcement details are also generated in drawing form. Foundation plans are useful for checking the overlapping of any footing. Combined footings can also be designed.



Center Line Plan





Three-dimensional schematic elevation of the building with walls, *chajja* projections, windows, etc., is generated without user giving any drafting command. It can be read in AutoCAD or **3D-Studio** for walk through effects and is also useful for data checking of wall heights, beam and column sizes in 3D.

Quantity Estimation

Build-Master works out the Quantities of concrete, brickwork, plaster, flooring, skirting, built-up and carpet areas, etc., using the same single line input data and design schedules. Reinforcement steel quantity is calculated with diameter wise breakups. Quantities are printed in L-B-D format, which are as good as measurement sheets.

Since the cost estimation is also available for user provided item rates, an optimum design for the entire building can be obtained easily.

ABSTRACT OF QUANTITIES AND COST OF FLOOR

Item	Type	Description	Quantity	Rate	Amount (₹)
CONCRETE BEAM & SLAB			mt^3	₹ / mt^3	
	C 1	Reinforced Concrete	53.35	2500.00	133380.00
REINFORCEMENT			kg	₹ / Kg	
	R 1	Mild Steel	297.00	17.00	5049.00
	R 2	Tor Steel	3936.50	18.00	70857.00
FORMWORK & SHUTTERING			mt^2	₹ / mt^2	
	S 1	Formwork For RCC Work	616.05	70.00	43123.82
WALLS			mt^3	₹ / mt^3	
	L 1	Brick Wall	43.068	400.00	17227.27
	L 2	Brick Wall	35.397	400.00	14158.81
	L 3	RCC Wall	2.743	800.00	2194.16
DOORS			Nos.	₹ / mt^2	
	D 1	TEAK WOOD	4	1200.00	10080.00
	D 2	FLUSH DOOR	23	12.000	52164.00
	D 3	FLUSH DOOR	8	800.00	10080.00
WINDOWS			Nos.	₹ / mt^2	
	W 1	DOUBLE SHUTTERED	10	1000.00	16200.00
	W 2	GLAZED	6	1200.00	10368.00
	W 3	LOUVERED	8	800.00	2304.00
PLASTERS			mt^2	₹ / mt^2	
	P 1	Int. Plaster On Int. Walls	555.78	80.00	44462.04
	P 2	Int. Plaster On Ext. Walls	247.70	75.00	18577.87
	P 3	Ext. Plaster On Ext. Walls	219.98	75.00	16498.87
	P 4	Int. Plaster On RCC	492.59	80.00	39407.54
	P 5	Ext. Plaster On RCC	282.61	80.00	22608.73
FLOORING/ SKIRTING / DADO			mt^2	₹ / mt^2	
	F 1	Mossaic Flooring	62.45	300.00	18735.00
	F 2	Kottah Flooring	20.37	350.00	7131.16
	F 3	Marble Flooring	78.69	500.00	39345.80
	F4	Spartex Flooring	28.71	375.00	10767.88
DOORS RCC LINTEL & *CHAJJA*			mt^3	₹ / mt^3	
	L 1	TEAK WOOD	0.146	2500.00	365.63
	L 2	FLUSH DOOR	0.673	2500.00	1681.88
	L 3	FLUSH DOOR	0.293	2500.00	731.25
WINDOWS RCC LINTEL & *CHAJJA*			mt^3	₹ / mt^3	
	H 1	DOUBLE SHUTTERED	1.699	2500.00	4248.25
	H 2	GLAZED	1.020	2500.00	2548.95
			Grand Total	Floor Cost ₹	616677.97

ENSOFT
BUILD QUANT

BUILDING QUANTITY ESTIMATION FROM CAD DRAWINGS

ENSOFT has recently released their new software **Build-Quant** for easy and quick estimation of quantities involved in building construction. **Build-Quant** reads an **Architectural Plan Drawing** prepared in **AutoCAD** directly. Providing additional information about doors, windows and flooring types, it worked out the quantities of brickwork, plaster, flooring without entering dimensions in L-B-D format. **Build-Quant** also reads a **RCC Plan Drawing** prepared in **AutoCAD**. Providing additional information of **Design Schedules** for Beams, Slabs, Columns and Footings it will workout quantities of Concrete and Reinforcement Steel (with diameter wise breakup) for each floor.

The main objective of **Build-Quant** Software is to workout the quantities directly from the working drawings. The conventional L-B-D format input is also available for the items whose information cannot be easily read from the drawings. The software is a handy tool for quick estimation of quantities for tender works and also for the detail checking of contractor's bills.

If any of the dimensions taken at site or written in the measurement sheet for working out quantities are by mistake incorrect, it becomes difficult to locate the mistake later. Since this software is reading the working drawings directly, it will prove to be very useful tool for cross checking the bill of quantities at office level.

About Input Drawings

Since **Build-Quant** reads the drawings prepared in AutoCAD, few norms are required to be followed while preparing these drawings. Wall lines in **Architectural Plan** are drawn with basic **LINE** command. Separate layers are used for different types of walls and plasters. Door & Window marking text (D1, D2, etc.) is put close to the wall lines and their sizes are given in a schedule. These actually are not any special norms, but usually followed by most of the Architects. A sample Architectural plan is shown below.

Program first reads the original Wall lines. It converts double lines for the walls to single lines. Each single line is drawn exactly at the centers of walls. It then numbers all these singles lines serially. Length of lines will be the length of walls. It now reads Door / Window Text marking from drawing and detects the wall lines near the Text. Quantities of Walls and plaster areas are thus calculated after deducting the door/ windows sizes.

Similarly, Beams in **RCC Plan** are also drawn as double lines with **LINE** command. Beam marking Text (B1, B2 etc.) is drawn near to these beam lines. Cross lines are drawn between slab corners to mark the extent of slabs. Slab Spanning and Slab marking Text is drawn near to the intersections of these cross lines. Column numbers are also put with **TEXT** command. Only column text is read and not the shape. A typical RCC plan is shown below.

Reinforcement details for beams, slabs, columns and footings are entered in **Schedule** Form, with in-built editor. Schedule drawings if available in soft copy drawing formats, can be read directly by the program. No need of entering the long schedules as well. That's All About INPUT!

Similar to the walls the double lines of beams are converted to single lines and each line is given a serial number. Beam numbers written on the drawing are read. Length of single line is the length of beam. Beam size and number of bars are read from schedule. Thus, beam concrete and steel quantities are worked out.

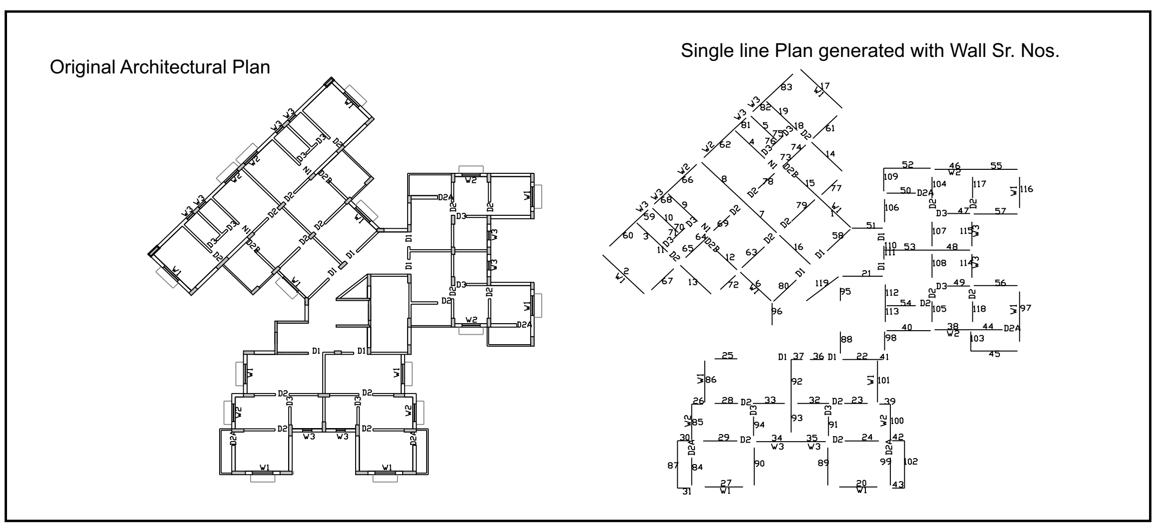


Figure 6.1 *Single Line Plan with Wall, Doors and Windows*

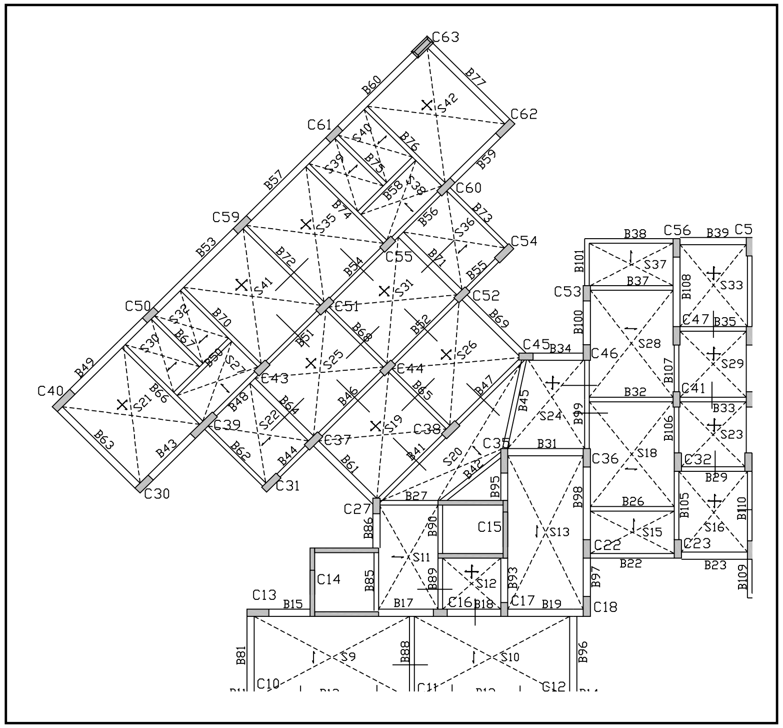


Figure 6.2 *Original RCC Plan*

Slab area is calculated using the end points of cross lines. Design schedule gives information about thickness and reinforcement details. The concrete and steel of slabs is also worked out.

Finally, program gives the diameter wise break-up of steel quantity. In the final Summary it not only gives the floor wise quantities, but also works out the cumulative quantities for the entire project.

PROJECT SUMMARY : Architectural Quantities

TYPE-WISE WALL QUANTITIES (FROM LEVEL 1 TO LEVEL 4)

SR. NO.	WALL TYPE	DOUBLE LINE LAYER NAME	WALL AREA MT^2	RATE ₹	AMOUNT ₹	DESCRIPTION
1	L1	W-200	606.02	1000.00	606024.83	WALL 230MM THK
2	L2	W-100	533.76	1250.00	667197.67	WALL 150MM THK
3	L3	R-100	176.00	2250.00	396010.93	RCCWALL 100MMTHK
		TOTAL	1315.79		1669233.43	

FLOOR-WISE WALL QUANTITIES

LEVEL	FLOOR CODE	L1	L2	L3	TOTAL AREA
1	PL	194.57	181.37	21.57	397.51
2	TYP	193.84	176.19	21.57	391.60
3	TYP	193.84	176.19	21.57	391.60
4	RF	23.78	0.00	111.30	135.08
		606.02	533.76	176.00	1315.79 MT^2

FLOOR-WISE PLASTER QUANTITIES

LEVEL	FLOOR CODE	P1	P2	P3	P4	TOTAL AREA
1	PL	858.58	353.34	56.22	0.00	1268.14
2	TYP	858.11	354.03	56.22	267.98	1536.34
3	TYP	858.11	354.03	56.22	267.98	1536.34
4	RF	79.01	0.00	283.86	267.98	630.85
		2653.81	1061.39	452.54	803.93	4971.67 MT^2

FLOOR-WISE FLOORING QUANTITIES

LEVEL	FLOOR CODE	F1	F2	F3	F4	F6	TOTAL AREA
1	PL	267.98	0.00	0.00	0.00	0.00	267.98
2	TYP	0.00	142.16	97.88	27.93	0.00	267.97
3	TYP	0.00	142.16	97.88	27.93	0.00	267.97
4	RF	0.00	0.00	0.00	0.00	267.98	267.98
		267.98	284.32	195.76	55.86	267.98	1071.90 MT^2

PROJECT SUMMARY : RCC Quantities

BEAM AND SLAB CONCRETE QUANTITIES

LEVEL NO.	FLOOR CODE	BEAM M20 MT^3	SLAB M20 MT^3	TOTAL M20 MT^3	AMOUNT ₹
1	PL	25.51	0.00	25.51	51021.15
2	TYP	20.20	28.21	48.41	96818.62
3	TYP	20.20	28.21	48.41	96818.62
4	RF	20.20	28.21	48.41	96818.62
		86.11	84.63	170.74	341477.01

TOTAL BEAM AND SLAB STEEL QUANTITIES

LEVEL NO.	FLOOR CODE	6	8	10	12	16	TOTAL WT. KG.	AMT ₹
1	PL	0.00	1173.68	410.56	1199.63	0.00	2783.87	55729.25
2	TYP	411.76	1984.90	222.57	1268.62	309.15	4197.00	75509.10
3	TYP	411.76	1984.90	222.57	1268.62	309.15	4197.00	75509.10
4	RF	411.76	1867.78	222.57	1268.62	309.15	4079.88	73400.84
		1235.28	7011.26	1078.27	5005.49	927.45	15257.75	280148.30

ABSTRACT OF COST

Level No.: 1 Floor : Pl Stilt

WALLS	:	469810.46
PLASTERS	:	109642.19
FLOORINGS	:	107191.10
SKIRTINGS	:	0.00
DOORS	:	116550.00
WINDOWS	:	42840.00
CONCRETES	:	159088.66
STEELS	:	140607.68
FLOOR TOTAL : RS.		1145730.09

Level No.: 3 Floor : Typ 2nd Floor

WALLS	:	462604.60
PLASTERS	:	136471.85
FLOORINGS	:	165093.93
SKIRTINGS	:	38240.32
DOORS	:	116550.00
WINDOWS	:	42840.00
CONCRETES	:	136926.94
STEELS	:	152251.02
FLOOR TOTAL : RS.		1250978.66

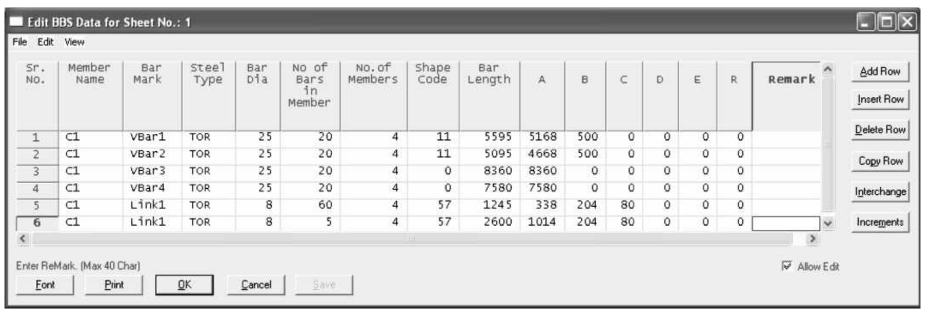
ENSOFT

BAR-BE-QUE

BAR BENDING SCHEDULE AND QUANTITY ESTIMATION OF REBAR STEEL

Preparation of Reinforcement **Bar Bending Schedules** for RCC work at construction sites is the most tedious and time-consuming task. The shape of each and every bar is to be derived exactly for cutting. With increasing cost of steel, it has become necessary to minimise the wastage.

ENSOFT has released **BarBeQue** software**,** for preparation of Bar Bending Schedules and Quantity Estimation of Reinforcement bars. **BarBeQue** has a standalone option for Manual data entry of each bar. The dimensions of each bar are entered in a tabular form. Program generates the **Bar Bending Schedule (BBS) Drawing** with **to-the-scale** graphical **sketch** of each bar. Bar Shape Code can be as per latest **IS 2502** or **BS 8666** code. Program eliminates time-consuming work of calculating the length of bars, as per code requirements. Diameters wise break up of Reinforcement Quantities is printed as the summary.


Edit BBS Data for Sheet No.: 1

File Edit View

Sr. No.	Member Name	Bar Mark	Steel Type	Bar Dia	No of Bars in Member	No. of Members	Shape Code	Bar Length	A	B	C	D	E	R	Remark
1	C1	VBar1	TOR	25	20	4	11	5595	5168	500	0	0	0	0	
2	C1	VBar2	TOR	25	20	4	11	5095	4668	500	0	0	0	0	
3	C1	VBar3	TOR	25	20	4	0	8360	8360	0	0	0	0	0	
4	C1	VBar4	TOR	25	20	4	0	7580	7580	0	0	0	0	0	
5	C1	Link1	TOR	8	60	4	57	1245	338	204	80	0	0	0	
6	C1	Link1	TOR	8	5	4	57	2600	1014	204	80	0	0	0	

Add Row · Insert Row · Delete Row · Copy Row · Interchange · Increments

Enter ReMark. (Max 40 Char) · Allow Edit

Font · Print · OK · Cancel · Save

Figure 6.3 *Dimensions of Reinforcement Bars*

Almost all possible of bar shapes are available in the library, with their formulae for calculating the bar lengths. Dimensions of the bars are entered in user-friendly dialog boxes.

Program stores the data in a **MS-ACCESS** and **MS-EXCEL** compatible file formats. Bar Bending Schedule Drawings are compatible with **CAD** packages.

Main feature of **BarBeQue** is that it is not Excel or any spread-sheet based. It is complete stand alone software which generates the to-the-scale sketches of each and every bar. Deduction in Bar Length can be done with different ways, as per IS or BS code or standard site practices.

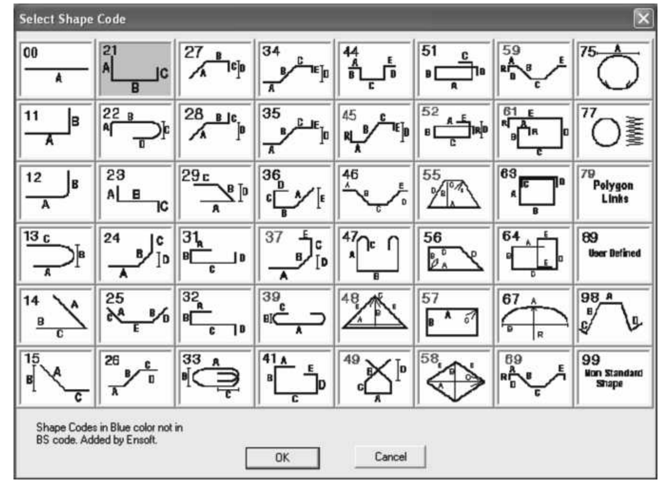


Figure 6.4 *Bar Shape Code in RCC Work*

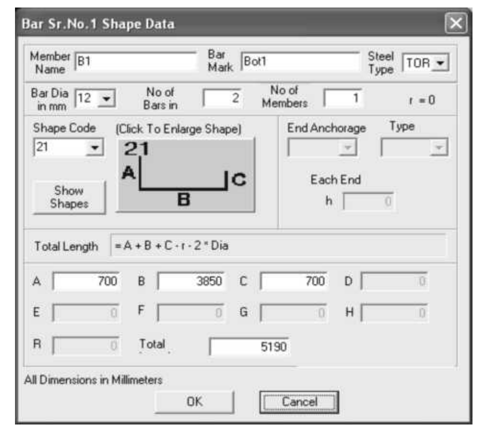


Figure 6.5 *Reinforcement Bars Shape Data*

BarBeQue program can read AutoCAD compatible **RCC Detail Drawings** showing Reinforcement Bar details. Shape of the Bars and the dimensions are read from the drawing without any user data entry. The associated text giving the information about each bar is also read. Number of bars, spacing of bars, diameter of bars and Member Name, etc., are read as Text.

Original drawing read is first displayed in one window. Program will automatically give serial number to every bar read and processed bar details are shown in another windows for easier checking of data, as shown below.

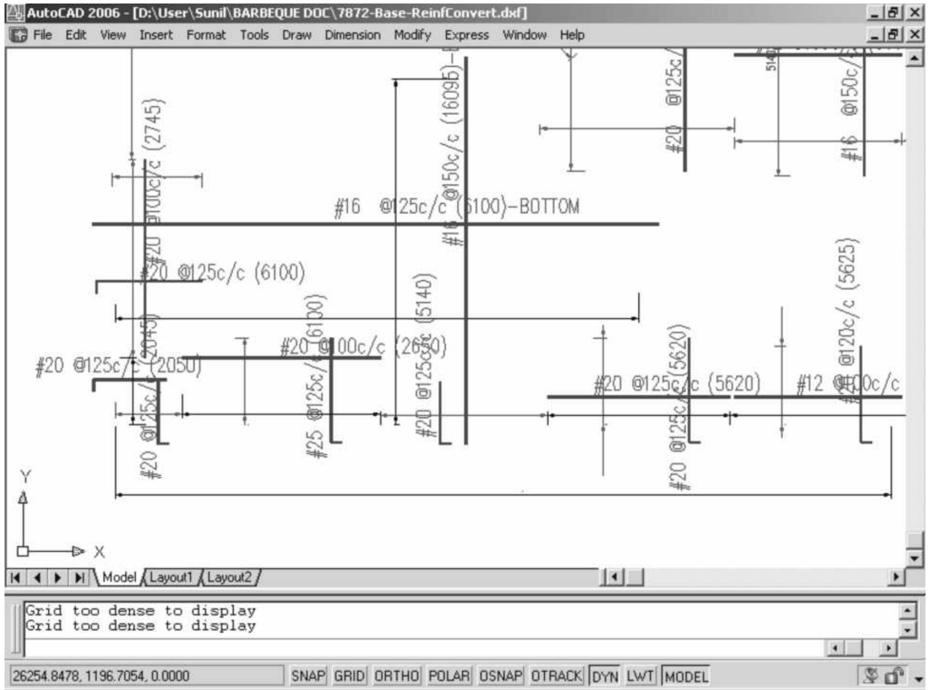


Figure 6.6 *View Show MS Bar Details*

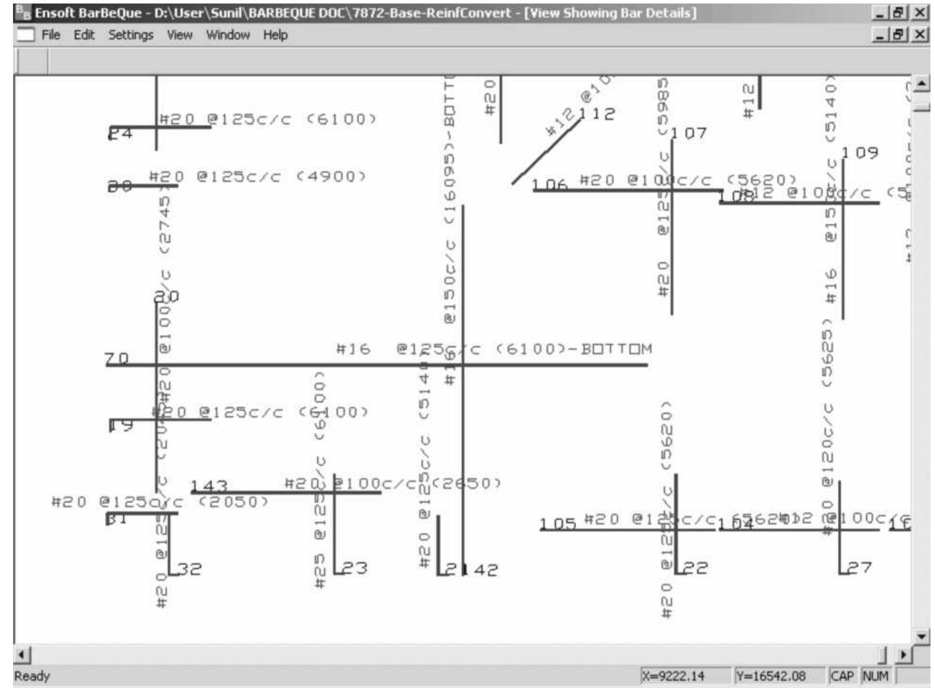


Figure 6.7 *View Showing MS Bar Details*

Bar Bending Schedule data is then generated for each bar serially numbered and displayed in the tabular form as shown earlier. This data can be edited for making any corrections, before printing BBS Drawing.

BarBeQue is compatible with **Formulator,** a Revolutionary General purpose Object based Quantity Estimator software by Ensoft. **Formulator** software comes with a library of various RCC objects like Rectangular Beam, Tapered Beam, Curved Beam, L-shaped column, U-shaped column, etc. **Formulae** for working out the dimensions of all the bars like, main bars, face bars, stirrups and links, etc., are pre-defined for these objects. User can add new objects in the library. Bar dimensions required for **BarBeQue** are generated by **Formulator** with simple data entry of Object dimensions.

BarBeQue also has a module for generating Optimised Cutting Arrangements for purchased lengths of bars, to minimise the wastage of steel.

ROAD MASTER™

ROAD QUANTITIES AND LAND SURVEY

Road-Master software has two modules, one for General Land Survey, Contour, L section plotting and other one for Earthwork quantities of Roads, canals, trenches, etc.

1. Land Surveying Module

Land surveying module, is useful for doing cumbersome earthwork calculations, for any general land profile. The Field book and Survey data, such as Change Points, Staff Readings and Tachometry Readings itself can be entered. The reduced levels are then calculated automatically using this data. Reduced levels can also be entered directly without any staff readings.

Program generates a 3-D View of the ground profile, which can be viewed from any angle for easy data checking. Contour Maps can be plotted for any desired height intervals. L sections and Cross-sections are also plotted. The cutting and filling quantities involved for the proposed ground profile can be easily calculated.

2. Road-Quantity Module

Road-Quantity module is useful for calculating the embankment earthwork quantities involved in road construction. The reduced level data shall be entered along the length of the road, at any desired intervals such as 10 mt, 15 mt, etc. Data shall be entered giving the levels of Original Ground Level (**OGL**), Hard Rock Top Levels (**HRL**), Soft Rock Top Levels (**SRL**), Black Cotton Soil Top Levels (**BCTL**), Formation Levels **(FNL)** and Progress Levels (**PRL**). Program will graphically draw the section at each chainage and work out the quantities of soil filling, soil cutting, rock cutting and black cotton soil cutting. Apart from earthwork quantities, it can also calculate non-earthwork quantities such as bituminous macadam, CRB, GSB, etc.

For various standard shapes of road profiles like, with gutter on sides, with retaining walls, double camber, etc., program can calculate the progress levels from a formation level value at the center of road. Although the name of software is **Road-Master**, its scope is not restricted to roads only. It can be used for any shape of land profiles such as **canals, trenches, bridge approaches, railway track earth fillings, etc**.

Land Surveying Module

The plot to be surveyed is first split into number of meshes. If the plot area is a regular rectangle, only one mesh is required. However, if the plot has irregular boundaries, it has to be split into a number of meshes to ensure that the whole plot area is covered in the mesh system. The spacing of grid lines in each mesh need not be equal.

The Input data is simple, such as Bench Mark (**B M**), Change Points (**C P**), Staff Readings and Tachometry Readings taken during survey. Program then generates Reduced Levels (**R L**) values at each grid intersections.

AUTOMATIC CONTOUR DRAWING

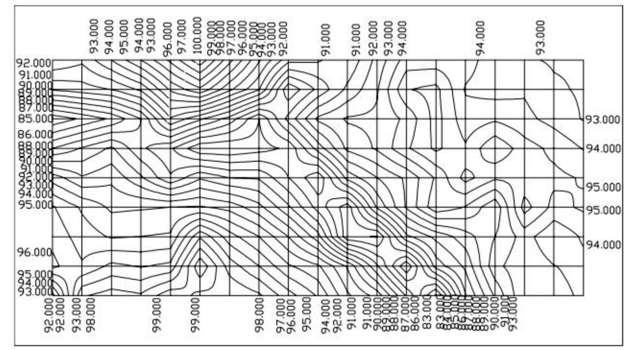


Figure 6.8 *Plan Showing Grid Lines, Reduced Levels and Contours*

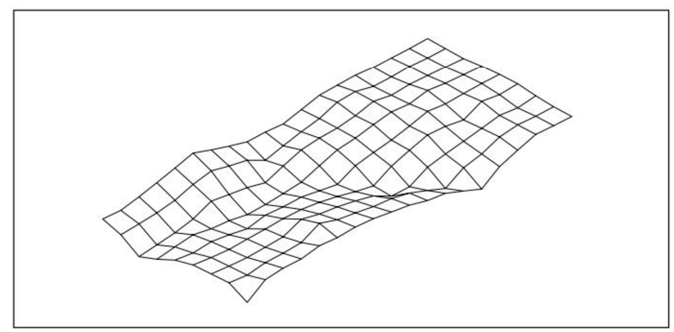


Figure 6.9 *Ground Profile in Three Dimension*

All your tedious work of plotting contours, ends with this software. You can now generate contours for any required height interval and precision with just click of a mouse. Even if the original levels are taken at a courser intervals say 10 mts, program can interpolate these levels at smaller intervals for more accuracy of the contours. Thus, your contour drawing is ready for you in no time.

You can now view the complete ground profile in three-dimension from any angle. This 3-D View helps in better interpretation of the ground area and for easy data checking.

The mistakes in data entry of levels values can be easily located.

QUANTITY CALCULATIONS

```
Datum Height Assumed : 80.000
Volume Of Original Profile : 183735.625
Volume Of Proposed Profile : 187200.000
Total Excavation : 21511.337
Total Filling    : 24975.712
Net Filling      : 3464.375
Sectional Areas
Grid      Original Area   Proposed Area
X:0.0000   A1 :  959.650   A1 : 1040.000
X:10.000   A2 :  945.125   A2 : 1040.000
X:20.000   A3 :  983.300   A3 : 1040.000

Trapezoidal formula :
  V = D/2 { A1 + 2A2 + 2A3 + ... 2AN-1 + AN }
  ORIGINAL PROFILE VOLUME =  183735.625
  PROPOSED PROFILE VOLUME =  187200.000

Prismoidal formula :
  V =D/3{ A1 + 4A2 + 2A3 + 4A4 + 2A5 +..2AN-2+ 4AN-1 + AN }
  ORIGINAL PROFILE VOLUME =  183947.250
  PROPOSED PROFILE VOLUME =  187200.000
```

Figure 6.10 *Quantity Calculations for Earthwork*

Road-Quant Module

The data for the road sections shall be entered along the length of the road at various chainages. Usually the chainage value is used in multiples of 5 mts. or 10 mts. The quantities are calculated between each two chainages, by taking the average of the area of cross sections.

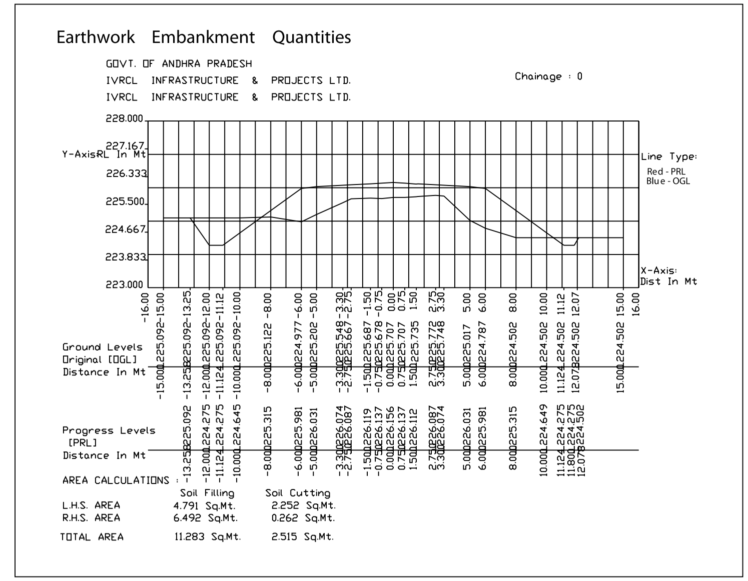


Figure 6.11 *Earthwork Embankment – Profile, Quantities*

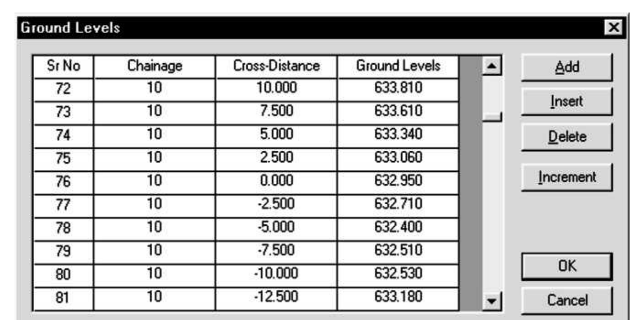
Following levels are entered at each chainage, on both left and right sides :

1. Original Ground Levels (**OGL**) : Top levels of the original ground.
2. Progress Levels (**PRL**): Levels at as per the work progresses.
3. Formation Levels (**FNL**) : The top most level at centre of road.
4. Hard Rock Top Levels (**HRL**): If hard rock is encountered during excavation.
5. Soft Rock Top Levels (**SRL**)): If soft rock is encountered.
6. Foundation Level (**FDN**): In case of black cotton soil, the level of good soil.

Non-earthwork layers like GSB, CRB, Bitumen, etc., can also be defined. Program will calculate the quantities of these layers.

AUTOMATIC EARTHWORK CALCULATIONS

User has to specify only the original and proposed R L values. Program reads these levels and calculates the quantities of hard rock cutting, soft rock cutting, soil cutting, black cotton removal and soil filling quantities between each two sections.


Ground Levels

Sr No	Chainage	Cross-Distance	Ground Levels
72	10	10.000	633.810
73	10	7.500	633.610
74	10	5.000	633.340
75	10	2.500	633.060
76	10	0.000	632.950
77	10	-2.500	632.710
78	10	-5.000	632.400
79	10	-7.500	632.510
80	10	-10.000	632.530
81	10	-12.500	633.180

Figure 6.12 *Data for Earthwork Calculations*

In addition to above, the program has the facility of interpolating R L's from four known corner points and many more interesting features.

Road Quantities Sample Output

QUANTITY STATEMENT

CHAINAGE	SOIL FILLING			SOIL CUTTING			SOFT ROCK CUTTING			HARD ROCK CUTTING			BC REMOVAL		
	SECTION AREA	MEAN AREA	QTY (CUM)	SECTION AREA	MEAN AREA	QTY (CUM)	SECTION AREA	MEAN AREA	QTY (CUM)	SECTION AREA	MEAN AREA	QTY (CUM)	SECTION AREA	MEAN AREA	QTY (CUM)
0	177.781	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	178.545	178.163	1781.632	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	173.858	176.201	1762.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	93.385	133.621	917.376	0.052	0.026	0.261	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	112.201	102.793	1027.934	0.924	0.488	4.880	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	145.914	129.058	1290.576	0.000	0.462	4.618	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	58.856	102.385	894.301	7.558	3.779	37.788	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	17.488	38.172	381.719	10.468	9.013	90.129	9.750	4.875	48.750	4.431	2.216	22.157	0.000	0.000	0.000
80	3.957	10.723	107.226	19.607	15.038	150.376	20.589	15.169	151.694	0.000	2.216	22.157	0.000	0.000	0.000
90	0.553	2.255	22.550	0.000	9.804	98.035	0.000	10.294	102.944	23.974	11.987	119.871	0.000	0.000	0.000
100	32.883	16.718	167.180	0.000	0.000	0.000	0.000	0.000	0.000	5.634	14.804	148.040	0.000	0.000	0.000
TOTAL QTY			**8352.512**			**385.826**			**303.388**			**312.225**			**0.00**

DETAIL AREA CALCULATIONS

CH NO	OFFSET L TO R	PRL	OGL	DEPTH	MEAN DEPTH	WIDTH	SECTION AREA
0	-3.558	100.139	100.139				
	-3.480	100.061	100.140	-0.079	-0.040	0.078	-0.003
	-2.000	100.105	100.170	-0.065	-0.072	1.480	-0.107
	0.000	100.165	100.210	-0.045	-0.055	2.000	-0.110
	2.000	100.105	100.310	-0.205	-0.125	2.000	-0.250
	3.480	100.061	100.354	-0.293	-0.249	1.480	-0.369
	3.783	100.363	100.363	0.000	-0.147	0.303	-0.044
						TOTAL CUTTING	0.882
10	-4.792	99.426	99.426				
	-3.480	100.301	99.817	0.484	0.242	1.312	0.318
	-3.000	100.315	99.960	0.355	0.420	0.480	0.201
	-1.000	100.375	99.960	0.415	0.385	2.000	0.770
	0.000	100.405	100.090	0.315	0.365	1.000	0.365
	1.000	100.375	100.410	-0.035	0.157	0.900	0.142
	1.000	100.375	100.410	-0.035	-0.017	0.100	-0.002
	3.000	100.315	100.390	-0.075	-0.055	2.000	-0.110
	3.480	100.301	100.392	-0.091	-0.083	0.480	-0.040
	3.572	100.393	100.393	0.000	-0.046	0.092	-0.004
						TOTAL FILLING	**1.796**
						TOTAL CUTTING	**0.155**

Figure 6.13 *Road Quantities and Area Calculations*

Compatibility

3-D view, contour drawings, L-Sections and cross-sections generated by Road-Master can be saved in DXF format. This format is compatible with AutoCAD and most other drafting packages, in which these drawings can be read, edited, printed or plotted.

KANIX-HIGHRISE

Website: *www.Kanix.com*

THE COMPLETE SOFTWARE SOLUTION FOR EFFECTIVE MANAGEMENT IN CONSTRUCTION INDUSTRY

Kanix' offers Highrise – A construction ERP as its flagship product. Kanix has invested 12 long years in research, designing and fine tuning proprietary business processes. This has resulted in making Highrise, which fills the gap between theoretical business/construction management and practical site operations giving the organisations multitude of benefits.

Highrise – Is a Construction ERP that is India's first specialised ERP useful for different construction sectors like residential, commercial, townships, SEZ's, infrastructure, turnkey type of projects, etc. Highrise has various versions to suite requirements of large, mid-size and small businesses. Also Kanix has an arm focusing on *management training* for construction and real estate businesses. It helps traditional construction businesses in making successful transition to a corporate through trainings in construction management and in turn builds trained manpower for its products. An institution like Maharashtra Institute of Technology (**MIT**) Pune teaches Highrise in their curriculum which helps build a good pool of young engineers with exposure to Highrise.

New Challenges for Construction and Real Estate Business

Construction is amongst the fundamental industries. With economy showing added strengths each day, the need of industrial, infrastructure, commercial and residential space is ever increasing. Construction companies are handling ambitious projects with very ambitious timeliness. The importance of managing projects in lesser funds and time is immerging. This will require optimal utilisation of available resources. We cannot now allow heap of material laying on site, spent money on nonproductive marketing exercises, make extra funds provisions than required, get into cash flow problems, so on and so forth. Also partnering and financing are getting a different dimension. Quality norms are set at new benchmark. The issues like *money saved is money earned*, *high commitment to the consumers*, *better marketing techniques, better organisational structure, etc*., thus have started getting importance's. These fast-track projects require sophisticated management and effective organisational structure. This has generated a need for a better management tool, which will assist in decision-making and analysis, thereby giving better direction to the organisation to handle and sustain increasing business. Highrise perfectly fits in this place assisting businesses to achieve their targeted goals.

What is an ERP?

In simple words, an ERP is an integrated software, encompassing all the functional departments of the enterprise. Enterprise Resource Planning or ERP is nothing other than a software but the difference is in the scope of application area. Commonly, we would find modules like Finance, Accounts, Purchase, Sales, Marketing, Planning, Execution, Human Resource, and Contracting in an ERP. All these modules are integrated and share common data. For example, in a non-integrated system, the training cell will have a list of all the employees, a similar list will be present with payroll. Now, if an employee has left the job the payroll cell updates their data but the training cell keeps on scheduling the employee for subsequent training programs. In an ERP, we would find a single employee record where each cell has access to the latest information at any time. Functional ERP will show exact picture of the cash flow. It will also help the management in taking policy decisions fast and implement with immediate effect. All the required valuable and correct information will be available on a key press thus, eliminate the dependency on subordinates for data. The latest graphical tools will show the summary data in form of colourful graphs, which will enhance grasping.

What is Highrise?

Highrise is a specialised ERP for construction industry. It has integrated modules for Project Estimation and Planning, Materials Management, Contact Management, Sales and Marketing Management, Accounts and Finance Management, Human Resource Management, Quality Control, Tender Management, Lease and Mall Management, and Property Management. All the above said modules are integrated and share same data. 'Highrise' supports three-tier structures of operations namely head office, branch offices and site offices.

'Highrise' is *Web enabled* and can be operated directly from site using internet connectivity. 'Highrise' has interface to mobile networks and can send alerts and warnings using SMS in addition to sending Auto-SMS to clients.

Advantages of Highrise

Engineering	Accurate estimates, Accurate project planning, Accurate project monitoring Timely project completions
Purchase and Inventory	Reduction in wastage, Reduced inventory holding, Better pricing, Reduction in events of delays in material receipt
Sales and Marketing	Improved client records, Timely recovery, Targeted follow-ups, Better conversion, Better broker management, Better management directions-analytical data available
Accounts	Integrated accounts eliminates possibility of errors, Reduction in manpower cost, Better corporate image - computerised statements, Accurate cash flow requirements, Improved liaison with bankers, auditors
Business	Controlled operations, Better transparency in operations leading to investor confidence, De-risking business, Indemnity against staff turnover, Better handling of high construction volumes, Facilitates controlled delegation of work, Helps business in becoming process driven rather than hero driven, Knowledge banking becomes possible

Module Structure

A. *Highrise Project Management*

Highrise helps project management team through various ways like accurate estimation (Directly converting CAD Drawings), project scheduling (Using Pert/CPM & Other techniques), project planning, costing and budgeting, computation of activity-wise and material-wise variance for quantity and cost, incorporation of quality checks using quality check lists and tender management.

Project WBS and Scheduling

Imagine if you have given an activity to calculate population of India. It is difficult for you to understand where to start. For this, you have to break the activity as calculate population of independent states such as Maharashtra, Gujarat, Goa, etc., and subsequently add them to get result. The second step, you have to take is breaking each state into districts and add them. In similar fashion, you would proceed down to a house level. Essentially, what you have done is a work break-down. If the above is represented graphically, it would look like a tree. Such a representation called WBS or Work Break down Structure. We employ the same principle for our project definition in Highrise. We first define a project (construction project), second level we break in to say individual buildings, at the third level, we will break a single building into floors, and fourth level, we break each floor into flats and so on. Now the root or leaf element will be the actual work. These leaf elements will be associated with its required resources as materials, labours and equipments with their quantum, specifications and quality checks. With this simplified concept, a project is defined in Highrise.

In simple words, scheduling is process of co-relating various activities in a project and putting in a period. Before we understand scheduling in detail, we need to understand two concepts. First is the '*time required to execute an activity'* and second '*How is a particular activity related to other activities'*. Let us take an example, a four-storied building. We will not require any intelligence to tell that we cannot cast the fourth floor slab on day one, for this activity to go ahead the third floor slab and fourth floor columns should be at place. This means that the fourth floor slab depends on fourth floor columns and in turn the fourth floor columns depends on third floor slab, so on. These are called leads or dependencies.

Key Features

(a) Estimation and project planning
(b) Project scheduling (Using Pert/CPM & other techniques)
(c) Project controlling and monitoring
(d) Risk, metrics management and quality assurance
(e) Maintaining estimate version and estimate change history with reasons
(f) Issue tracking and closing

B. *Highrise Material Management*

Materials contribute to a majority portion of construction cost. Controlling inventory and bagging the best competitive offer are crucial elements of purchase. The purchase module in Highrise will assist you in gaining overall control over all the purchases made. Requisitions/ indents to make on site for the required material or they automatically generate, if the schedule is perfect. Highrise supports two types of requisitions, the normal one (against estimates), and extra (for non-estimated or extra materials). The *engineering-section* in head office or site office will approve these requisitions looking at the demand and project plan. All approved requisitions will go to the purchase department to raise the purchase orders. Highrise provides rate masters, which hold all the data like list price, discount, supplier, applicable taxes, etc. Senior purchase person controls the rate master. This saves time to raise the purchase order to some mouse clicks and junior staff easy to handle it. If required, we keep the approval mechanism for purchase orders. Once purchase orders are made and issued, the supplier starts supplying material. The site staff makes GRN's. Highrise purchase module provides a purchase bill entry mechanism. The bills are automatically checked while entry eliminating the possibility of a duplicate purchase or transport bill. Upon approval, these purchase bills go to the accounts department for payment.

SIMPLIFIES PROCESS DIAGRAM

- Purchase Cycle

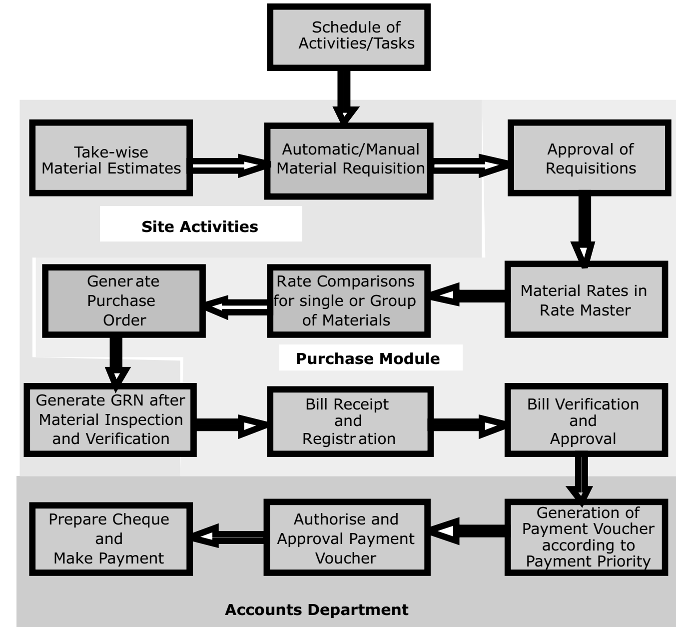


Figure 6.14 *Flowchart Showing Purchase Cycle*

Key Features

(a) Vendor development and grading
(b) Cross comparison against estimates
(c) Generate comparative statements
(d) Generation of Goods Receipt Notes (GRN's)
(e) Checking and passing of materials and transport bills
(f) Effect to accounts
(h) Generation of issues slips
(i) Stores management and stock reconciliation
(j) Inventory control using FIFO, LIFO, FEFO, Recorder levels, etc.
(k) Handling of all inter-site material transfers

C. *Highrise Contracts Management*

"Labour and equipment", are the major parameters of construction industry. Different types of contracts are executed based on the nature on work, availability of labour, material and time for execution, etc. These contracts and bills submitted against these contracts are of different types. These can be broadly divided as:

C.1. *Types of Contracting*

(a) Departmental Labour Contract / Daily Basis Contract

In this case, the owner appoints the labours directly on daily basis and their payment is made weekly/monthly basis. Normally, such type of contracting is used for less quantum work / maintenance work in private sector.

Payment of labour = Attendance (Days) × Wages (₹/Day)

In this case, payment is made irrespective of quantity of work completed by labour, but it is based on number of attendance of that labour.

(b) Labour Contract

This type of contract mostly used in private sector. In this case, work is allotted to a contractor and a owner provides material for task and the contractor provides labours for it.

Payment to Contractor = Quantity of Task is completed by contractor × Pre decided unit rate for that task.

In this case, payment is made irrespective of number of labours required for completion of task but it is based on quantum of task completed by labour.

(c) With Material Contract

In this type, the contractor uses his material as well as labour to execute the work. In this type of contract, the client's role is only to monitor material quality, work schedule, work quality and make regular payment. Advantage of 'contract with material' is to reduce material wastages. In case of 'labour contract', wastage percentage is very high due to negligence of labour, which leads to unnecessary high construction cost.

Payment to Contractor = Quantity of Task completed by contractor × Pre-decided Unit rate (Material + Labour) for that task.

(d) Lum-Sum Contract

In this case, the Payment, is made not on daily basis/quantum of work, but on the basis of completion of task. This is useful for those tasks which are unable to measure in any engineering units [i.e., Cleaning work, Shifting, etc].

C. 2 ***Labour Bill***

(a) R A Bill

This is intermediate bill made on partial completion work periodically. This period is normally of one week or one month.

R A Bill Amount = Quantity of Task completed by contractor during predefined time period × Pre-decided Unit rate for that task.

(b) Full and Final Bill

In this case, there is no any intermediate bill. Bill paid to the contractor only after total completion of task. This is useful for those tasks that have lesser quantity and completion period.

R A Bill Amount = Quantity of Task completed by contractor × Pre-decided Unit rate for that task.

(c) Advance Bill

This is advance given to the contractor due to reasons like, festival advance, labour advance, etc. This advance is later on debited from his final bill.

(d) Departmental Labour Bill

This is muster role payment of departmental labours, directly made by company.

Departmental Labour Bill = ∑ (No. of labour per day of category × Per day salary of labour for that category).

Highrise has all functions to enter and handle different types of contracts and bills.

- Contract Cycle

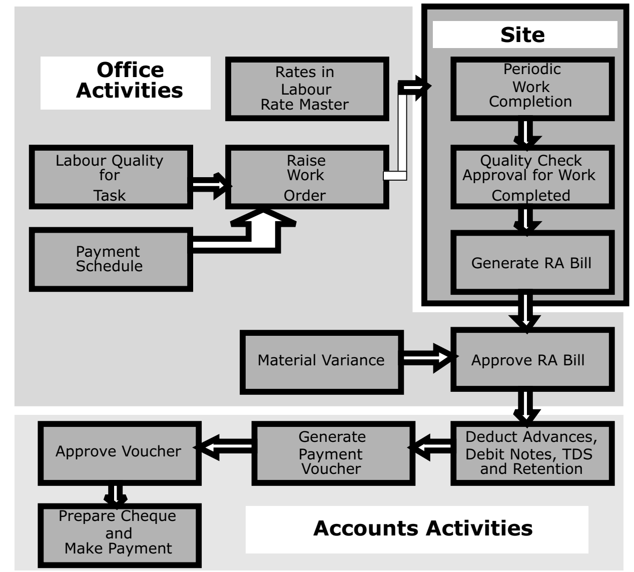


Figure 6.15 *Flowchart Showing Contract Cycle*

Key Features

(a) Contractor registration and grading
(b) Floating of contract tenders
(c) Generation of work orders
(d) Monitoring work completion
(e) Generation of RA bills and interface with financial accounts
(f) Passing of RA bills (Linking to material consumption and quality approvals)
(g) Handling with material Contracts, TDS, retention, advances, debits

D. *Highrise Marketing and Sales Management*

In case of builders and developers, sale of units constructed is one of the major activities. With the new growing market, new techniques of marketing are required for selling their units. These unit types could be flat, shop, parking, bungalow, go down, etc. The marketing division organises/attends different marketing units by which they can reach to the customer. They book enquires received to them and keep regular follow up to customer till it is converted in Sale. Once the job of marketing department is complete, i.e., they have closed a sale, the job of sales and recovery begins. Once a sale is confirmed, the unit is allocated against the buyers' name. The sales details like *agreement value*, committed possession date, joint customers, payment schedule, loan arrangements, etc., are fed into the system. The payment type entries in payment schedule are either *Date-wise* or *Task Start* or *Task End*. Once an activity is marked as completed in engineering section the demands get automatically generated in the recovery section eliminating any delay in furnishing claims. This module also handles the society maintenance and electricity charges till the society is formed. The recovery section generates the claim letters, reminders and interest letters in addition to letters like NOC, Bank letters and many more. The module has all the flexibility to cancel or transfer a sale. The most interesting feature of sales is its participation in the cash flow.

• Sales Cycle

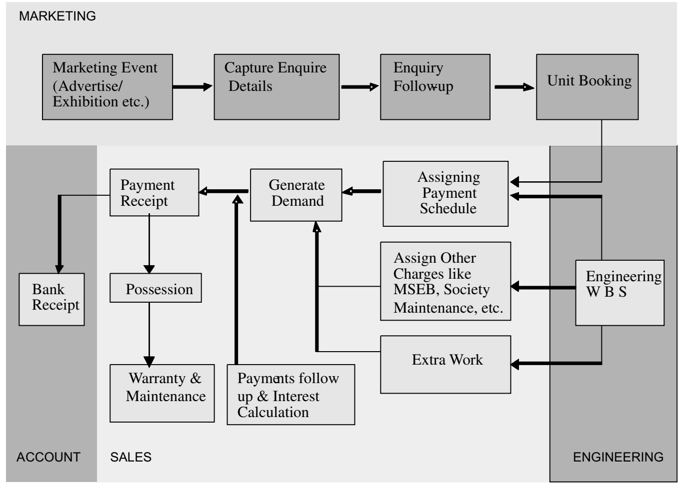


Figure 6.16 *Flowchart Showing Sales Cycle*

Key Features

(a) Concept of marketing in construction industry
(b) Executing marketing campaign; enquiry follow-ups
(c) Enquiry tracking and analysis of response
(d) Brokers management
(e) Loan processing
(f) Payments follow-up and recovery
(g) Maintaining booking position and outstanding position.

E. *Highrise Accounts Management*

The cash outflow side comes from the engineering module after the scheduling, whereas the inflow side comes from sales. Both these graphs can be mapped on the same date range to analyse the places of cash crunch and surplus.

Key Features

(a) Integration with other departments
(b) Introduction to taxation and concepts
(c) Concepts of balance sheet, P and L, Ledgers
(d) Budgeting and monitoring
(e) Multi-company balance sheet and P and L
(f) Cash flow analysis

F. *Highrise Land and Legal Management*

Purchase of land and the complete legal formalities of project starting from land purchase to handover of project is important angle of any construction project. A land to be developed may be owned by multiple owners or also may have multiple encroachers on it. So as to make a free and fair possession of land, different strategies are prepared and followed. The records of land owners, encroachers, brokers, consultants, etc., along with their records of financial transaction are handled in software. The required project sanctions by different government bodies are done by legal and lessoning department. The record of rules, notifications and circulars released by these bodies is required for ready reference and is maintained and updated in software. The complete flow of the legal compliances in approval stages is defined and its status is tracked in system.

Key Features

(a) Handles land projects as open land, rehabilitation (SRA and MUIP), redevelopments (By BMC, MAHADA, etc.), private housing properties and auctioned properties.
(b) Maintain detail records of land, land owners and occupant's with legal and other information. Assign multiple land owners with their land shares, land purchases and payment schedules.
(c) Prepare compliance list of legal formalities with stages of land development work. Prepare checklist for documents to be submitted.
(d) Maintain legal case follow-ups with date and remark, and get automatic reminders for followups.

CALQUAN INDIA

Website: *www.calquan.com*

KrossX – Software for quantity calculation, cross-section drawing generation and planning. Useful in projects with an alignment and a typical cross section, like highway, road, dam, canal, airport, railways, river training, pipelines, etc.

KrossX is an open platform that has revolutionised the way how such tasks are handled. Other software's are based on template library, where the drafting is expedited based on predefined set of parameters. These software's are nothing but Auto Drafters–tool for draftsmen. KrossX is a software for engineers, where cross-sections are generated based on "*User Defined Settings*". KrossX is a generic tool that can be implemented to cater to any requirement, where ever there is an alignment and a typical cross-section. The user can intelligently define the section based on the engineering requirements. In addition to normal features, KrossX provides the following user defined features:

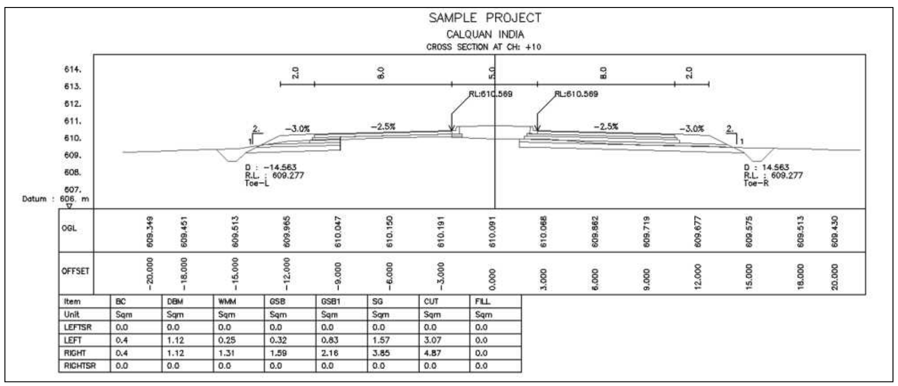


Figure 6.17 *Cross Section of Road with Median and Profile Correction to Existing Road*

User Defined Templates

The "Templates" or "Typical Cross-Sections" as they are called are becoming more and more complex.

The complexity is because of various reasons:

- In case of roads and highways there is overlay / profile correction / widening.
- Different structures like retaining wall, toe wall, drain are incorporated.
- Use of flyash, geo synthetics, in Pavement.
- Different canal shapes are required based on cut / fill types, there heights, etc.

KrossX uses the most fundamental entities in a drawing – points and lines - to define the template. Hence, without exception any type of cross-section can be generated.

Condition Evaluation of Cross-Section

It is a unique feature of KrossX; conditions can be defined, evaluated and correlated to points, lines, areas, drawing layouts, etc.

This feature enables the user to make analysis of the section and redefine the parameters of the section, on the fly.

- Conditional evaluation allows the user to detect the type of overlay in case of roads.
- In case of flyash sections the dimensions are decided only after the section is evaluated, i.e., for e.g., the side cover is decided after calculating the height of filling.
- In case of canals, the shape, size of cut-off trench is decided based on the height of embankment.

Area Definitions

Cross-sectional areas are basis for volume calculations. Normally, sectional areas are between two layers (levels) but sometimes there is a need to calculate complex areas that are between multiple layers. A classical example is when the cut level of road is shifted between sub grade top and sub grade bottom, based on laboratory testing (like CBR) of the existing ground. KrossX can handle such scenarios in single area definition.

Multiple Types

In National Highway projects, normally 8 to 10 different types are required based on the number of lanes, retaining walls, toe walls, cutting, drain types, etc. Simultaneously, in single projects, all these types can be implemented and used for different stretches in permutations and combinations.

User Defined Drawing Layouts

Cross-sectional drawings are required for different reasons, for e.g., in the initial stage of the project working CS drawings are required, where layer charts, toe reports are displayed. After completion of project, the same CS drawing needs a different presentation like the areas of different layers are required as they will be referred during quantity calculation and billing. KrossX provides tools so that the end user can specify the required drawing details on the drawing.

As Build Cross-Sections

Once the project is complete, it is essential to draw "As Build" cross-sections. It is not practical to develop 100% as build section. The normal practice is that only some key parameters are surveyed. Balance parameters are obtained from design. This combination of partial "As-Build" and "Design" is actually a very complex task, it can be easily handled in KrossX as its template definition is based on points and lines.

Batch Processing / Scripting / Auto RUN

KrossX has its own scripting language. The user can thus execute a batch of commands at one go. With a single button click all data (excel) can be converted to drawings and reports.

Various Editions of KrossX

Kross X – Enterprise – Open platform that can be implemented for any project with an alignment and typical cross-section; like roads, dams, canals, pipelines, airports, railways, etc.

Kross X – Roads / Highways – Implemented edition of Kross X Enterprise – Any type of sections of rigid or flexible pavement, with retaining walls, service roads, profile corrective course can be handled. Quantities of various items like bituminous concrete, dense bituminous macadam, wet mix macadam, granularsub base, subgrade, embankment, cutting in different strata, surface pitching, etc., can be calculated. It is possible to evaluate the section conditionally and revise the parameters if required, as in the case of flyash sections.

Kross X – Dams–Implemented edition of Kross X Enterprise – useful for quantity calculation of various quantities like casing, hearting, cut-off trenches, pitching, sand filters. Generates cross-section drawings, in addition, it can generate toe plans at various progress levels that are very useful during working.

Kross X – Canals–Implemented edition of Kross X Enterprise – useful for quantity calculation of various quantities like casing, hearting, cut-off trenches, pitching, sand filters. For canals, different types of sections can be assigned depending upon whether the section is in cutting, deep cutting, filling, high embankment. Parameters of COT are many times based on the height of embankment. KX dynamically revises the COT parameters after evaluation of cross-sections. Quantities can be segregated based on various lift heights.

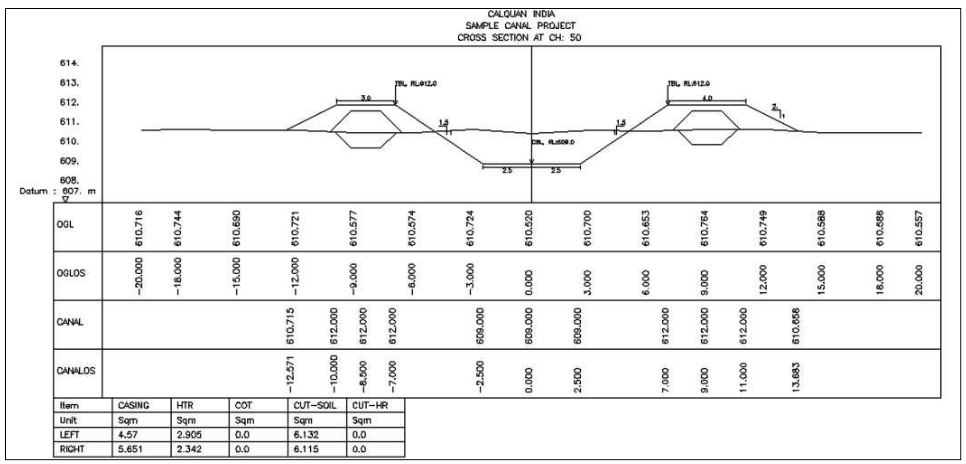


Figure 6.18 *Cross-section of Canal*

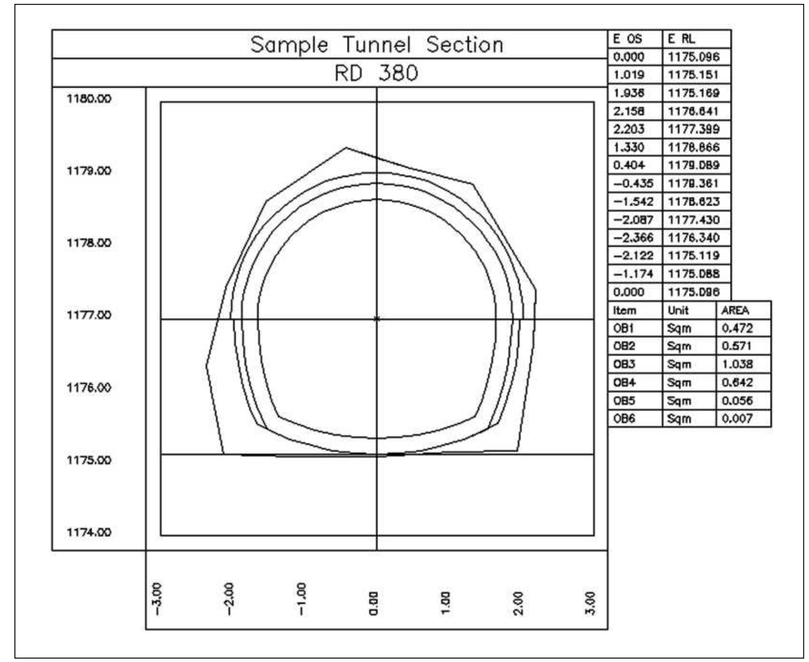


Figure 6.19 *Cross-section of Tunel*

KrossX – Tunnels – Any shapes like horse shoe, semicircular, etc., can be handled. Provision for calculating over and under breaks. Also calculates surface quantities.

PGoD – Parametric Generation of Drawings.

General software useful for civil, mechanical, electrical, or any engineering application.

Software for generation of series of drawings based on user defined template and associated parameter set.

This is the engine that drives KrossX. The revolutionary approach of KrossX is now made available to other engineering applications.

LDT - Land Development Tools – Typical Survey Software useful for

- Preparation of general survey drawings
- Processing total station data, converting it to grid format, generating strings based on codes, etc.
- Generation of contours
- Curve calculations - vertical and horizontal curves for roads
- Volume calculations – methods include – grid, by cross-sections, TIN-TIN, contour-area, etc.
- L-section and cross-section drawing generation

Free Education edition (Not for Commercial use) is available for download on our web site *www. calquan.com*

SURVEY SOFTWARE'S – BASIC CONCEPTS

Civil Engineering Surveying is the process where certain dimensions of the surface of the Earth (along with relevant manmade structures) are measured. This data is used to generate the graphical representation of the Earth's surface. This information is subsequently used for design, planning or execution. This survey data is normally the basis of all major civil engineering activity. It may be used for layout of roads, railways, townships, harbors, etc. Optical surveying instruments such as levels and theodolites which were used for major part of the twentieth century are now replaced with more powerful instruments like EDMs, total stations, GPS and laser scanners. These are based on a combination of electronic technologies. Total station is one instrument that has revolutionised the general survey work.

DATA GATHERED BY TOTAL STATION (TS)

The data collected by TS can be exported in various formats. CSV text is one format that is common to all, irrespective of the TS manufacturer. CSV text file can be opened in a spread sheet editor like MS Excel. Every row represents a point. Every row, i.e., point is defined in terms of X, Y, Z co-ordinates (or Northing, Easting, Level). In addition, there may be a reference point number and remark (code) that carries some associated information about the survey point.

Survey Software

The survey data gathered is processed for further use. This may be related to transportation, water management, urban planning, etc., the list is endless. Various softwares are available for various tasks.

Let us discuss some core concepts in survey software's that are common to all.

- TIN / DTM (Triangular Irregular Network/ Digital Terrain Model)
- Contours
- General Survey Drawings (processing codes)
- L Sections
- Cross-sections

TIN / DTM

These are two terms that have very broad and similar meaning. We shall limit ourselves to the current scope.

The survey data that is currently a collection of points needs to be converted to a surface. This surface is a collection of 3-D faces. Every face is a triangle. The surface is a collection of triangles that do not overlap each other. There are various algorithms to convert set of points to triangles.

Delaunay Triangulation method is the most popular one. Delaunay triangulation for a set of points in the plane is a triangulation such that no point is inside the circumcircle of any other triangle. Delaunay triangulations maximise the minimum angle of all the angles of the triangles in the triangulation.

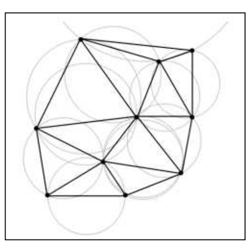


Figure 6.20 *Triangular Network*

Contours

Contours on a survey map are polylines that connect series of points of equal elevation (z value). Contours are normally created for fixed elevation differences. The contour interval of a contour map is the difference in elevation between successive contour lines. Contours on a map help the viewer to have a feel of the terrain. In a 2-D drawing, it gives a better understanding of the third-dimension. Viewers can identify valleys and hills along with the steepness of slopes.

How are contours generated?

The surveyed points are triangulated to generate a TIN as mentioned above. The triangle edges are interpolated to locate a new set of point at a given contour interval.

These interpolated points are joined by Polyline. These plines are then smoothened. It may be interesting to note that contour lines never intersect each other.

Also these lines are either closed loops or are discontinuous only at the edge of the survey area.

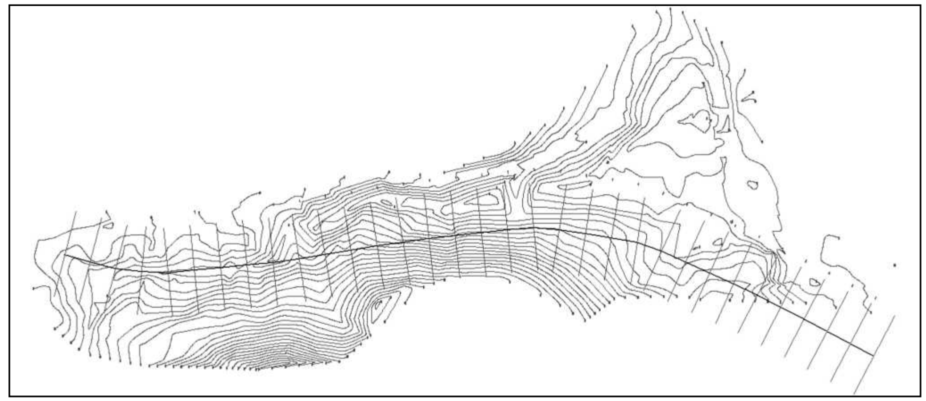


Figure 6.21 *Contour Map to give a Feel of the Terrain*

HORIZONTAL ALIGNMENT / CORRIDOR / CROSS-SECTIONS

An alignment is a Polyline on the survey drawing. This PLine may or may be based on the survey data. If it is from the survey data, then the points are grouped by code. Else, the user may wish to draw a Polyline and use it as an alignment. The alignment is a one-dimensional entity, it may be associated with width to create a corridor. Also, the alignment may be segmented by an increment length to create additional intermediate points.

L-Sections of the Alignment

A L-Section is drawn along an alignment. This is the profile along the alignment. It is useful for design purpose. For example, in road design the vertical curve is marked with reference to this L Section.

Cross-Sections across the Alignment

The L-Section does not represent the full width of corridor. Once the vertical alignment is marked on the L-Section, the cross-sections are generated for a given width along the horizontal alignment. The cross-sections are normally drawn at a fixed incremental distance.

Design Template on Cross-Sections

Superimposing the design template on the ground cross-section is necessary for quantity calculation.

General Drawings from Survey Data

Survey data may contain points that are marked by codes. It may be the centerline of an existing road, edges of buildings, electric poles, boundary edges, etc. The points can be directly marked on the drawing based on the x, y. But a group of points which are segregated based on the codes need to be processed by the survey software to corresponding drawing entities. For example, the set of points coded as electric poles are connected by a Polyline with appropriate line type. Similarly, building corners are connected and hatched to show a building.

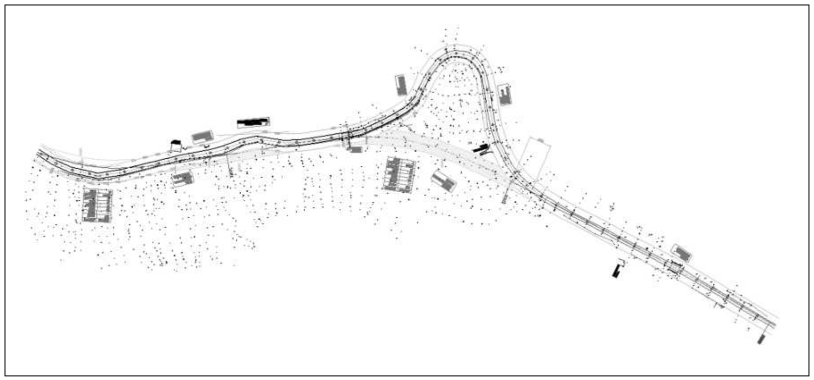


Figure 6.22 *Details of Buildings, Electric Poles etc. are shown*

HIGHWAYS, ROADS

Infrastructure projects in highways, roads, canals, etc., are at the center of booming Indian economy. International financial institutions and monetary fund's find India, a safe bet to invest. Every day new infrastructure projects are declared in roads, metros, airports, power, etc.

To encash this opportunity global giants entered the Indian market. Except for a couple of honorable exceptions, In the year 2000 no Indian company had an experience to execute such projects. They started by collaborating with international construction companies. Today, in 2011 they have matched the standards of these multinationals and delivered unbelievable results. The Indian construction industry is now at par with their global counterparts. In fact, Indians are more cost effective because of the hard work and innovative methodology they put in. The Indian companies are now foraying into international markets like Gulf and Africa. It should not be a surprise to see Indian companies dominating the developed market in the near future. Indian technocrats too are now a respected lot.

Let us see some simple but challenging techniques implemented by the National Highway Authority of India, to upgrade roads and highways. Before proceeding let me make it clear, Prima fascia these techniques look simple, also these methodologies are not new nor revolutionary. In reality, they are simple on paper but very complex to implement. And because of the complexity, rarely are they used by the developed countries.

UPGRADING THE EXISTING ROAD NETWORK

Rarely will there be a case where a highway is constructed on a totally fresh alignment. India is a densely populated country, hence, there exist smaller roads, which are upgraded. For example, an existing two-lane road, will be upgraded to a four-lane with a central median. To do this there are two options, one can simply dismantle the existing pavement and construct a new one from scratch. This is normally done in the developed countries. Here we are dismantling a well-compacted road which does not make sense. The second option as used in india is to use the existing pavement effectively to cut costs. This is called as profile correction or overlay or widening or shoulder strengthening. The meaning of all these vary slightly but in general, it means in the background that the existing pavement will be utilised.

Increasing the width of road

It is the fundamental requirement of any road up-gradation. Increasing the width means adding lanes, for example the two-lane road is upgraded to four or a paved shoulder is added for safety. Bus bays are introduced. In general, the width of existing road is increased for various reasons.

Concentric and Eccentric Widening

In concentric widening, the centerline of the new alignment is at the center of the existing road. This type of widening is preferred when the new carriageway does not have a median.

In eccentric widening, the centerline of the new carriage ways is located at one side of the existing carriage ways. The advantage of this is that the existing traffic is not disturbed till the new carriageway is constructed. The traffic is then diverted to the new carriage way and the existing carriageway is resurfaced.

Improvising the Horizontal Alignment

The existing road may have sharp turns. The curves are smoothened to achieve higher design speeds. The curves are designed in such a way that only one side is extended. Extending on both sides means opening a new workfront. So it is normally avoided.

Improvising the Vertical Alignment

The vertical alignment of the existing pavement is distorted because of various reasons. To list a few, resurfacing in patches, uneven settlement of the embankment below, etc. The vertical alignment needs to be upgraded for speed criteria. Let us understand the implications of this revision. As we have said that the existing pavement will not be dismantled, the overlay on the existing pavement is done with the crust layers like bituminous concrete (BC) / dense bituminous macadam (DBM) / wet mix macadam (WMM), etc. Compared to the embankment, these are costly and hence the quantity of overlay must be controlled. Improper design of vertical alignment may lead to exorbitant cost rise defeating the very purpose of retaining the existing pavement. On the other hand, if the thickness goes below the minimum specified thickness of overlay then the existing pavement needs to be milled in patches. To demark the patches on site is a very meticulous time consuming task, that may delay the whole progress. So, designing the vertical curve in such a way that there is no or minimum milling on one hand and minimum thickness on the other, is the key to economy of the project.

Complexity created because of the above three factors

Executing the project becomes very complex as there is a lot of variation along the alignment. For example, because of smoothening of curves, the road needs to be widened unevenly for every cross-section. Similarly, because of improvisation of vertical curve the number of layers may vary. It is very important to have the working drawings for every cross-section with minute details.

Providing underpasses, flyovers, service roads

Flyover was a concept that was previously limited to metros. Now they are introduced along the highways, near junctions. Under passes are provided for the local traffic. Service roads cater to the slow moving vehicles like carts. etc. Cattle underpass was something unthinkable a couple of decades ago. Now it is a very popular and practical concept. Similarly, via-ducts (bridge for crossing a valley) are a routine. New methodologies are used for various activities.

In simple terms, it means that the existing carriage ways will not be dismantled.

Two new carriage ways will be constructed alongside these existing one. Again it looks to be a simple alternative. Complexity arrives because of many reasons. First, the existing pavement will have camber in opposite direction. Since a kerb on median edge is to be constructed on the inner edge the camber needs to be made unidirectional in the opposite direction towards the shoulder. Also whenever such up gradation of road is done, the design speed is also upwardly revised and hence, it is essential to improve the horizontal and vertical alignments (curves).

HIT-OFFICE

Website: *www.edss.co.in.*
www.hit-office.com
The Only Construction ERP with Consultative Approach.

Construction sector was said to be the most un-organised sector in India. Because of its uncertain activities and dependencies on various tasks, it is still tough for many companies to organise it. Huge man force is involved in different activities. Use of software to simplify the processes is not a new thing for the industry. We all have witnessed many types of softwares who have asked huge investments and still not been able to make us depend on them.

Almost all softwares failed because of standardisation of procedures and no scope of flexibility. EDSS Pvt. Ltd. – A Market Leader in Construction Management Software provides software dedicated for Indian Market. With 82 years of collective experience from parent company, EDSS Pvt. Ltd. has mastered the solutions for the various diversified operations and serving the industry with its brand HIT-Office since last 10 years in India as well as out of India.

HIT-Office - A Complete Solution for Construction Sector

The software is well-equipped with different modules like – Quotation Module, Project Module, Inventory module and Builder Module.

The Quotations, Estimations, Tenders can be easily done through HIT-Office **Quotation Module**. As it offers ready databases of Resources, Work Item Specifications and Rate Analysis, the users can accurately perform his estimation related responsibilities. Various analyses can be readily available like – Abstract, Measurement, Resource Requirements, A-B-C Analysis, Overhead Analysis and many other customised reports.

The **Project Management Module** will be the best suite for the planning, scheduling, through budgeting, R A billing, subcontractor management, etc., with various reports output like resource planning, cash flow planning, billing formats, excess – saving statements, project progress statement and many value added specialised reports.

The core of any project execution – inventory, can be perfectly managed through **Inventory Module**. The complete connectivity of sites to Head Office will solve the major problems of projects. The processes of indenting, comparing suppliers, "PO-Purchase Order generating", daily inwards register, "auto GRN-Goods Recevied Note", issues of materials transfer to other Projects, cross checking of bills and supplier payments, etc., everything is taken care by the inventory module.

Enquiries can be easily handled and followed up through **Builder Module**. Decisions for marketing about the project can be easily taken with the help of builder module. The actual sales management will be easily done as provision of payment schedule, amenities. Crucial work of reporting in terms of status of sales, auto – e-mail, letter generation will make the end user to generate it within a second. Pre-sales, sales and post-sales can be effectively managed by builder module.

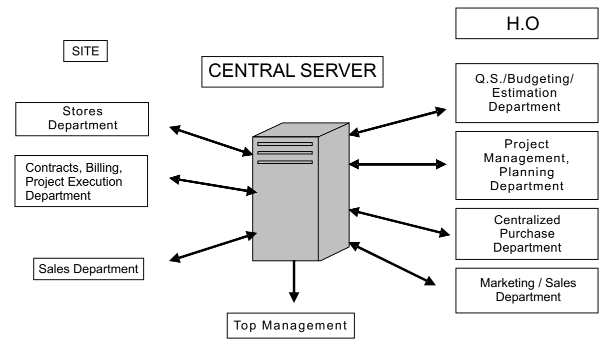


Figure 6.23 *Diagram Showing Central Server Connecting Reomote Sites*

Additional benefits to maintain your **Assets** like equipments, etc., help clients to concentrate on macro planning. The consultative approach of HIT-Office will lead the user to take the finance related decisions regarding budgeting, execution, inventory and sales very easily and without any extra efforts. HIT-Office with a market leadership in construction software's also provides customised solutions to the users. For the differences in practices by construction companies, HIT-Office is a well-equipped solution for the industry.

The flow of connecting the remote sites can be well-explained through the figure given as above.

HIT-Office value added features will intimate the top management about the daily, weekly, monthly and quarterly status of the project through different modes like SMS, auto-mails, etc.

The versatility of software can be utilised in different modes to get the required solutions by the clients. The vertical, horizontal and diversified flows can also be managed by the software with the necessary user restrictions as defined by top management.

HIT-Office Certification Course

HIT-Office provides a consultative approach to the users. The course develops the mindset of the users to handle a project at its best. The reputed institutes like MIT College of Management offer their PG students of Construction Management to develop the vision with HIT-Office. Company allows some certified trainees to work as Software Trainee Consultants to its existing clients. Company also provides Certification Course for the working professionals across the companies so as to see the wider vision of **Estimation, Project Management, Inventory Management, and Sales Management**. Even many companies offer the certification course of Hit-Office ERP to their concerned staff members.

HIT-Office – Window based software with its standard as well as customised solutions has became the first choice of the construction industry.

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Http://wwwsofttech-engr.com

SoftTech Engineers Private Limited (SoftTech) an ISO 9001:2000 accredited company having its registered office located at Pune, India with presence all over India and abroad.

Company is a provider of technically sophisticated standalone, client server and web based engineering software products and solutions that provide fully integrated, easy to use automation for construction enterprises, structural consultancy organisation, engineering analysts and design professionals worldwide.

The company is promoted by Technocrats to provide international quality software tools assisting Architectural Engineering Construction (A / E / C) fraternity in computerisation of all manual activities of organisation right from conception till final execution and delivery.

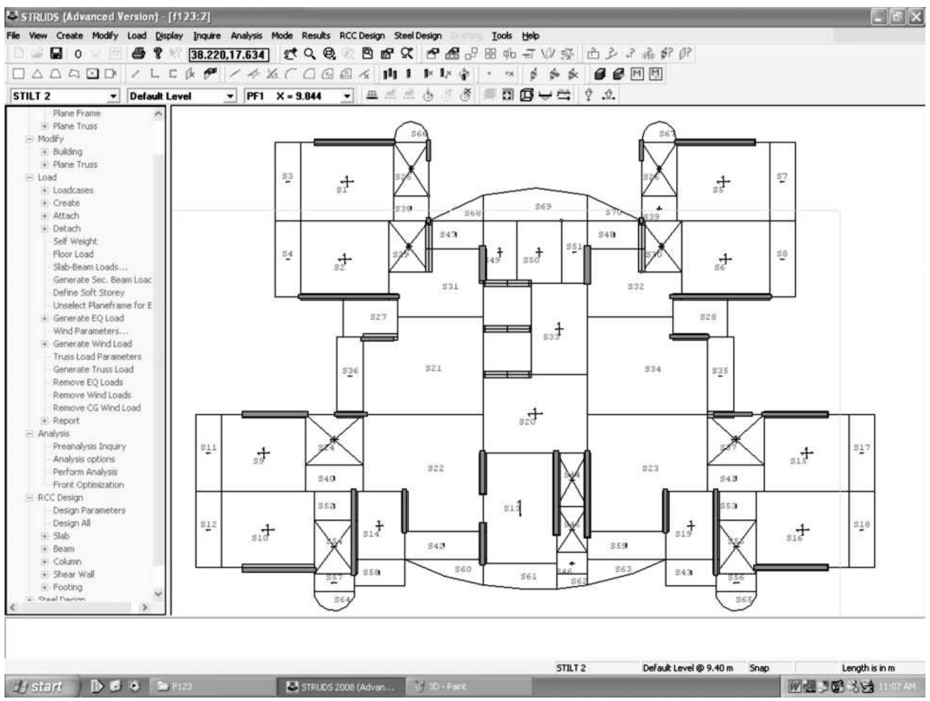

Figure 6.24 *Building Plan with Structural Details*

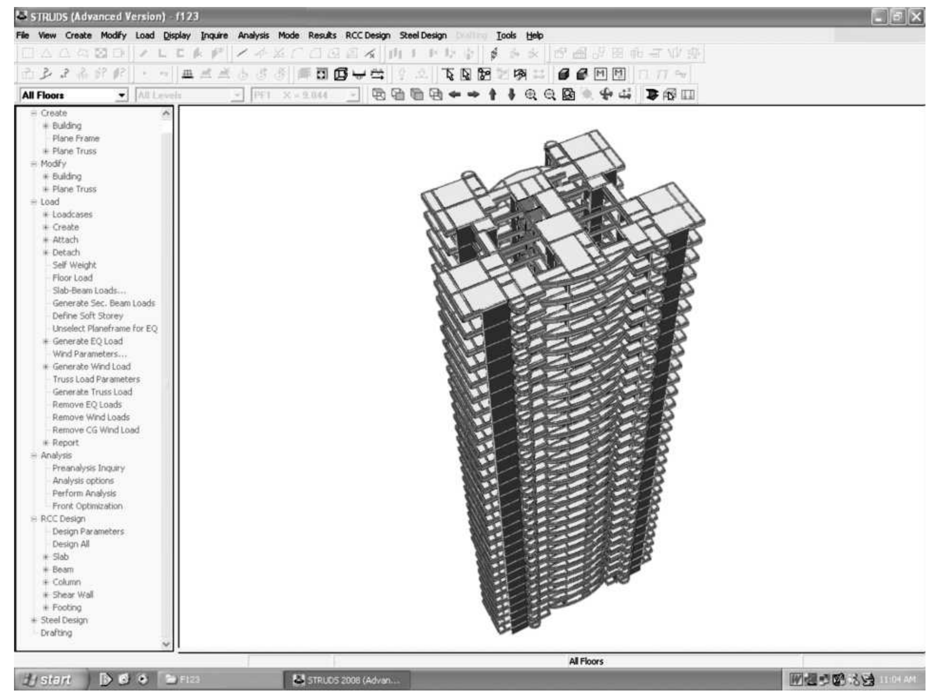

Figure 6.25 *3D Model Generation*

STRUDS© (Structural Analysis, Design and Detailing Software for Buildings)

This software is developed by SoftTech Engineers Private Limited (*www.softtech-engr.com*). It has three main parts, modeler, analysis engine, post-processor, design and detailing.

Modeller has the capabilities of: * Import Building Plans in CAD drawings format * 3D model generation with render view * UCS/WCS coordinate system with any angle, floating columns, sunken slabs * Import / export with other structural software * T, L shape columns in addition to regular rectangular and circular shapes * Flat slabs * Automatic Generation of Seismic and Wind Loads as per as IS:1893 and IS:875.

Analysis module has the capabilities of * Analysis as floor grid, plane frame or space frame method * 3-D frame static analysis * Shear wall analysis * Seismic analysis (Response Spectrum Method) * Soft Storey effect * Vertical seismic loads on cantilever projections * Torsion analysis due to eccentricity between center of mass and center of rigidity * Front width optimisation for faster analysis.

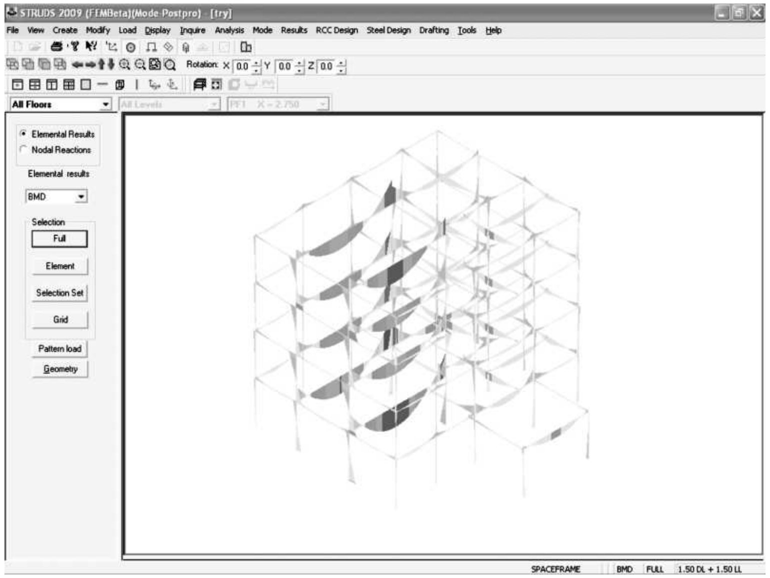

Figure 6.26 *View for Structural Analysis*

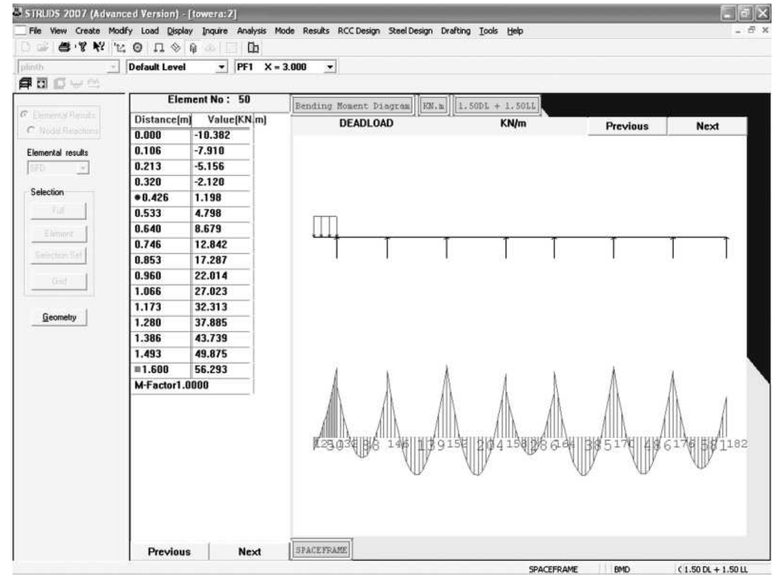

Figure 6.28 *View for Structural Analysis*

Design and Detailing is the strong point of STRUDS software. The design capabilities include * Design of slabs, beams, columns, shear walls and foundation as per IS:456 * Design for Combined footings, Strip Footings, Slab- Beam Raft and Piles (Friction / End Bearing) * Detail design drawings as per SP-34 * Ductile detailing as per IS:13920 * Bar bending schedules * Detail CAD drawings for plans, sections, schedules for entire building * BOQ for concrete and steel.

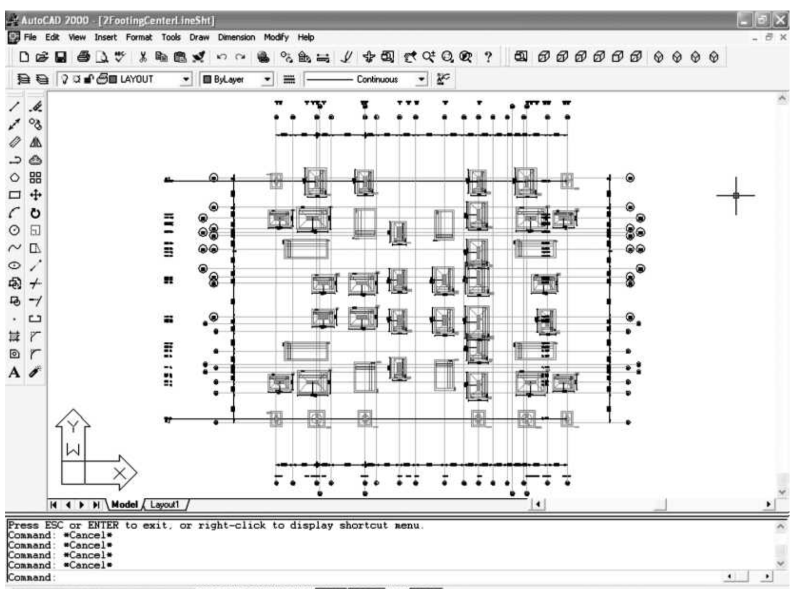

Figure 6.27 *Centre Line Plan*

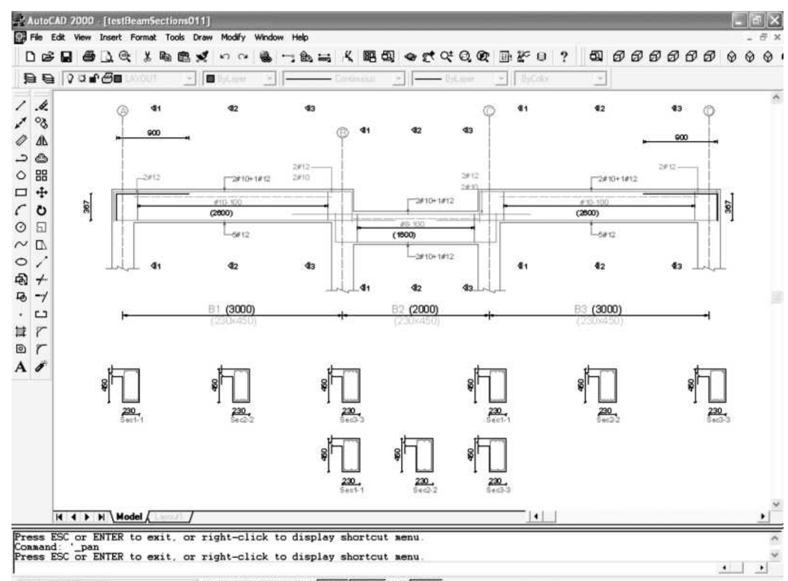

Figure 6.29 *Structural Details*

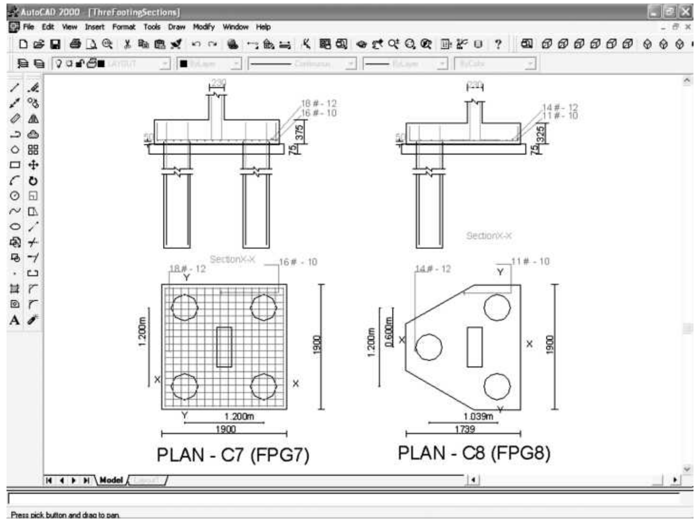

Figure 6.30 *Structural Details*

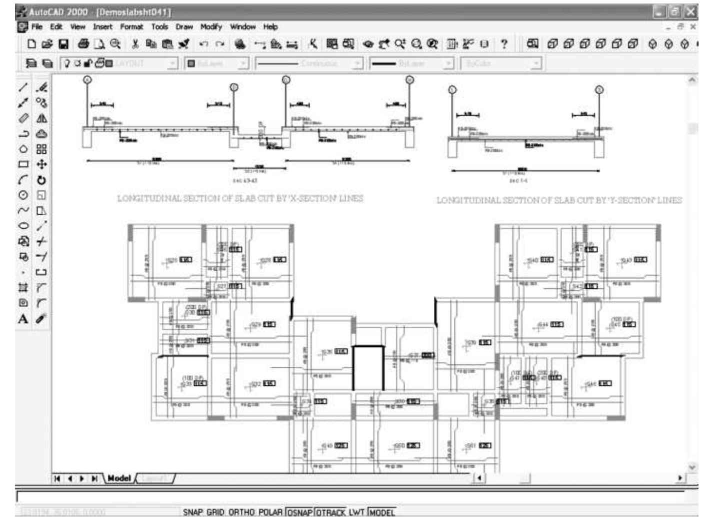

Figure 6.32 *Structural Details – Slabs*

Q-mate (Quantity Estimation Software)

This software is developed by SoftTech Engineers Private Limited (*www.softtech-engr.com*). It is the Unique Cadd-based estimation software which read the soft copy of architectural and structural drawings to extract quantities and generate abstract sheet.

Q-mate has a capability to read the structural and architectural drawings in a format checked by Q-start which ensures the compability of drawing format suitable to read in Q-mate.

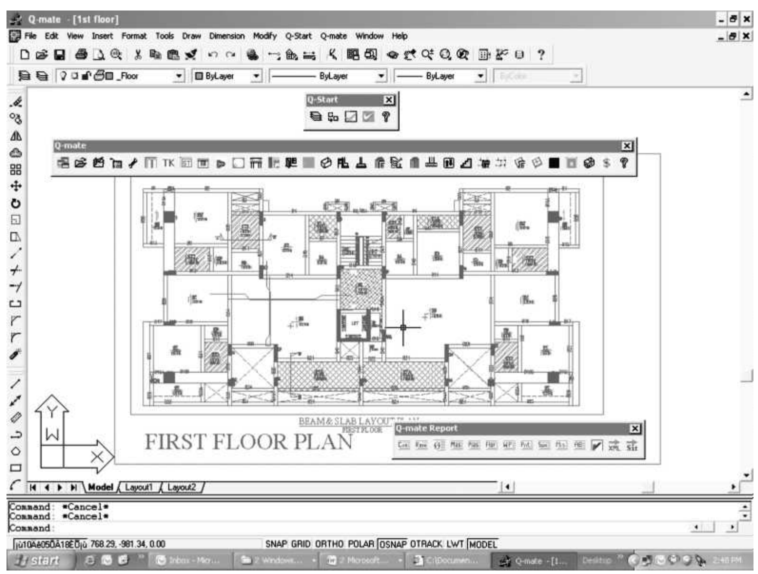

Figure 6.31 *Quantity Estimation Details*

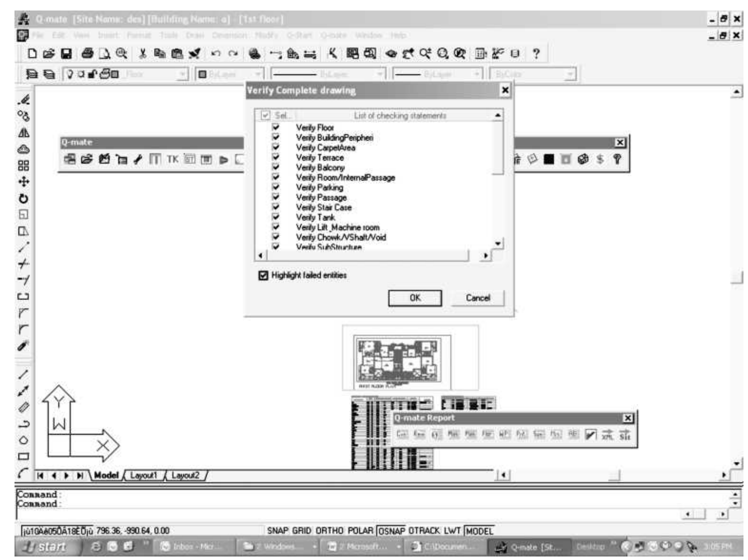

Figure 6.33 *Quantity Estimation Details*

Q-mate has capabilities to define entire project floor wise, map the architectural / structural drawings and schedules to corresponding floors. Read and extract quantities.

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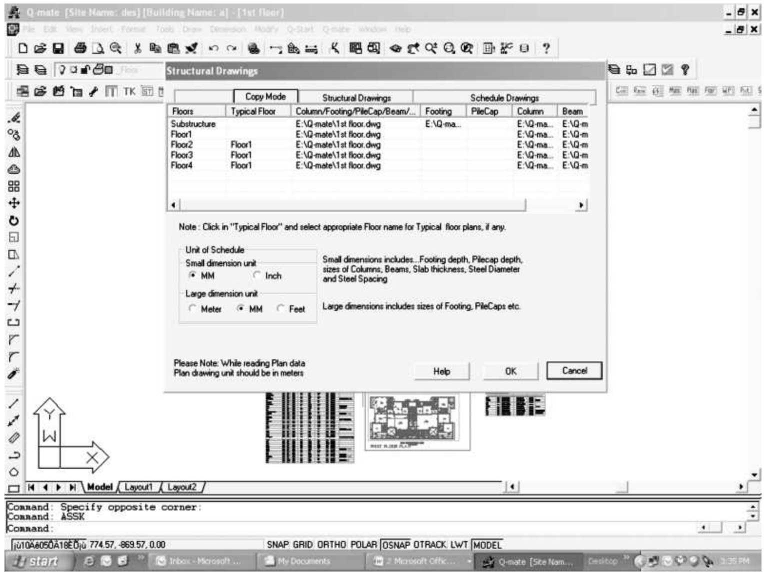


Figure 6.34 *Quantity Estimation Details*

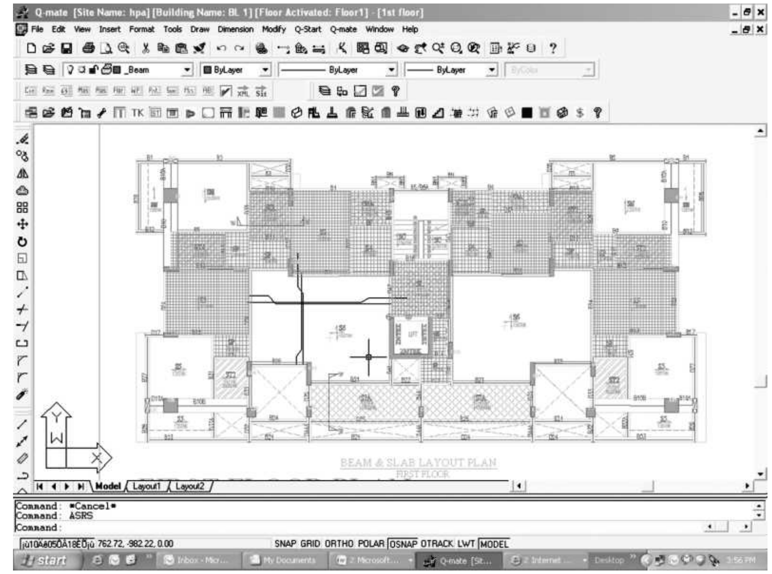
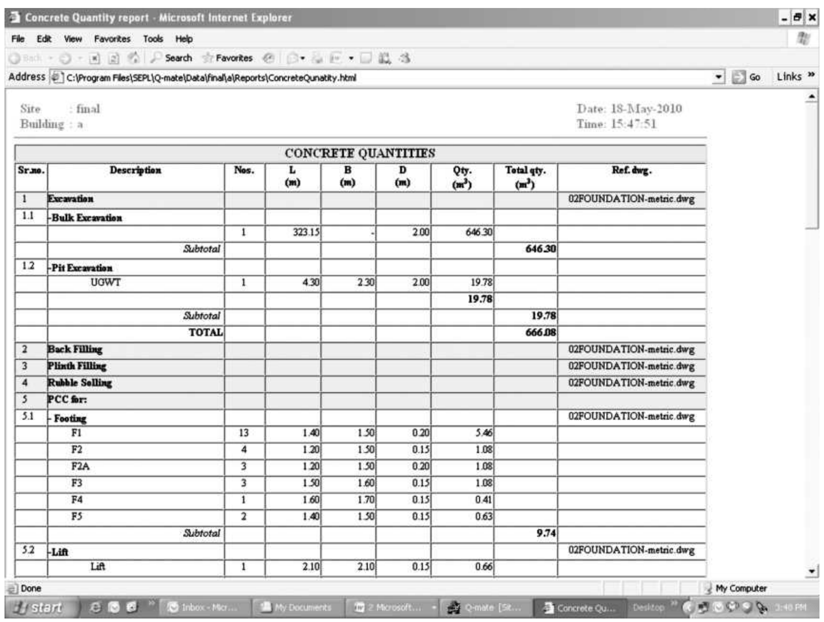


Figure 6.36 *Beam and Slab Layout Plan*

Q-mate generates various dynamic reports for concrete quantities, reinforcement detail and diameter wise, masonry with all deductions, plastering, painting, waterproofing, etc., all civil works with an abstract sheet.



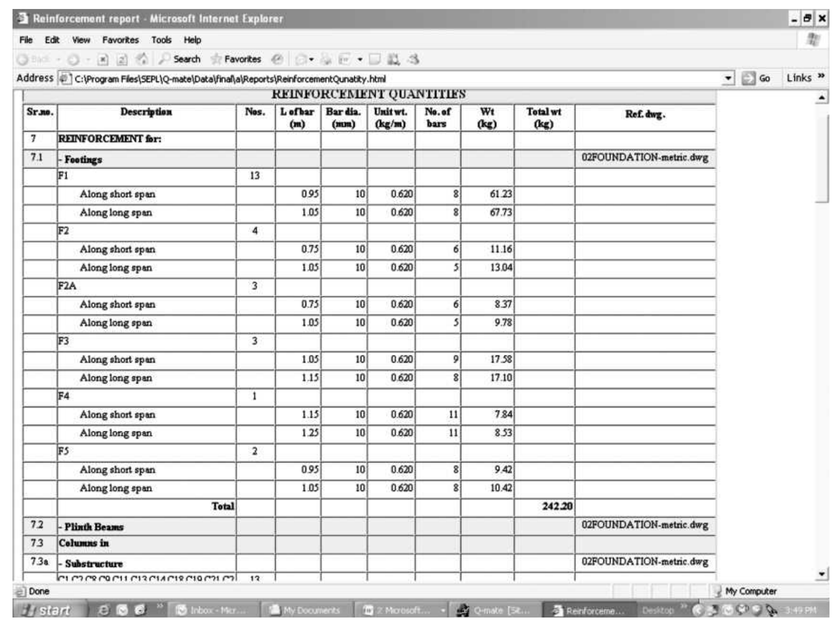
Site : final
Building : a

Date: 18-May-2010
Time: 15:47:51

CONCRETE QUANTITIES

Sr.no.	Description	Nos.	L (m)	B (m)	D (m)	Qty. (m^3)	Total qty. (m^3)	Ref. dwg.
1	Excavation							02FOUNDATION-metric.dwg
1.1	-Bulk Excavation							
		1	323.15	-	2.00	646.30		
	Subtotal						646.30	
1.2	-Pit Excavation							
	UGWT	1	4.30	2.30	2.00	19.78		
						19.78		
	Subtotal						19.78	
	TOTAL						666.08	
2	Back Filling							02FOUNDATION-metric.dwg
3	Plinth Filling							02FOUNDATION-metric.dwg
4	Rubble Solling							02FOUNDATION-metric.dwg
5	PCC for:							
5.1	- Footing							02FOUNDATION-metric.dwg
	F1	13	1.40	1.50	0.20	5.46		
	F2	4	1.20	1.50	0.15	1.08		
	F2A	3	1.20	1.50	0.20	1.08		
	F3	3	1.50	1.60	0.15	1.08		
	F4	1	1.60	1.70	0.15	0.41		
	F5	2	1.40	1.50	0.15	0.63		
	Subtotal						9.74	
5.2	-Lift							02FOUNDATION-metric.dwg
	Lift	1	2.10	2.10	0.15	0.66		

Figure 6.35 *Estimation of Concrete Quantities*



REINFORCEMENT QUANTITIES

Sr.no.	Description	Nos.	L of bar (m)	Bar dia. (mm)	Unit wt. (kg/m)	No. of bars	Wt (kg)	Total wt (kg)	Ref. dwg.
7	REINFORCEMENT for:								
7.1	- Footings								02FOUNDATION-metric.dwg
	F1	13							
	Along short span		0.95	10	0.620	8	61.23		
	Along long span		1.05	10	0.620	8	67.73		
	F2	4							
	Along short span		0.75	10	0.620	6	11.16		
	Along long span		1.05	10	0.620	5	13.04		
	F2A	3							
	Along short span		0.75	10	0.620	6	8.37		
	Along long span		1.05	10	0.620	5	9.78		
	F3	3							
	Along short span		1.05	10	0.620	9	17.58		
	Along long span		1.15	10	0.620	8	17.10		
	F4	1							
	Along short span		1.15	10	0.620	11	7.84		
	Along long span		1.25	10	0.620	11	8.53		
	F5	2							
	Along short span		0.95	10	0.620	8	9.42		
	Along long span		1.05	10	0.620	8	10.42		
	Total							242.20	
7.2	- Plinth Beams								02FOUNDATION-metric.dwg
7.3	Columns in								
7.3a	- Substructure								02FOUNDATION-metric.dwg

Figure 6.37 *Estimation of Reinforcement Quantiies*

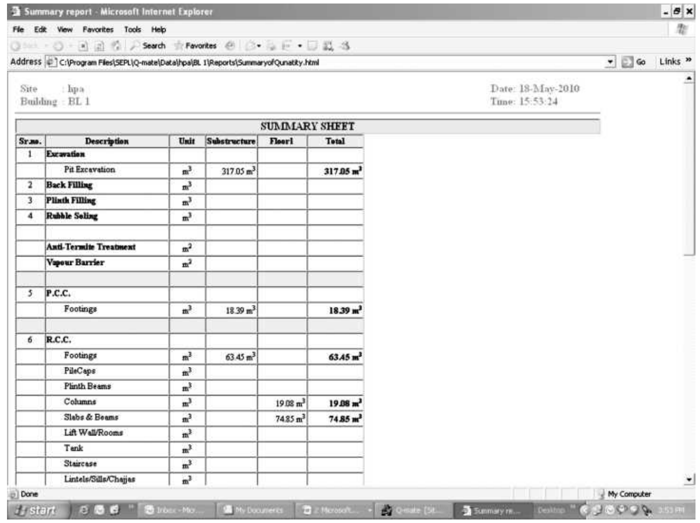


Figure 6.38 *Estimation–Summary Sheet*

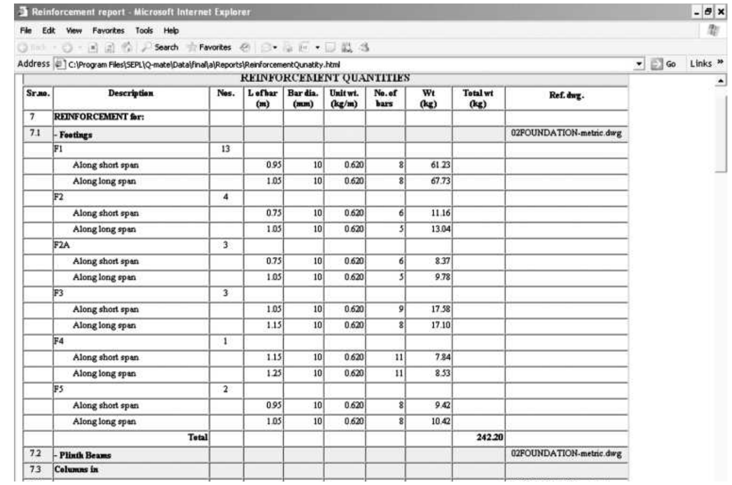


Figure 6.39 *Estimation of Reinforcement Quantities*

SEPL-ESRGSR© (Structural Analysis, Design and Detailing Software for Water Tanks)

This software is developed by SoftTech Engineers Private Limited (*www.softtech-engr.com*). It is the only software available in the market for analysis, design and detailing of Elevated Service Reservoirs (Overhead Water Tanks) and Ground Service Reservoirs (Ground Water Tanks). It has the capacity to design rectangular, cylindrical, conical and intze type water tanks. Input is done through a single window dialog box.

Analysis is * Hydrodynamic analysis * Continuity Analysis * Seismic and Wind Load analysis * 3-D analysis for staging system * Response spectrum analysis

Design is as per IS:456, IS: 1893, IS: 875, IS:13920, IS: 11089 for all the components of tank – Container, staging system and foundation. Staging system can be column beam trestle or shaft-type.

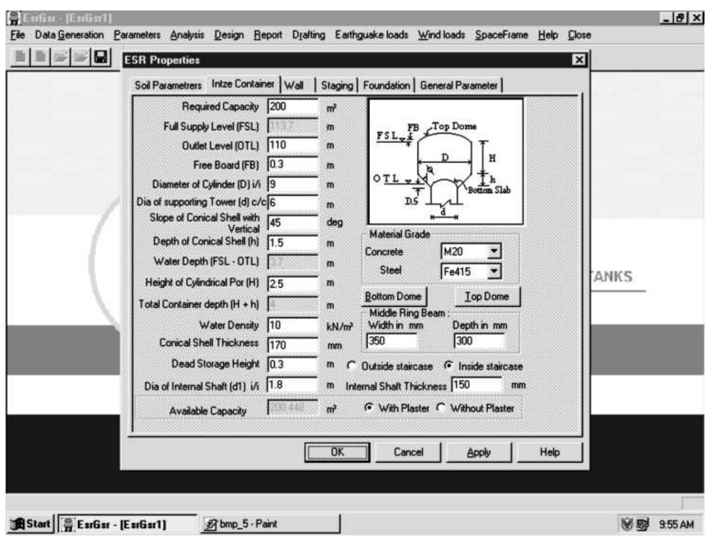


Figure 6.40 *Elevated Service Reservior Properties*

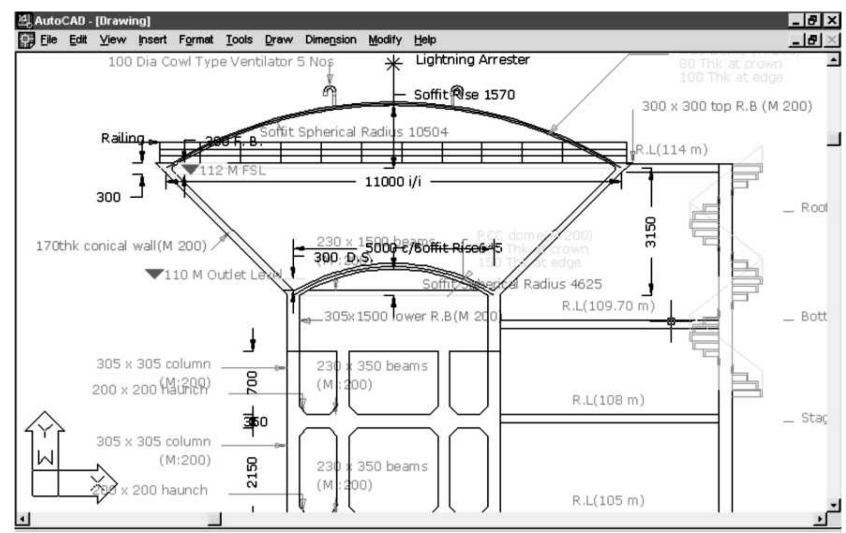


Figure 6.41 *Detailing of (ESR) Overhead Tanks*

AutoDCR (Automated Building Plan Scrutiny Tool)

AutoDCR is a unique and innovative solution provided by SoftTech for automation of building plan approval, reading CAD drawings and mapping them to development control regulations of Municipal corporations and approving authorities.

AutoDCR is seamlessly integrated to online Approval Workflow to monitor the plan approval process with associated document and physical site scrutiny. The complete building approval management system is a web based system where Architects submit the plans and proposal basic data either on Internet or will put them on a CD with physical submission of data. The proposal is targeted to be brought to the single window facility centers at Corporation. After initial scrutiny of the documents, a date for site visit of concerned officer may be notified to Architects / Licensed Engineer and concerned officer via SMS. After drawing and document scrutiny, proposal is either approved or rejected.

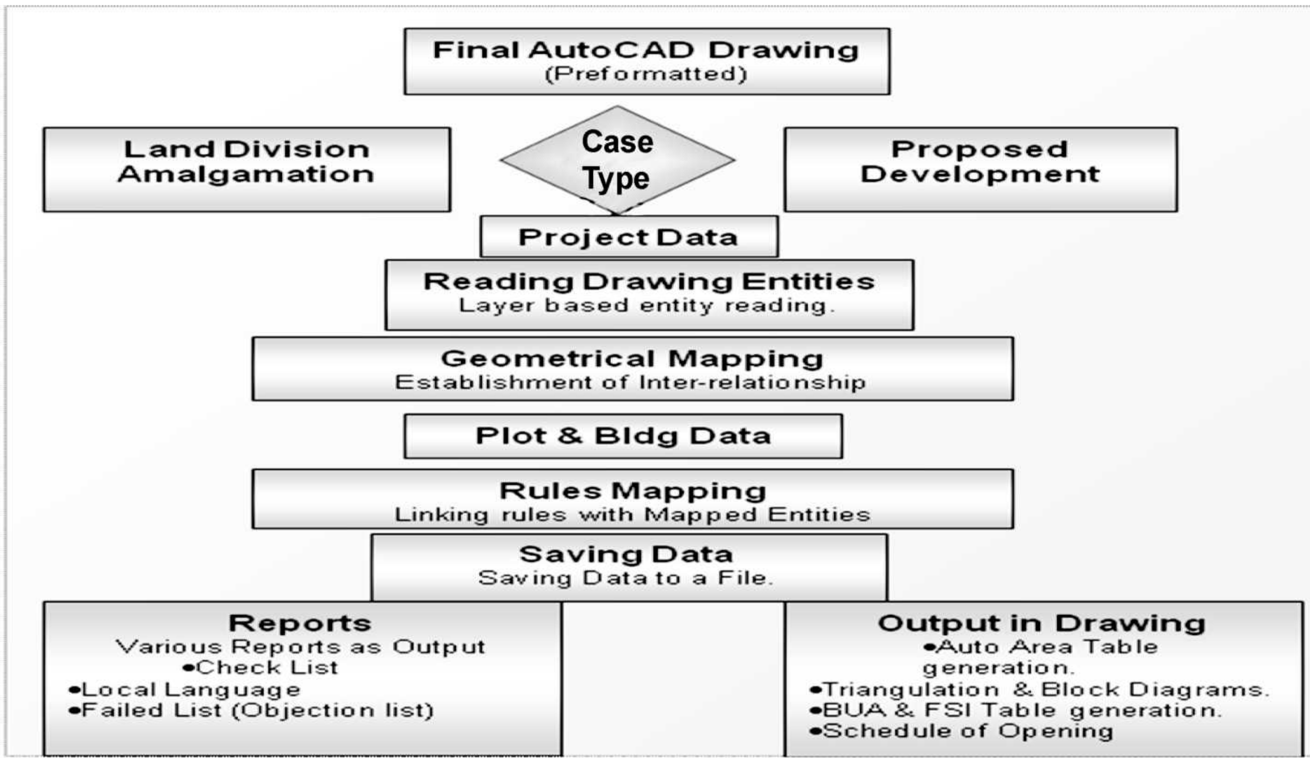


Figure 6.45 *Flowchart Showing Final auto CAD Automated Building Plan Scrutiny Tool*

Process flow of Drawing Scrutiny through AutoDCR

Architect needs to submit Preformatted Auto-CAD submission drawing which is opened in Auto-DCR through BPAMS. Case type, whether proposed development or amalgamation/subdivision is identi-fied. If proposed development, then building use (residential, commercial, etc.) ,building structure (low-rise, high-rise, etc.) is auto-detected by Auto-DCR from drawing. Workflow system and Auto-DCR is integrated to associate documental data with drawing. Auto-DCR reads data from drawing, establishes relationship between various entities. Analysis is done as per development control regulations by Auto-DCR. Tables and report are saved with drawing.

Some tables are generated in drawing like area statement, FSI table per building, summery of FSI calculations, opening schedules, water/parking calculations, triangulation area for plot, area block diagram with dimension, required margin regions, coverage per building, etc. Some reports are generated like drawing scrutiny report, failed list report, check list report which are send to work flow system for making status available online.

Novel features of AutoDCR

- Verifications are done according to project type- Building permission or subdivision amalgamation.
- Auto-Detection of building use: It can auto detect use of building (e.g., residential, commercial or Resi-comm. mixed) and can also auto detect Building Structure (e.g., High-rise Bldg. or Low-rise Bldg.) by drawings only.
- Auto-Triangulation: AutoDCR generates plot area diagram by triangulation method and plot area calculation itself for cross verification.
- Auto-Dimensioning with Block Diagram: AutoDCR generates block diagram for each floor and provide dimensions with area calculation.
- Auto-Generation of FSI and Built-up area table: AutoDCR automatically inserts FSI and built-up area tables with per floor detail for each building. Same way inserts FSI and built-up area table for whole project.
- Auto-Generation Plot Area Table: AutoDCR automatically detects the type of layout proposal – amalgamation or subdivision and creates standard area table as per the case.
- Auto-Generation of Area-Statement: AutoDCR automatically inserts area statement with all proposed and permissible value in traditional format.
- Auto-Generation of Schedule of Opening and Parking Table: AutoDCR automatically inserts schedule of opening for each building. Same way inserts proposed parking for whole project.
- Auto-Hatching to Particular Object: AutoDCR provides hatching to particular objects as described in D C rule book, e.g., green coloured hatch in main road, yellow coloured hatch in open space, etc.
- Auto-Linking : It can auto-link objects like each building with corresponding proposed work (Max. Coverage area) drawn in layout plan, each floor plans with its section, tank with its section, ramp with its section, stair, chowk, v shaft, etc.
- Section reading and Association: It reads section, associates each floor plan with floor section and gives height of building and each floor by auto dimensioning.
- Margin Generation: AutoDCR generates required margin from main road, plot boundary, open space, etc., itself. Even it shows proposed failed margin with auto dimensioning.
- Verification with Actual Coverage Area: AutoDCR verifies built up area (Max. Coverage area) proposed by auto-punching of each floor plan automatically.
- Checking Double Ht. and Verification of Chowk/ V shaft: AutoDCR checks double height of each terrace. It verifies each chowk and Vshafts for its clear height by auto punching of each floor plan automatically.
- Generation of Scrutiny Reports: AutoDCR generates the various scrutiny reports dynamically based on the DC Rules described by the respective authority. Generated report shows the failed/passed items with their rules in a very user friendly viewable/printable format. Reports can also be generated in local regional language. Customisation of reports can be made using user defined templates. Software reads the building entities from drawings, geometrically map each and every entity by corresponding with complex and interlinked rules. After scanning and saving the drawing, scrutiny reports are generated where all failed and passed rules are displayed with required/permissible values with proposed values so that architect can easily correct them.

Readers are advised to print this note at the end. Refer website of softtech for more details.

TEKLA

Website: *www.tekla.com*

Tekla

Tekla develops software solutions, products and services for customers' core business processes in building and construction and infrastructure management and energy distribution. Tekla's model-based software products are used in nearly 100 countries.

Tekla structures

Tekla Structures is Building Information Modeling (BIM) software that enables the creation and management of accurately detailed, highly constructable 3-D structural models regardless of material or structural complexity. Tekla models can be used to cover the entire building process from conceptual design to detailing, fabrication, erection and construction management.

Tekla Structures configurations

Tekla Structures is one product available in different configurations and localised environments that provide specialised set of functionality to suit the segment and culture-specific needs of the construction industry.

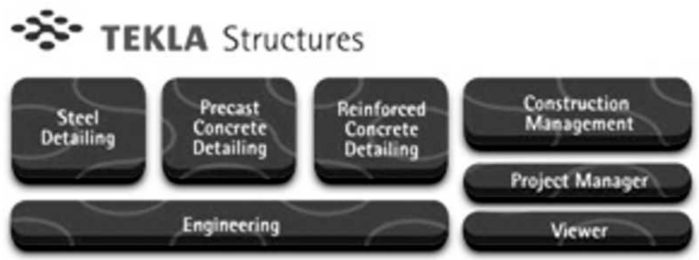


Figure 6.46 *Tekla Structures Functionality and Configurations*

Interoperability – the ability interact with 'best of breed' systems

Tekla Structures can be used to interface with other existing applications, or solely as a platform to develop a customisable internal solution. Its open platform supports interoperability and standardisation. Tekla Structures links with various systems through Tekla Open API™ application programming interface that is implemented using Microsoft® .NET technology. Examples of standard formats supported by Tekla Structures are IFC, CIS/2, SDNF and DSTV. Examples of proprietary formats supported by Tekla Structures are DWG, DXF and DGN.

Links between Tekla Structures and Architectural Software

This link is achieved through standard IFC files which allows the BIM models to be shared between the architect, engineer, structural contractor and any other interested party from conceptual design through manufacture, construction and into building maintenance and finally to the building decommissioning and demolition.

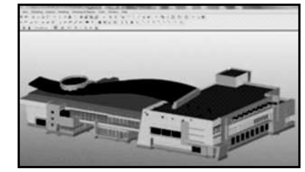


Figure 6.47 *Architectual model in Tekla Structures*

Links between Tekla Structures and MEP Software

This link is made available by a special variation of the IFC standard which is a compressed version of the IFCXML format. The reason for this variant is that MEP contractors usually do not have a strict schema and they require different forms of information to be passed, in different projects, as user defined attributes.

Figure 6.48 *Model in MEP Software*

Links to Analysis & Design systems (COM/API):

Common object models (COM) or API links can be written to allow Tekla Structures to communicate directly with various A&D systems. This link allows the physical model information for steel, concrete and timber to be transferred from the structural BIM model to various A&D systems, with the final member sizes being returned, if required, and the model updated, together with transferring all co-existing loads for the design of the objects connections.

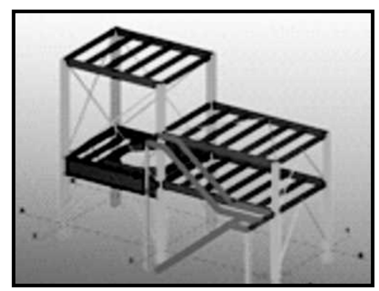


Figure 6.49 *Physical Structural Steelwork Model*

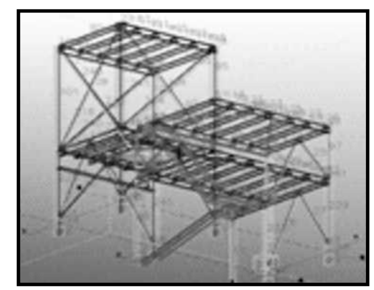


Figure 6.50 *Analytical Model*

TEKLA

Website: *www.tekla.com.*

Industry transfer standards

The latest and most complete transfer standard used within the BIM environment is the Industry Foundation Class (IFC) as defined by the buildingSmart organisation (*www.buildingsmart.com*), formally the International Alliance of Interoperability. The buildigSMART organisation defines themselves as "buildingSMART is all about the sharing of information between project team members and across the software applications that they commonly use for design, construction, procurement, maintenance and operations.

General Industry standards that are use for high-level or low-level information transfer are – cis/2; SDNF; DSTV; dwg; dxf; dgn; STEP and IGES using these standard will allow Tekla Structures to transfer data, at different levels, to many packages. This allows collision checks and reports to be completed in many different systems.

Quick overview of the standards

cis/2

The CIS (CIMsteel Integration Standards) are one of the results of the Eureka CIMsteel project. The current version 'cis/2' is an extended and enhanced second-generation release of the CIS. Developed to facilitate a more integrated method of working through the sharing and management of information within, and between, companies involved in the planning, design, analysis and construction of steel framed buildings and structures.

SDNF

Steel Detailing Neutral File (SDNF) was originally defined by Intergraph®, for electronic data exchange between structural engineer's analysis and design systems to steelwork modelling systems. Version 3.0 is the latest format supported by the software industry and this format has been used for many years for transferring even complex plant structures between system like Tekla Structures and plant design systems.

DSTV

(Deutscher STahlbau-Verband) manufacturing format is the standard format used for manufacturing steel components on numerically control (NC) machines. It also has an A&D format that is used for transferring the A&D model to the physical 3D model.

DWG

The dwg format is Autodesk's® standard file transfer vehicle, used mainly between 2-D applications. It is also possible to create 3-D files and both formats can be used as reference files within modeling applications and these types of files only contain geometric information.

DXF

The Drawing exchange Format (dxf) is mainly used to transfer 2-D information between users or as reference objects within 3-D modelling systems as again only geometric information is included.

DGN

MicroStation's® native file format, which can either be used to exchange information with other systems or used as a reference object with modelling applications. As well as BRep (boundary representation) geometry information some user-defined attributes and ID numbers can also be included.

STEP

The International Standardisation Organisation (ISO) is concerned with creating standards for the computer interpretable representation and exchange of product manufacturing information, so STEP files are available across many manufacturing industries.

IGES

Initial Graphics Exchange Specification (IGES) defines a neutral data format that allows the digital exchange of information among CAD system. It was defined by the U S National Bureau of Standards and has largely been replaced by STEP over recent years.

Open Application Programming Interfaces (API)

API's act as a vehicle, fundamentally to transfer 3-D geometry or object variables and relevant information between applications, allowing for bespoke internal, client and third-party development, which are normally written adopting .NET development platform. .NET is a flexible programming platform for connecting applications; systems; devices; information and people together using a modern programming environment and tools.

Before API's were available, COM technology was used to link applications, each component was connected with a form of plumbing which was easily broken and always application version dependant. .NET applications are built directly on top of the computers operating system so multiple platforms and devices are supported allowing a more flexible approach.

Figure 6.51 *Excel input sheet*

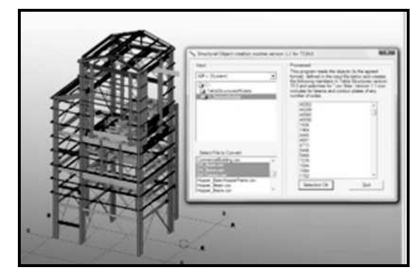


Figure 6.52 *Shows an application that has been written to read the values of an Excel sheet which defines the objects – size; grade; orientation; offsets together with its start and end positions. The defined objects are then created in the model as below.*

Drawing production

Tekla Structures has intelligent objects and connections since the applications launch which can be traced back to the mid 90's. The multi-material objects will automatically detect any modification in the connected elements, or its own position, and will automatically reposition themselves to the new situation. This helps the user to keep the structure consistent when layouts or sections are revised, especially when the drawings are directly linked to the physical model. So any modification to the model will automatically be reflected on the general arrangement and manufacturing drawings or details. This ensures consistency between the model and the documentation.

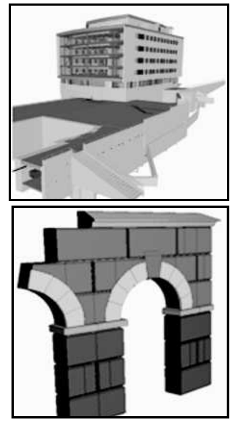
TEKLA

Website: *www.tekla.com.*

Structural Building Information modelling with Tekla Structures

What is BIM?

BIM is a collaborative tool used by any member of the architectural, engineering and construction (**AEC**) industry based upon a number of software solutions. BIM incorporates all the building components (or objects), including their geometry, spatial relationships, properties and quantities, including all the services and equipment information for the full life-cycle management of the building and even its demolition. One of the main advantages of this way of working is that different members of the AEC design teams can utilise physical or reference models from other team members, without having any specialised industry knowledge. For example, the integration of services and structure schemes could first be co-ordinated by simply checking the objects from the two schemes to ensure clash avoidance.



Figures 6.53 *BIM models*

It is commonly acknowledged that the only solution for managing building information efficiently is with product modelling. This type of modelling was originally developed as a solution for the mechanical and plant design sectors. Since the early 1990s, structural steelwork detailing has made a remarkable shift from 2-D drawing to 3-D product modelling and a finite number of software solutions have played a pivotal role in facilitating this change.

Structural BIM

The use of a single 'total' BIM on large projects, containing all the architectural, structural and services object information, is still some time away and may never be totally available, owing to the mass of information and subsequent data compression that will be required. When this type of solution occurs various linked databases will exist, as all interfaces will be modelled on their sector's 'best of breed' solutions, one of which will be the structural BIM. Structural BIM is the most important area for structural engineers and their immediate supply chain and is currently available. This multi-material (steel, concrete, timber, masonry, etc.) subset can include the physical and analysis and design (**A&D**) information, and can be used for all drawing and report production.

Structural BIM is the part of the BIM process, where the majority of multimaterial structural information is created and refined to form the actual structure. Architects' models are not included in the scope of structural BIM, as these are not based on the same concept as this model. Architects work with space, mass, texture and shapes; they do not work with building objects in the same way as defined in the structural BIM. However, the connection between architects' models and structural BIM is a very obvious way to help in the future development of intelligent integration and these should always be available in the form of reference models, in the same way that the XREF function is used in a 2-D drawing. These reference models could also be 2-D information for collaboration with non-BIM applications.

The model starts to evolve during the engineering stage, where conceptual decisions of the structural forms are made. It is sometimes thought that the design portion of A&D is just the pure physical sizing of the structural elements. In practice it is more than that, as it should also include the engineering and the value engineering of the project, including all materials, their relationships and their reference to the architectural objects.

The load-bearing structures are designed and integrated into the model and A&D plays a significant role at this stage, though not in the classical sense of using separate independent tools. Structural BIM A&D, is not a primary phase in the process, just another output that could be generated and maintained through the physical model. When changes occur, they are made directly in the structural BIM model, with all A&D results and all other output updated accordingly, as parametric objects can adapt and react to change.

Open interfaces are fundamental for a structural BIM solution, not only from an interoperability point of view, however also from that of customization and localisation. It is also easy to use open interfaces, which provide the opportunity to supplement the functionality of the structural BIM system with plugin software modules.

Structural BIM is not an island of interoperability, so it needs to interface and synchronize with other applications and information. In the past, the Steel Detailing Neutral File (SDNF) and CIMsteel Integrated Standard Release 23 (cis/2), together with other industry or proprietary neutral file transfer formats, have been adopted to transfer 3D element information, sometimes adopting agreed Globally Unique Identification (**GUID**) numbers to track element history between the analytical and physical models and to monitor change.

The problem is that these formats have mainly been defined around the structural steelwork market requirements, as this was the lead sector. A multimaterial solution will always be required as even the structural steelwork contractors need to model their industries' interfaces. These formats have provided a firm foundation for data interoperability; however, technically the future for data transfer has to be with the IFC developments, as this is the only way to support the round trip of true multimaterial objects.

With the use of IFC and .NET technologies, BIM will become more transparent and complete within the next few years, as these two developments will greatly advance the interoperability of the BIM platform. The structural BIM is also not restricted just to members, as loads and load combinations can normally be handled within the modelling application.

Figure 6.54 *Some global BIM models*

TEKLA

Website: *www.tekla.com.*

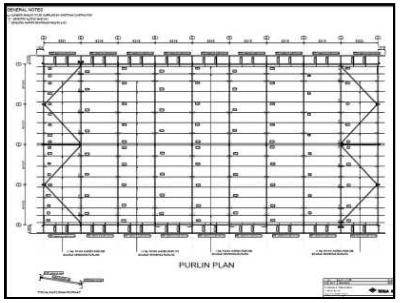


Figure 6.55 *General Arrangements Drawing*

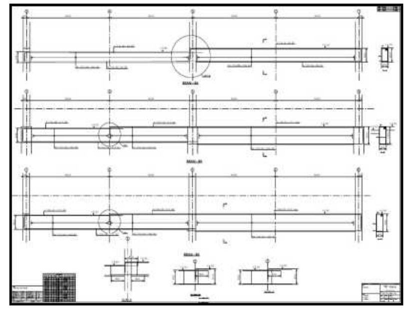


Figure 6.56 *Concrete Manufacturing Details*

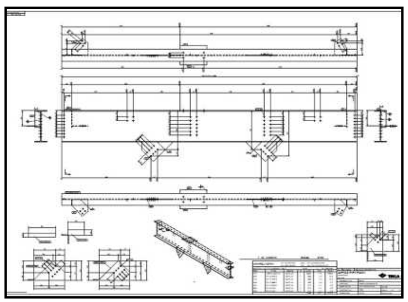


Figure 6.57 *Steel Fabrication Details*

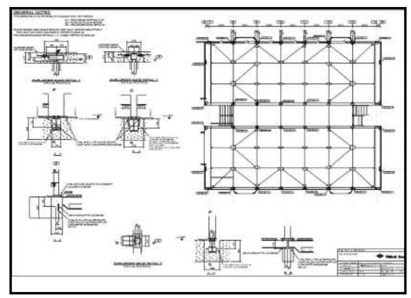


Figure 6.58 *Foundation Drawing*

Reference Cases:

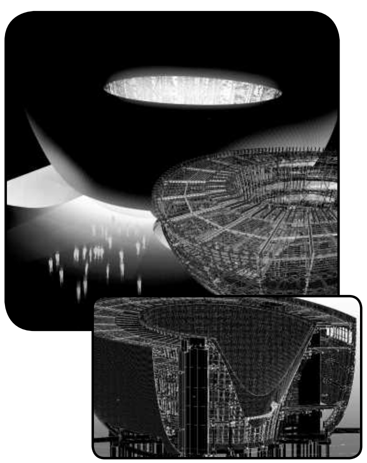


Figure 6.59

Finland Pavilion in Shanghai World Expo 2010

Finland's pavilion for the Shanghai World Expo 2010 is called Kirnu, or 'Giant's kettle'. Tekla Structures BIM (Building Information Modeling) software is being used to model and manage its structural information in 3-D throughout the project. The use of Tekla Structures supports the pavilion being constructed as a laboratory for sustainable building.

A World-Class Landmark: Mumbai Airport Terminal Building

Mumbai's Chatrapati Shivaji International Airport (formerly Sahar International Airport) is the busiest airport in India, and caters to cargo and passenger flights. It has two terminals: the Domestic Terminal and the International Terminal. The domestic terminal includes two terminals: Terminal 1A and Terminal 1B. After the expansion and modification of Terminal 1B it was opened to the public on September 17th 2007. Tekla Structures software was used to model this complex framework, thus ensuring highly effective detailing and optimised fabrication of this exceptional structure.

Figure 6.60

World's Highest Railway Bridge crossing Chenab Bridge

Figure 6.61

The world's highest railway bridge crossing over the **Chenab** river in India is under construction.The Chenab bridge is extremely challenging logistically, as the terrain is rough and the roads are poor. The structure was modelled with Tekla Structures in its entirety, including base structures and also parts of the existing structure. During the different phases of construction, the bridge geometry was measured several times, and the results were compared with the Tekla model.

CADSENSE TECHNOLOGIES

CADSENSE ARCHITECTURAL DRAFTING PACKAGE

CADSense-ADP is the milestone of our technical ability and performance. This masterpiece is an enhanced output of Late Mr Shrikant Kelkar's Architectural Drafting Package. This is the first fully indigenous 2-D drafting package, made by Indian Programmers in consultation with Indian professionals. It is a stand-alone windows based CAD software not requiring AutoCAD or any other CAD software as its base.

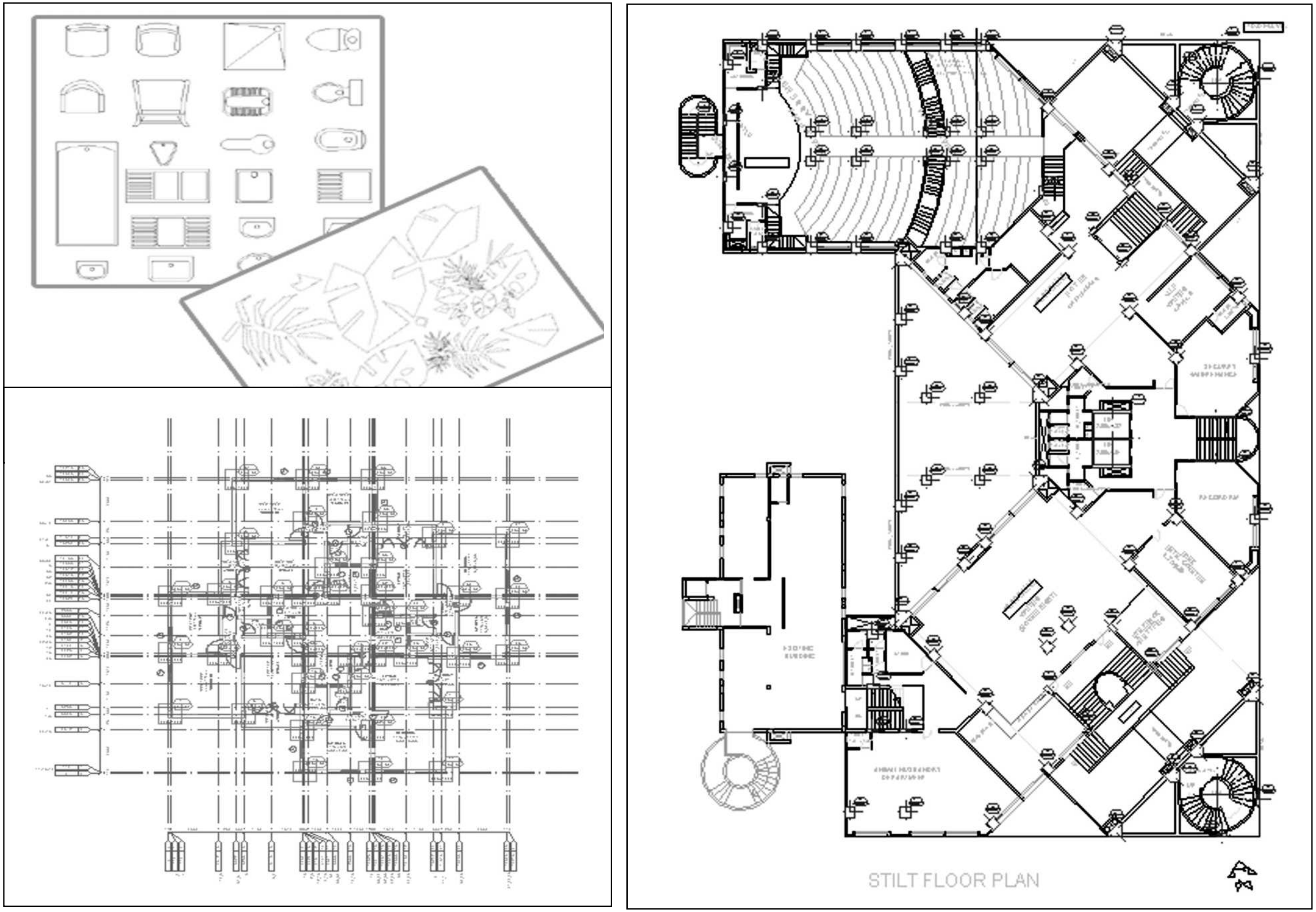
We have many drafting solutions available in the market. But unfortunately, all these software solutions are generalised and developed for international drafting standards. The usability of these softwares are reduced at our domestic level because most of the time consuming and specific demands of architects and local Municipal Corporations may not be covered by them.

Architects have to do some time consuming and tedious drafting jobs like door, window and opening insertions, column creation, centerline plan with measurements, built-up area calculation and statement using triangular formation method and so on. Thus, it becomes important to develop a perfect software solution for draftsmen, customised to satisfy their specific architectural drafting needs and to give automatic calculations and schedules.

After consultation with reputed and experienced architects and civil engineers, we initiated research and development work to build a product that will be user friendly, fulfilling all the 2-D drafting needs of Indian Architects. After comprehensive study of architectural process and demands now we are ready with our first model of Architectural Drafting Package.

The CADSense- ADP is furnished with

- **All 2-D Drafting Commands** Like line, arc, circle, pline, Bspline, points, blocks, etc. with layer manipulations and further modification commands like trim, chamfer, fillet, break, mirror, array, offset, extend, move, rotate, scale, stretch, and dimensions with easy zooming and panning.
- **Special Delivery Text:** Choose from any font, just click anywhere on the screen with angle and start writing.
- **Rooms and Outer Walls:** Give or show room dimensions and insertion point for room. No need of operations like offset, trim and break of lines to draw the room and outer walls.
- **Door, Window and Openings:** Directly inserts doors windows and openings with proper trimming and healing of walls. After insertion also generates the DOW schedules.
- **Columns Creation and Insertion:** Columns can be created by giving horizontal and vertical dimensions for rectangular shaped and diameter for circular shaped columns.
- **Center Line Plan:** This tedious and time consuming job has been reduced to a fraction of a second miracle. The centerline can be drawn at any angle, if you require to align with existing roads, etc., and through all columns or using selected columns, along with a shift and measurement distances.
- **Built Up Area Key Plan:** Built-up area calculation and statement is drawn in the format of local Municipal Corporation. Key plan and statement are shown with triangulation for odd shaped areas. This is a huge time saver for complicated shaped areas like trapezoids or quadrilaterals and directly gives area of curvatures like arc and circles.
- **Printing:** There is a page window option to get an exact window portion of your drawing or window at selected scale.
- **Import and Export:** This feature allows you to communicate with other CAD software solutions. Because of this feature, you can export ADP drawing to AutoCAD and also import AutoCAD drawing to ADP. This and the center line feature are the USP of this software and therefore very popular with all draughtsman.



CADSense Technologies, Pune
Email: neelesh.zende@gmail.com
Cadsense@india.com

Figure 6.62 *Drafting of Plans using CAD Sense - ADP*

Neil Automation Technology Ltd.
Infrastructure Software Division

Eagle Point Software

Architecture Power Suite

ArchPro is a comprehensive architecture module with power, flexibility and can be easily used. This is not found in other software packages. ArchPro's industry leading user interface makes it the easiest package to learn on the market. Some of the features included in ArchPro are walls, doors, and windows created with polymeshes rather than polyline extrusions, roofs, stairs, steel/joist and grider databases, extrusions utility, meshmaker utility, symbols library with nearly 3000 symbols in plan, elevation and 3-D, keynoting and completely customised schedule routines, and so on.

Quantity Takeoff reduces the time spent on calculating lengths, areas and volumes for items within a project, report tabulation of materials, unit cost for specific items, labour costs and/or totals for the entire project. It automatically recalculates after any modification.

HVACPro reduces the time spent on drawing ductwork. Its 3-D capabilities allow you to draw or auto-route ducts in any direction while automatically checking for interference problems.

PipePro is a full 3-D module that allows you to draw or auto route piping systems in any direction while automatically checking for interference problems.

Virtual Simulator allows you to walk through, drive by, fly over, peer into, etc. any AutoCAD 3-D drawing IN REAL TIME by simply using your mouse. You can take your clients on a tour of a project that has yet to be constructed and perform "what if?" scenarios while viewing the results.

Presentation

Picture Perfect is the fastest and easiest home and landscape design visualisation package available. By allowing your client to see the completed project before construction, you will shorten the sales cycle and help the clients envision their project, preventing time consuming revisions.

Land CADD

Site analysis works with any gridded terrain model. It analyses the slope, aspect elevation, visibility shadow, proximity and map overlays, site analysis map symbols and watershed flow direction. Additionally, it calculates actual surface area as well as plan area. It can be used in conjunction with surface modelling.

Site planning is used to assist the landscape architect in the layout of recreational areas, golf courses, sports complexes and parking lots and allows for the easy placements of buildings, utilities and hardscapes. It is a must for all planners.

Landscape design allows you to design in 2-D and 3-D, simultaneously. You can view your site in multiple windows while you design. Changes made in any window are automatically reflected in all windows. A planned growth simulator and a database for plant selection are provided. The plant database contains information on approximately 1,100 plants, covering every climatic zone around the world.

Irrigation design provides powerful tools for designers to layout, design and perform calculations on any size irrigation project using popular manufacturers equipment. Once you select a boundary the programme automatically inserts sprinkler heads at all the appropriate places. Once pipes are laid out, they are automatically sized for each zone.

Construction details is a set of over 600 high quality, predrawn details available for the sub-groups—civil, site design and irrigation. These high quality details save many hours of tedious digitising work and are easy to modify and available on a variety of topics. Details are quickly inserted in the drawing or combined to create a complete sheet of details. A printout of each drawing is provided.

Site Designer is a stand alone window based solution for landscape planning and site design. Anything drawn by hand can now be handled with greater accuracy. Designing and drafting are done in a single step.

Surveying

Data collection allows you to collect topographic, line and arc data. You can load the data to your computer and create a drawing within seconds. It supports all popular data collectors.

COGO, the backbone of our surveying series, takes standard industry routines to a new level. Input data as well as create and search drawings. The sophisticated lot layout makes this module a must for architects and engineers.

Drafting enhances any drawing with annotation, sheet borders, symbol/cell libraries, custom line types and layering standards to help you create professionally finished drawings. Dynamic annotation links line, arc, polyline/chain and COGO nodes to the information; when modifications are made to the ArchPro drawing, any affected annotation automatically corrects itself.

Survey adjustment's tools provide mathematical routines to balance and adjust traverses and side shots. This module includes detailed report output and audit trail before and after adjustments. Minimum square adjustments are included.

Data transfer provides bi-directional file transfer capabilities and supports a a vast library of standard exchange format for both cross-section and coordinate information. You can create your own custom format to meet your needs. It creates node reports with ease.

ProSurveyor offers a complete stand alone solution with full 3-D layout and design capabilities. It has downloads from all popular data collectors. This module includes complete annotation and legal descriptions. 100% AutoCAD and Windows compatible.

ProSurveyor Plus incorporates all the features of ProSurveyor with the addition of several powerful features, including TIN's contours, rectangular grids, volume calculations, etc. 100% AutoCad and Windows compatible.

Hydraulics and Hydrology
Watershed Modelling
Storm Sewers
Sanitary Sewers
Water Surface Profiling

Site Planning and Roadway Design
Surface modelling
Site Design
Quantity Take-off
Road Calc
Profiles

Predesign, Planning and Management
Water System Management
Parcel Records Management
Land Use Planning
Storm Sewer Management
Sanitary Sewer Management
Street Maintenance and Management
Building/Leasing Management
Telephone System Management
Natural Gas Pipeline Management
Electrical Distribution Management

Street Light/Signage Management
Address Location Management
Imaging
Rx Auto Image
Rx Auto Image Corex
Rx Auto Image Edit
Rx Auto Image Pro

In case you require further information regarding pricing/live demonstration on Eagle-Point Software, you can contact at the given address.

Datapro Infoworld Limited

"Yojana" for Construction Industries

Yojana is a Windows-based Project Management Software whose features compare with the best in the world. Yojana offers time analysis, resource levelling and cost monitoring with cashflow projections. It has powerful tools, which include Zoned PERT, Time scale PERT, Gantt charts and Work Breakdown Structures. Yojana is targeted at the engineering and construction projects in chemical, petrochemical, construction and power segments to name a few. It is already being used for critical monitoring of over 300 large projects in private and public sectors. Some of its customers in construction industry include Tata Housing. Gherzi Eastern, Simplex concrete, Trafalgar House, Lok Housing, Madhav Patil Group, Penden Cement, L & T and ACC. With Yojana you can take challenges to manage and monitor even the most complex projects easily and effectively. For achieving your project goals, Yojana offers you options for managing various resources with different availability constraints. Yojana helps project managers to make quick, critical and timely decisions based on information available about schedules, progress and resource requirements. Yojana helps in saving cost and time overruns in project implementatior. It warns of the project's slippage, before it leads to a crisis situation. Yojana is especially suitable for the construction industry in India as it provides for quantity driven activities and also allows for up to 100 cost profiles for resources. Yojana is unique in providing integrated time, resource and cost management. Yojana can be used at corporate levels and at sites. Yojana helps project managers in optimum utilization of resources to ensure that projects are completed on time. Its powerful reporting capabilities allow project managers to actually put Yojana at project sites for on-line decision making.

Yojana is available under LAN, NT servers and single user windows platform. The upcoming new version of Yojana will have ODBC client/Server access to popular RDBMS's and also provide for internet/e-mail gateways. Datapro Infoworld Limited markets Yojana through its various branches and selected business partners in India. The product is marketed overseas through internet.

Autodesk—Total CAD Solution

"As creator of physical space, building design professionals have a profound impact on how we experience the world. New construction techniques and evolving architectural styles continually redefine the interface between the built and the natural worlds. Architects need to conceptualize and communicate their design ideas accurately and respond quickly to client input. Building system engineers need to balance performance requirements with the architect's vision and client demands. And all this must be done in less time than ever before."

Autodesk's Building Design Solutions help you focus on distinctive design, while providing the flexibility and productivity you need to get your designs documented and out the door.

Training Courses

Autodesk offers training courses in the following.

BASIC AutoCAD (2D) Overview of AutoCAD, its peripherals, CAD applications, drawing editor, coordinate systems, two dimensional drawing commands, utility, display, editing, inquiry commands, selection sets, object snap, blocks, symbols, layers, colour and line types, hatching, dimensioning, calculator. Isometric drawings, text, basic plotting and printing techniques.

Advanced AutoCAD (3D) XYZ point filters, Object filters, intermediate usage of blocks and symbols, attributes and data extraction, multiline, menu customisation techniques, UCS commands, part modelling and assembly modelling, surface modelling, intermediate file management techniques, systems variables, model space and paper space concepts, external references, rasper and save image, slides, script files, shading and rendering, lights, camera, material effects, aerial view, perspective view, sectional views, mass properties.

Customisation Tablet menus, screen menus, pop-up menus, pull-down menus, buttons, macros, lisp in macros, system configuration of computerware, introduction to AutoLISP, dialogue control language, Direct interpretativeiy evaluated string expression language interfacing with other Autodesk products.

AutoLISP Lists, atoms and function, arithmetic functions, data types, setting and using variables inside AutoCAD, creating and loading functions, using AutoCAD commands inside of AutoLISP, the "GET" functions, local and global variables, arguments, if/then statements.

Release Updates About the latest release of AutoCAD: lecture, demonstration, hands-on class to cover the new commands, features, concepts and modifications of AutoCAD's latest release.

3D Studio (Max/Viz) 3D Studio interface, 2D shapes, lofting 2D shapes into 3D objects, manipulating objects in the 3D editor, assigning materials, lighting, rendering scenes, animating scenes/creating walkthroughs, applying materials and textures, input and output techniques, CAD importing or/and exporting to CAD.

Mechanical Desktop 3.0 Parametric, feature-base solid modelling, NURBS surface modelling, associative drafting, Real time rendering, exploded view.

Unnati CAD Marketing Services (UCMS)

UCMS is Autodesk Authorised Dealer for the entire range of Autodesk Software. UCMS offer the licensed copies of latest Autodesk software like.

1. **AutoCAD Rel. 14, AutoCAD 2000** Drafting and Detailing Software.
2. **Max 2.5 and Viz R-2** It is meant for 3D design and conceptualisation, intuitive modelling, photo-realistic rendering and animation. One can create stunning presentations and visuals, high quality rendering and walk throughs that clearly represent one's design ideas.
3. **AutoCAD Architectural Desktop** With its intelligent AEC objects, content and annotation routines, and 3D conceptual massing tools, this software supports the entire architectural design process. With the help of this object, drawing content can be automatically linked to the architectural schedules all exported to databases, letting one produce construction documents and estimates faster and more accurately. Drawings and models created in this software can be shared seamlessly with colleagues, extending the benefits of intelligent AEC object to the entire design team.
4. **Land Development Desktop** Infrastructure design and the accompanying land development work demands a seamless bland of form and the function often on a massive scale. Such projects require the skills not only of designers but also of land and urban planners, surveyors, civil and environmental engineers and mappers. This extended team

needs comprehensive software solutions—for structural design, for terrain modelling and topographic analyses, for environmental assessment, for creating coordinate geometry, and for creating more an environment that promotes collaborative efforts and the mutual sharing of data. This software has powerful and intuitive tools plus intelligent object models, for creating base geometry and terrain models, for mapping, planning, editing and visualizing. It helps you automate your tasks creating volumes and contours. The project database centralizes the location of foundational data the team creates, making it easy to access and manage all of the information related to a particular project.

5. **Autodesk Civil Design** It extends the functionality of AutoCAD Land Development desktop with tools for completing complex designs, analyses and drafting tasks of engineering projects, including roadway design, grading schemes, site layouts, sewer designs, ponds and drainage structures and more. It can access project's reference data from the existing folders in land development desktop but it does not have to be imported in your drawings. This streamlines your drafting processes, eliminates errors, improves productivity and gives you more time to explore and optimize your design.
6. **Autodesk Survey** It is an add-on application for AutoCAD Land Development desktop. It provides focus survey data inputs, reduction and analyses capabilities for a wide range of surveying projects. Data can be automatically downloaded to and from a host of industry STD. Data collector, survey instruments, GPS receivers, allowing line work and field coding features for automatic mapping are the special features of this software.
7. **AutoCAD Map** This software lets you quickly and accurately automate the creation and maintenance's of MAPs that contain very large amounts of data and cover large geographic area. With this software, you can also work with multiple maps and multiple users can access the same MAP simultaneously without versioning conflicts. It also links attribute data to geographic features which allows you to make your maps intelligent. This software integrates a wide variety of data types and formats from different sources, one can leverage the value of existing data and easily share data with others.
8. **Unnati CAD Digitizing Services (UCDS)** UCDS takes care of Digitizing, i.e. conversion of manually made engineering drawings into AutoCAD format. It can also develop LISP routines for companies according to their applications.

Adil Kapuswala
Director
SFX-Arch, Imaging and Visualisation

Architectural Presentation-A Modern Approach

In this modern age of technology, the mode of architectural presentation has undergone a drastic change. With the advent of computers, walkthroughs, flybys, etc. are the order of the day. Traditionally, the art of perspective making is out of place in this fast paced world.

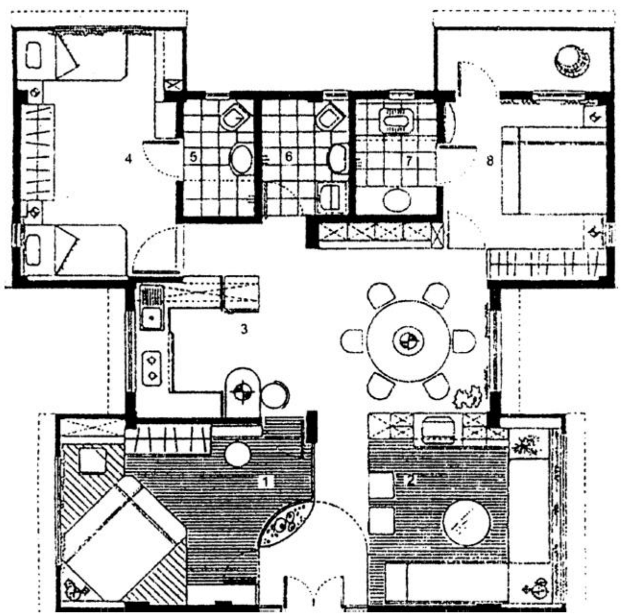
In schools and colleges of engineering and architecture, there is a definite emphasis on presentation. In the engineering sciences, accuracy and clarity is required, whereas in the architectural presentation, realism of colour, texture and geometry is harped upon. What is required is an amalgamation of both—accuracy and art. Computers can achieve both these efficiently. Also the time taken is tremendously reduced due to low editing and modification time required.

In the accompanying example, the colours look vibrant due to adaptation from nature. The landscape has been borrowed from landscape books. The elements— people, the sky, etc., have all been scanned in for various effects. Therefore the overall impression is more realistic. The procedure to achieve this is mentioned below:

1. Create geometry, i.e., geometrical designs in any CAD software (AutoCAD preferable)-for accuracy and assembling of individual objects.
2. Export geometry to a rendering Software (3-D Studio, topas, lightwave 3-D, etc.) for applying realistic textures and materials to the various objects.
3. Create images which explain the entire geometry.
4. Use paint software (photoshop, picture publisher, fractal design) to add special effects.
5. Use high-end printers to get long lasting prints.

The time taken for accomplishing a computer generated image could be 2-7 days depending upon the complexity of the geometry and the extent of your library. Finally, the most important element is your dedication to this field.

7 PREPARATION OF SUBMISSION AND WORKING DRAWINGS



Art

"Our loveliest works of art show how independent factors can unite in an object of unique beauty in a way that is impossible to analyse."

Ref: Simone Weil

Interior Designing

"Houses are being carved up into apartments, apartments into studios, and family houses are getting smaller every year. Interior design is now no longer focussed merely on decorative issues, but on the way you actually use and maximise your living space to create an atmosphere that feels airy and spacious, even if the room is not.

Interior Designer: Alexandra Campbell
Book: *East Meets West*, (Rizzoli, New York)

Topics covered in this chapter

7.1 DRAWING-GRAPHICAL LANGUAGE FOR CONSTRUCTION

Building plans and working drawings are important legal documents. Correct drawings save cost, labour and time in the office as well as on the site. They act as valuable tool during construction. Hence, architects, draftsmen, civil engineers, structural engineers, supervisors, contractors and clerks of works, have to understand the basics of this graphical language of engineers;

Why to draw?
What to draw?
How to draw? and
How to read what is drawn?

Chart 7.1 shows answers for the above mentioned questions. Ideas are brought into reality through drawings. Few lines drawn on graph paper or in the sketch book are the originals of the newly completed huge structure. The construction work is completed with the co-operation of various people, ranging from workers to specialists. Everyone looks at the structure with pride and feels, "I have contributed and helped to erect this structure." This is a moment of satisfaction in everybody's job. The architect is the key figure. His skill in handling many persons is always put to test. Also, technology is changing fast. Computers for planning, designing, estimating, drawing, accounts, etc., xeroxing for quick copies of documents and drawings, fax machines, e-mails, mobile phones for contacting people and messages, critical path method and charts to control the progress of work are important changes in the field of construction. One can plan and fix visits of specialists well in advance. One can also plan for purchase of materials well in advance and quite in time without blocking the capital. This requires well-dimensioned drawings and correct estimation. The set of drawings is a legal document between the owner, the architect and the contractor. Hence, an experienced architect always ensures correct working drawings and estimates in spite of the greater time factor input to avoid further wastage of time in delay and litigation, involving financial liabilities. The most important variable factor in recent years is the availability of raw materials, and their varying rates. Basic rates for the same materials are quoted in the tender so as to claim for variation in the rate.

Hence, it is interesting to study this graphical language for construction work, language developed with the help of different types of lines, symbols and conventional signs. This language needs grammar; hence, there are rules for preparing different types of drawings. They are known as 'Indian Standards for Architectural and Building Drawing.' (IS 962 : 1989 — code of practice for architecture and building drawing).

7.2 ORTHOGRAPHIC METHOD

A pictorial drawing showing the proposed building, garden, road, etc., in the most realistic way is a requirement of the owner, but from the construction point of view such a beautiful drawing without any dimension and construction notes is of no use. To render the required technical description graphically, graphical language using the method of orthographic projection is used. It is found to be a very clear method of expression.

7.2.1 Multi-view Projection

'Ortho' means 'perpendicular' or at 'right angles'. Horizontal, vertical, and profile planes are extended beyond their line of intersection and four different quadrants are formed. An object is assumed to be placed in one quadrant as shown in Fig. 7.1 and rays parallel to each other and perpendicular to the object are drawn to meet the different planes. These parallel rays are known as *projectors* and the final image created by these projectors on the planes is known as an *orthographic projection*.

If the object, say a building, is kept in one of the quadrants, for example, in the first or third quadrant, as shown in Fig. 7.1, then the orthographic projections on the different planes will be plans and elevations.

7.2.2 First Angle Projection

First angle projection is that in which the view is so placed that it represents the side of the object remote from it in the adjacent view with reference to the front view (Figs. 7.1, 7.2, 7.3). The other views are arranged as follows:

1. The view from above placed underneath.
2. The view from below placed above.
3. The view from the left placed on the right side.
4. The view from the right placed on the left side, and
5. The view from the rear may be placed on the left or on the right as found convenient.

7.2.3 Third Angle Projection

If the same object is now kept in the third quadrant, the orthographic projections on the different planes will be as shown in (Figs. 7.1, 7.2, 7.3). Third angle projection is that in which each view is placed so that it represents the side of the object near it in the adjacent view. This method has the important advantage that the features of adjacent views are in juxtaposition. It is thus easier than the first angle projection in projecting one view from the other while drawing and is also easier in associating those features when dimensioning or reading drawings with reference to the front view.

The other views are arranged as follows:

1. The view from above placed above.
2. The view from below placed underneath.
3. The view from the left placed on the left side.
4. The view from the right placed on the right side; and
5. The view from the rear may be placed on the left or on the right side as found convenient.

The third angle projection is generally recommended as a standard method of projection. While drawing these different views, hidden surfaces are shown by dashed lines, having uniform dashes, leaving very little space between each dash. The ends of each dash should be made prominent.

7.3 PLAN, ELEVATION AND SECTION

7.3.1 Architectural Views-Combination of First and Third Angle Projection

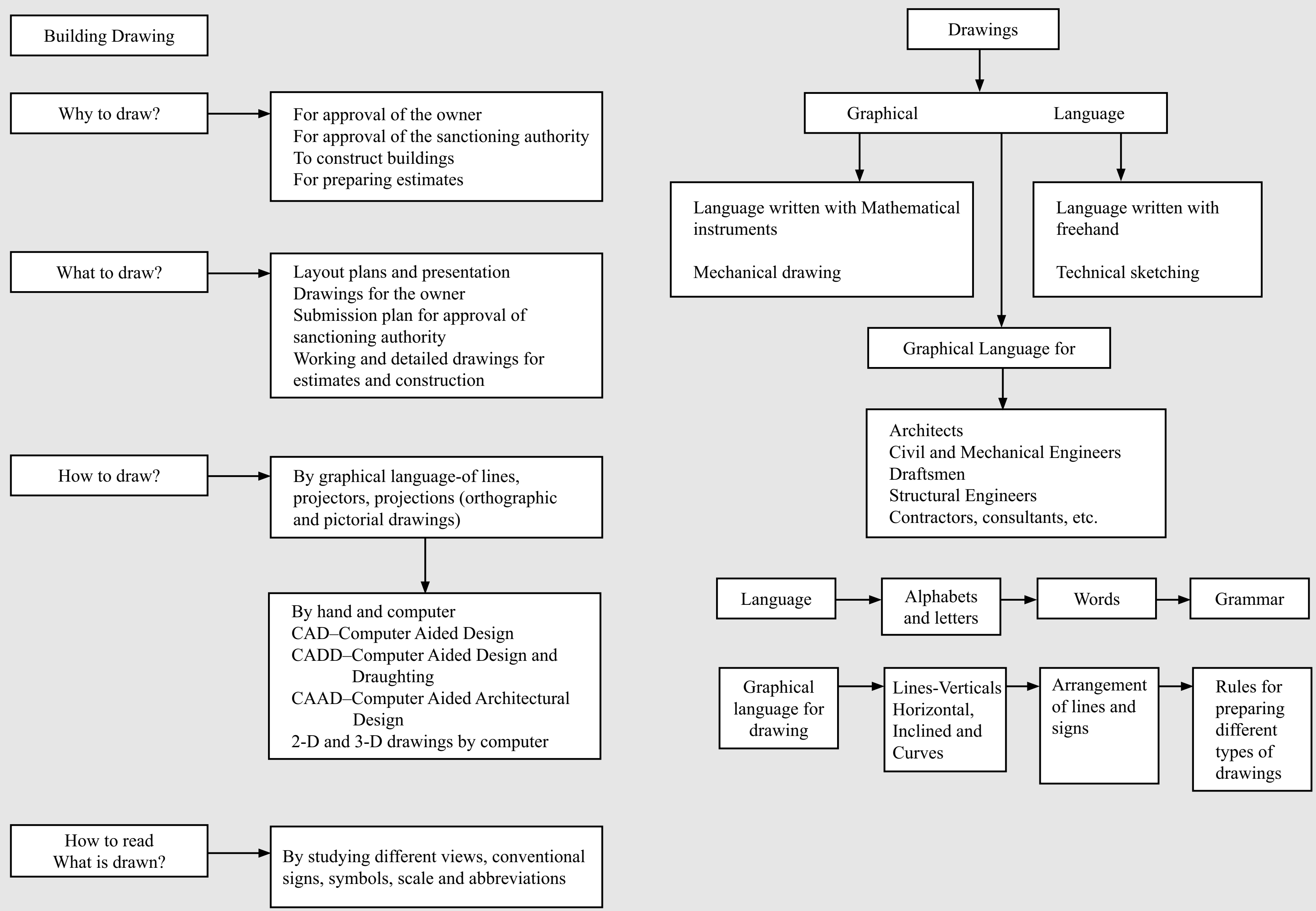
In architectural drawings, views projected to horizontal planes and observed from the top (or bottom) are called 'plans' and orthographic views projected to vertical planes such as the front side and rear views, are called 'elevations', such as front elevation, side elevation, and rear elevation.

First angle projection method which was used in the beginning was replaced by the third angle projection method. Later, it was found convenient to use the combination of the first and third angle projection for building drawing, having the merits of both these methods.

In this method, in relation to the elevation, end views are so placed that they are in third angle projection and the plan is placed as per first angle projection (Fig. 7.2). All elevations

Chart 7.1

BUILDING DRAWING-GRAPHICAL LANGUAGE



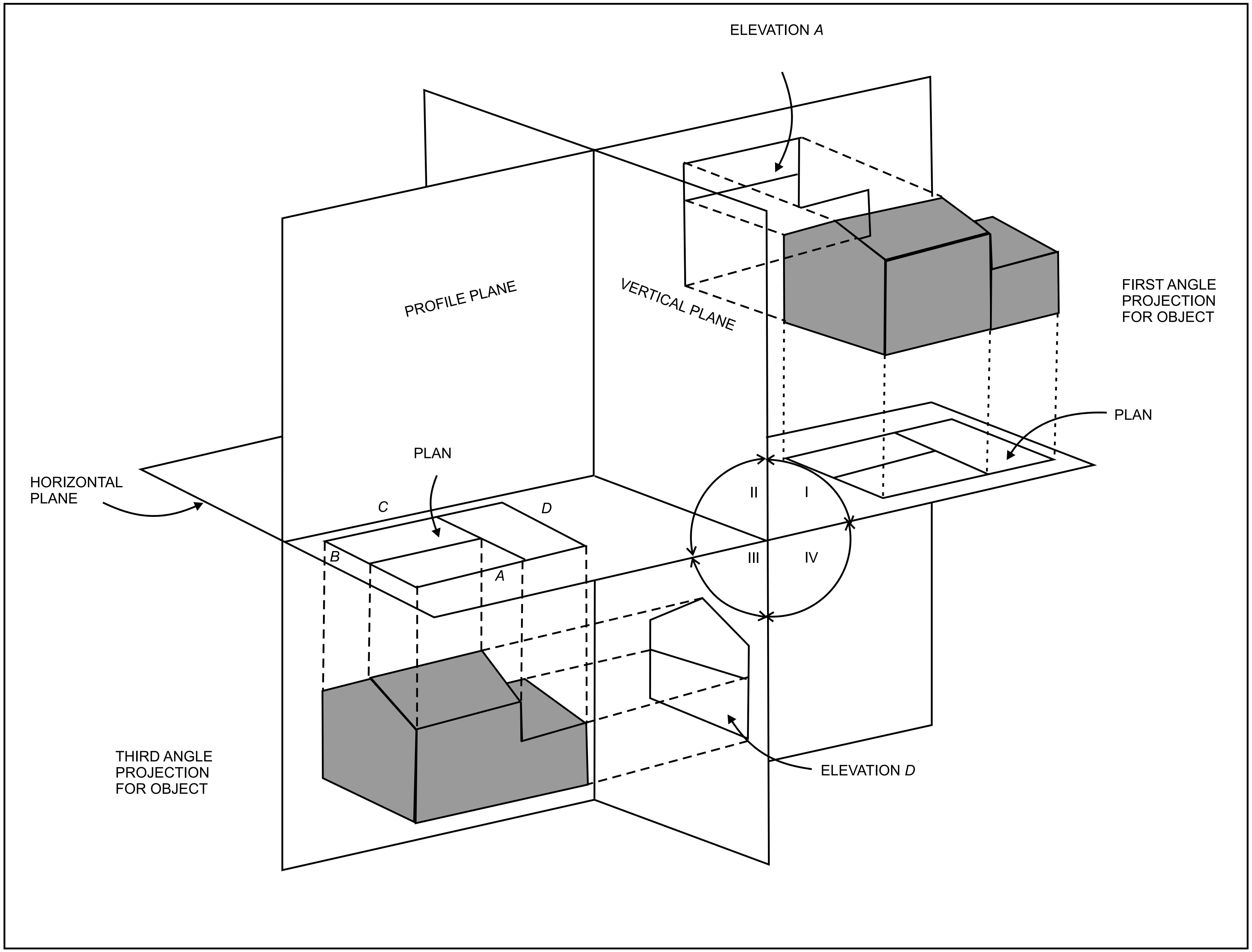


Figure 7.1 *Multiview or Orthographic Projection*

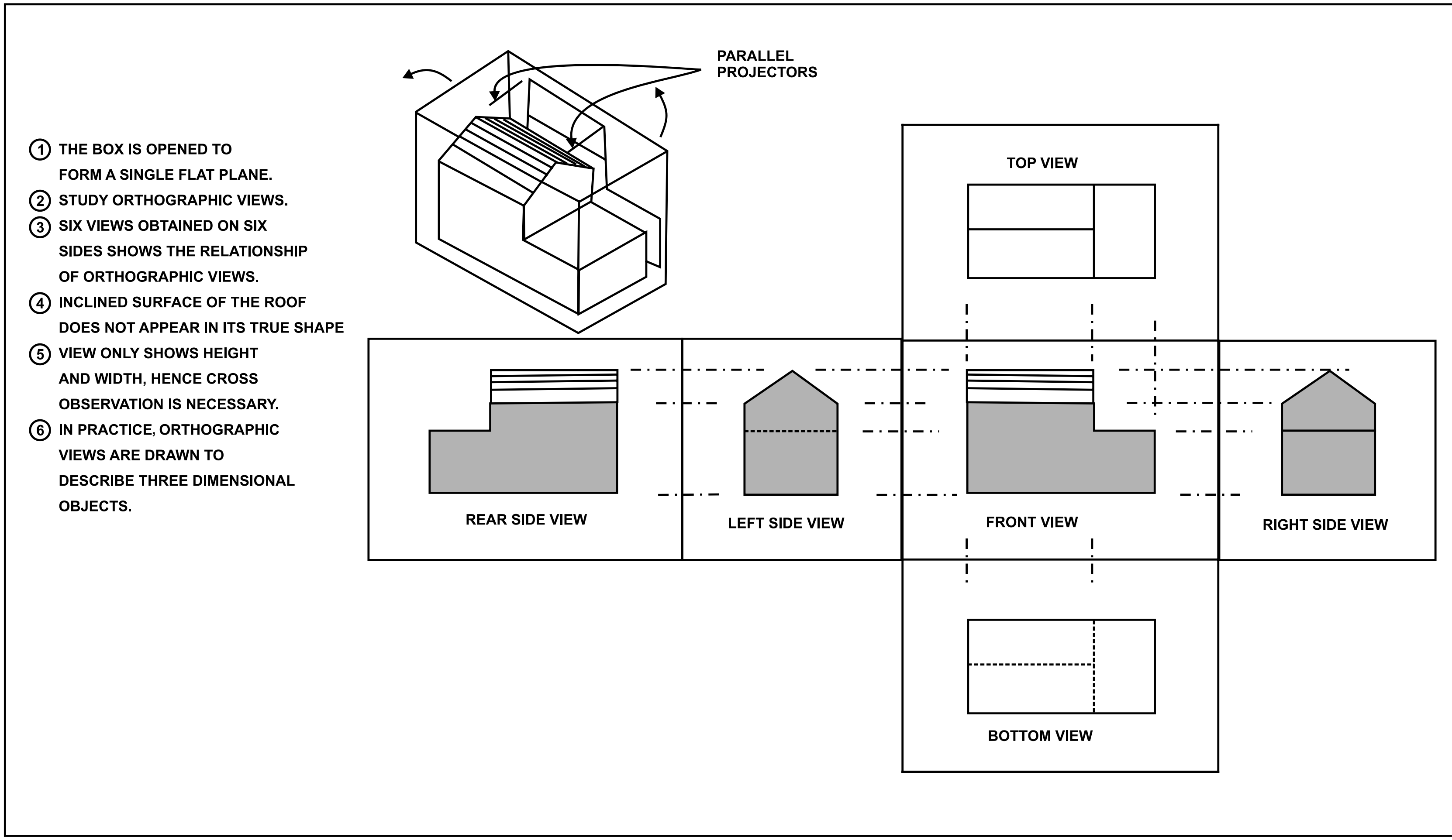


Figure 7.2 *Graphical Language – Orthographic Views*

should be properly identified, either with descriptive notes or joined with projection lines, or by some other suitable means. The number of views shall be sufficient to illustrate clearly the shape of the part and there should be no misunderstanding. Views shall be selected in such a way so as to read as few hidden lines as possible (Fig. 7.3).

7.3.2 Plan

All these views give information regarding two dimensions—length and width in the case of plans, and length and height in the case of elevations. From the point of view of construction, some additional information is also necessary. A plan drawn by the orthographic projection method shows only the shape of the structure, but the details required from the point of view of construction such as thickness of walls, size of the room, positions of the door, etc., are not known. Hence, in order to show these details, the building is imagined to be cut by a horizontal cutting plane at a convenient height, so as to cut all walls, doors, windows, stairs, etc. Such a plan will now show all details. Whatever is above the cutting plane is shown by dotted lines, for example, ridge lines of the roof, canopy, *chajja* and roof projection. (Figs. 7.4 and 7.5). The position of the cutting plane should not be shown on the elevation.

7.3.3 Elevation

An elevation gives information regarding the view of the building, materials for external finish, and other features.

7.3.4 Section

A section is necessary to show internal details such as height of the door and window, thickness of the wall, details of footings and foundation depth, details of roof, and other details inside the house.

Plan, elevation and section together furnish data required for preparing estimates and for execution. In order to have a clear idea of plan, elevation and section, students should be asked

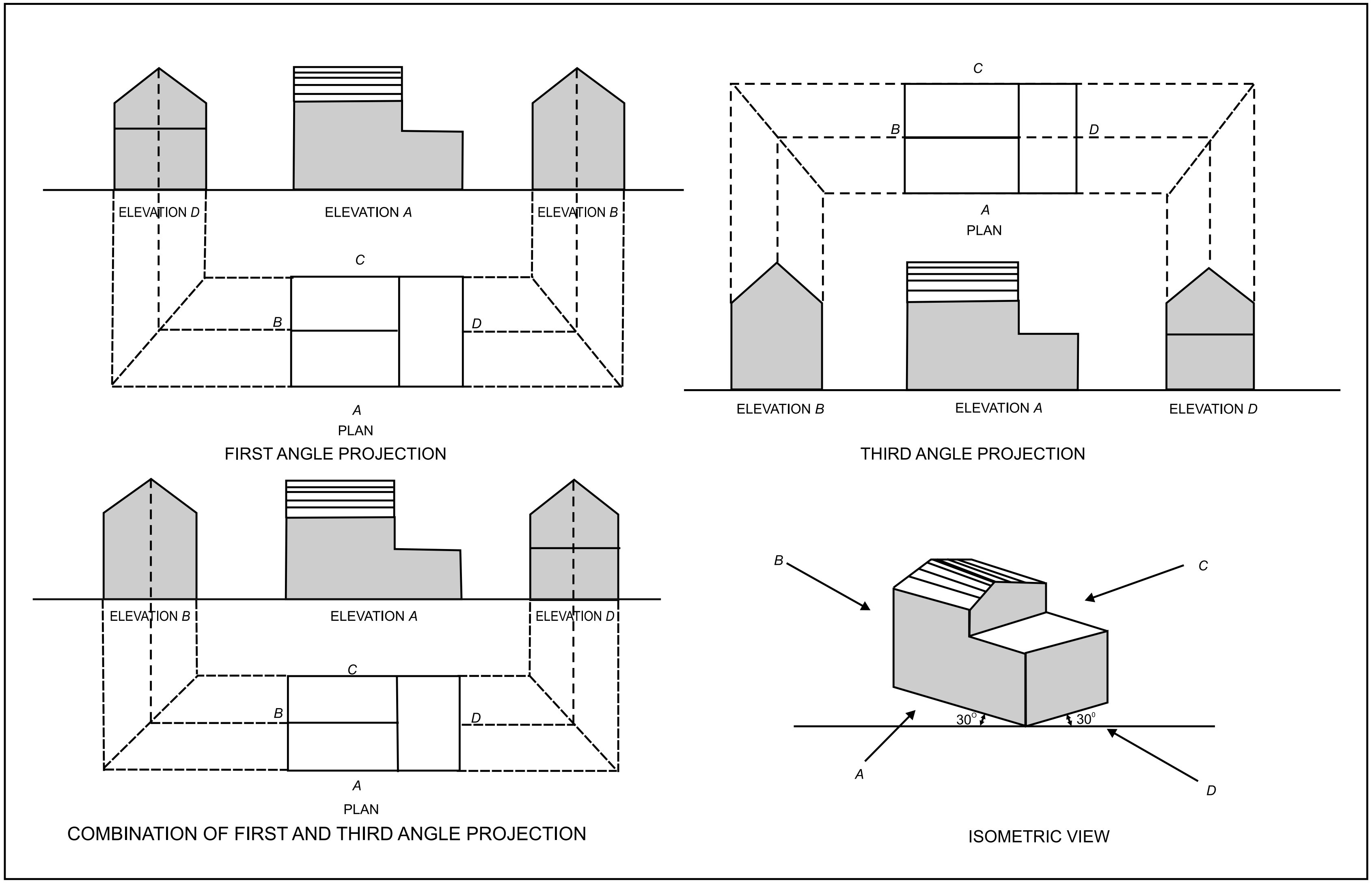


Figure 7.3 *Orthographic Projections – Different Methods and Isometric View*

to record measurements—external and internal for height, length, and width of the existing building. They should then draw the plan, elevation, and section. These drawings are known as *measured drawings*. In practice, students are supposed to follow the reverse way, i.e., preparation of the plan, elevations, and sections from the given line plan and not from the completed structure. The method of drawing plans, sections, and elevations has been discussed in detail.

7.4 ISOMETRIC DRAWING, OBLIQUE DRAWING AND PERSPECTIVE DRAWING

Orthographic views offer certain advantages, but at the same time, there are some limitations. Two or three views are required to be studied to get the exact idea and details of the object. Hence, in order to give a detailed representation, an architect has to use other methods such as isometric, oblique and perspective drawings. Each drawing has got a different purpose, method and principle of drawing. These methods are used according to the requirements.

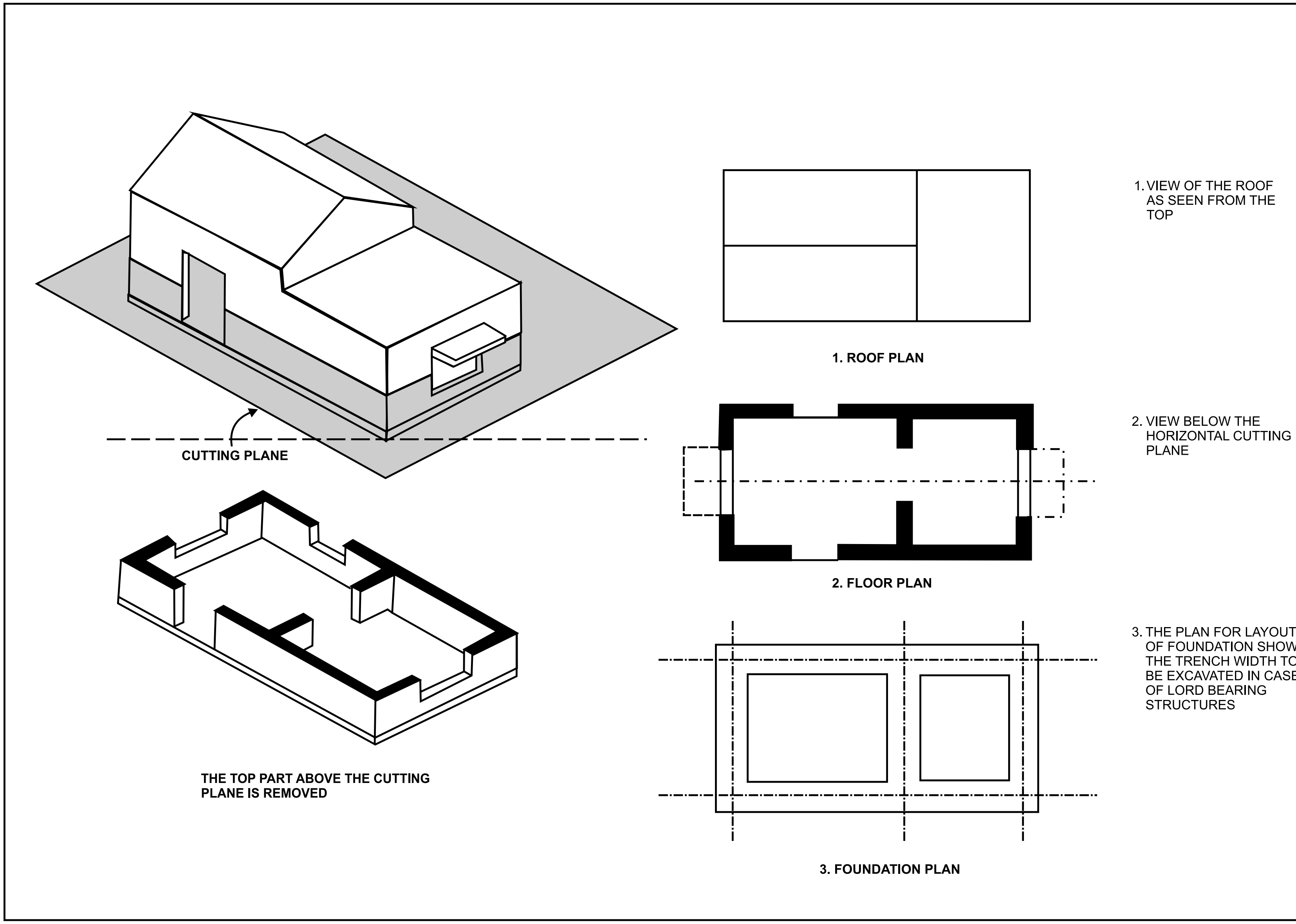


Figure 7.4 *Types of Plans – Roof, Floor, and Foundation*

Isometric and oblique drawings are pictorial in nature. As such, three sides of the object are seen and the principal lines of each side or plane are measured directly. To the average man, it gives a realistic view. Both these methods are found to be quick and suitable for giving construction details to co-workers. On the other hand, perspective drawings show the building and surroundings as seen by the observer after the completion of the structure, in a pleasing manner.

7.4.1 Isometric Drawing

The prefix 'iso' is taken from the Greek word 'isos', which means equal. The object is turned to make three sides visible and in such a way that they should be on three equally divided axes cut about a centre. The axes may be turned in any position, but it is found that by keeping one axis vertical and the other two axes at 30° angle with the horizontal, a pleasing view is obtained.

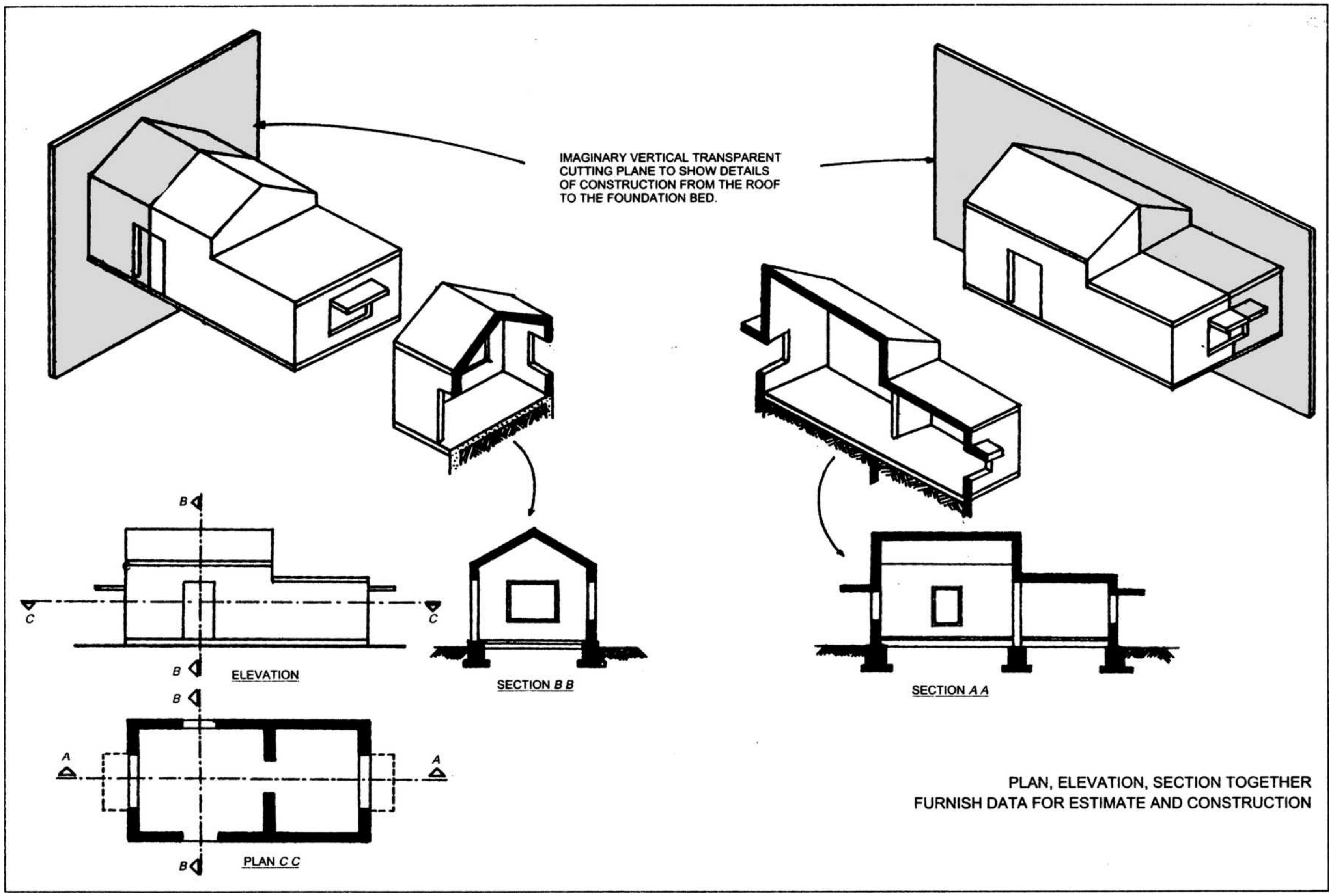


Figure 7.5 *Sectional Views – Use of Cutting Planes*

First, select the angle from which the object is to be viewed to get the required details. Study the geometric form of the object and imagine the box in which the object can be placed. Draw the axis lines and other details by drawing parallel lines as shown in (Fig. 7.6(a)). In order to draw overhead structural features such as joints of members of timber roof work, 'reverse axis' method is used. In isometric drawing, a circle appears as an ellipse.

7.4.2 Oblique Drawing

In an oblique drawing, the top and side view of the object is shown by projecting oblique lines from a frontal orthographic view, i.e., elevation as shown in Fig. 7.6(a). Angles commonly used for the oblique axis are 30°, 45°, and 60°; 30° axis from the horizontal, shows the side view with more emphasis, 45° axis gives importance to both the sides and 60° axis gives emphasis to the top view. The axis may be projected on the right or left side according to the requirement, and if required, can be projected below the horizontal.

If the oblique drawing is drawn using the same scale for all axes, then a distorted view is obtained. Hence, for a more realistic appearance, the depth along the oblique axis is reduced by 1/4, 1/3 or 1/2 and the lines on the frontal plane are drawn with the full scale. Circles and irregular shapes are drawn in the front plane or elevation conveniently. In an oblique drawing, a long dimension line is placed on the front elevation for the sake of convenience. If circular shapes are on the oblique axis, then they are drawn elliptical in the same way as isometric circles.

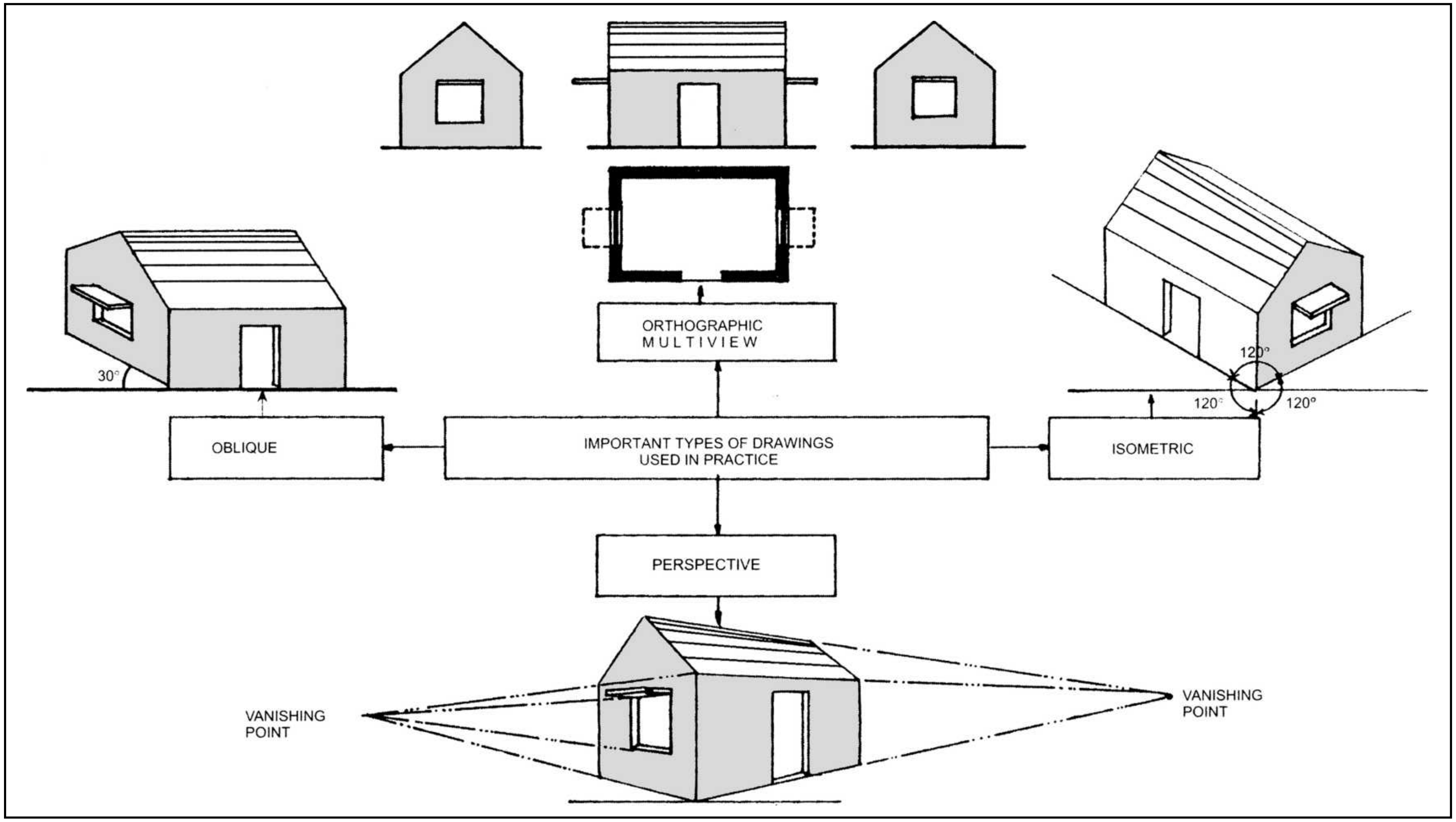


Figure 7.6(a) *Orthographic, Isometric, Oblique and Perspective View of Object*

7.4.3 Axonometric Drawing

Axonometric and oblique drawings are similar in nature. Parallel lines in any direction are drawn parallel in both methods. It is easy to draw three dimensional drawings with these methods as compared to perspective drawings (Fig. 7.6(a)). They serve the purpose of explanatory drawing for showing interiors of buildings and rooms and for details of furniture pieces, entrances, and structural details (Fig. 7.6(b)).

The drawings in Figs. 7.21, and 7.22 can be drawn in accordance with the following steps:

1. Turn the plan so that the main axes are at any given angle to the T Square, e.g., 30°, 45° or 60° or any convenient angle.
2. Keep tracing paper on the plan.
3. Use a 90° set-square for projecting up the verticals which are drawn to the same scale of the plan.
4. Mark plinth, window sill, door and window top level on the vertical line and complete the drawing by drawing projections for all windows, doors, cup-boards, etc. If essential, the vertical scale is reduced to 1/4, 1/2 or 3/4. Sometimes one or two external walls are omitted in order to show internal details.

7.4.4 Perspective Drawing

An isometric drawing or oblique drawing for a building will not represent the building's view as seen by the observer. An architect is interested in knowing how the proposed structure will really look after completion. Hence, right from the planning stage and during the development of elevation, he draws sketches of a perspective view or a perspective drawing.

In the case of an orthographic projection, the projectors are parallel to each other and the size of the orthographic view remains the same as the size of the object. The principle of the perspective drawing is that of a conical projection. Rays come from one point of observation, i.e., eye to the object and the perspective view is obtained on the picture plane. In this method, the size of the view will depend upon the position of the picture plane or the transparent plane (Fig. 7.7).

Centre of Vision, Horizon and Vanishing Point

If we stand between two rails, then the two rails appear to meet at one point, though they are separated by a constant distance (Figs. 7.8 and 7.9). Such a point where two parallel lines appear to meet is known as the *vanishing Point*. It is situated on the horizon, i.e., on a line where

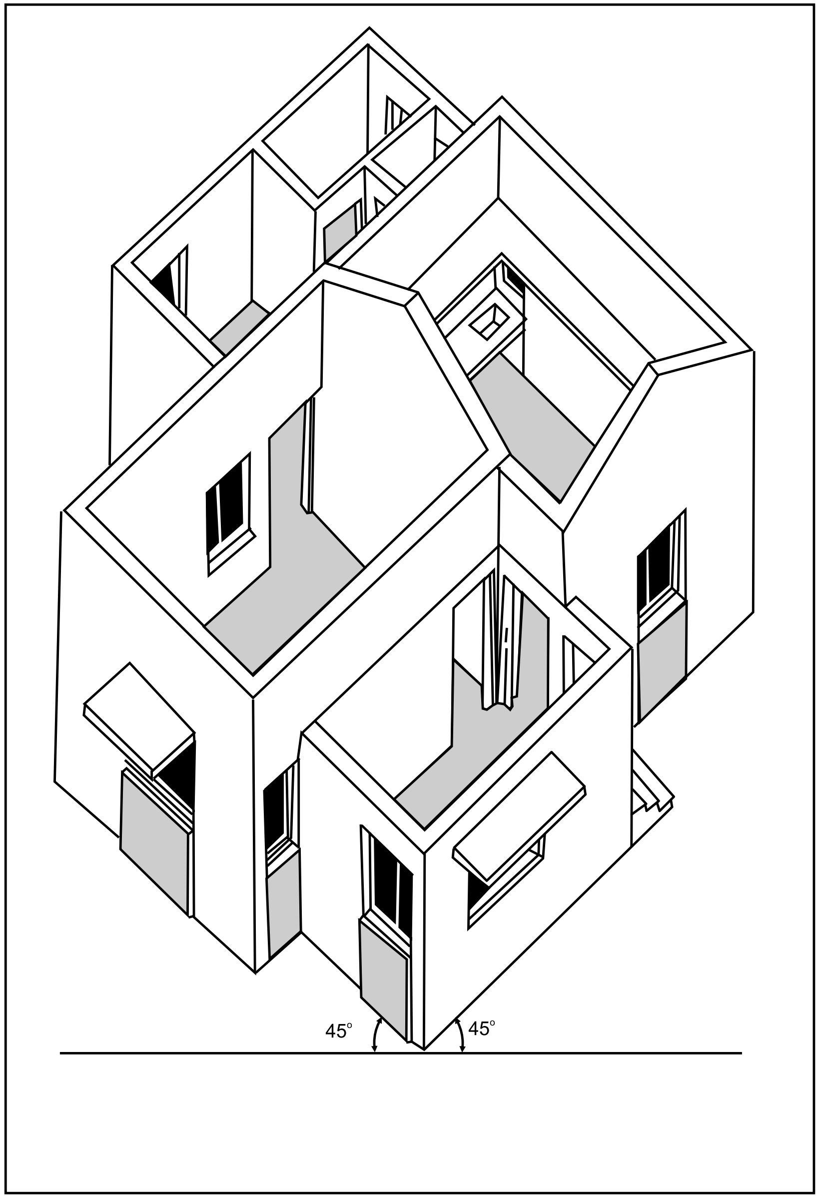


Figure 7.6(b) *Axonometric View of a Building*

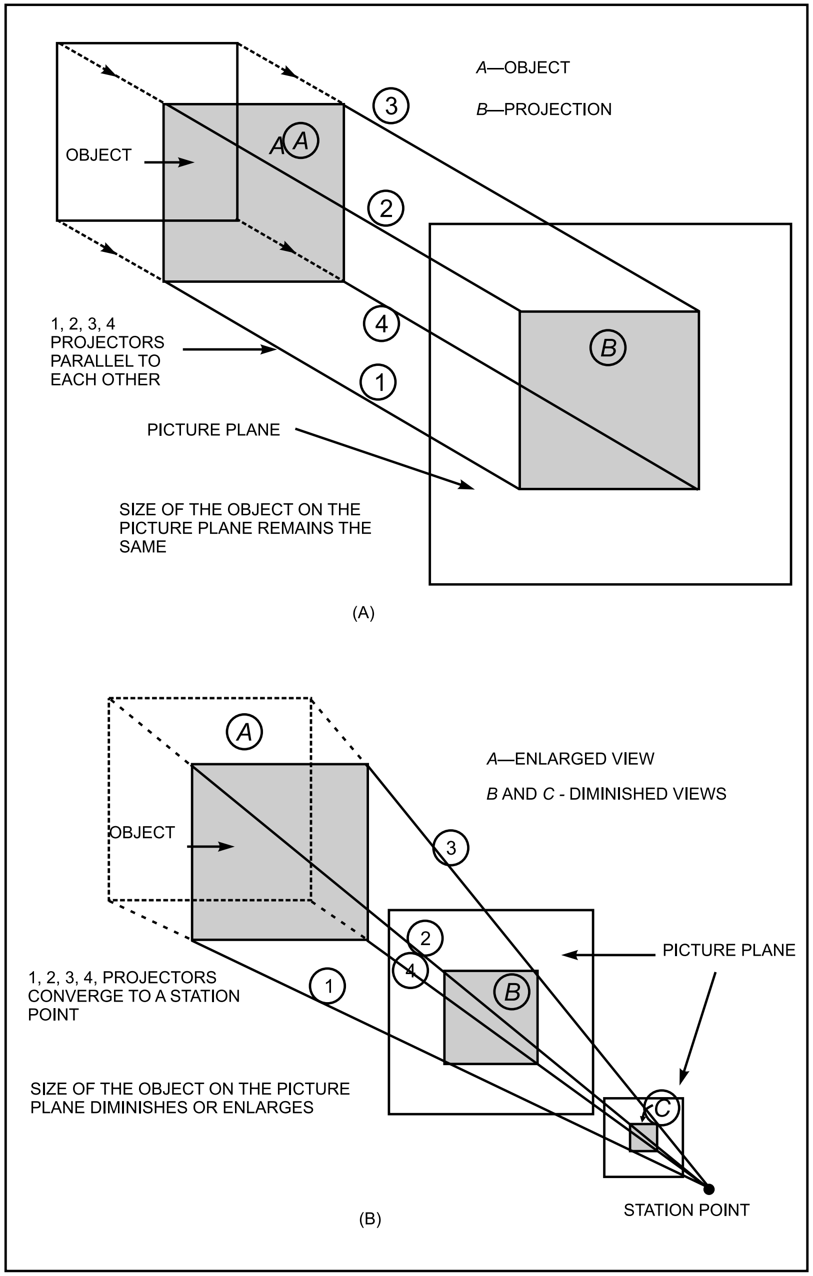


Figure 7.7 *(a) Orthographic projection (b) Conical Projection*

the sky appears to meet the ground. When we look towards the different points on the rails nearer or away from the place where we stand, then our eye is required to adjust simultaneously for different angles in the vertical and the horizontal plane. This is the reason why we see the two rails meeting at the vanishing point. If we stand in front of a building, then it appears that the two sets of the parallel horizontal lines of the walls meet at two different vanishing points on the right and the left side. These two vanishing points are also situated at the eye level of the observer, i.e., the horizon. There are three types of perspective drawings with reference to the number of vanishing points, (i) one-point or parallel perspective, (ii) two-point or angular perspective, and (iii) three-point perspective.

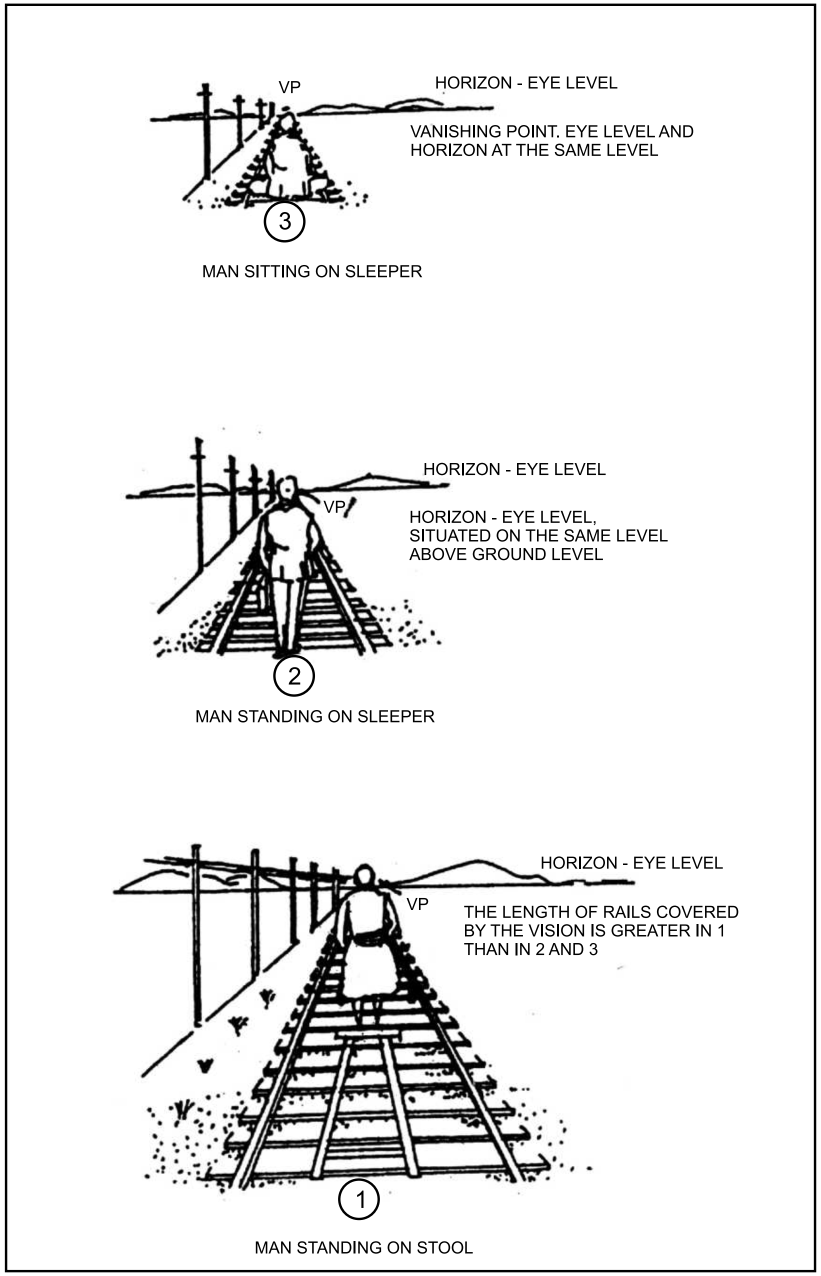


Figure 7.8 *Perspective View – Location of Vanishing Point*

One-point Perspective If the two sides of an object are parallel to the picture plane and the remaining sides are perpendicular to the picture plane (Fig. 7.10(a)), or as in the case of the rails and sleepers, then all lines perpendicular to the observer will vanish to one point known as the *centre of vision* which is in line with the station point and at a convenient or desired height above the ground level. The distance between the picture plane and the ground level may be kept as per convenience. Rays are drawn from the station point to various corners. The projections are then taken on ground line as shown in the figure. A one-point perspective drawing is then drawn in accordance with the following rules:

1. Vertical lines remain vertical.
2. Lines parallel to the picture plane remain parallel.
3. Lines perpendicular to the picture plane vanish to the centre of vision. The method is found convenient for showing interiors of an auditorium, plan showing furniture arrangements, views showing, interior, street views, and sometimes for front elevations of the building.

Two-point Perspective If the two sides of an object are inclined to the picture plane, then there are two vanishing points for two sets of horizontal lines as shown in (Fig. 7.10(b)). The method of drawing a two-point perspective is explained below.

1. Draw the line representing the picture plane.
2. Draw a plan inclined to the picture plane with a convenient angle. It is better to keep one corner of the building touching the picture plane so that the same scale can be used for the perspective and plan.
3. Mark the position of the station point, i.e., position of the observer as per desired view of the building. Distance between the station point and the picture plane should be more than three times the height of the object to get a pleasing perspective.
4. Draw lines parallel to 1, 6 and 1, 2 from the station point to cut the picture plane in VPR (vanishing point, right) and VPL (vanishing point, left). These are the positions of vanishing points on the picture plane.
5. Draw rays to all corners, doors, windows, etc., from the station point as shown.
6. Draw a line representing the ground level at a convenient distance from the picture plane.
7. Draw a horizon line above the ground line at a distance of 1.5 m for normal eye level, or at more or less height as per the desired view.
8. Transfer the positions of VPR and VPL on eye level, i.e., the horizon line.
9. Point (1) of the corner of the building is on the picture plane. Draw a vertical line by projecting point (1) on the ground line. All vertical measurements for plinth, window sill, door, window top, eaves level, etc., should be marked on this line and then they should be transferred to the required positions.
10. Mark 1,1’ height at corner (1) and then vanish it to right and left. Then mark the projections 6, 6′, 2, 2′, 3, 3′ and 4, 4′. The vertical lines will remain vertical. Parallel lines 1-6, 3-2, and 4-5 will vanish to VPLl(eye level) and parallel lines 1-2, 3-4 and 6-5 will vanish to VPR1 (eye level).
11. For the roof, project lines 7, 8 to cut the picture plane in *X*. Draw vertical *XX* on the ground line and mark the true height of the roof top as per scale. Then vanish the lines 7 and 8 to VPL1. Similarly, mark 9, 10 and 11 and 12.

The two-point perspective or angular perspective method is used for buildings. By changing the height of the eye level, i.e., horizon, a bird’s eye view is obtained. (Figs. 7.11, 7.18).

Details of Perspective Drawings

Perspective Study carefully one-point and two-point perspective, views. Different views are obtained by changing the position of the station point and eye level. Draw such views. Compare different views which will help in selecting locations for the station point and suitable eye levels. (Figs. 7.10(a), 7.10(b), and 7.11)

1. ***Two-point perspective*** Picture plane behind the object for an enlarged perspective view: An enlarged perspective view is drawn by keeping the picture plane, behind the object as shown in Fig. 7.12. Draw a plan, and keep a picture plane behind the plan and locate a station point at a distance greater than three times the height of the object. Locate vanishing

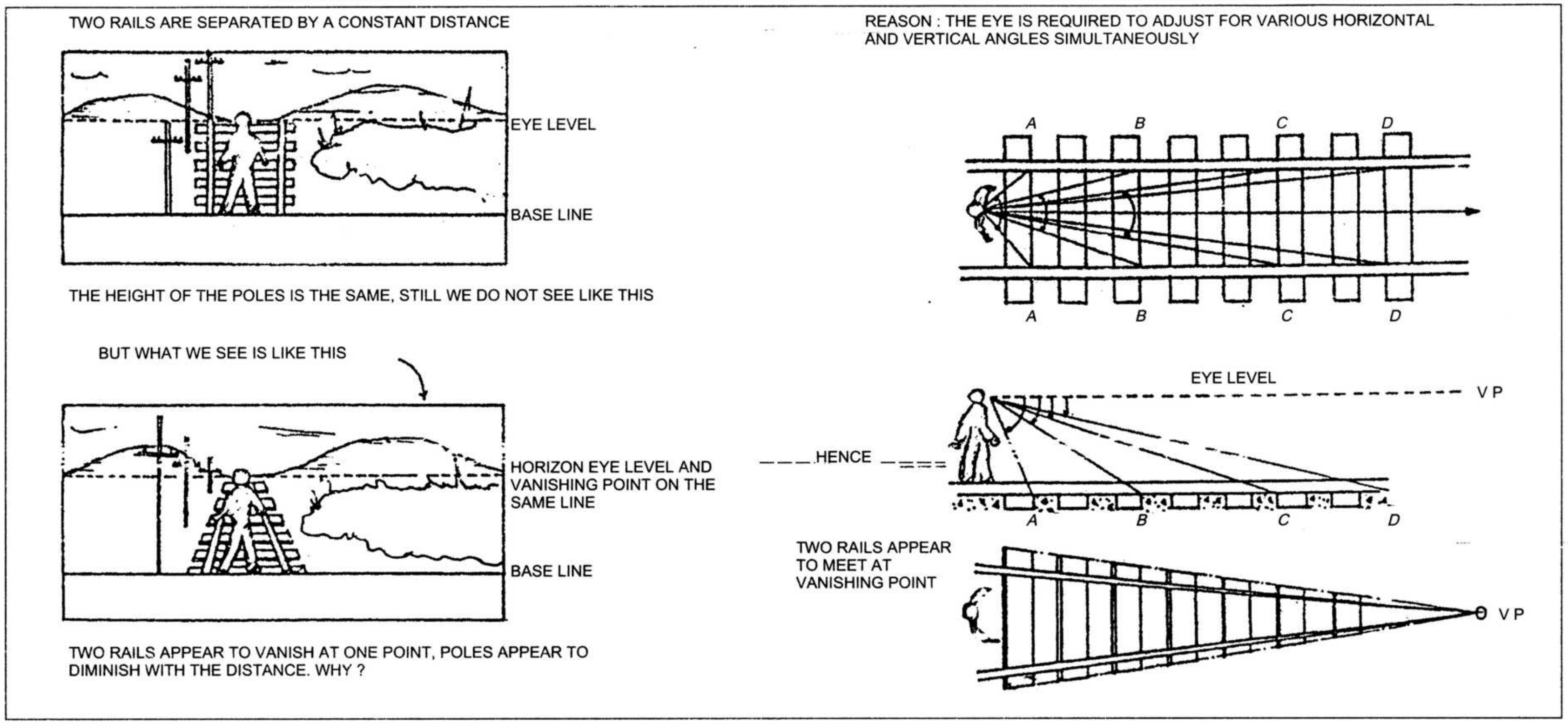


Figure 7.9 *Vanishing Point*

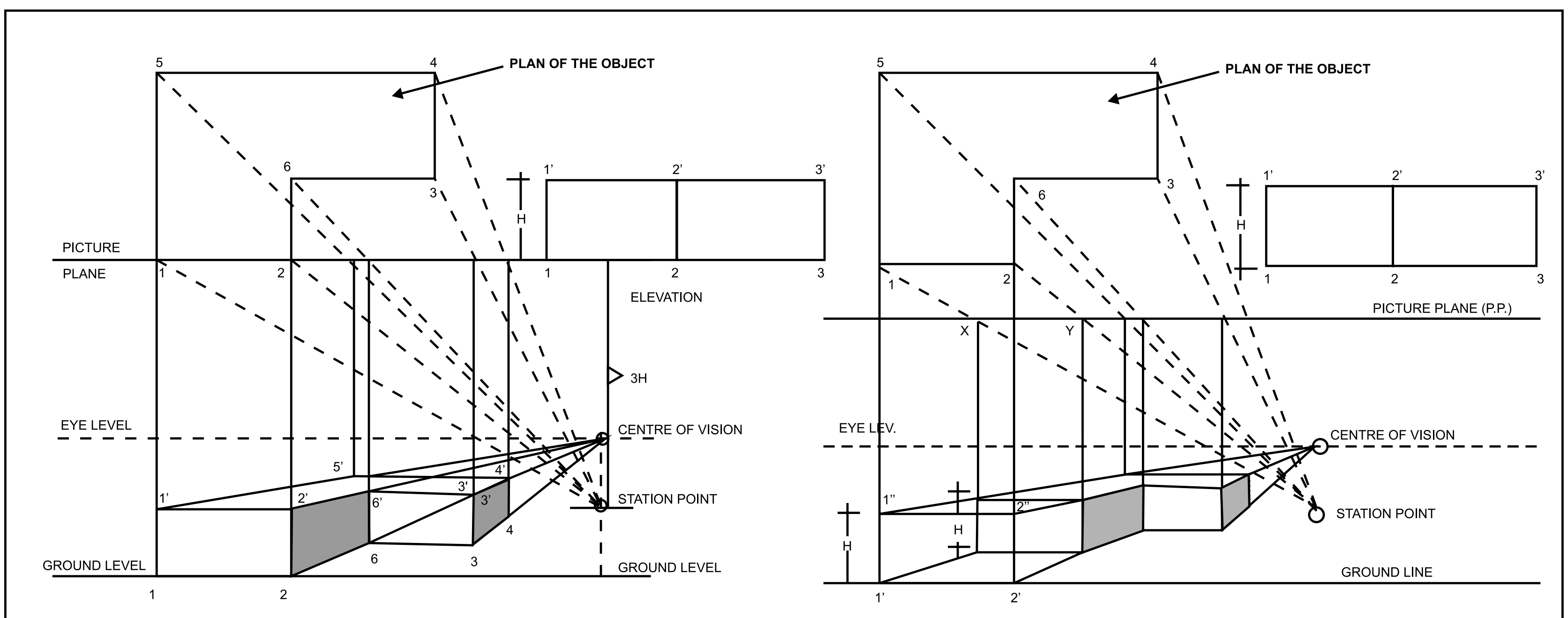


Figure 7.10(a) *One-point perspective (1) Object touching the PP (2) Object away from the PP*

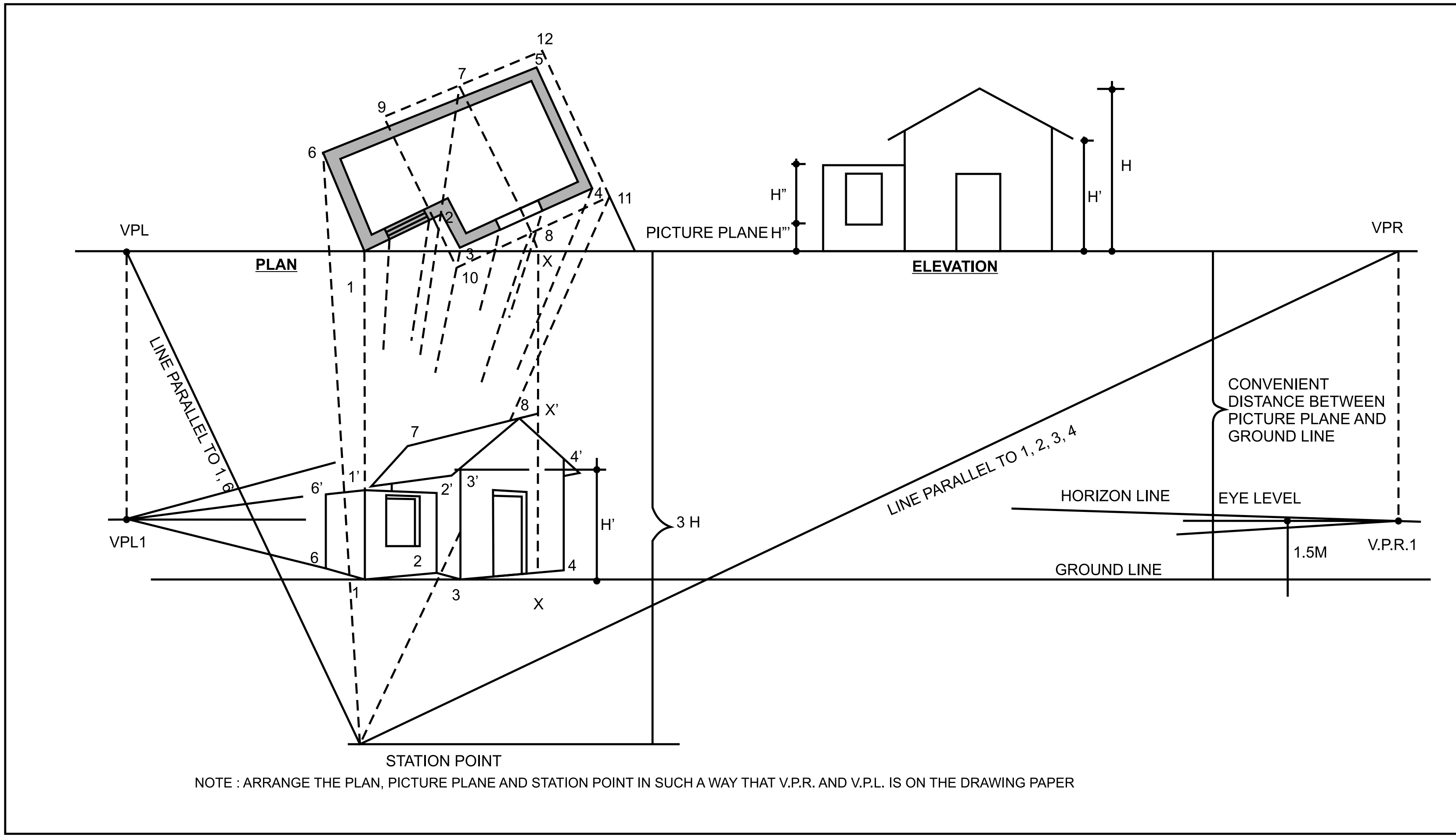


Figure 7.10(b) *Two-Point or Angular Perspective*

points on the picture plane. Extend line 1 and 3 so as to meet the picture plane. Mark meeting points as *X*. Draw a height line, i.e., vertical line through *X:* Draw the ground level at any convenient height above the picture plane and eye level above the ground level as per the desired view. Mark VPL and VPR at the eye level. Draw rays from the station point through points 2, 3, 5 and 6, etc. so as to meet the picture plane. Draw vertical lines through the meeting points. Draw the elevation above the ground level as shown. Mark points *Y* and Z on the height line. Draw vanishing lines through VPL and the points Y and Z. Complete the perspective by drawing the remaining lines.

2. ***Direct projection method*** Figure 7.13 shows a method for drawing two point or angular perspective by direct projection method. Location of station points in the plan at a distance *X* from the picture plane and in elevation at a distance of *X* from corner 1 of the object in elevation helps in marking heights of corners 4 and 2.

3. ***Common or office method*** Figure 7.14 shows the method for drawing a two point or angular perspective by common or office method.

4. ***Perspective plan method (Figs. 7.15, 7.16 and 7.17)*** Perspective plan method requires less space on the drawing board and has more versatility. This plan method requires no orthographic plan. A perspective plan is drawn from measurements laid off on a horizontal line. From this plan, vertical projectors establish widths and feature locations on the finished perspective. Heights are measured on a true height line. The plan and elevation views furnish all the measurements for drawing the perspective. The size of the perspective can be controlled by merely changing the scale of the dimensions.

Step I (Fig. 7.16)

1. Draw a line representing the horizon near the upper part of the paper. It also serves as the picture plane.
2. Mark station point *SP* at the given distance on the centre of vision to scale, and draw 30 degree and 60 degree projectors to the picture plane. This locates the left and right vanishing points VPL and VPR.
3. Construct the right and left measuring points on the picture plane, MPR and MPL as shown with VPR and VPL as centres, draw arcs.

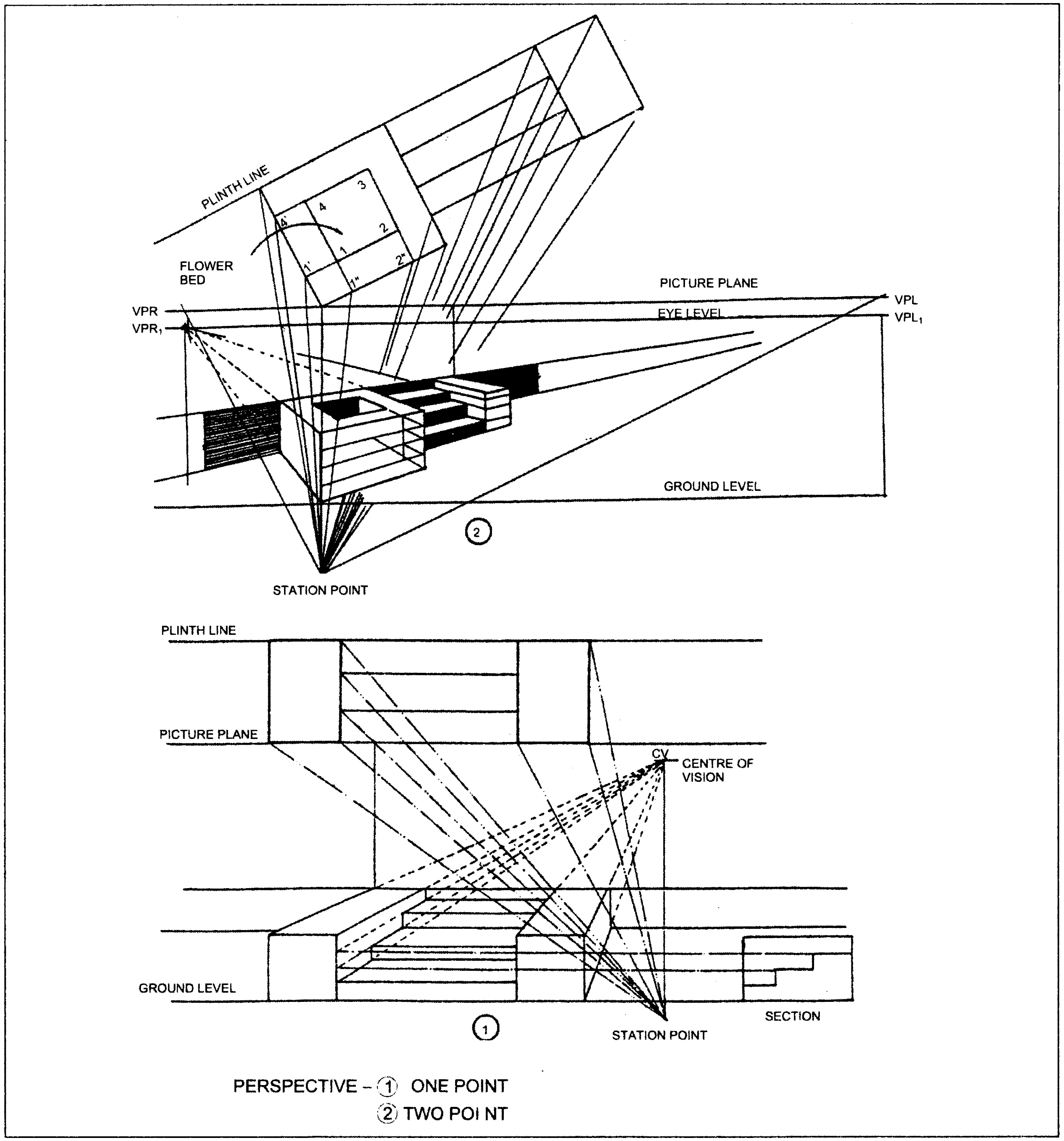


Figure 7.11 *Perspective Views – One and Two-Point*

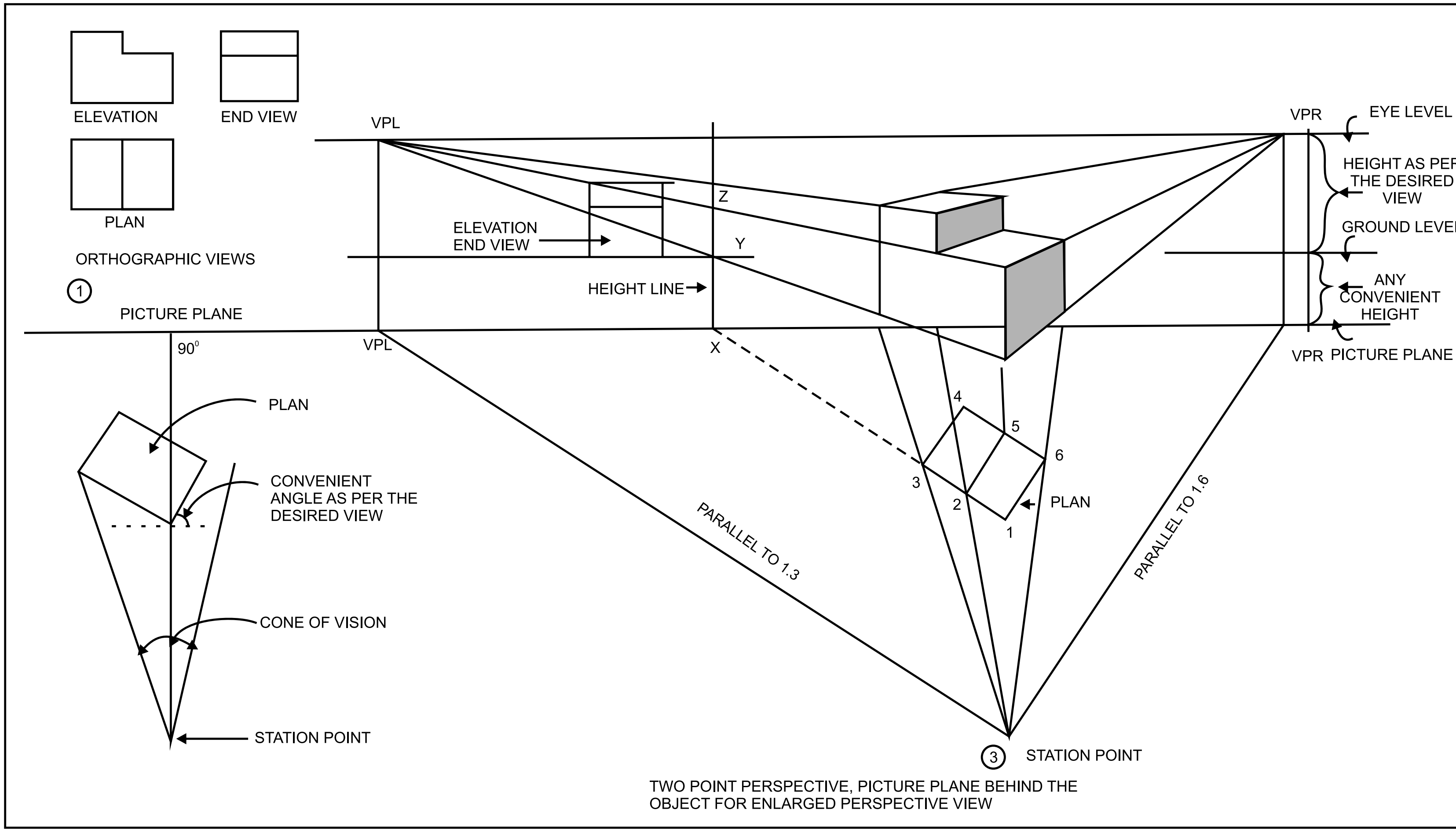


Figure 7.12 *Enlarged Perspective View*

4. Draw the ground plane line at a distance of 2.0 m from the horizon line. This is the eye level.
5. The orthographic plan shown in dotted lines is not necessary. It is given for visualisation of the plan and picture plane relationship for a beginner.

Step II (Fig. 7.17):

1. Draw a horizontal measuring line at a convenient distance below the ground plane.
2. Transfer the corner of the building touching the picture plane to the measuring line (point *C*).
3. Measure and mark points *B* and *D* on the measuring line. Locate points *X* and *Y* as shown on the base line.

Step III:

1. Project a vertical line through *C* above the ground plane and mark height *H*. Project verticals through *X* and *Y.*
2. Vanish lines through *E* and *F* to VPL and VPR to get a perspective view.

5. Perspective Monumental Pillar Figure 7.18 shows two point or angular perspective for a monumental pillar. Study carefully how the height of the point *G* is marked. The point *G* is away from the picture plane. Extend line through *G* to *G'* parallel to *AB,* then draw a vertical through *G'*. Mark true height of point *G* above the ground level. Vanish line through *VPL* to get point *G (VPL; G'')* on the perspective view. Line *GF* is a nonperspective line. It is simply joined on the perspective view after locating points *G* and *F.*

Three-point perspective In this case, vertical lines do not appear to be vertical and they vanish to a point. This happens when we view a skyscraper from a road or from an aeroplane.

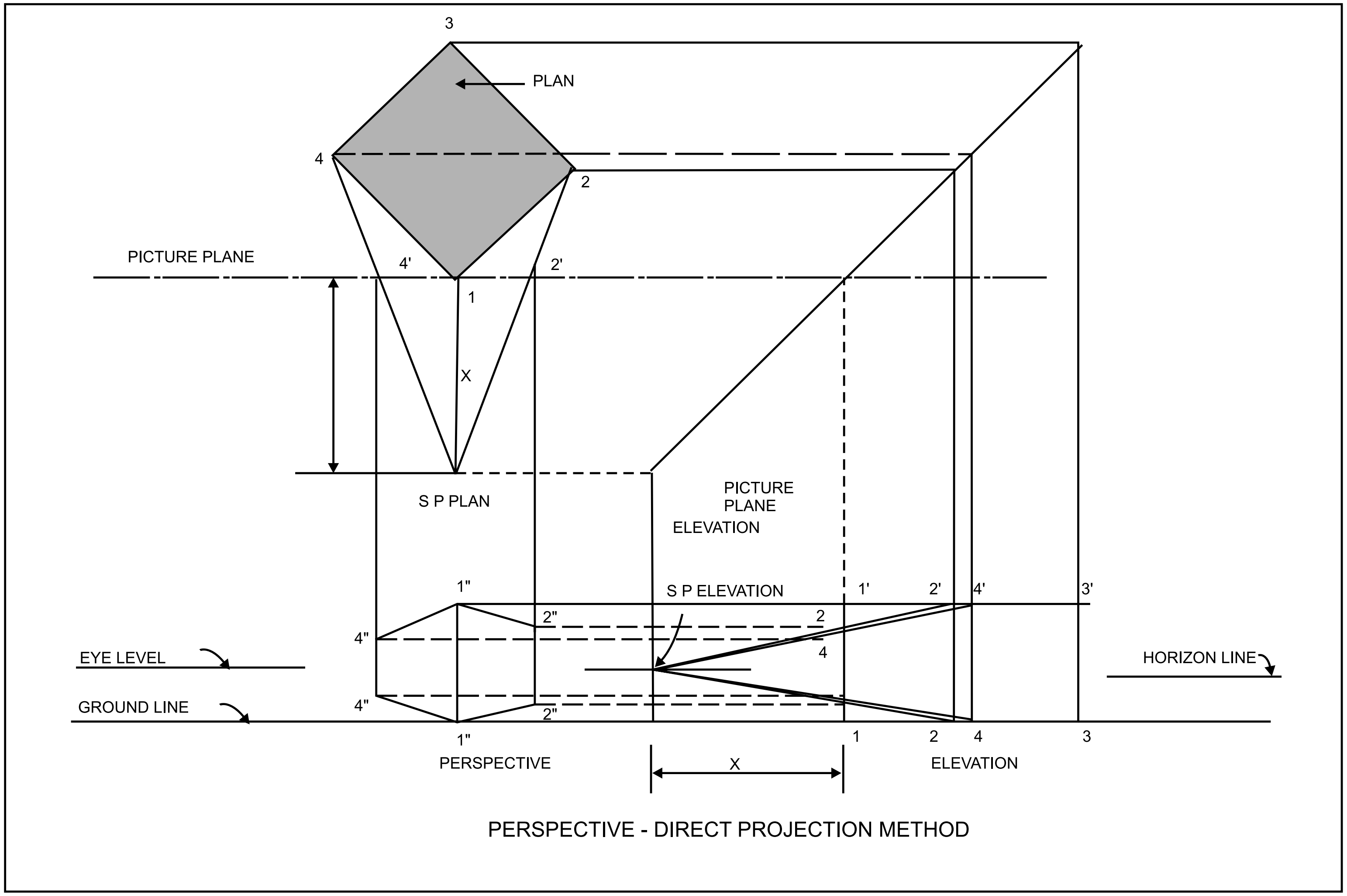


Figure 7.13 *Perpective-Direct Projection Method*

7.5 SHADES, SHADOWS, RENDERING AND PRESENTATION DRAWINGS

A perspective drawing would be incomplete without showing natural surroundings comprising road, trees, gardens, and the sky. In nature, we always observe shadows of various objects such as *chajjas*, canopies, roof overhangs, trees, and so on. The introduction of shades and shadows to a perspective drawing adds a pleasing three-dimensional view on a two-dimensional surface giving a solid appearance (Fig. 7.19).

7.5.1 Shades and Shadows

A perspective drawing produces only the outlines of objects. Shades and shadows of various objects do not have uniform tone. Contrast and intensity of shadows should be studied and sketches should be drawn of existing structures and surroundings which will help an architect in giving a touch of reality to the drawing.

The sun is the source of illumination. It illuminates the object from a distance. Rays of light are assumed to be parallel. A shadow is a part of a surface from which light is excluded by an opaque object. A shade is a part of an object not exposed to rays of light. A dividing line is a line which divides the illuminated and shaded portions of an object.

Conventional Lighting

In architectural drawing, it is customary to assume that the light comes from one direction, i.e., the upper left side in case of elevations. Light appears as a 45° line on an elevation and plan. The shadow falls to the right side and below the object. The shadow clearly indicates the depth of recessed features. A 45° set-square can be conveniently used in drawing shadow lines. Shadows are also shown on the front elevation for an attractive presentation drawing. Casting of shadows is affected by the following conditions:

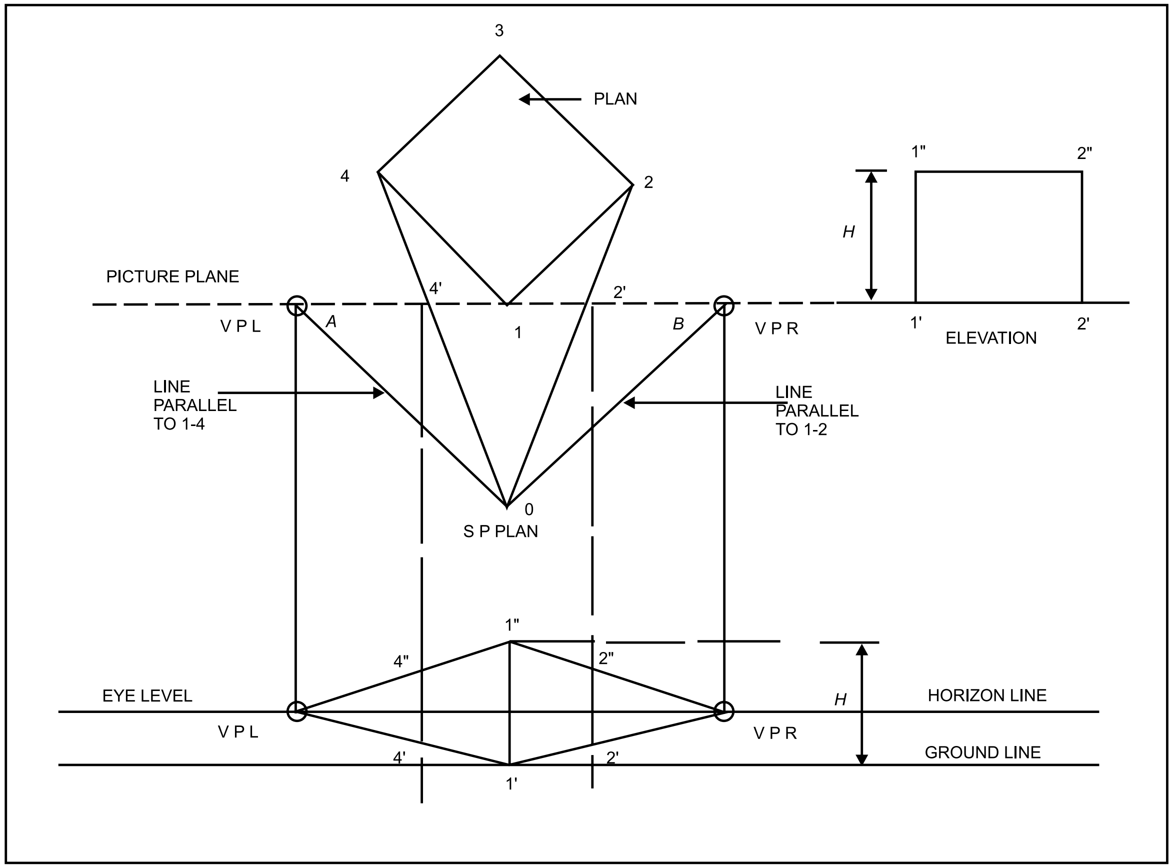


Figure 7.14 *Perspective-Common or Office Method*

1. The direction of light.
2. The shape of the object.
3. The manner and shape of the surface upon which the shadow will fall.

7.5.2 Rendering

The architect prepares a plan showing furniture arrangement and a perspective with rendering or an elevation with rendering, i.e., he shows different features and their texture using strokes of soft pencils giving different pressure. These drawings give a clear idea of the would-be structure to the client, to the assistants of the architects who help in preparing submission and working drawings, and also to the contractor and his workmen.

7.5.3 Presentation Drawings

This is a tool that the architect uses to sell his ideas to the client and get his final approval. The proposed scheme is presented in a realistic and artistic way, avoiding unnecessary technical information. Light and shade, landscaping and texture are the elements which give a touch of reality to the linear perspective. Drawings may be in black ink or in different colours. These are normally prepared by architects, although the assistance of professional specialists is also taken at times. Presentation drawings include:

1. Floor plan—ground, first and other floors with furniture arrangement.
2. Rendered elevation—elevation along with surrounding details. Rendering may be in pencil, ink or colour.
3. Perspective drawings and elevations.
4. Scheme, layout plans showing plots, roads, garden, shopping and open areas and location of proposed buildings/bungalows in individual plots.
5. Brochures showing all details mentioned above along with names of the promoter, builder, structural designer and other consultants.

Presentation Drawing-Composition

Composition is the arrangement of masses, lines, spaces and other requirements which is presented in a pleasing and beautiful manner. The success of presentation drawings depends upon the planning of views and environmental surroundings. The following suggestions may be useful in deciding the composition:

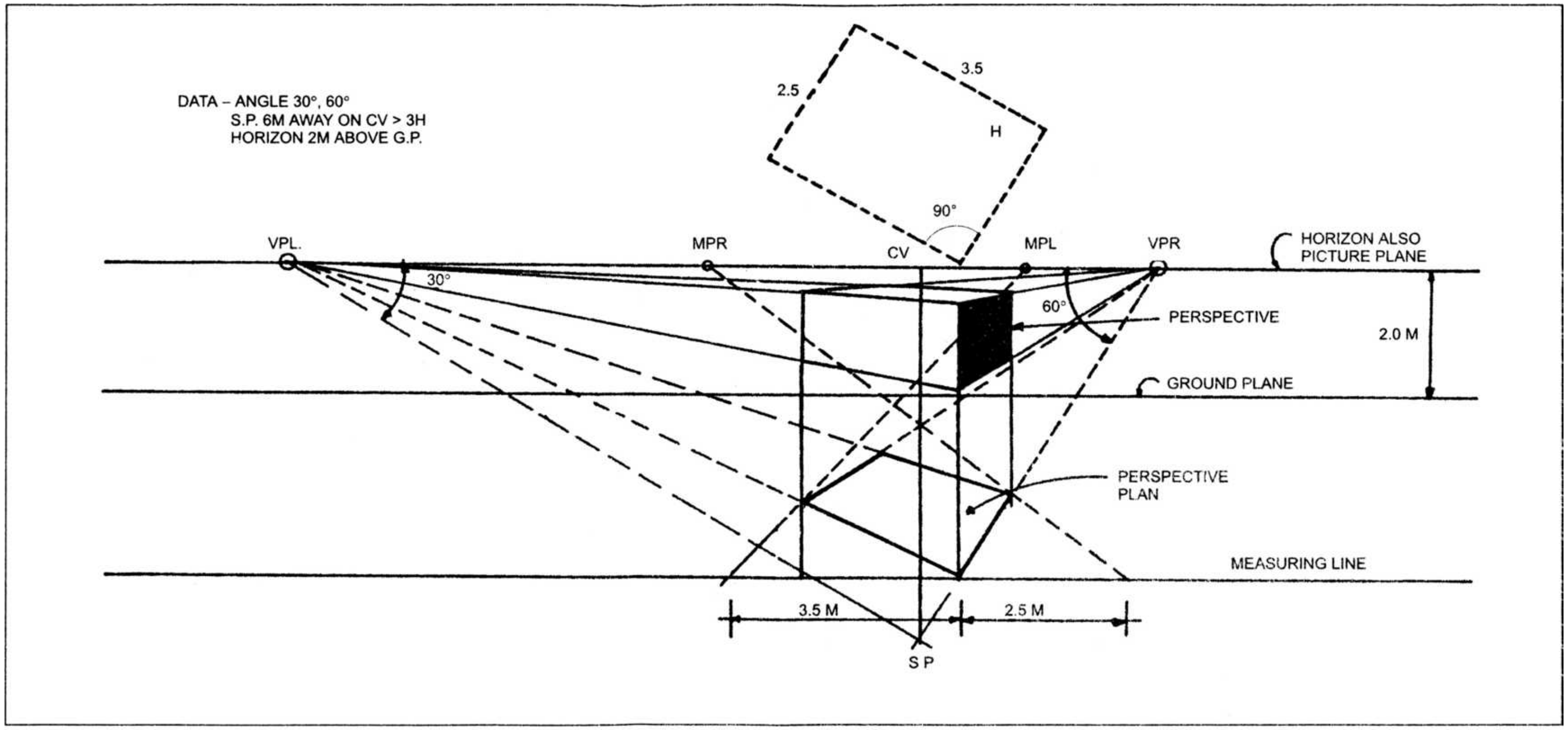


Figure 7.15 *Perspective Plan Method*

Study of Forms The basic geometric shape of the building should be studied with details of foliage around the building. Trees should be arranged so that they are in harmony with the surroundings. A mechanical and uniform pattern should be avoided and rendering for distant objects should be faint.

Balance Large and dark elements and those with intense colour have more weight, i.e., are more effective than smaller, lighter and pale coloured elements. These graphic weights must balance in a presentation drawing. The dominating element should be the main building, while the surrounding details should be subordinate to it. The centre of interest of the building should be marked as the entrance. The building should not be kept exactly at the centre of the paper.

Contrast A dark background for important architectural features in a light tone and light background to catch the attention of a dark feature should be used as a contrast. This contrast may be in value, size, shape and texture. If a building is shown in warm sunlight, the surrounding areas of shadows, foliage, sky, ground, etc., should be shown in darker tones for emphasis and relief. A convenient direction of light should be chosen for interesting shadow patterns and feeling of depth. The space around, behind and in front of the building should be intelligently used. Heavy lines become more important than thin or light lines. Hence, the desired effect should be produced by varying line weights.

Surrounding Details The main building and other elements like trees, shrubs and grass should be tied together in a realistic way. The type of trees suitable to the location of the building must be selected. The location of trees should not obstruct the view of the building. If necessary, the trees can be shown in front with several branches without obstructing large areas. Strong indications of clouds or the sky, and birds should be avoided. Only the essential surrounding details should be shown. Areas of superfluous details should be erased.

Proportion A drawing must look realistic. Trees and other features should be shown by a correct indication. Human figures and vehicles should be used to check the heights of other details, but their details should be avoided.

Texture Stone, brick, concrete, wood, glass, and roofing material, etc., should be shown by a correct indication. The objects would appear as rough, smooth, dark or light, depending upon their nearness and conditions of light.

Character of Trees, Shrubs, and Human Figures It is necessary to sketch different types of trees to study their forms, trunk and branch structures, as also their foliage texture. Sketches showing a single tree and trees in groups should be drawn. Action of light and shade and sketches drawn in bright as well as dull light should be studied. A study should also be made of various drawings by professional architects and artists.

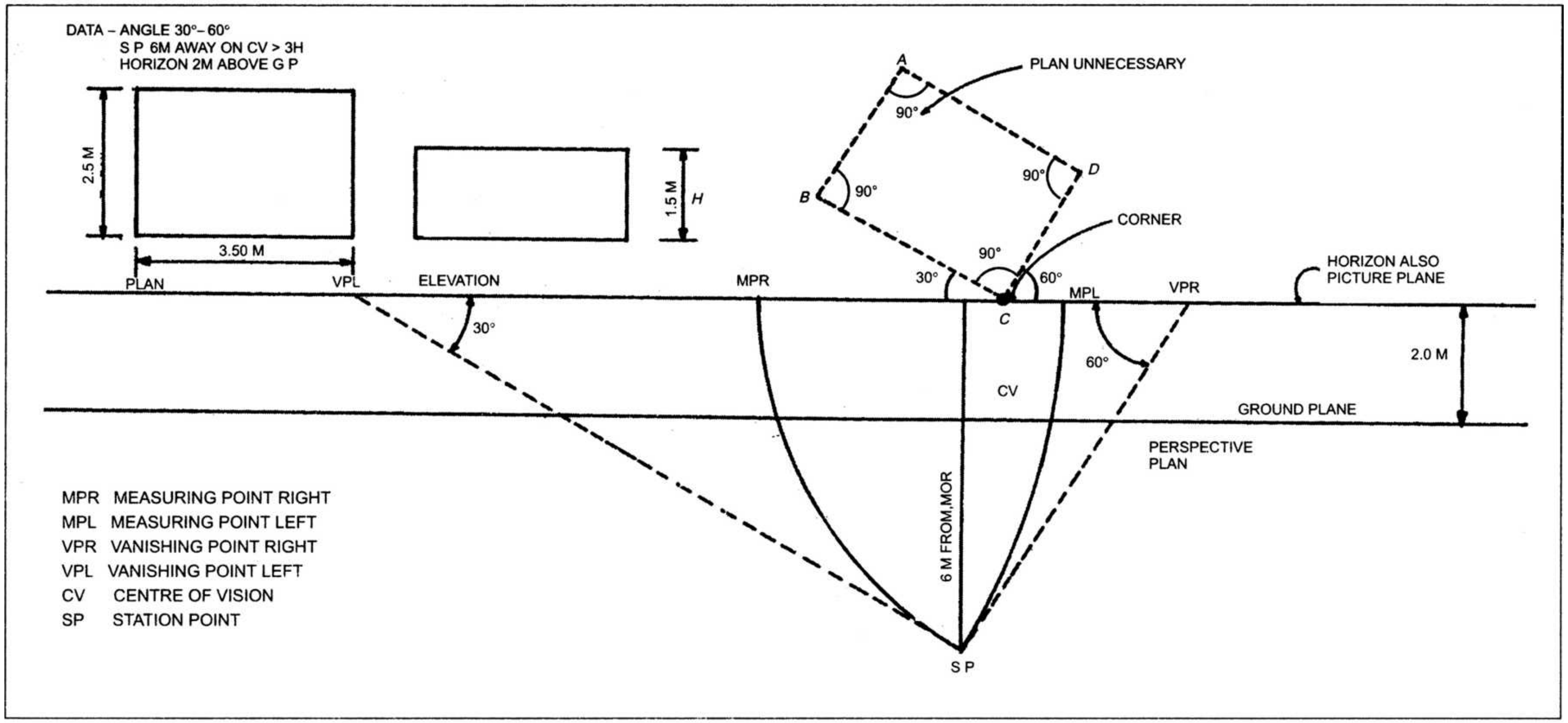


Figure 7.16 *Perspective Plan Method*

7.6 TRACING AND AMMONIA PRINTING

7.6.1 Tracing

The method of tracing normally prescribed is to prepare a direct drawing on tracing paper in ink or pencil and take prints. This is easy, efficient, and economical. Tracing paper is obtained in sheets or in rolls. Record drawings are done on tracing cloth. Tracing cloth is obtainable in rolls. Waterproof ink is used for doing tracing. The shiny or glazed surface is turned to the drawing board and inking is done on the dull surface of the cloth. The tracing cloth is stretched on the drawing board, and is then dusted lightly with French chalk. The surplus chalk powder should be removed by a soft duster ensuring that only fine film is kept over the surface as too much chalk powder will clog the inking pen. Erasing on the tracing paper or tracing cloth must be done carefully. Ink on the tracing cloth is removed by a fine razor blade or ink remover paste. A bow-pen, and a crow-quill were used previously for doing inking work. Now a days, waterproof ink pen is used for the same. Line work and lettering on tracing cloth or tracing paper must be opaque and distinct in order to produce legible copies.

7.6.2 Ammonia Prints

Ammonia prints are found to be convenient and economical. The original paper is coated on one side with light sensitive diazo chemicals. The sensitive paper is kept in contact with the tracing in the machine and is then exposed to light for a controlled amount of time. After the exposure, the sensitised paper is fed into a dry developer, i.e., ammonia vapours, which turn the background of the print white and of the lines either blue, black, or sepia, depending upon the chemicals used.

7.6.3 Xeroxing

Now a days, xerox copies with enlargement and reduction facilities are found to be useful for obtaining additional copies. Coloured xerox copies and coloured prints are recent developments in this field.

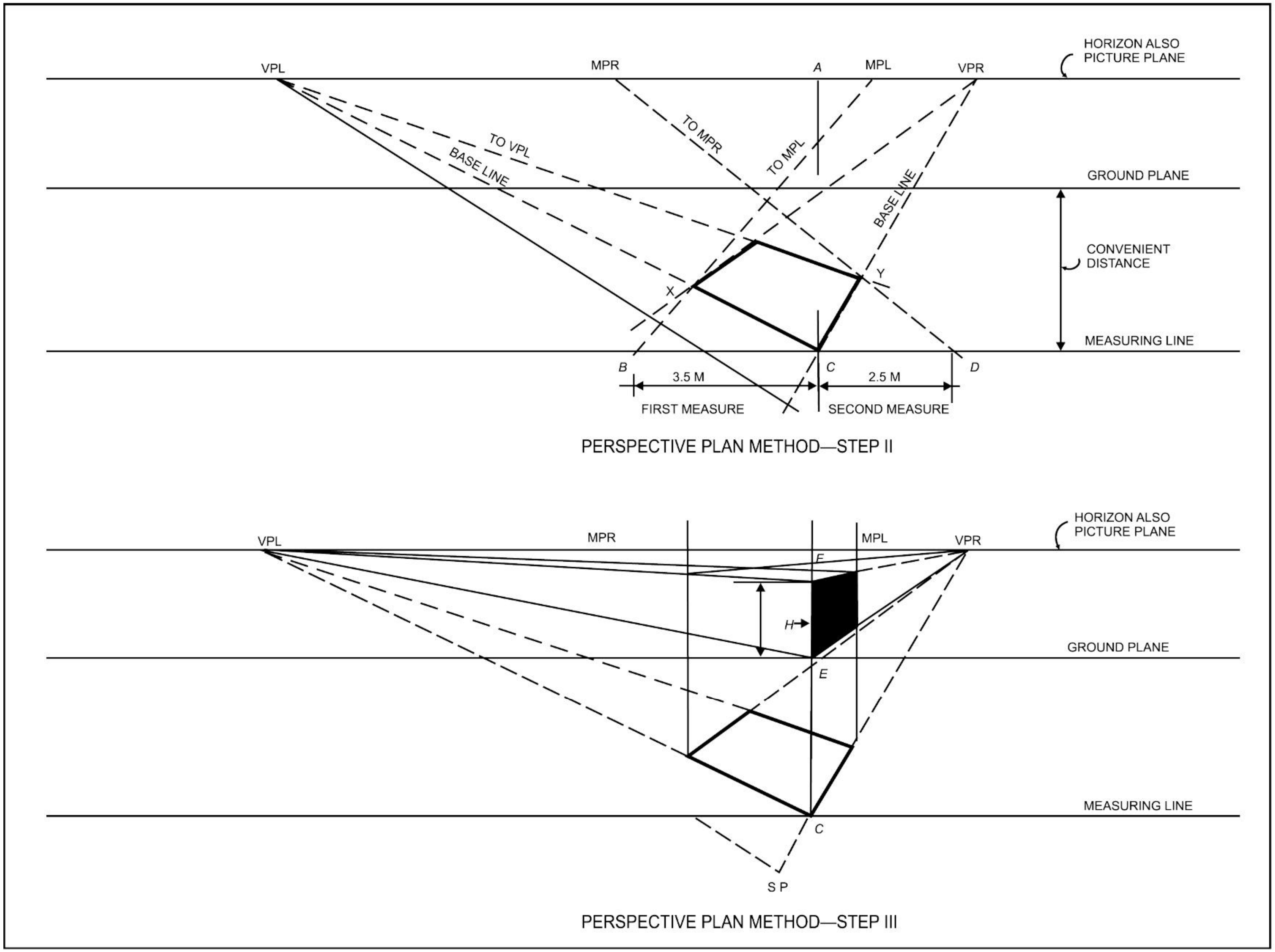


Figure 7.17 *Perspective Plan Method*

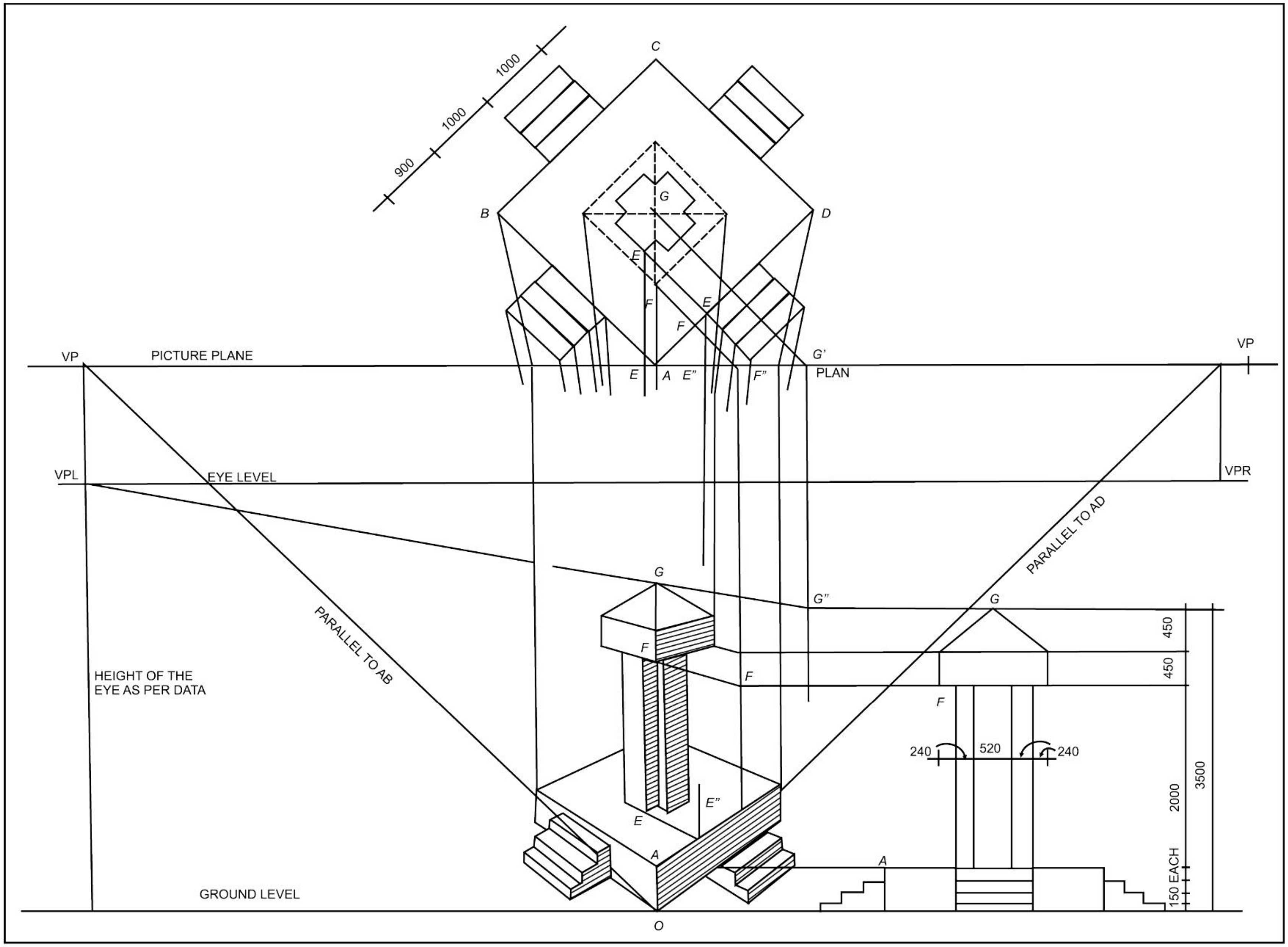


Figure 7.18 *Perspective View–Monumental Pillar*

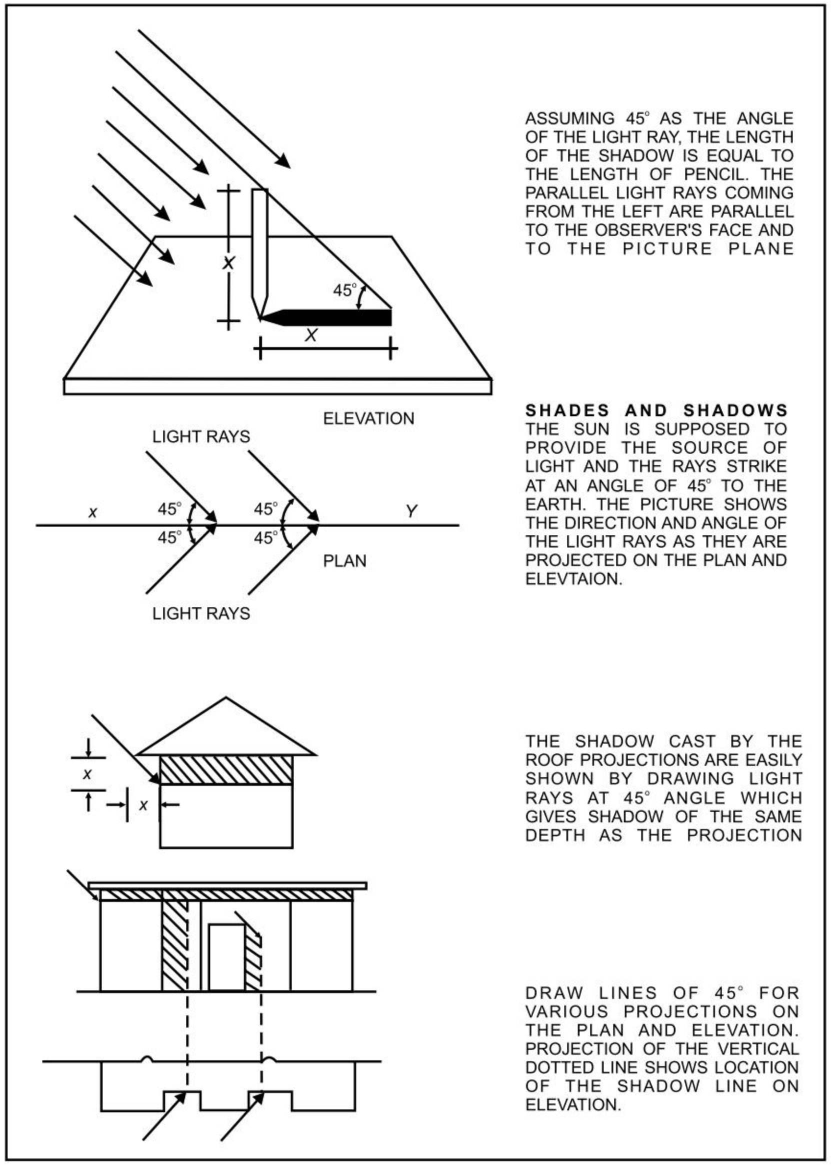


Figure 7.19 *Shades and Shadows in Perspective Views*

7.7 PREPARATION OF SUBMISSION AND WORKING DRAWINGS

The preparation of submission and working drawings, becomes an important part of architectural service. Ideas are converted into drawings in order to provide information to tradesmen, estimators, contractors, and other concerned persons for the construction of a building. The draftsman should place himself in the place of these persons. Only then will he be in a position to realise the importance of drawings with correct dimensions and clear notes. One must avoid misinterpretation and wastage of time due to wrong dimensioning. Hence, it is absolutely necessary to adopt some measure of uniformity in the preparation of drawings. Indian standard specification IS 962-1989 specifies the code of practice for architectural and building drawings.

7.7.1 Conventions as per IS 962-1989

This code of practice lays down recommendations for sizes and layouts of drawings, methods of projections, sectioning and sectional views, sizes of lettering, dimensioning, abbreviations, and symbols used in architectural and building drawing office practice. These recommendations are given below.

Lines

All lines in a drawing should have significance or they have no reason for being on a drawing. All lines should be dense, clean and black to produce good prints. A full line should be used to indicate visible outline, and the thickness of the line should be varied in accordance with its purpose. A line showing a wall should appear prominent and heavy as compared to the guideline for dimension which should be light. Thickness of lines should be in accordance with the accuracy and character of the drawing permit. The finest line that a draftsman is able to draw is 0.20 mm in thickness. Centre lines and extension lines require minor emphasis and should be made fine. Keep your pencil sharp, and vary pressure on lines according to the purpose. Also use a chisel point pencil whenever required.

Visible Outlines The visible outlines should be outstanding in appearance on the drawing. A thick line may be 0.60, 0.80, 1.00 or 1.30 mm, according to the purpose (Fig. 7.25).

Centre Lines These lines should project for a short distance beyond the outline to which they refer, but in order to aid dimensioning or to correlate views, they should be suitably extended so that the dimension figures are clear of the drawing outlines (Fig. 7.25). Alternate long and short lines should have a proportion ranging from 6 : 1 to 4 : 1 closely and evenly spaced, but in any drawing, the ratio once adopted should be maintained.

Hidden Lines These lines show hidden or interior surfaces or work to be removed. They should be included only where their use definitely assists in the interpretation of the drawing. These lines, consisting of short dashes closely and evenly spaced, should be used to represent hidden lines. They should begin with a dash cutting the adjoining outline, and all lines should cross at corners. Broken lines are used on the plan to show various lines of the roof such as ridge, valley, eaves, gable board, truss, RCC loft, canopy, *chajja*, etc.

Dimensions

Dimensions are given by drawing dimension and extension lines, arrow heads or dots and leaders.

Dimension Lines These lines should be thin full lines so as to contrast with the heavier outlines of the drawing, and should be placed outside the figure, wherever possible. The drawing is useful only when dimensions are correct and the manner of placement is easy to read. Mistakes can be avoided and a lot of time can be saved by the use of correct dimensions (Figs. 7.26(a), 7.26(b) and 7.26(c)).

Extension Lines These are light or thin lines drawn from the extremities of the feature requiring dimension. These lines should not touch the feature, but should start from a distance of 2 mm and the lines should extend to about 4 mm beyond the dimensioning line.

Arrow Heads or Dots These are used to terminate dimension lines. The length of an arrow head is about four times the depth. The space of the arrow head should be filled in.

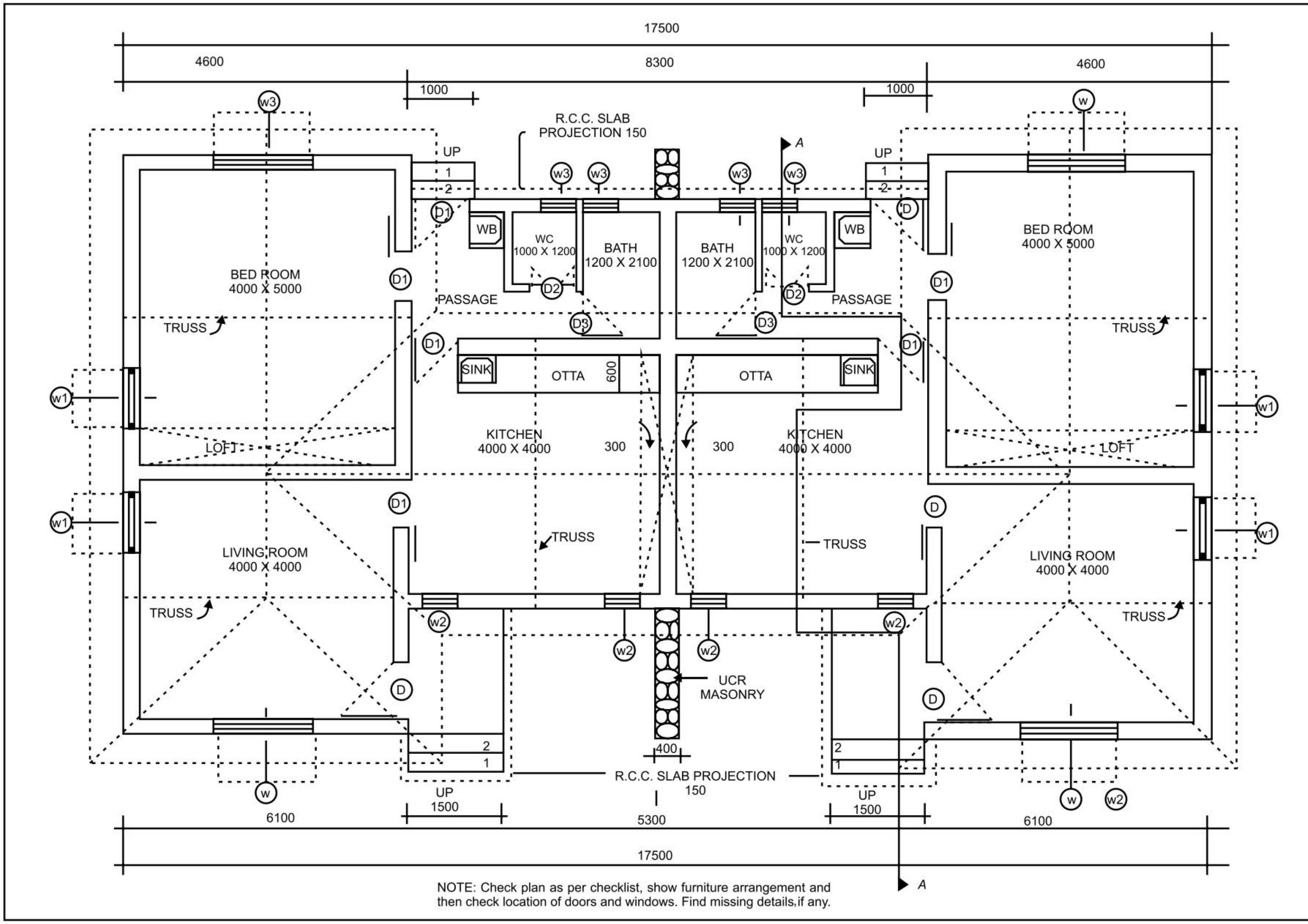
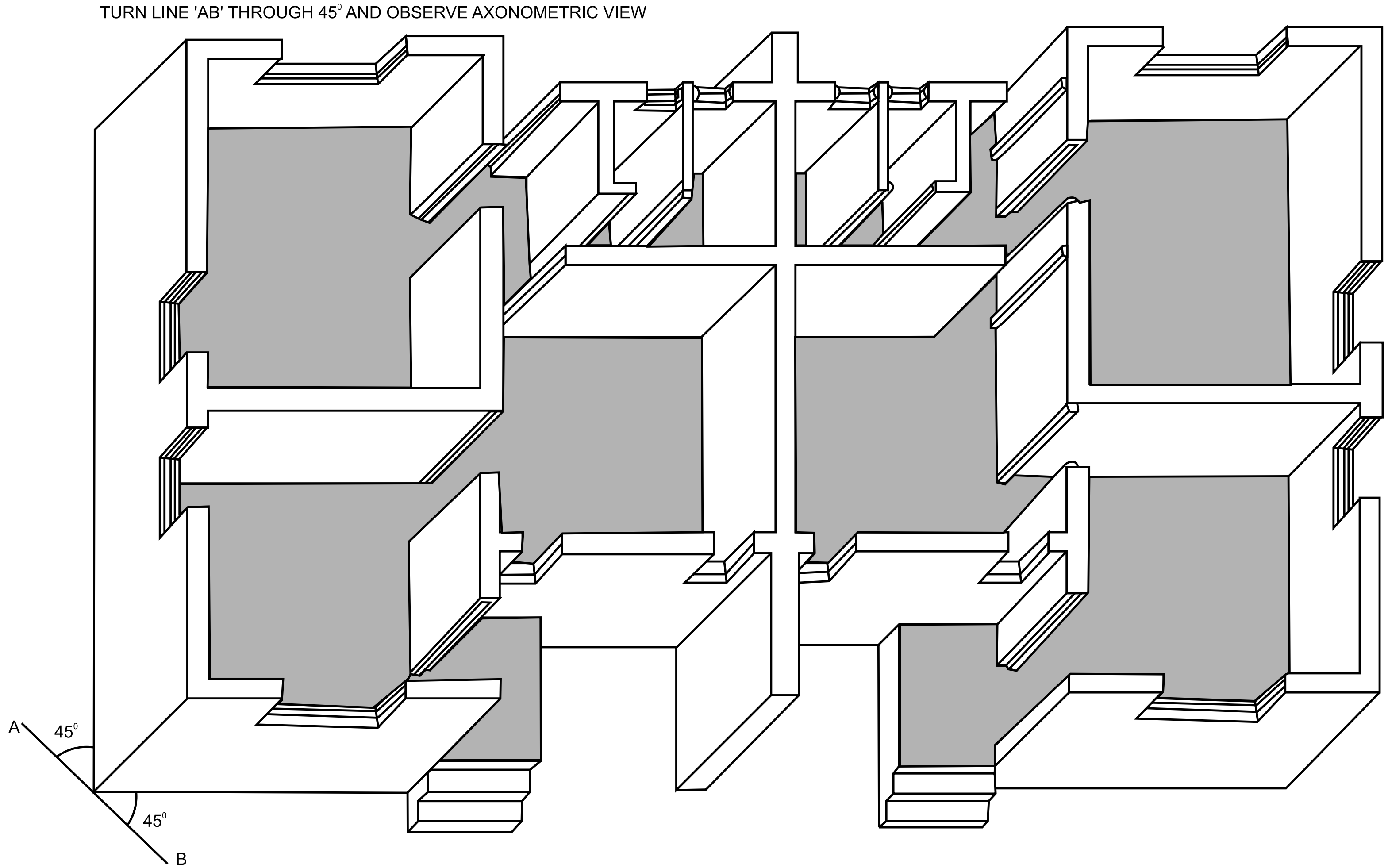


Figure 7.20 *Plan for Load Bearing Structure*



AXONOMETRIC VIEW

THE VIEW SHOWS CONSTRUCTION UP TO 1.5 M LEVEL ABOVE THE PLINTH. THE PLAN IS DEFINED AS AN IMAGINARY HORIZONTAL SECTION TAKEN AT A CONVENIENT LEVEL. COMPARE THE PLAN AND AXONOMETRIC VIEW. FIND MISSING DETAILS IF ANY.

Figure 7.21 *Load Bearing Structure – Axonometric Sectional View*

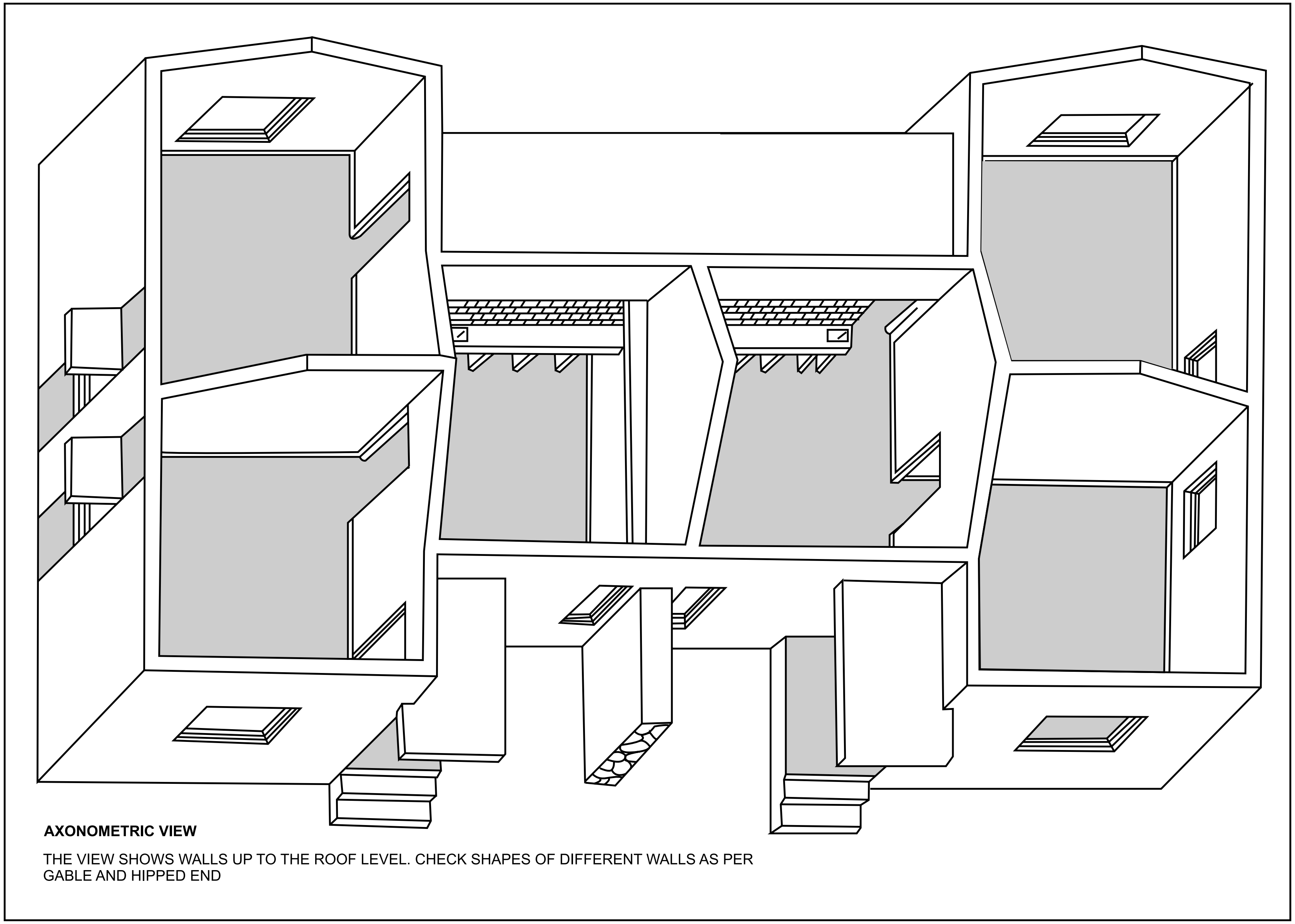
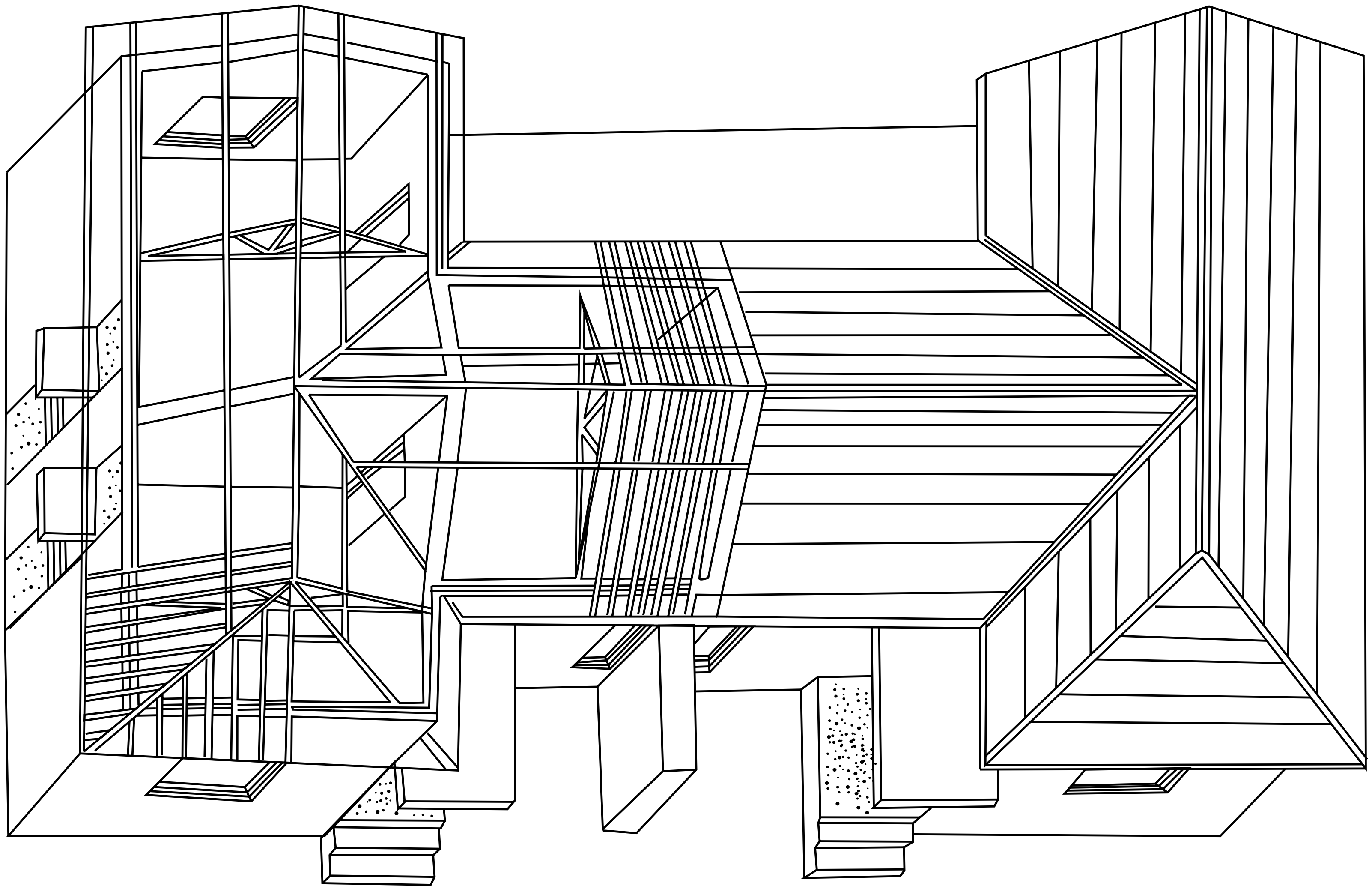


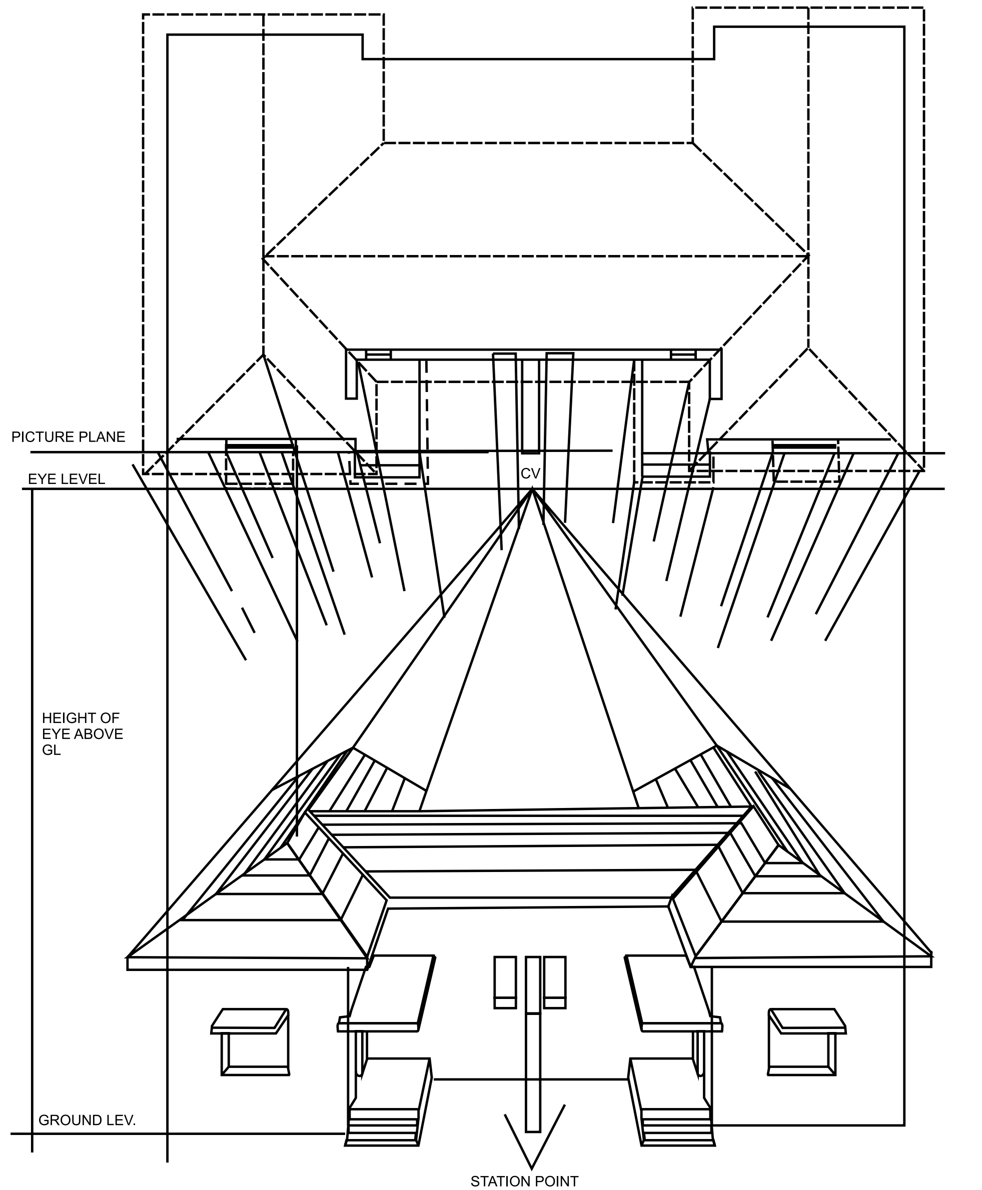
Figure 7.22 *Axonometric View – Walls up to Roof Level*



AXONOMETRIC VIEW : PITCHED ROOF

PART OF THE VIEW ON THE LEFT HAND SIDE SHOWS TRUSSES, RIDGE, PURLINS, WALL PLATES, HIP RAFTERS, COMMON AND JACK RAFTERS, WHILE THE PART PLAN ON THE RIGHT HAND SIDE SHOWS RIDGE VALLEY, HIP AND BARGE BOARD. WRITE THE NAMES OF ALL C C TEAK WOOD MEMBERS SHOWN FOR SUPPORTING THE TILES.

Figure 7.23 *Axonometric View – Details of Roof*



ONE-POINT PERSPECTIVE VIEW

THIS PERSPECTIVE VIEW IS A BIRD'S EYE VIEW. DRAW ONE-POINT PERSPECTIVE VIEW BY TAKING EYE LEVEL AT 1.5 m ABOVE THE GROUND LEVEL. STUDY ROOF LINES IN THE PLAN AND IN THE PERSPECTIVE VIEW.

Figure 7.24 *One-Point Perspective View*

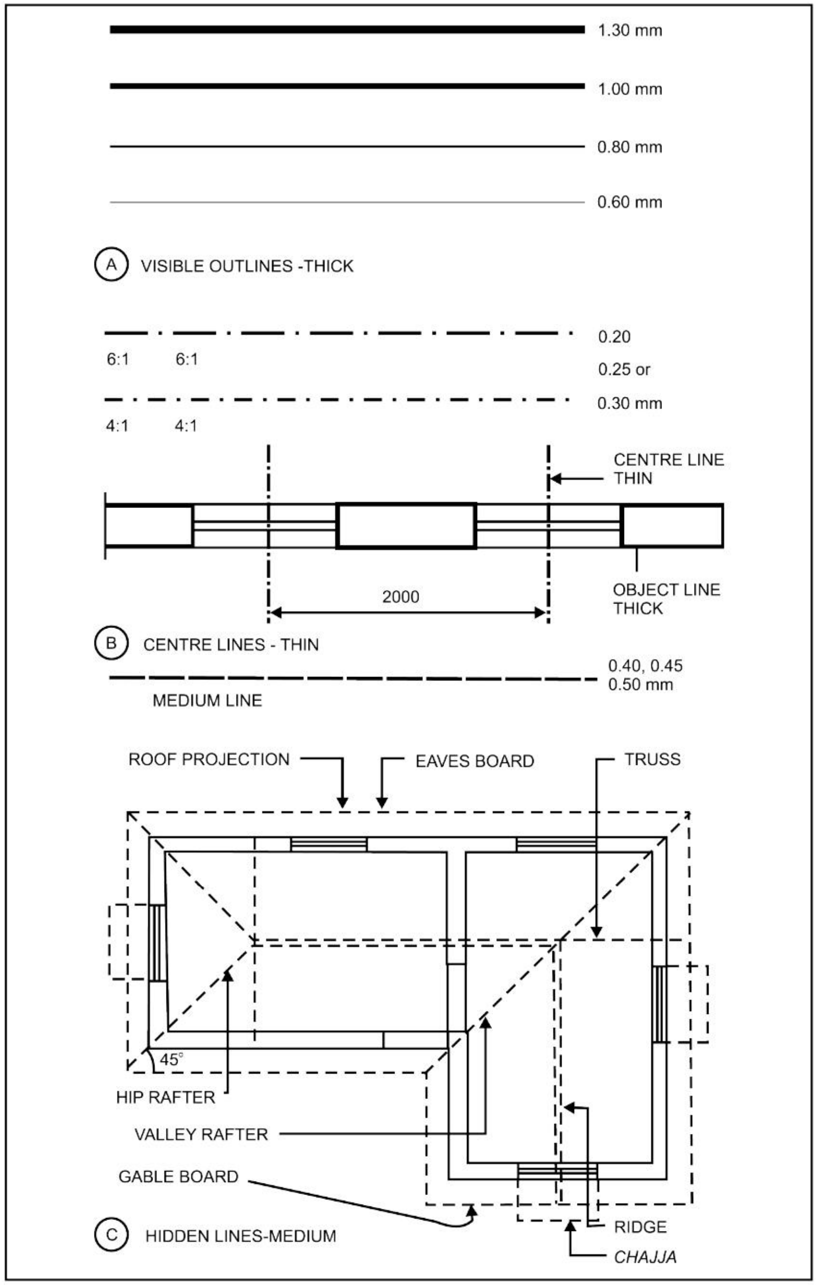


Figure 7.25 *Different Types of Lines in Drawing*

When a dot is used, it should be placed at an intersection of the extension line and the dimension line. They should be neat and uniform with their points just touching the extension lines. Use a sharp pencil to avoid a 'spotty' appearance.

Leaders (pointer lines) Sometimes, it is not possible to write the note and the dimension figure near the feature of the drawing to which it relates. In such cases, it is written slightly away from the feature and lines known as *leaders* or *pointer lines*, are drawn from notes and figures to show where the notes, figures, etc., apply. These are thin straight lines terminated by arrow heads or dots. Arrow heads should always terminate on a line; dots should terminate within the outline of the object. The leader may terminate in a short horizontal bar at mid-height of the lettering at the beginning or at the end of the note.

Dimension has nothing to do with the scale. It should represent the actual size of the structure or feature. Dimension figures should be placed near the centre either in the space of the broken line or immediately above the unbroken dimension line. Where the structure is a framed structure, i.e., RCC or steel, all dimensions should be related to the column or stanchion centres, which, in turn, are related to the building line. Where the structure is of load bearing construction, dimensions should be related to the rought unfinished wall faces. Line up all dimensions so as to draw, write and read quickly, and to improve the appearance of the drawing.

Units of Dimensioning Dimensioning should be done in metres and millimetres. If the dimension is in metres, write 'm' and if it is in millimetres, do not write 'mm' but give a note on the drawing stating that all the dimensions are in mm.

Dimensions, dimension lines, and extension lines should not interfere with the other construction lines of the drawing. If the drawing sheet is to be inked, red ink should be used for the dimension line.

Break Lines Break lines are used in drawings to show a break of continuity (Fig. 7.27). For short break, it should be a free hand line and for long breaks, it should be a ruled line and free hand zig-zag.

Section Lines The cutting plane on which a section has been taken should be indicated by a thick long dash and two short dashes alternately and evenly spaced and lettered at the ends (Fig. 7.27).

Photographic Reproduction

Where drawings are to be reproduced to a smaller scale by a photographic process, the thickness of the lines in the originals should be suitably accentuated to ensure sufficient legibility and clarity after reduction.

Lettering

The main requirement for lettering on architectural and building drawings are legibility, uniformity, ease and rapidity in execution. All letters should be in capitals except where lower case letters are accepted in international usage for abbreviations. If a sloping type is used, an inclination of approximately 75° is recommended.

1. Main titles and drawing no. 6, 8, 10 and 12 mm.
2. Sub titles and headings no. 3, 4, 5 and 6 mm.
3. Notes, schedules, materials dimensions 2, 3, 4 and 5 mm.

All letters and numerals should be kept clear of dimension and other lines. Words may be underlined in a drawing where preferred.

Lettering should be done on the drawing in such a manner that it may be read when the drawing is viewed from the bottom edge. Lettering, which is required to be written in a direction at right angles to the bottom edge of the drawing, should be so written that it is readable when viewed from the right hand edge of the drawing.

Symbols

Symbols for materials in section are shown by various types of hatching. Discretion should be used in adopting the spacing of hatching lines to the scale of drawing. It is recommended that when hatching is required to be done on tracing paper or cloth, a sheet of squared paper shall be placed underneath to maintain uniformity of spacing and direction of the hatching (Fig. 7.29).

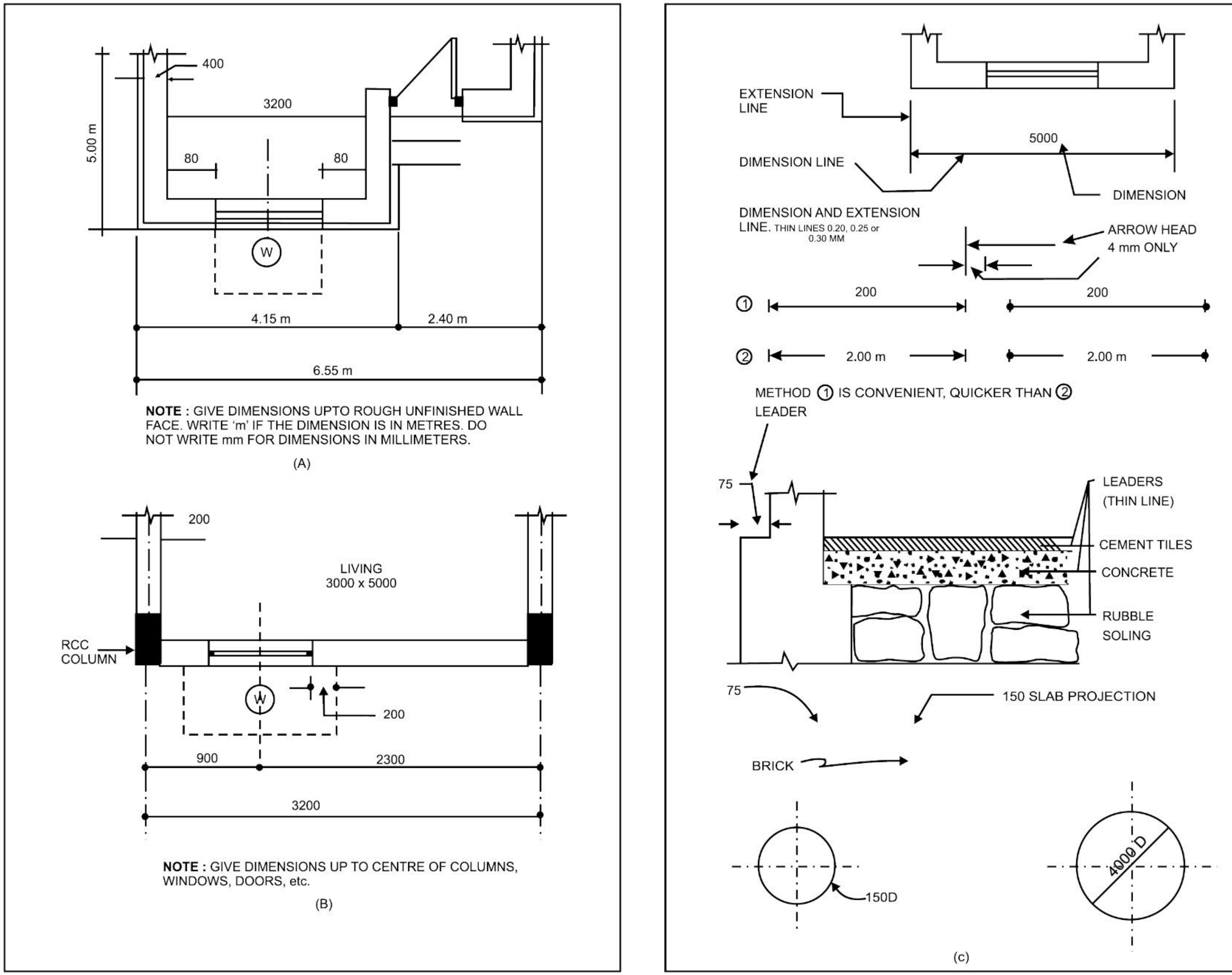


Figure 7.26 *(A) Dimensions on a plan of a load bearing structure (B) Dimensions on a plan of a framed structure (C) Details-dimensions, leaders*

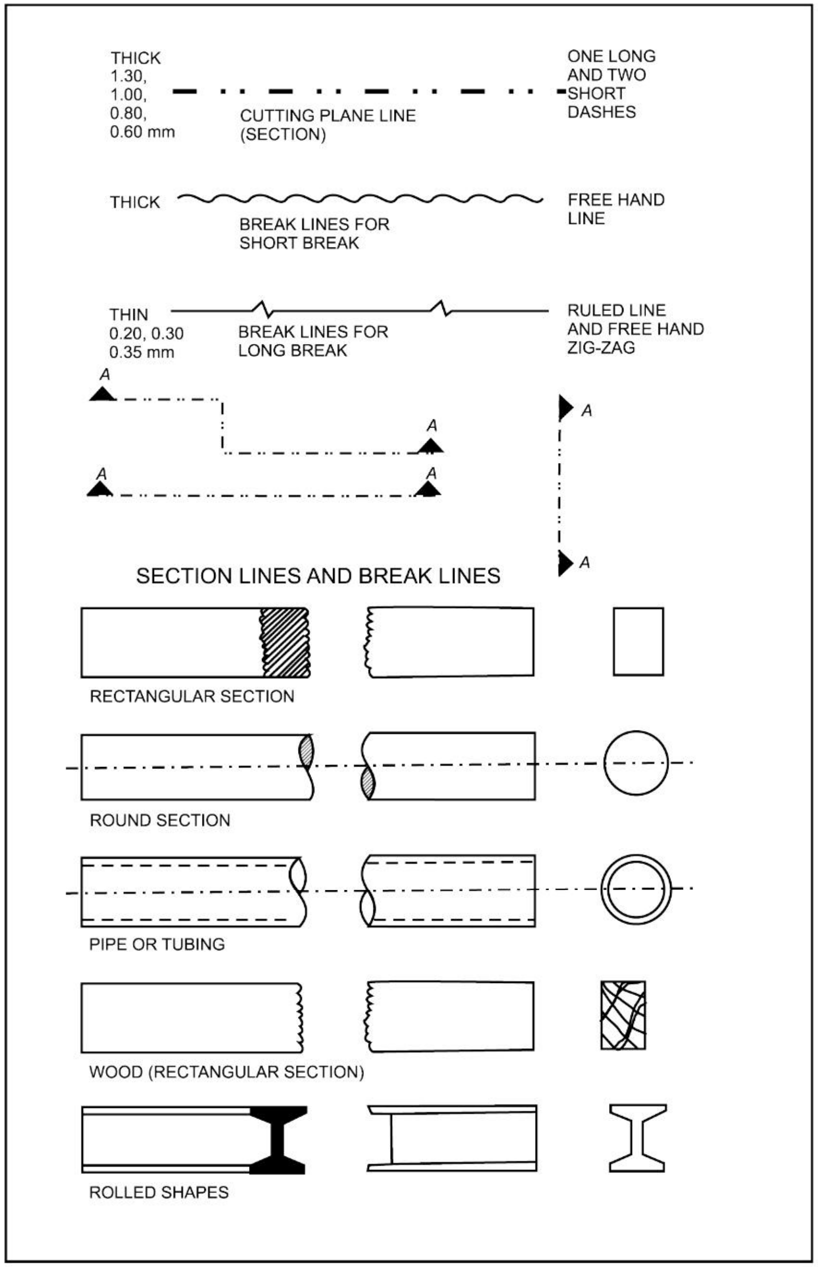


Figure 7.27 *Section and Break Lines in Drawing*

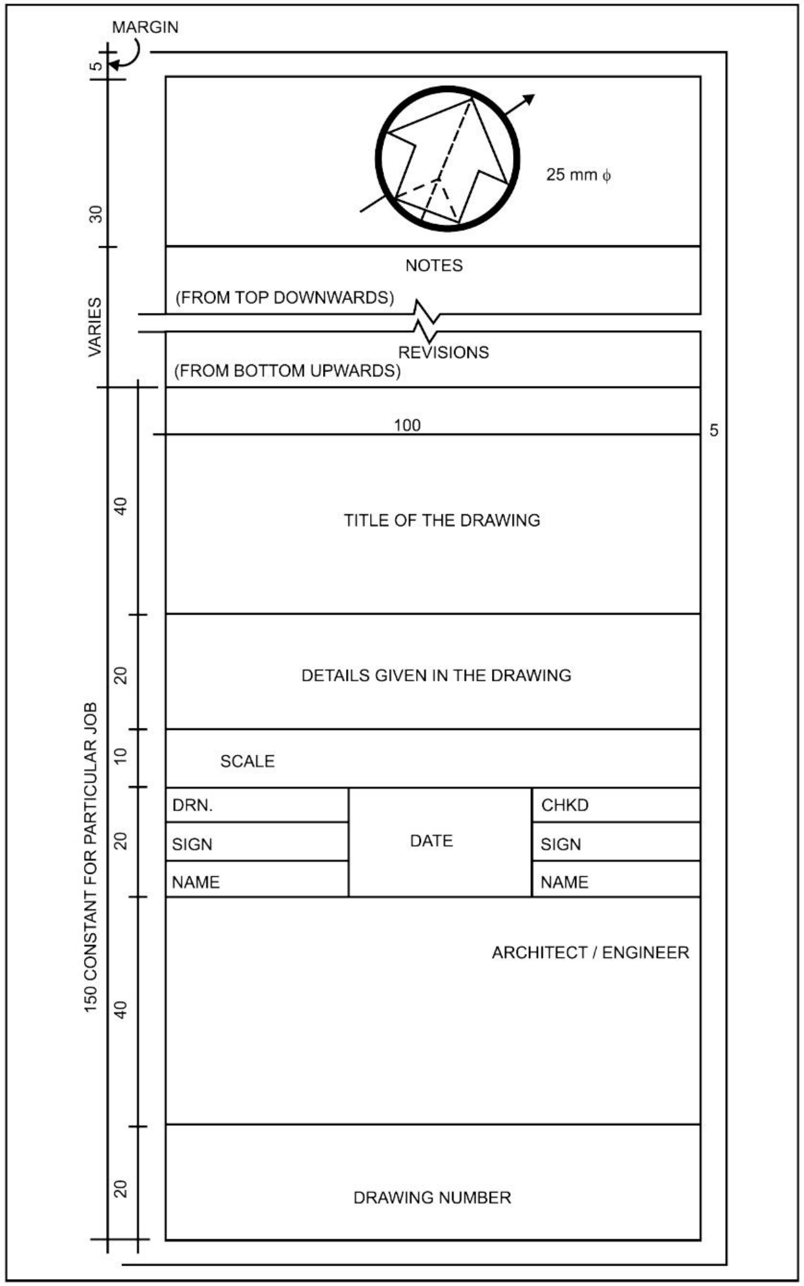


Figure 7.28 *Details of Title Block*

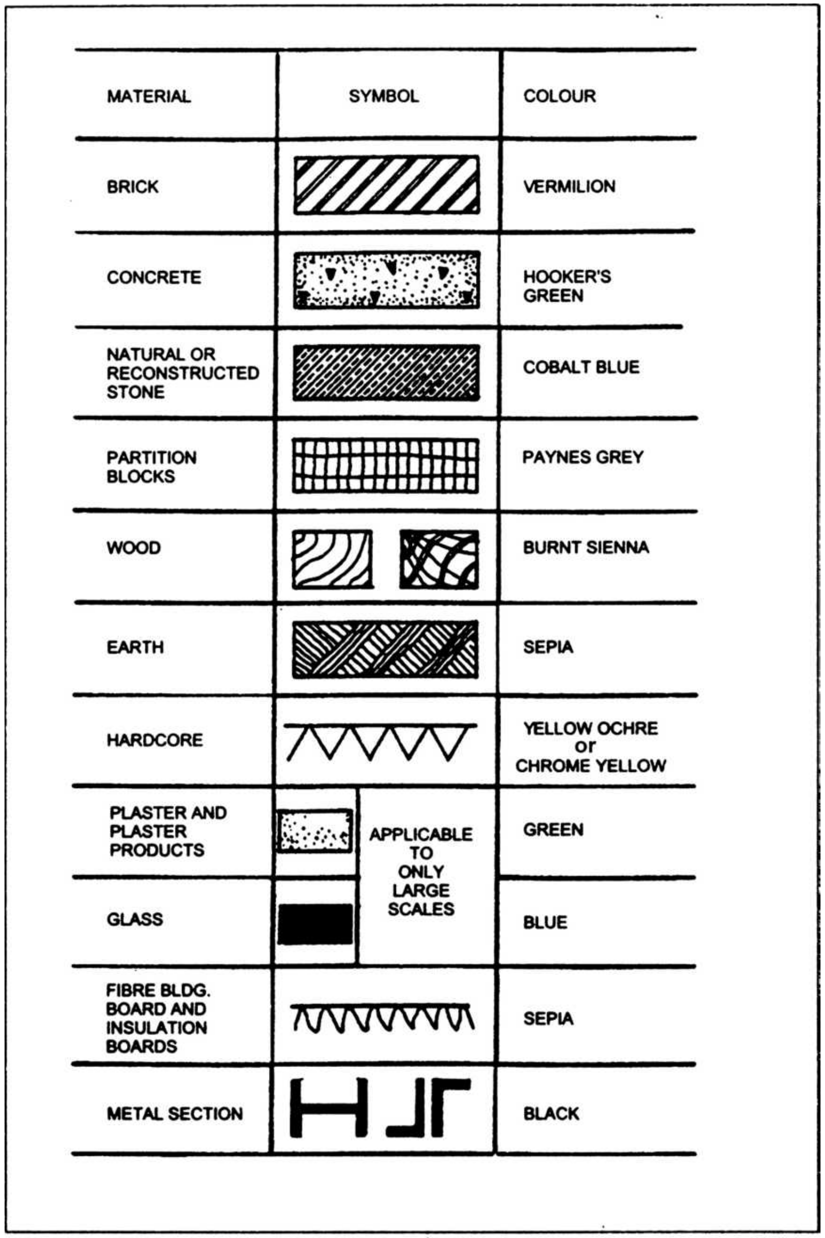


Figure 7.29 *Symbols for Materials in Sections*

Where large areas of section hatching are to be indicated, especially for such materials as concrete and plaster, it is recommended that a portion near the edge only be treated, the hatching gradually fading towards the centre.

Areas in sections which are too thin for line sectioning, such as some metal sections, should be blackened in solid, leaving a thin space between adjacent portions.

On a drawing showing existing and proposed work, the existing work may be distinguished from the new work by blackening in solid or by discretionary hatching.

Abbreviations Abbreviations are generally used in drawing for the sake of clarity. A systematic notation of architectural and building terms is necessary for uniformity, and for avoiding confusion and ambiguity. IS 962-1989 gives a standard list of abbreviations.

Graphical Symbols Symbols are in constant use on small scale drawings and it is considered that time can be saved and confusion avoided, if a standard range of symbols is extensively used. Careful attention shall be given to the size of these symbols having due regard to the scale of the drawing. Wherever practicable, they shall be drawn to scale. Some symbols may have to be slightly enlarged for the purpose of clear indication (see IS 962-1989).

Windows and Doors Generally, window openings shall be defined in elevation, and of doors, screen and sliding windows on the plan (Fig. 7.30). For windows, the point or apex of two lines crossing the ventilator or casement indicates the hinged side.

Doors of different types like (1) single shutter, (2) double shutter, (3) sliding, (4) folding, (5) revolving, etc., are shown by graphical symbols. The direction in which the shutter of the door will swing should be shown clearly in the plan.

Service Pipes Identification letters shall be used to denote the service. For example, we can use (i) Air–A, (ii) Drainage–D (iii) Electricity–E, (iv) Fire service–F, (iv) Gas–G, (vi) Oil–O, (vii) Refrigeration–R, (viii) Steam–S, (ix) Water-W, etc. A note shall be given in the drawing about the letters used.

7.7.2 Scales

For the preparation of submission and working drawings, the following scales shall be used. Other scales for the preparation of different types of drawings are given in IS 962-1989.

1:200	(5 mm = 1 m)	—	For submission and working
1:100	(10 mm = 1 m)		drawings; plans, elevation and
1:50	(20 mm = 1 m)		sections
1:20	(50 mm = 1 m)	—	For large scale drawings and
1:10	(100 mm = 1 m)		general drawings
1:5	(200 mm = 1 m)	—	For enlarged details
1:2	(500 mm = 1 m)		
1:1	(full size)		

7.8 ENGINEERING DRAWING AND ARCHITECTURAL DRAWING WITH ARCHITECTURAL STYLE

It would be interesting to observe the difference between a drawing prepared by a mechanical engineer or draftsman for a part of any machine and a drawing prepared by an architect for a building. The difference in these drawings can be noted easily. Maximum accuracy, uniform thickness of lines, lettering work with solid block type for easy reading are the main features of an engineering drawing, while an architectural drawing shows an artistic touch in line work and lettering by varying thickness of lines and types of lettering with what is known as architectural style. As compared to a building, any machine consists of different parts, some may be stationary while some may be rotating. What is important is their finished dimensions, precise accuracy, threads, etc. Hence, such drawings are totally different as compared to the drawing of a building.

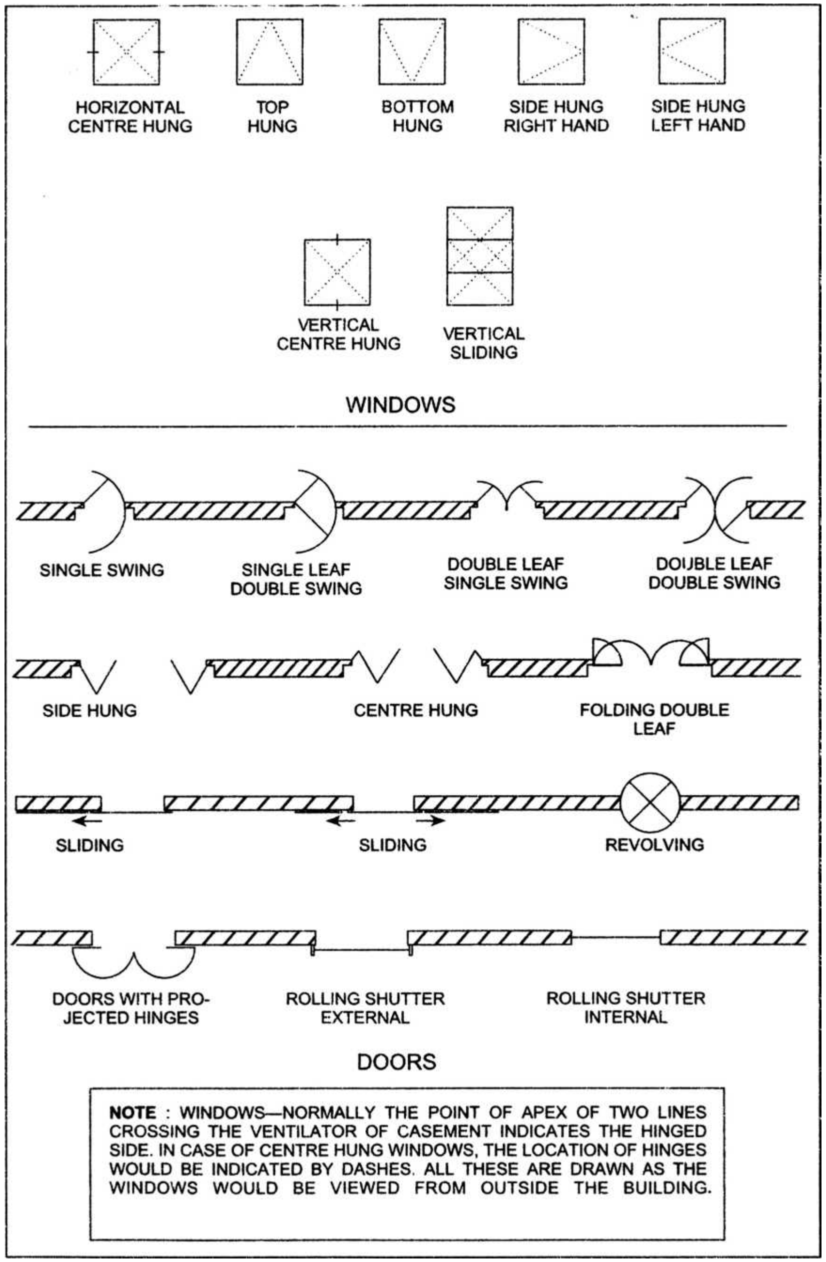


Figure 7.30 *Graphical Symbol for Doors and Windows*

7.9 SKETCHING AND LETTERING WITH ARCHITECTURAL STYLE

Drawings of different architects are prepared with what is known as a different style in draftsmanship. Pure line work and lettering is also done by a typical style giving a professional touch to the drawing. In order to acquire this pleasing style with ease and speed, one has to strive hard. The architect experiences pleasure and excitement as his drawing progresses. Pencil and drawing or tracing paper are the initial requirements. It is necessary to train the hand systematically by sketching lines, circles, geometrical figures, etc. The brain, eyes and hand should work simultaneously. Variation in the pressure while sketching will show different effects. Sketching of different objects and their three dimensional views with shading will create an interest in the drawing. Ease and speed depends upon practice. Slight pressure is given at the beginning and end of pencil lines to make them sharp and distinct. An architectural line work looks more pleasing by extending it slightly at corners. This also helps in taking correct dimensions.

The extension should be about 2 mm. Over elaboration is a waste of time. The main aim of a drawing is to make clear the ideas of the designer and to give data and guidelines for an estimate and execution of work.

Different draftsmen worked on the same project, hence in order to have uniformity in all drawings, stencils are used for lettering work. Latest drawing equipments like improved pencils, pens, stencils, etc. gives more accuracy. With this, a lot of time and energy is saved as compared to the systems followed previously. Drawings prepared with the help of computers give uniformity and accuracy.

In the beginning of one's career as an architect and engineer, it is essential to develop a skill for sketching. This would be useful in the field and office to explain quickly and correctly, requirements as per design. The following guidelines will be useful in drawing sketches:

1. Sketching or a freehand drawing is simply a drawing without the use of any drawing equipments.
2. Well-dimensioned sketches are used for preparing working drawings; hence, sketches must be proportionate and show sufficient details.
3. Appearance of the sketch improves with experience.
4. H or B pencils, tracing paper, graph paper, eraser, and sand paper should be used. For preliminary line work, 2 H pencils should be used, and 2 B for darker accents.
5. Draw different parallel, vertical, horizontal, and inclined lines with conical and chisel points.
6. Draw lines perpendicular to each other, draw squares, rectangles thereafter. Divide the lines into the number of required divisions by visual comparison.
7. Draw an inclined line with different angles like 30°, 45°, 60°, etc.
8. Sketch circles and curves.
9. Maintain proportions in a sketch by comparing length, width, and height of the object.
10. Important lines in a sketch should be bold and other lines should be thin.
11. A sketch book containing different types of masonry, joints in wood work, types of doors, windows, staircases, and roof work should be prepared. Sketches should be first drawn on the graph paper and then the same sketches should be drawn on drawing paper which will show improvement in the line work.

7.9.1 Lettering with Architectural Style

The quality of a drawing depends upon the quality of lettering and line work. Lettering and dimensioning should be done rapidly and easily. It should be pleasing and a uniformity must be maintained. In order to give a pleasing artistic touch to the drawing, different styles in lettering have been developed by different architects. Students should study these different styles, and develop a suitable style. A refined and polished style is a result of constant drawing work. Important styles (Fig. 7.31) are condensed, extended, variation and kabel modern.

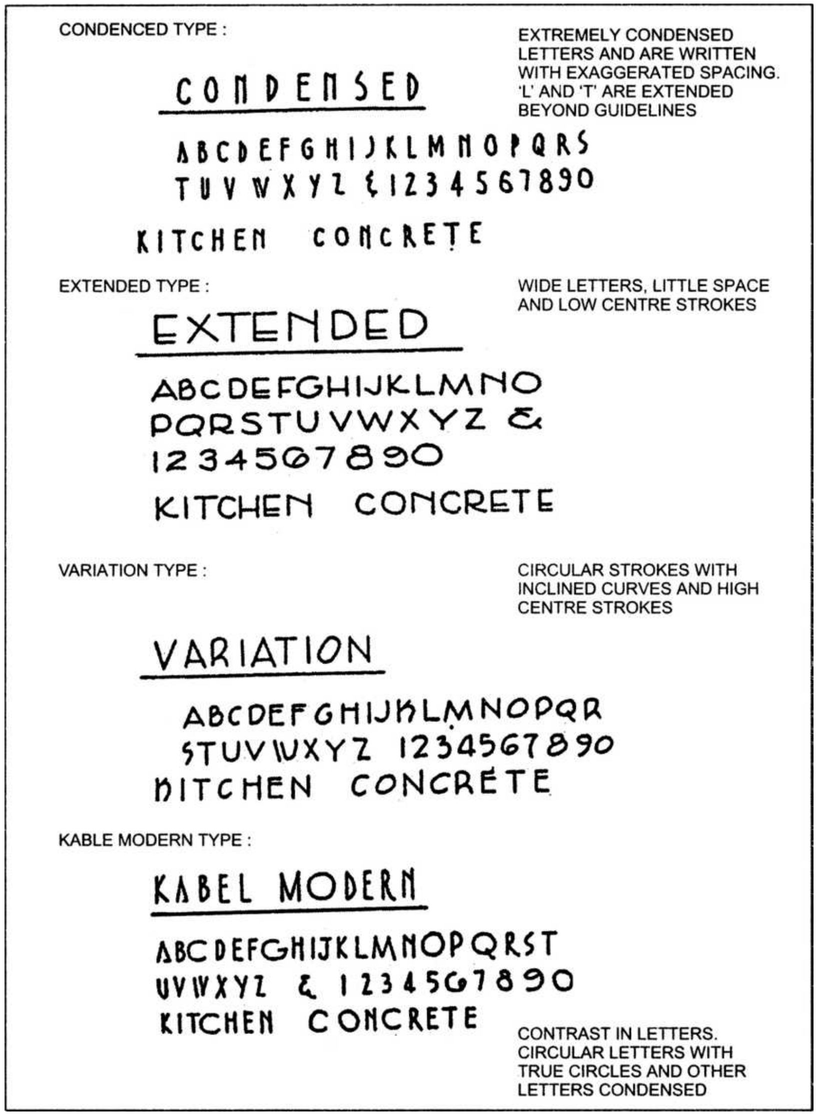


Figure 7.31 *Styles in Lettering*

1. Condensed Type: Letters are condensed and are written with uniformly spread spacing. The letter 'S' is written with one reverse curve stroke. End stroke for letters is marked with prominent points. The letters 'L' and 'T' are extended beyond guidelines.

2. Extended Type: Letters are wide with little space between each letter opposite to the condensed type. 'E', 'F', and 'H' have low centre strokes.

3. Variation Type: Curved strokes or inclined centre strokes are placed high. O and P do not have full round nature but are slightly rectangular.

4. Kabel Modern: Kabel is the name of the designer of this type. He has provided a contrast between the full round circular letters and other letters. They are kept as condensed. The spacing may be spread or tight. Sometimes, a dot is marked in O, C, G and P.

7.10 TEACHING BUILDING DRAWING

The following are the basic steps in teaching building drawing; (i) sketching, (ii) tracing, (iii) measured drawing, and (iv) development of the line plan.

The basic requirement of a student intending to work as a draftsman, civil engineer, or an architect is artistic ability. He/she must know freehand sketching, and should have a knowledge of perspective and orthographic drawings. A good understanding of construction and construction materials is also required.

7.10.1 Sketching (Fig 7.40)

In order to develop confidence, ability, and architectural style in drawing, the first part of the training should start with sketching, which will help in understanding the construction methods, joinery details, and various technical terms.

7.10.2 Tracing

The second step should include the tracing work on tracing paper, first by using pencil and then ink. Drawings of different types of buildings such as load bearing and framed structures by different architects, should be studied, and then given for tracing. This will help in studying the composition of the drawing sheet, plan, elevation and section details, and requirements of each view. Thus students will get sufficient practice for lettering and dimensioning and for writing notes and schedules.

7.10.3 Measured Drawing

The third step in training should involve measured drawing. The first visit should be used for studying construction details and writing of construction notes, and drawing elevations of all sides. Second visit should be used to take all external and internal measurements and preparation of sketch plans. Then the section line should be marked on the plan and students should be asked to draw the section. This method would give them confidence. They would become familiar with the construction aspects and indirectly study different styles in architecture, elevation treatment, proportion, balance, shadow projections and symmetry in the structures. Afterwards, they should be asked to draw plans, elevations and sections first on graph paper, and then on drawing sheets with an appropriate composition.

Table 7.1 Schedule for Doors

Sr. No.	Door symbol	No.	Clear size masonry openings mm	Frame size type mm	Shutter thickness mm	Finish oil paint/polish	Remarks
1.	D	4	900 × 2100	75 × 150	30	Oil paint	CCTW single shutter, panelled door as per drawing
2.	Dl	1	900 × 2100	75 × 150	30	Oil paint	–do–
3.	D2	1	750 × 2100	75 × 150	30	Oil paint	double shutter
4.	D3	1	750 × 2100	75 × 150	30	Oil paint	single shutter

Table 7.2 Schedule for Windows

Sr. No.	Window symbol	No.	Clear size, masonry opening mm	Frame size, type mm	Shutter thickness mm	Finish polish/oil paint	Remarks
1.	W	3	1500 × 1350	75 × 100	25	Oil paint	CCTW partly glazed and partly panelled with MS grill as per drawing
2.	Wl	4	1000 × 1350	75 × 100	25	Oil paint	CCTW partly glazed and partly panelled with MS grill as per drawing
3.	W2	2	600 × 600	75 × 100	25	Oil paint	CCTW with glass louvres and MS grill as per drawing

Note: A separate detailed drawing showing plan, section, and elevations is necessary for different types of doors and windows. Prepare schedule for steel and aluminium windows.

7.10.4 Development of the Line Plan

The fourth step in teaching should include development of the line plan with the given data and construction notes. Sketches for plan, elevation, and sections should be prepared first on graph paper and then on drawing paper. At this stage, the students should also study construction, building bye-laws, and design of structural members (Fig. 7.32).

7.10.5 Working Drawings, Detailed Drawings and Estimates

Working Drawings of a building generally consist of plans, elevations and sections.

1. ***Plans***
   - (a) Foundation plan
   - (b) Ground floor plan
   - (c) First floor plan and plans for other floors
   - (d) Terrace floor plan/Roof plan
   - (e) Site plan
   - (f) Layout plan showing different buildings, gardens, internal roads, water supply and drainage lines, etc.
   - (g) Basement plan
   - (h) Structural plans showing details of RCC columns, beams, slabs, etc. (i) Plan for electric wiring with details of points, etc.
2. ***Elevations*** Elevations of all sides (front, back and both the sides).
3. ***Sections***
   - (a) Typical sections through doors, windows, and balconies
   - (b) Sections through staircases and sanitary units.
4. ***Details*** Details should be provided of the following:
   - (a) Door frames and material for shutter and a list of fixtures and fastenings
   - (b) Window frames and material for shutter and a list of fixtures and fastenings and grill work.
   - (c) Staircase handrail, MS grill, method of fixing, rise, tread, etc.
   - (d) Compound wall and gate
   - (e) Balcony railing, RCC vertical drops, pardi, etc.
   - (f) Kitchen arrangment otta, sink, etc.
   - (g) Bathroom, WC, attached toilet.
   - (h) Details of dado
   - (i) Sanitary and water supply fixtures, location and method of fixing, connection of water supply and drainage pipes, gully traps, inspection chambers, supply from overhead storage tank, etc.
   - (j) Any other specific details as per the type of building like furniture pieces, cupboards, etc. While making working drawings, their utility and importance from the point of view of estimates and site supervision should be kept in mind.

Table 7.3 gives details of various items and their units of measurements and payment. Quantities are required to be calculated in m^3 and m^2 or per running metre. Hence, students should have a knowledge of the items and respective units of measurement and payment. This naturally imparts a new practical vision to write and then check the dimensions so as to calculate the quantities in m^3, m^2 or metre.

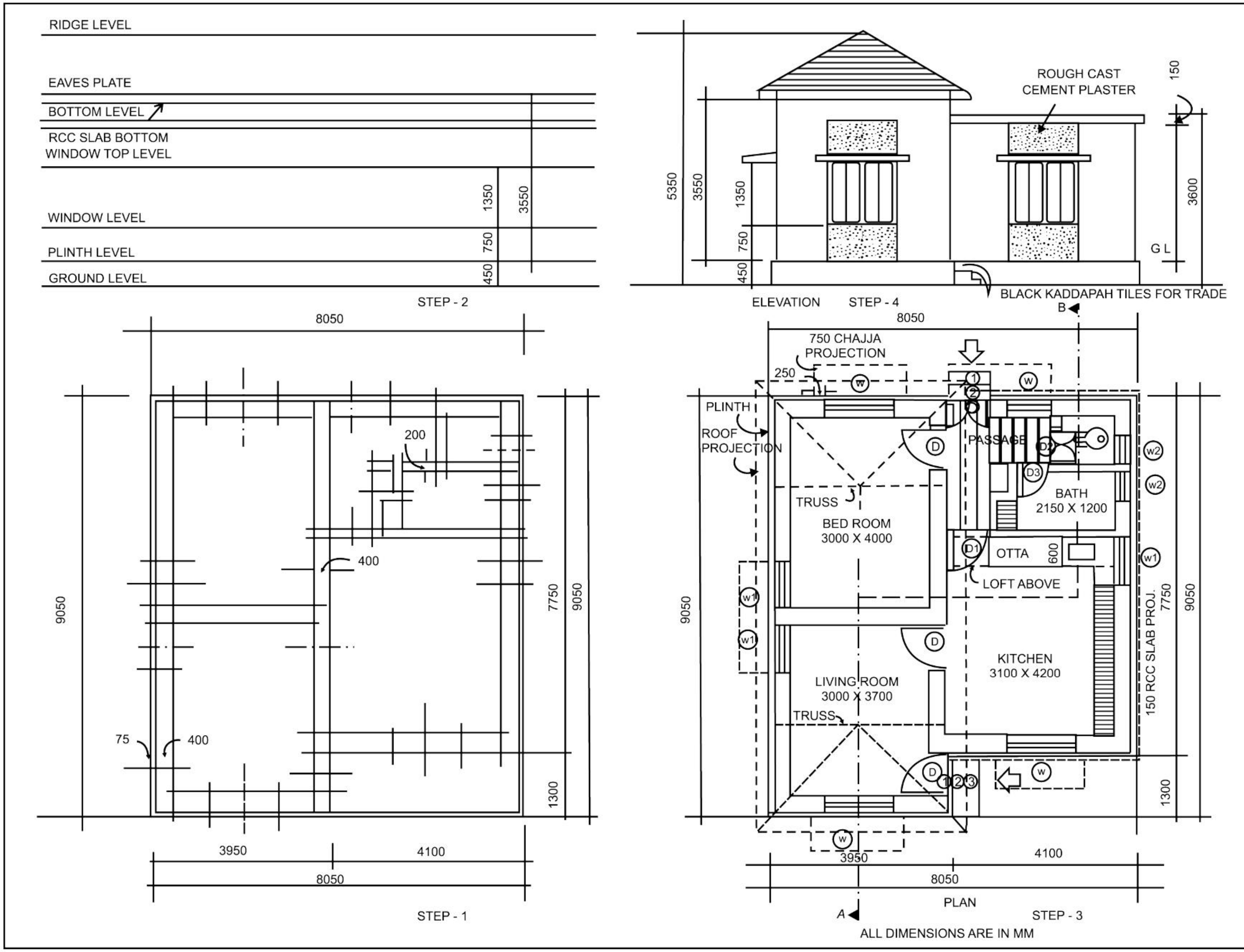


Figure 7.32 *Development of Plan and Elevation—Load Bearing Structure*

Table 7.3 Units of Measurement and Payment for Various Items of Works

Sr. No.	Item	Unit of measurement in mks	Unit of payment in mks
1.	*Earthwork, excavation, filling*	m^3	per % m^3
2.	*Concrete*		
	(a) Lime concrete in foundation	m^3	per m^3
	(b) Cement concrete	m^3	per m^3
	(c) Reinforced cement concrete	m^3	per m^3
	(d) RCC *chajja*	m^3	per m^3
	(e) Precast CC or RCC	m^3	per m^3
	(f) Jali work (thickness to be specified)	m^2	per m^2
	(g) Damp-proof course (thickness to be specified)	m^2	per m^2
3.	*Brick work*		
	(a) In foundation and plinth, super structure and in arches, etc., in cement, lime or mud mortar	m^3	per m^3
	(b) Half brick work with or without reinforcement	m^2	per m^2
4.	*Stone work*		
	(a) Stone masonry—Random rubble, coursed rubble, ashlar masonry in walls, arches, etc.	m^3	per m^3
5.	*Wood work*		
	(a) Doors and window frames, rafters, beams, roof trusses, etc.	m^3	per m^3
	(b) Doors and window shutters, panelled, battened, glazed. Part panelled and part glazed (Thickness to be specified)	m^2	per m^2
	(c) Wood work in partition, plywood, etc.	m^2	per m^2
6.	*Steel work*		
	(a) Steel reinforcement bars, etc., in RCC reinforced brick work	quintal	per quintal
	(b) Bending, binding of steel reinforcement	quintal	per quintal
	(c) Iron works in truss	quintal	per quintal
	(d) Welding, soldering of sheets, plates	cm	per cm
	(e) Barbed wire fencing	m	per m
	(f) Iron gates	m^2	m^2
	Iron gates or in	quintal	per quintal
	(g) Iron railings (height and type to be specified)	m	per m
	(h) Iron grills	m^2	per m^2
	(i) Collapsible gates	m^2	per m^2
	Collapsible gates or in	quintal	per quintal
	(j) Rolling shutters	m^2	per m^2
	(k) Steel doors and windows (type and fixing to be specified)	m^2	per m^2
7.	*Roofing*		
	(a) Tile roofs, Mangalore tiles including battens	m^2	per m^2
	(b) Corrugated iron roofs, (GCI), asbestos cement (AC) sheet roofs, etc.	m^2	per m^2
	(c) Eaves boards (thickness to be specified)	m^2	per m^2
	(d) RCC slab roofings excluding steel	m^3	per m^3
	(e) Ridge, valleys, gutters	m	per m
	(f) Tarfeltings	m^2	per m^2
	(g) Ceilings—Timber, AC sheet	m^2	per m^2
8.	*Plastering, pointing and finishing*		
	(a) Plastering—Cement mortar, lime mortar, mud, etc. (thickness to be specified)	m^2	per m^2
	(b) Pointing	m^2	per m^2
	(c) Dado (thickness and type to be specified)	m^2	per m^2
	(d) Skirting (thickness and type to be specified)	m	per m
	(e) White washing, colour washing, cement washing (number of coats to be specified)	m^2	per m^2
	(f) Distempering (number of coats to be specified)	m^2	per m^2
	(g) Oil painting	m^2	per m^2
9	*Flooring*		
	Type and thickness of tiles, type and thickness of bed concrete to be specified	m^2	per m^2
10.	*Window sills (width to be specified)*	m	per m
11.	*Miscellaneous items*		
	(a) Ornamental cornice—projection	m	per m
	(b) Pipe—rainwater, sanitary, water pipe	m	per m
	(c) Laying pipe line—sanitary, water pipe, etc. (diameter, depth, bedding, etc., to be specified)	m	per m
	(d) Glazing work	m^2	per m^2
	(e) Pile driving	m	per m
	(f) Electric wiring, or electrification; light, fan, plug points	point	per point
	(g) Water closet (WC), wash basin, manholes, etc.	no.	per no.
12.	*Supply of materials*		
	(a) Bricks	1000 nos.	per 1000 nos.
	(b) Sand Surkhi	m^3	m^3
	(c) Cement	bag of 50 kg	per bag or per tonne
	(d) Timber	m^3	per m^3
	(e) Steel	quintal	per qunital or per tonne
	(f) AC sheet (measured, flat)	m^2	per m^2
	(g) Gl sheet	quintal	per qunital
	(h) WC (size and specification to be specified)	no.	per no.
	(i) Wash basin (do)	no.	per no.
	(j) GI pipe, SW pipe, Hume pipe, AC pipe, cast iron pipe (dia. to be specified)	m	per m

Mild steel bars

Dia. mm	6	10	12	16	20	22	25	32	40
Wt. per kg. meter	0.22	0.62	0.89	1.98	2.47	2.98	3.85	6.31	9.86

Such working drawings with a scale of 1:50 or even 1:25 or 1:10 with all dimensions, notes, and data as regards materials, etc., are not only useful in preparing estimates but also save a lot of time on the site at the time of supervision. Correct estimation, accurate dimensioning, and desired specification details avoid unnecessary dispute and loss of time even at a later date.

7.11 CHECK LIST FOR DRAWING WORK

Submission and working drawings consist of plans, elevations, sections, site plans, schedules and built up area calculations. Composition of drawing consists of arrangement of different views which makes reading easier. The recommendations by IS regarding graphical language should be followed thoroughly. This will help in having uniformity in methods of dimensioning, height of lettering, scale, notes, schedules and titles.

The ground floor plan is used for preparing all structural and other plans—foundation, terrace, roof, car park, interior designing, etc. The method consists of keeping tracing paper on the ground floor plan. Trace necessary details and add additional details as per the check list. This method saves time, gives satisfaction and checks the essential details for construction. It also lists the overall requirements of the proposed building.

A study of drawings by architects, structural designers, interior designers and other consultants help in understanding the details essential for estimation and construction.

Graphical language is a precise language. It is to be interpreted with imagination and skill. The ability to read a drawing requires a thorough knowledge of the principles of graphical language. Correct natural interpretation of the several lines, symbols and different views, ability to think in three dimensions and visualisation thereof, is a gift possessed by a few persons of extraordinary creative ability. Otherwise it is essential to develop this ability by hard work, perseverance and paying visits to construction sites.

The points to be remembered while learning graphical language are:

1. Select equipments of the best quality to assure accuracy.
2. Drawing equipments requires proper care and treatment. Do not use an equipment for any other purpose than the purpose for which it was designed.
3. Deliberate and well, directed practice is necessary to have control over instruments. Speed develops with practice.
4. Lettering should be legible and pleasant to look at. Make your drawing informative and complete with notes, dimensions, symbols, conventional signs and a title.
5. Develop an ability to make spontaneous sketches. Free hand quick sketching is a vital means of communication.
6. Always keep the pencil as nearly vertical as possible and in close contact with the straight edge.
7. When joining two points, first place the straight edge evenly between them and test whether the pencil will pass through both before drawing the line.
8. All lines should be drawn firmly. They should be of required thickness throughout and sufficiently long to avoid any later lengthening.
9. Lines should be drawn from a given point and not to it. This is important in the case of two or more lines radiating from a point.
10. Larger the scale, smaller the percentage error will be.

7.11.1 Check List

Plan

It is an imaginary horizontal section at a convenient level which shows the constructional details, various areas, openings of doors, windows, etc. Details above the section line are shown by dotted lines.

The plan includes:

1. All external dimensions for all sides with arrow heads
2. Wall thickness, plinth offset
3. Column—number and size
4. Title of the rooms, passage and areas
5. Clear internal dimensions of the rooms

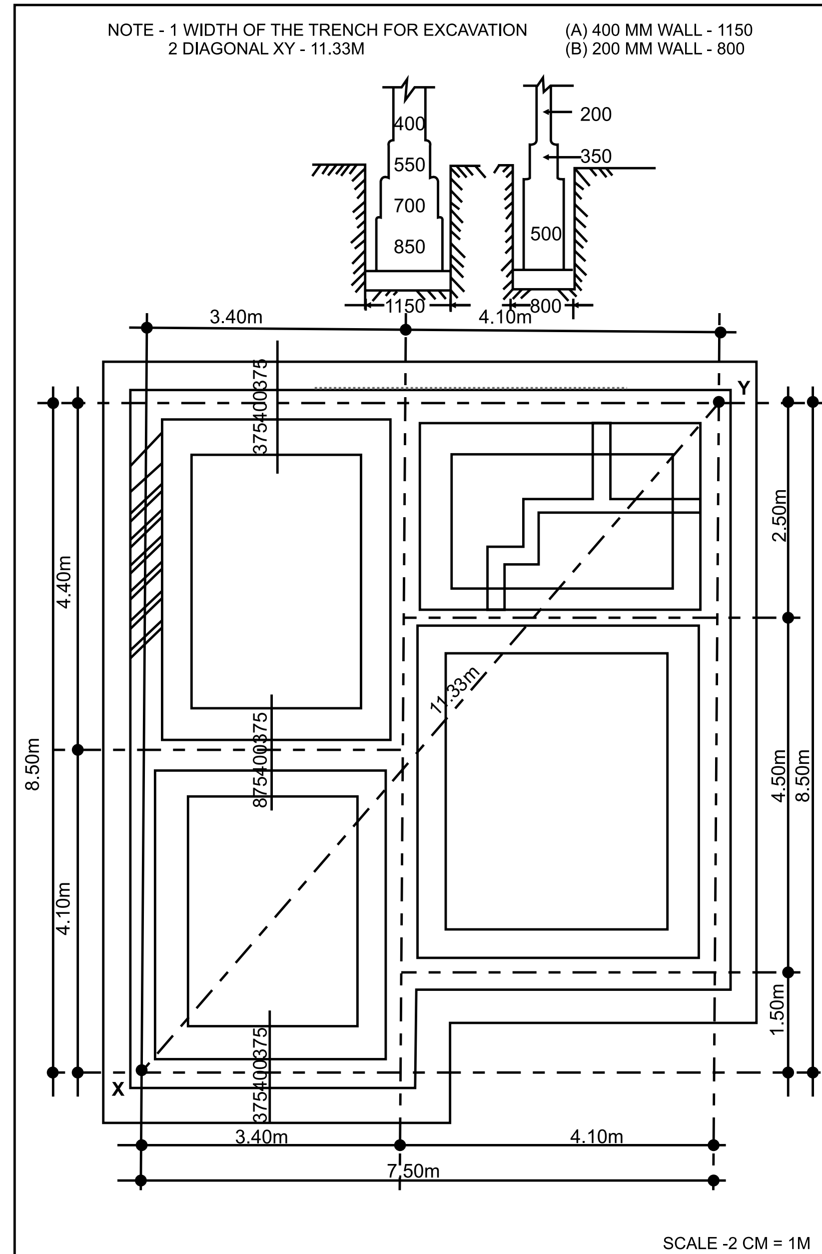


Figure 7.33 *Load Bearing Structure – Foundation Plan*

6. Dimensions for placing windows—from a corner of the wall or centre to centre dimensions
7. Window and door symbols with swings
8. Window and door centre lines
9. Stairs, notes for ups and downs and number of steps at exterior doors.
10. Broken lines for roof outline, *chajja,* canopy, balcony, etc.
11. Broken lines for trusses and beams
12. Notes indicating floor finish in each room, passage, etc.
13. Correct symbol hatching for materials, and symbols for WC, wash basin, etc.
14. Cupboards
15. Section lines
16. Floor plan title and scale.

Elevation

It is a view of a building from the ground level to the top of roof obtained on a vertical plane parallel to the face of the building. The elevation shows the length, total height and different levels such as the ground floor level, plinth level, window sill level, lintel bottom and top level, *chajja* and canopy level, parapet and different levels for the roof, finishing for walls, water supply and drainage pipes, architectural features and so on.

The elevation should be drawn over the plan by projecting lines from corners, window and door locations, etc. (Figs. 7.32, 7.35).

Checklist for Elevations

1. All vertical dimensions from the outside and different levels.
   (a) Plinth height
   (b) Floor to ceiling height
   (c) Sill level
   (d) Window height
   (e) *Chajja* level
   (f) Roof top level
2. Grade line for ground—existing ground level, finished ground level
3. Window and door symbols
4. Roof slope indication
5. Exterior materials of finish for walls and steps—conventional signs and notes
6. Steps and flower beds
7. Rain, drainage and water pipes
8. Elevation title—front elevation or north/east/west/south elevation.

Dimensions of Elevations It is necessary to give vertical dimensions on working drawings which are useful for calculating quantities, the details of which are not available in the plan or elsewhere.

1. *Plaster Finish*: Some part of the elevation which is provided with different type of plaster such as rough cast, needs to be calculated separately as it is to be paid as per different rate.
2. *Shape of chajja, and canopy*—RCC quantity is to be calculated in m^3.
3. *Drainage Pipe*: Cast iron pipe is provided up to a height of 2.4 m or so or it may be an AC pipe. The height of a vent pipe should be taken above the parapet or terrace slab level.

An elevation drawn for the owner may not have dimensions but it is then finished with shades and shadows (Sciagraphy).

Section

It is a sectional view of a building from the foundation level to the top of roof obtained on a vertical plane parallel to the face of the building.

The sectional view shows all constructional details, such as thickness of walls, and foundation for the walls, roof and flooring details, etc. In short, the entire information of levels and dimensions necessary for an estimate and supervision is provided by the sectional view.

Checklist for Sections

1. All vertical dimensions from the foundation bed level to the top of the roof, top of parapet, etc.
2. Thickness of walls, depth and width of the foundation trench, details of spread footings.
3. Columns, column footings, thickness of bed concrete.
4. Details of flooring—floor finish and bedding.
5. Vertical heights above the floor level for window sill, height of doors and windows, lintel level, thickness of lintel, thickness of *chajja,* loft, etc., bottom of truss, bottom of the floor slab.
6. Staircase details, vertical height below landing, rise, tread, etc.
7. Lines showing:
   (a) Foundation level
   (b) Ground level
   (c) Plinth level or ground floor level
   (d) First floor level and levels of other floors
   (e) Terrace floor level
   (f) Total height up to top of the roof above ground level
8. Notes regarding construction materials
9. RCC beams
10. Door and window symbols—D, Dl, W, Wl, etc.
11. All other information which is essential for an estimate and construction.

Site Plan

Checklist for Site Plan

1. Dimensions of the plot and north direction, roads and their width.
2. Survey number of the plot and adjoining plots.
3. Dimensions of front, side and rear marginal distance for the proposed building.
4. Location and dimensions of garage and its distance from the main building.
5. Location of walls, drive ways and approaches with dimensions.
6. Location of steps, terraces, porches, fences and retaining walls.
7. Ground elevation levels or contours.
8. Location of reference bench mark and its elevation.
9. Existing trees, trees to be removed and to be retained.
10. Proposed building
11. Water supply line
12. Drainage line
13. Boundary line
14. Compound wall

Block Plan

Check List for Block Plan

1. Line plan showing the shape of the proposed structure and dimensions.
2. Area calculations
3. Area of the plot
4. Area allowed to be built
5. Area proposed to be built

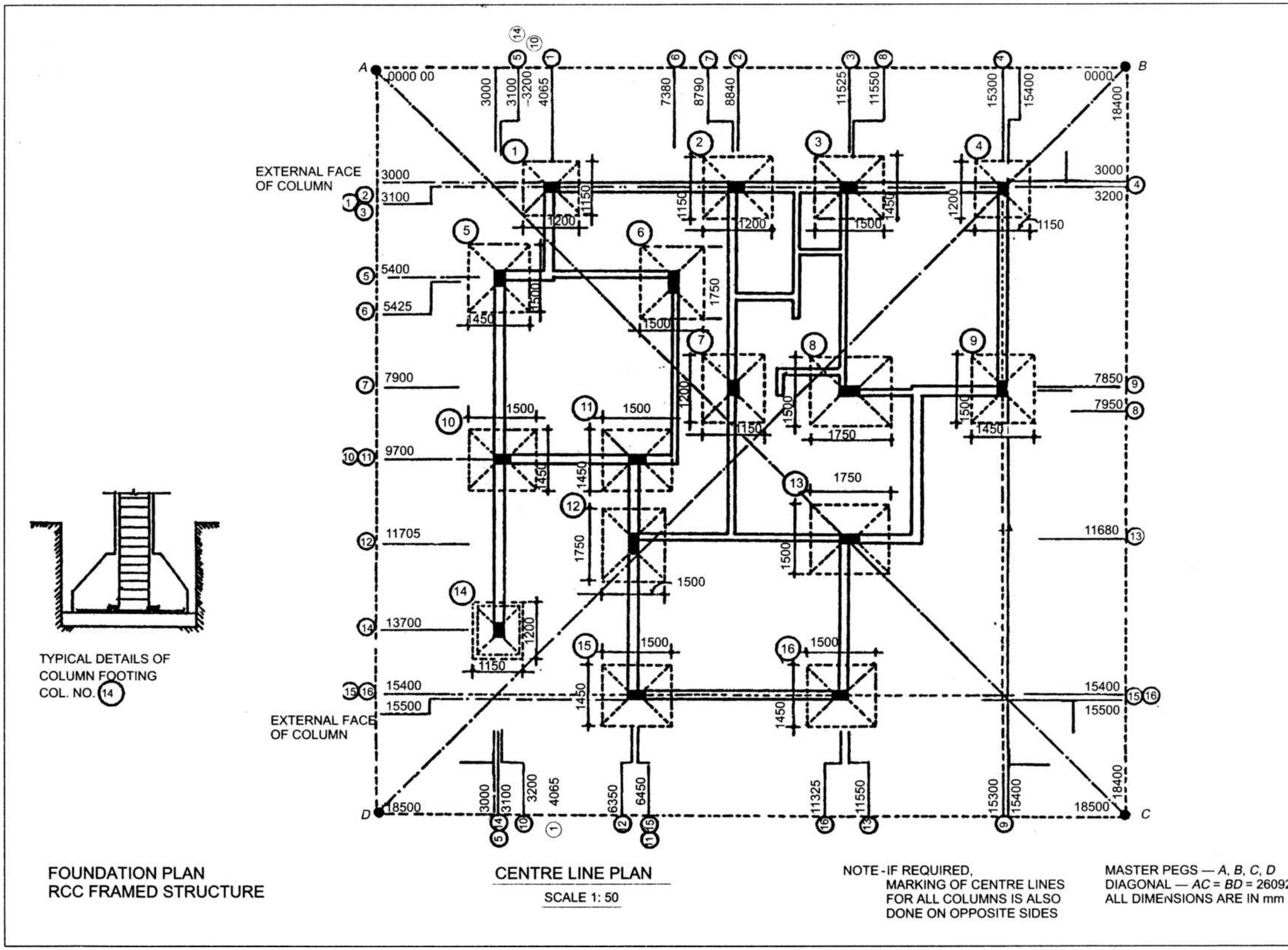


Figure 7.34 *RCC Framed Structure – Foundation Plan*

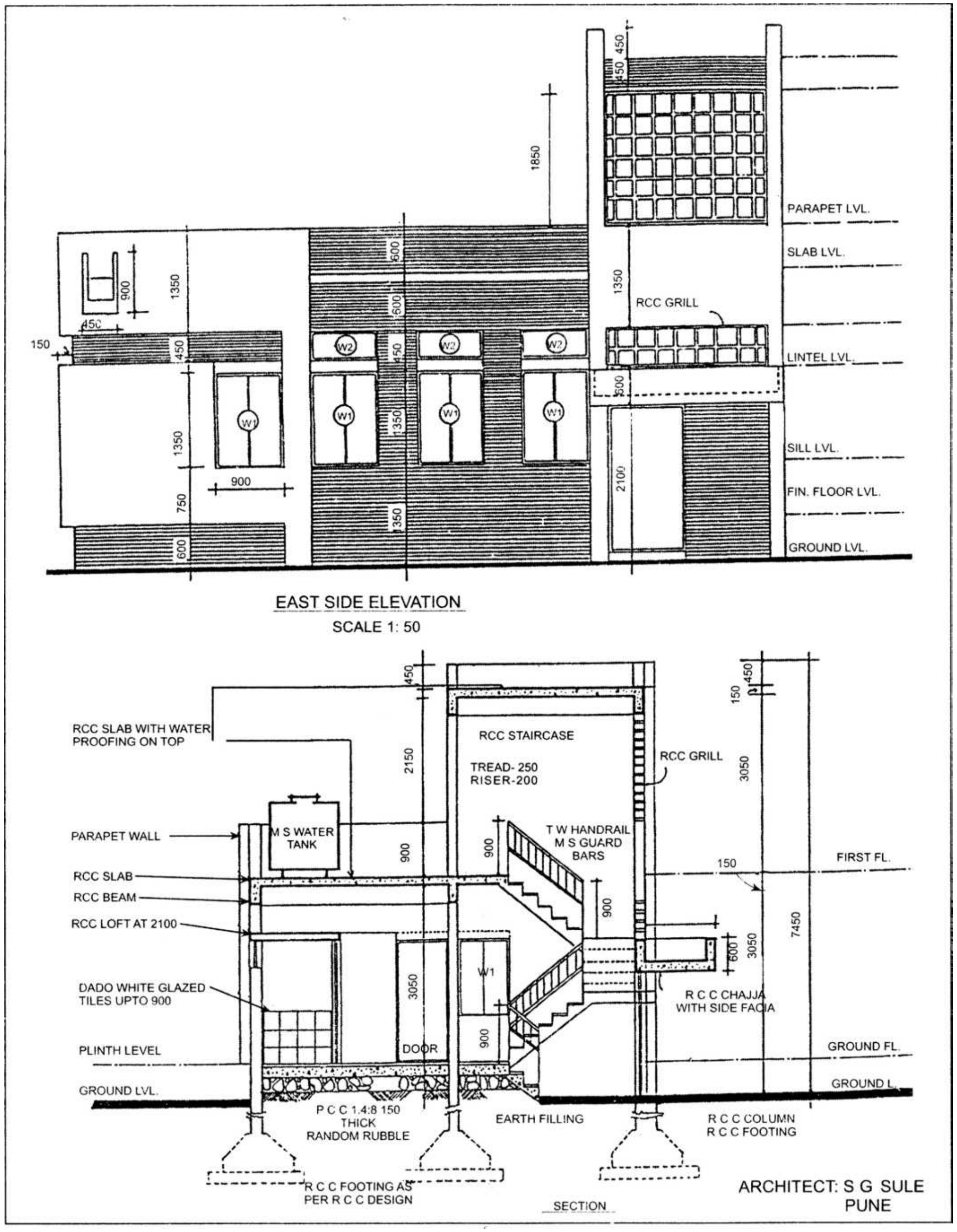


Figure 7.35 *RCC Framed Structure – Elevation and Sectional View*

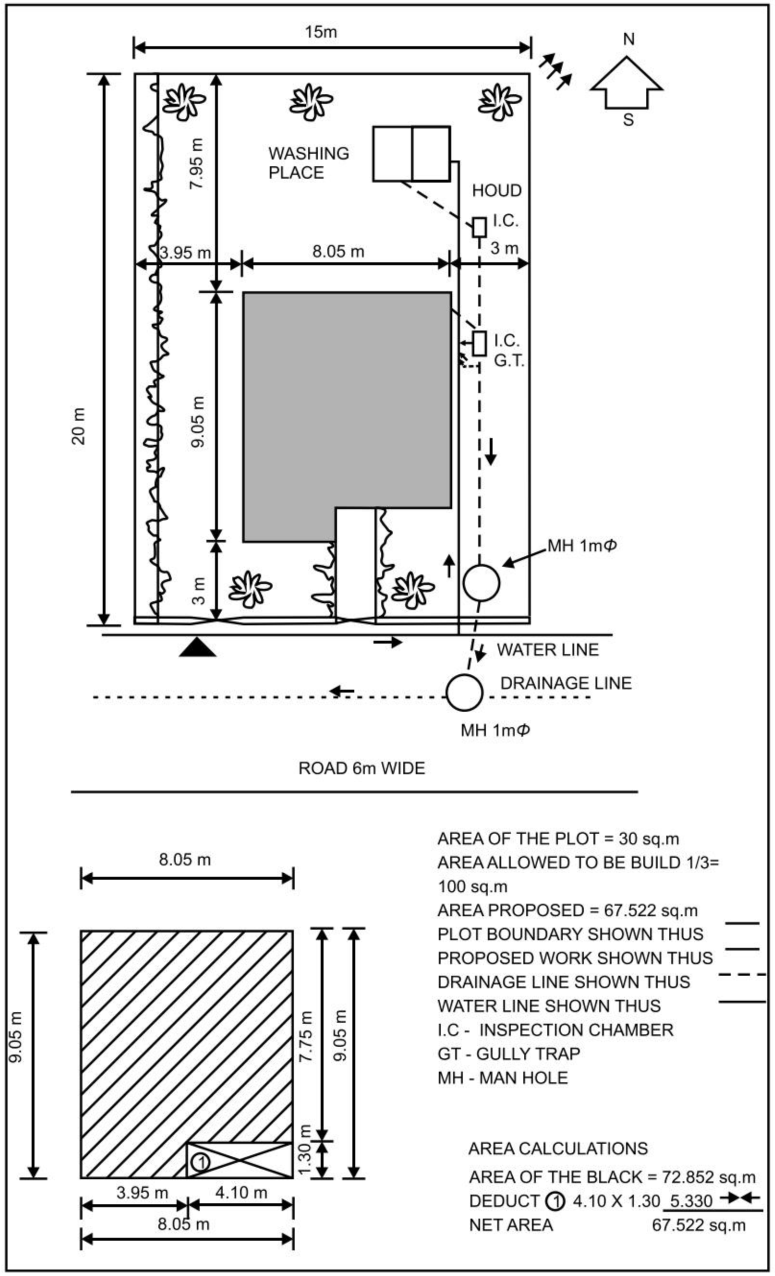


Figure 7.36 *Site Plan and Area Statement*

Schedule for Doors

Sr. No.	Door Symbol	Clear size (Masonry Opening)	Frame Size, Type	Shutter tk.	Finish Oil paint/ polish	Remarks
1	2	3	4	5	6	7

Schedule for Windows

Sr. No.	Window Symbol	Clear size (Masonry Opening)	Frame Size, Type	Shutter tk.	Finish Oil paint/ polish	Remarks
1	2	3	4	5	6	7

Schedule for Room Finish

Sr. No.	Room Title	Carpet Area	Tiles, Type, Size	Skirting Type, Size	Colour for walls, Distemper, Oilbond Distemper, Plastic Emulsion	Remarks
1	2	3	4	5	6	7

7.12 WATER SUPPLY, DRAINAGE AND SANITATION

'Today, the system of water supply, drainage, heating, cooling, ventilation, lighting, cleaning, elevators, fire protection, intercommunications, etc., is becoming complicated... effective organisation of services needs experience, collaboration and construction'.

Howerd Robertson

All buildings are planned, taking into consideration their requirements with regard to adequate water supply, drainage and sanitation. Plumbing drawings are prepared showing piping systems that supply water and carry waste water to the sewer. Much of the residential plumbing is standardised by the local authorities. Students should understand the principles underlying good plumbing practices, plumbing code, requirements of water closets, baths, urinals, etc., for various types of buildings and various types of fitments available in the market.

The data supplied in this chapter will provide sufficient guidance in the preparation of plans and working drawings. Recommendations given in the handbook of National Building Organisation and various IS specifications for house drainage, sanitation and water supply should be referred to.

7.12.1 General Requirements

All premises intended for human habitation and use shall be provided with the supply of pure water in sufficient quantity under adequate pressure. Drainage shall have connection with the public sewer on a street. Each family dwelling units shall have at least one water closet, one kitchen type sink and a bath.

Water Supply Requirement

Residential Requirements The requirements regarding water supply, drainage and sanitation for residence should assume that a minimum water supply of 135 litres per head per day is assured, together with a full flushing system.

Other Buildings The requirements for water supply for other buildings are given in Table 7.4.

Table 7.4

Sr. No.	Type of Building	Consumption per head per day in litres
1.	Factories where bathrooms are required to be provided	45
2.	Factories where no bathrooms are required to be provided	30
3.	Hospitals (including laundry) per bed	
	(a) No. of beds not exceeding 100	340
	(b) No. of beds exceeding 100	455
4.	Nurses's homes and medical quarters	135
5.	Hostels	135
6.	Offices	45
7.	Hotels (per bed)	180
8.	Restaurants (per seat)	70
9.	Cinemas, concert halls and theatres (per seat)	15
10.	Schools	
	(a) Day schools	45
	(b) Boarding schools	135

Note: Since the requirements of water for industrial plants and process vary, they are not taken into consideration.

Materials for Pipes Pipes may be of the following materials: (i) cast iron, (ii) steel, (iii) reinforced concrete, (iv) prestressed concrete, (v) mild steel tubes and tubulars (galvanised), (vi) copper, (vii) brass, (viii) wrought iron, (ix) asbestos cement, (x) lead, and (xi) polythene.

Selection of the type of pipe depends upon the character of water, nature of the ground, relative cost and purpose.

Guidelines for Planning Water Supply and Drainage System

Water Supply System The water supply system of building or premises consists of the service pipe, and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building premises.

Plumbing System The plumbing system includes the water supply and distribution pipes; plumbing fixtures and taps, soil, waste, vent pipes and antisiphonage pipes, buildings drains and building sewers including their connections.

1. Mains should be of adequate size, and sufficient to satisfy the peak demand.
2. Provisions should be made of sluice valves, air valves, hydrants, and washout valves.
3. Mains should be arranged in ring formation or interconnected in the form of a network so as to avoid dead ends.
4. Hydrants should be provided to act as a washout where dead ends are unavoidable.
5. Thrust blocks of concrete should be provided at all bends to transmit the hydraulic thrust over a sufficient area.
6. Layout should be direct and simple with the aim of reducing the length of the pipe. Try different alternatives.
7. Pipes should be laid in a straight line as far as possible to avoid losses at bends. Refer the subject of Fluid Mechanics to know various losses.
8. Pipes should not be buried in the walls or floors. In case of concealed pipes in Bath and WC, testing should be done before fixing tiles. Study procedure for testing of pipes.
9. Layout should be such that it is free from the occurrence of air pockets— upward bends and downward dips should be avoided. Study the plumbing system in existing buildings.
10. Pipes should be away from windows. Why?
11. There should not be risk of contamination.
    No cross-connection between a waste water pipe and potable water pipe. These should not be laid very close to each other. Refer rules for the same.
12. The pipes should be laid in such a way that sufficient pressure is available at the point where the consumer gets the supply. Overhead storage tank should store sufficient quantity of water. There should be separate compartments for WC storage, and bath. How to calculate capacity for storage?
13. Direction of the pipe should not be at an acute angle.
14. The pipe line should follow the profile of the ground, in order to reduce cost of excavation. The mains should have cover of not less than 900 mm.
15. The water supply line in the streets should be 2 m above and 3 m away from the sewer in order to avoid contamination. The sewer runs on one side and the water supply pipe on the other side.
16. The pump house is to be located as centrally as possible to provide the minimum length of the rising main. Sluice valves should be located for the convenience of repairs of the pipe line and to allow pumping in different buildings separately. Visit and prepare drawings for any pump house.

7.12.2 Storage of Water for Domestic Purposes

The purpose for storing water is:

1. To provide against interruptions of the supply caused by repairs to mains, etc.
2. To reduce the maximum rate of demand on the mains, and
3. To enable a reserve of water to be maintained for fire fighting.

Overhead storage tanks are of two types, viz., iron or steel coated internally with galvanised or a bituminous composition and coated externally with weather resisting paint, and concrete/RCC/Ferrocrete tanks precast or cast in situ. Tanks should be provided with well fitting covers.

Tanks should be provided with (a) overflow pipes having internal diameter greater than that of the inlet pipe and not less than 20 mm; (b) stop valve or stop tap at every outlet other than overflow pipes, and (c) an outlet at the end opposite the inlet to avoid stagnation.

In the case where overhead storage tanks are supported on the roof slab of the building, a calculation should be done to ascertain whether the structure of the building is of sufficient strength to take the increased load. Tanks should be supported on supports to facilitate cleaning. A minimum of two tanks are necessary even in small installations. Each tank should have its inlet pipe with own float operated valve, overflow pipe, and wash out valve stop valve.

Underground Storage Tanks

1. The tank should project at least 300 mm above the highest flood level or ground level, whichever is higher.
2. The inner surface of the tank should be rendered smooth and should be perfectly waterproof.
3. The top of the tank should be so levelled as to prevent accumulation of water thereon.
4. The tank should have an RCC cover with a manhole with mosquito-proof hinged cast iron cover and pipes for ventilation with a wire gauze cover of 1.5 mm mesh.

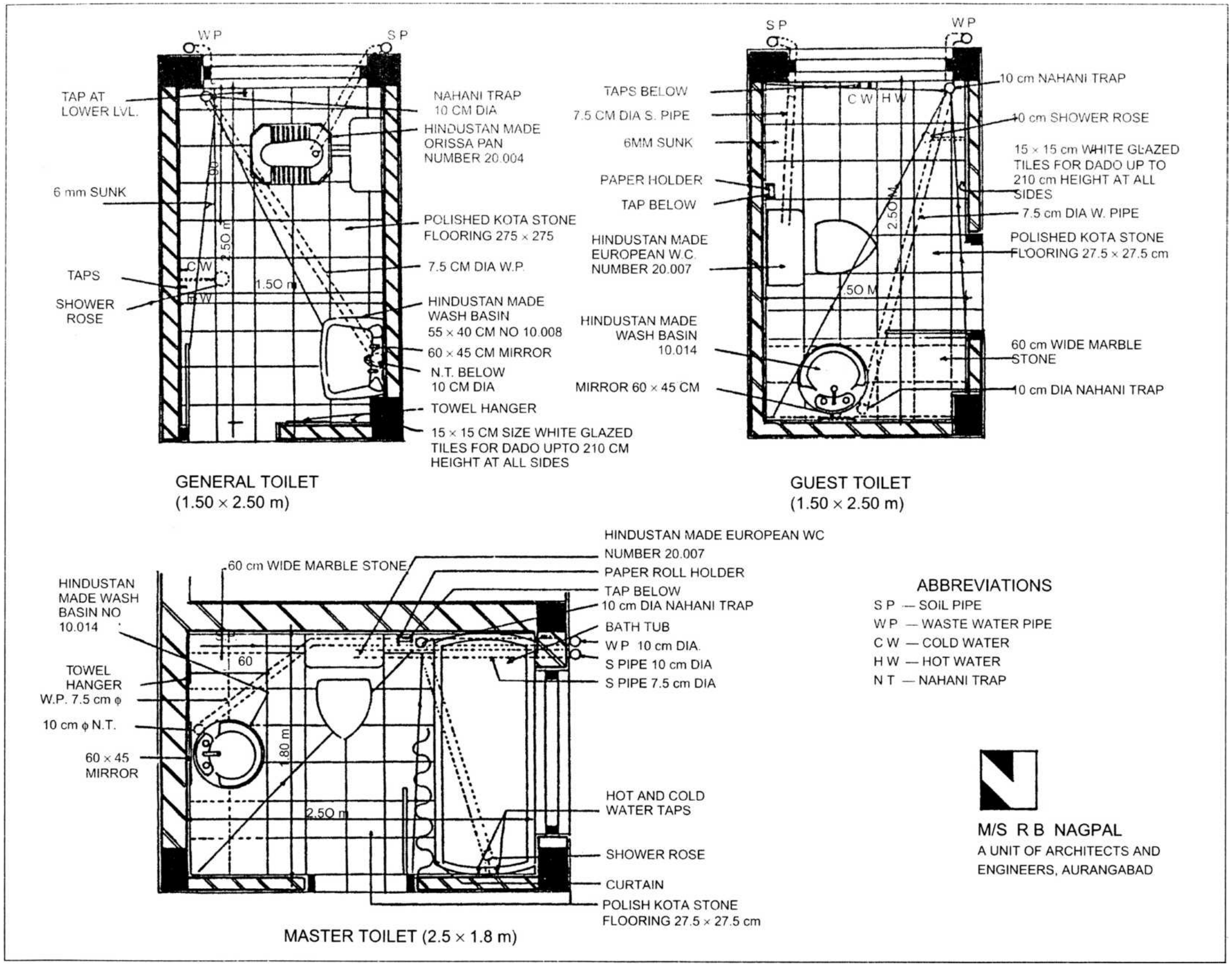


Figure 7.37 *Detailed Drawing – Toilets*

Storage Capacities

The quantity of water to be stored should be calculated taking into account the following factors:

1. Hours of supply at sufficient high pressure to fill up the overhead storage tanks.
2. Frequency of replenishment of overhead tanks during 24 hrs.
3. Rate and regularity of supply.
4. Consequences of exhausting storage, particularly in case of public buildings, like hospitals.

Storage capacity should be calculated for one day in case of regular supply and for two days in case of irregular supply. The following considerations decide the requirements of storage capacity:

1. The number of consumers
2. The use to which water is to be put.
3. The number and types of fittings to be served, and
4. Flushing storage

Fitting	*Storage Required (Litres)*
WC	180
Lavatory Basin	90
Sink	90
Urinal	180
Yard Tap	180

Pumping of Water

In the case of multi-storey buildings where water cannot be fed with the available pressures in the water main, due to the height of the storage tank, pumping is necessary. These pumps are usually of the centrifugal type driven by electric motors.

The capacity of the suction tank should be normally around 40 per cent of the total overhead storage, both for flushing and domestic requirements. Out of 135 litres per head per day supply, it is assumed that 45 litres may be taken as the requirement for flushing and 50 litres for other domestic purposes.

Bib taps and stop taps are the two most extensively used types of water fittings. They are made of corrosion resistant material.

Bib Tap It is a draw off tap with a horizontal inlet and free outlet.

Stop Tap It is a valve with suitable means of connection, for insertion in a pipe line for controlling or stopping flow. These taps are of the following sizes : 8, 10, 15, 20, 25, 32, 40 and 50 mm.

Washers Washers for cold water taps should be of specially selected leather, rubber, asbestos composition. Washers for hot water taps should be of good quality fibre, rubber and asbestos composition.

7.12.3 Housing Drainage

Layout (Ref. Figs. 5.21, 5.22)

1. A two pipe system should be used in which one pipe collects the foul soil and lavatory wastes, whereas the second pipe collects the unfoul water from the kitchen, bathrooms, house washings, etc. Study connections in one pipe and two pipe systems.
2. (a) Separate pipes should be provided for sewage and rain water.
   (b) P, Q and S Traps—These traps are classified according to their shape. They essentially consist of a U-tube which retains water acting as a seal between the foul gas and the atmospheres. Draw sketches of these traps.
   (c) *Gully Traps*—This trap is provided at different places in the drain pipes, to receive waste water from sinks, baths and wash basins. It is usually placed near the external face of the wall at a distance of about 450 mm. It leads the sewage either to a manhole or to an inspection chamber. Draw sketches of these traps.
   (d) *Intercepting Trap*—The trap which is provided in the manhole at the junction of a house drain and a sewer is called an *intercepting trap*. It conveys sewage from the building to the public sewer. But its main function is to prevent the entry of foul gases from the sewer into the building. It is also called the *interceptor* or *disconnecting trap*. This trap also has an inspection arm for inspection or cleaning purposes. Draw sketches.
   (e) *Manholes*—The opening constructed in a sewer for the purposes of permitting a man to enter or to leave the sewer is called a *manhole*. It allows the joining of sewers or alignment changes in the direction or both. They are generally located at all changes of directions, all changes of gradients and all connections of main and branch sewers in the sewerage system.
3. Sewage pipes should be connected to sewers. All soil pipes should be carried direct to the manholes without gully traps. This is because waste pipes are connected through the trapped gully. All the traps used in this system are fully ventilated.
4. All pipes should be laid in straight lines as far as possible in both the vertical and horizontal planes.
5. No bends and junctions are to be permitted in sewers except at manholes and inspection chambers.
6. All junctions of pipes should be oblique and the contained angle should be not more than 45 degrees.
7. If it is necessary to lay a drain under a building, pipes should be of cast iron/RCC and drains should be laid in a straight line and at a uniform gradient. Manholes should be provided at each end immediately outside the building. Drains should be placed under a staircase room, or a passage.
8. (a) The following gradients should be adopted:

Pipe Diameter (mm)	Gradient
100	1 in 35
150	1 in 65
230	1 in 120
300	1 in 200

   This gradient will allow the discharge of three times the dry weather flow, while the pipe will flow to only half full.
   (b) The drains should be laid in such a way that sewage is removed quickly from the building. The quick removal is governed by the falling gradient of the pipes. The drains should be laid at such a slope that self cleansing velocity of 1 m/sec is developed in them. What is meant by self cleansing velocity, nonscouring velocity and nonsilting velocity? Find the answer.
9. A minimum size of 100 mm should be used.
10. All vertical soil, waste, ventilating, and anti-siphonage pipes should be covered on the top with a copper or heavily galvanised iron wire dome or cast iron terminal guards. Cast iron pipes should be painted periodically.
11. Waste pipes—Every pipe in a building for carrying off the waste or overflow water from bath, wash basin or sink to a drain should be of 32–50 mm diameter.
12. Ventilating pipes—The drain pipes carrying waste water and sewage should be provided with at least one ventilating pipe. This ventilating pipe or shaft should be carried to a height of at least 600 mm above the outer covering of the roof in the case of a pitched roof, 1200 mm above the parapet in case of a flat roof and not less than 3 m above plinth level in any case.

13. Anti-siphonage pipes—The minimum diameter of these pipes for soil pipe should be 50 mm and for waste pipes, 40 mm.
14. Manhole and inspection chamber—At every change of alignment, gradient, or diameter of a drain, there should be a manhole or inspection chamber.
15. Inspection chambers of suitable size-min. 600 × 450 mm should be provided at the junction of pipes, change in direction and at intervals for maintenance purpose.
16. Rain water pipes—A rain water pipe carrying rain water should discharge directly or by means of a channel into or over an inlet to a surface drain or shall discharge freely in a compound drained to a surface drain. Normally, rain water pipes should not be less than 100 mm for every 5–6 m^2 of roof surface drained. The distance between two pipes should be about 6 m.
17. Roof gutters—They should generally be of galvanised iron sheets having a thickness of 1.25 mm. The gutter should be semi-circular in section with a width at top of about twice the diameter of the downtake pipe. The gutter should be fixed at 25 mm below the edge of the roof. MS brackets 25 mm wide and 6 mm thick are to be used to support the gutter at about 1.2 m intervals.

A convenient method would be to fix the bracket to every alternate rafter. Ends of gutterings should be closed with galvanised sheets. Gutters should have a general minimum fall of 1 in 120.

System of Plumbing (Fig. 7.38)

Two-Pipe System—It is the system of plumbing in which soil and waste pipes are distinct and separate, the soil pipes being connected to the drain directly and waste pipes through trapped gully. All traps are completly ventilated.

One-Pipe System—It is the system of plumbing in which the waste connections from sinks, baths, wash basins, and the soil pipe branches from water closets are all connected into one main pipe which is connected directly to the drainage system. Gully traps and waste pipes are completely dispensed. All the traps are completely ventilated to preserve the water seal.

Single-Stack System—It is a one-pipe system without trap ventilation pipe work. The traps of water closets, sinks, basins, etc., are directly connected to the single stack.

One-Pipe System (Partially ventilated)—It is a via media between the one-pipe system and the single-stack system. There is one soil pipe into which all water closets, baths, sinks, and basins discharge. In addition, there is a relief vent which ventilates only the traps of water closets.

The two-pipe system of plumbing is safer than other systems of plumbing.

Design of Drainage System

Drainage system should be designed with reference to the following data:

1. *Site plan*—A plan to scale 1 : 400 or 1 : 800 with reduced levels of ground, lowest floor level, position and diameter of public drain, water supply main on the road, and invert level of public drain or sewer.
2. *Detailed drawings*—Plans and sections of the proposed building showing the positions and types of all sanitary fittings with positions and types of rain water down pipes.
3. *Use*—Use for which the building is intended, periods of occupation, and peak hour discharge.
4. *Bye-laws*—The requirement of local bye-laws in regard to the drainage and sewerage.
5. *Sub-soil conditions*—These conditions govern the choice of design of the sewer or drain, and method of excavation. Sub-soil water level should be ascertained.

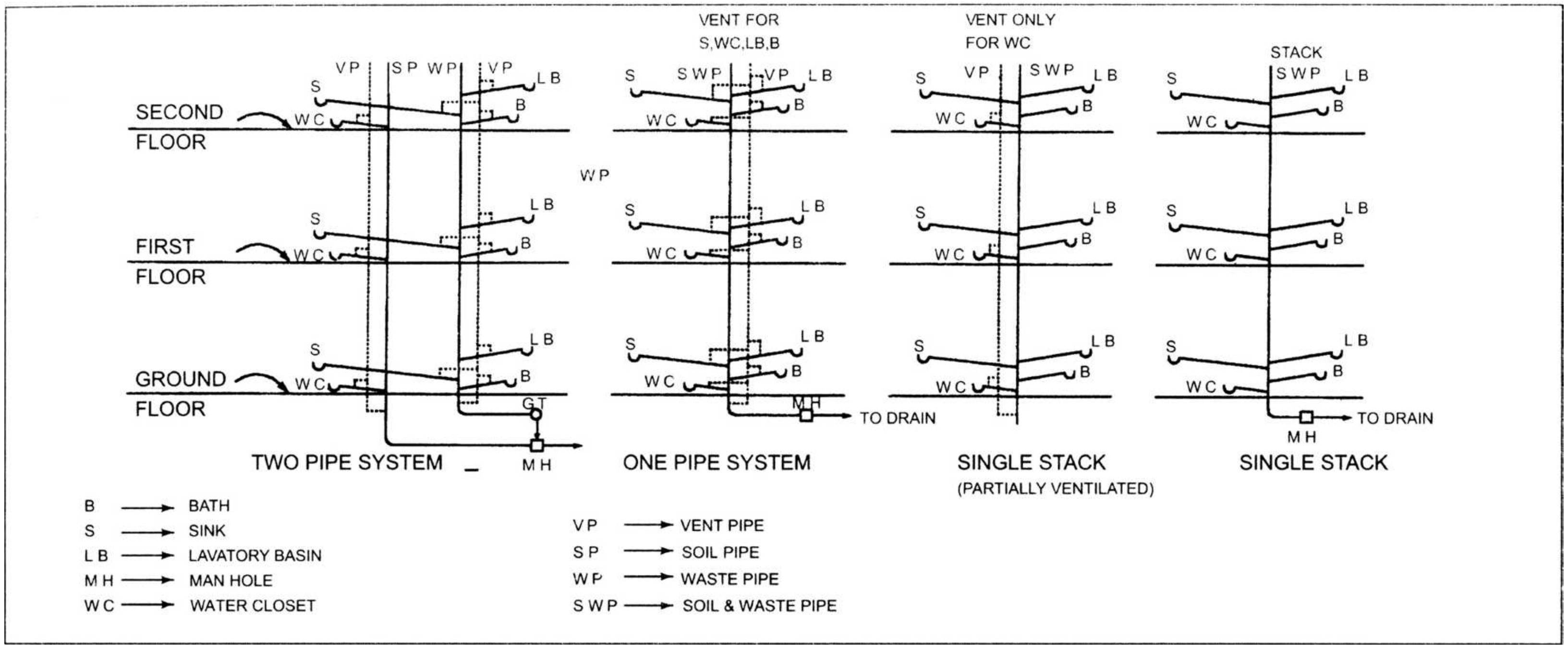


Figure 7.38 *Systems of Plumbing Building Drainage*

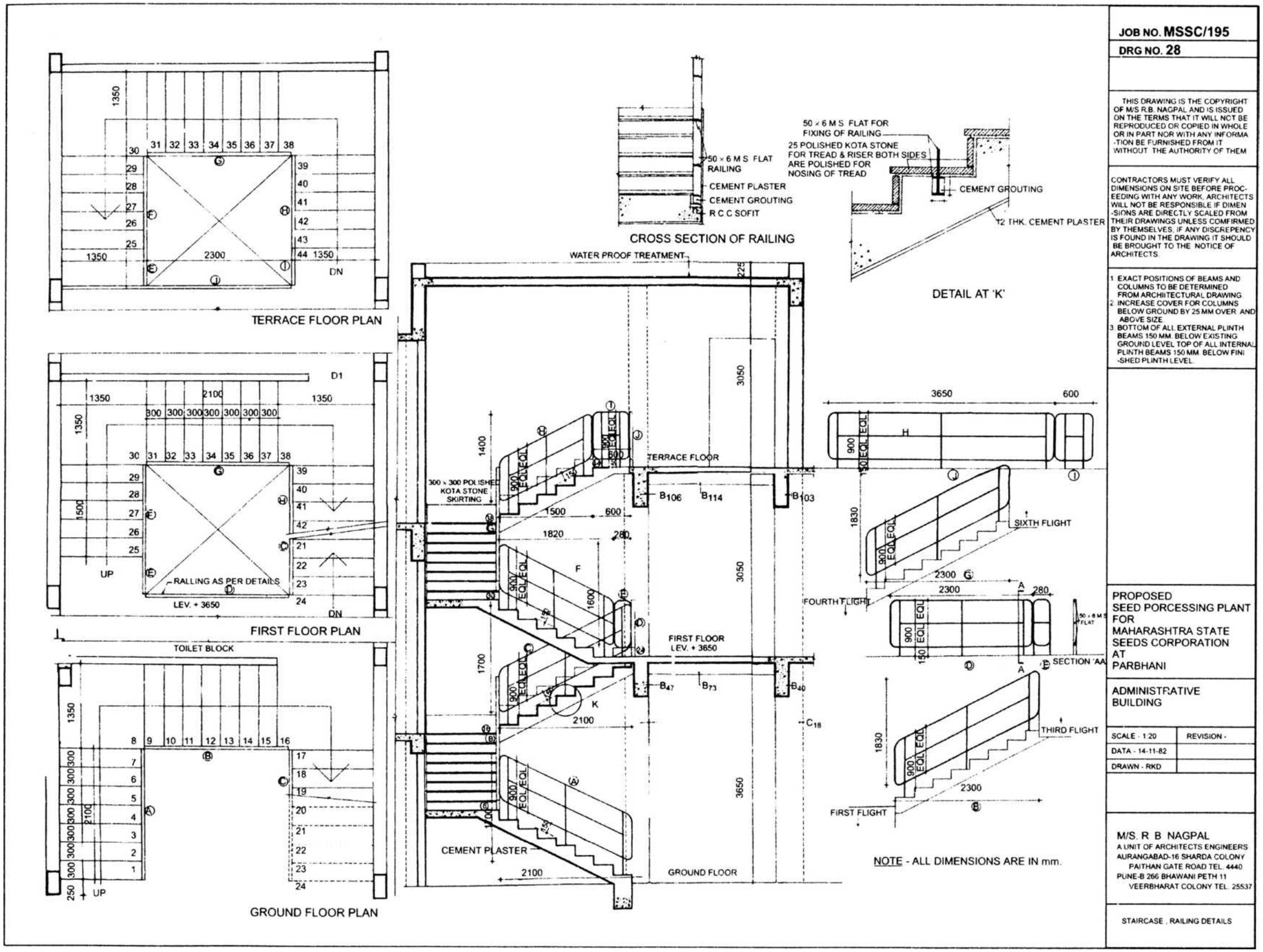


Figure 7.39 *Detailed Drawing – Staircase*

Reading Exercise

1. *Sketching*

Figure 7.40 shows exercises for sketching work.

Horizontal, vertical, inclined, parallel and dotted lines should be drawn by free hand.

Angles (in degrees) 90, 45, 30, 60 etc., should be drawn without using a protractor.

Division of lines by visual comparison will help in correct sketching work.

Sketching of circles, squares and rectangles will help in quick sketching for arches, door and window frames and different plans.

2. *English and Flemish Bonds for Brick Work*

Figure 7.41 shows English and Flemish bonds for brick work. Various bonds for brick work are designed so that no vertical joint in any course is directly above or below a vertical joint in the adjoining course. This ensures stability of the structure and helps in producing a pleasing appearance. Use of special bricks or cut from the whole brick is done to achieve the desired bond. Properly bonded brick work distributes the load over larger area, the angle of the spread of the load through the bonded brick work is 60 degrees.

Draw sketches showing different bonds for different courses. Draw isometric views for the same.

1. What is the difference between English and Flemish bonds?
2. Refer IS: 1077-1976
   (a) What is the standard size of the brick?
   (b) State dimensions and tolerances for the same.
   (c) What should be the minimum strength of the brick?
3. State the procedure for testing of bricks as per IS : 3495-1976 for:
   (a) Compressive strength
   (b) Water absorption
   (c) Efflorescence
   (d) Warpage
4. How many bricks are required for 1 cubic metre of brick work?
5. State the proportion of cement mortar for brick work.
6. Prepare a check list to supervise brick work.

3. *Typical Example of Brick, Stone Arches*

Study Fig. 7.42 carefully. Draw sketches: elevations and sections

An arch is an arrangement of wedge-shaped bricks called *voussoirs* which are designed to support each other. They carry the load over the openings and distribute it to abutments on either side.

1. What is the difference between a rough brick arch, axed brick arch and gauged brick arch?
2. Draw sketches for centering or form work for arches.
3. Discuss various modes of failures of an arch. What are the remedies?

4. *Types of Stairs-Plans*

Referring to Fig. 7.43, draw plans, sectional elevations and axonometric views for different types of stairs.

1. Define a stair, step, tread, riser, flight, hand rail and head room.
2. State the requirements of a good staircase.
3. What are the thumb rules for the rise and tread of steps?
4. State the classification of stairs with simple sketches.
5. Sketch the details of reinforcement in RCC stairs.
6. What are the requirements for a lift—different sizes, structural requirements?

5. *Roof-Pitched Roof and Trusses for Different Spans*

With reference to Fig. 7.44, study carefully the details for pitched roof and trusses. Draw all sketches showing:

1. Common rafters, jack rafters, battens and Mangalore tiles.
2. Purlins and AC sheets.
3. Purlins and GI sheets.
4. Sketch different types of pitched roofs, leans to roofs, gable roof, and hip roof.
5. Define span, rise, pitch, ridge, eaves, hip, valley, hipped end, verge, different types of rafters and truss.
6. Write names for various members of trusses.
7. Draw details of steel roof trusses showing various members, gusset plates, purlins, cleats for AC sheets, base plate and foundation bolts with cement concrete block.

6. *Furniture Template*

It is convenient to use such templates for showing furniture pieces and details in bathroom, WC and kitchen. A zerox copy of Fig. 7.45 will be useful for showing various details to check location of doors and windows in the plan. The scale is 1:50.

7.13 PROJECT WORK

1. Measured Drawing
   A. Prepare a set of working drawings: (1) Ground floor plan, (2) Terrace plan/roof plan for pitch roof, (3) Site plan showing water and drainage lines, compound wall, gates etc., (4) All elevations, (5) Foundation plan, (6) Details of doors, windows, kitchen and toilets, and (7) Axonometric view of a single-storeyed small bunglow. Scale 1:50 for 1, 5 and 7 and suitable for details.
   B. Write construction notes. Calculate—Plinth area, Floor area and Car pet area as per rules.
   C. Comment on Planning, Specifications.
2. Assuming reduced level of bench mark as 100.00, find levels of: (a) Road, (b) Finished level of ground, (c) Plinth level, (d) Window sill level, (e) Window and Door Top level, (f) Terrace/roof levels, and (g) Level of water pipe line below ground level (h) Invert level of drainage pipe on the road
3. Prepare estimate for the bunglow project, assuming
   (1) Current rate of developed plot per sq. mt., (2) Construction cost per sq. mt. of plinth, and (3) Professionals fees, etc.
4. Prepare working drawings for plans shown in Figs. 8.22 and 8.23 by assuming suitable data.
5. Prepare detailed working drawings for
   1. Aluminium window—Size 2000 × 1200, 3 shutters
   2. Folded door—4 folds with glass and grill, CCTW
   3. Panelled door—Size 900 × 2100, Masonry opening, steel frame. Prepare table for fixtures and fastenings.
   4. Dog-legged stair—tread 300, rise 150, floor to floor height 3150, RCC stair with MS Railing.
   5. MS entrance gate—Size 3000 × 1500 with details for fixing.
   6. Collect all forms from plan sanctioning authority for submitting proposal for the construction of the residential bungalow and scheme of ownership flats.

7. Collect information about rules and regulations of plan sanctioning authority like Municipal Corporation, study carefully all details related to size of the plot, marginal distances, FAR, number of storeys and rules for number of tenaments.
8. Collect set of submission and working drawings prepared by architect. Display the same in the drawing hall. Prepare for lecture with reference to site, planning considerations and other details.
9. Collect working drawings for
   (a) Drinking water supply
   (b) Water supply for fire safety
   (c) Drainage layout plan for a building such as
      1. Hospital
      2. Hotel
      3. Commercial complex

   Study all drawings and comment on planning and design.

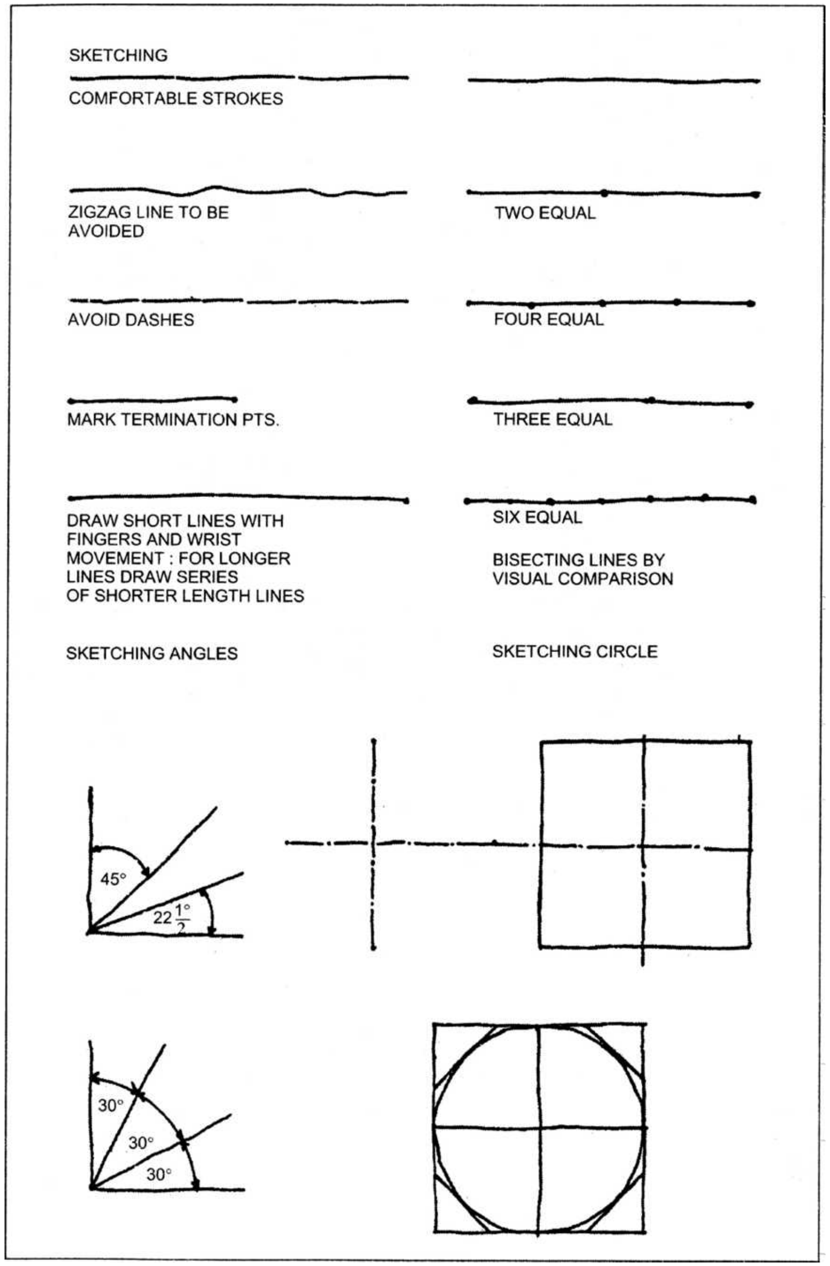


Figure 7.40 *Sketching Work – Exercises for Practice*

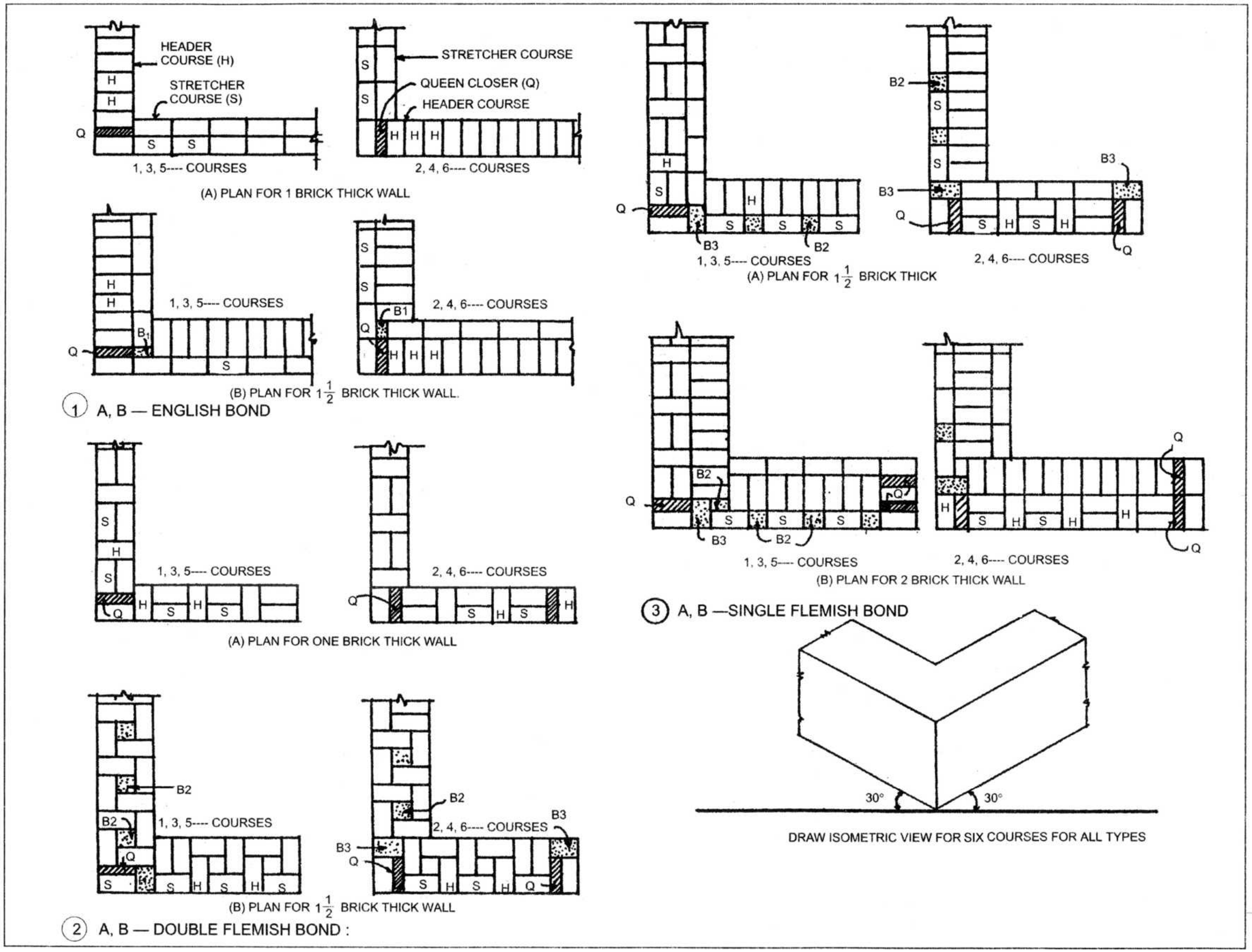


Figure 7.41 *Brick Work – Types of Bonds*

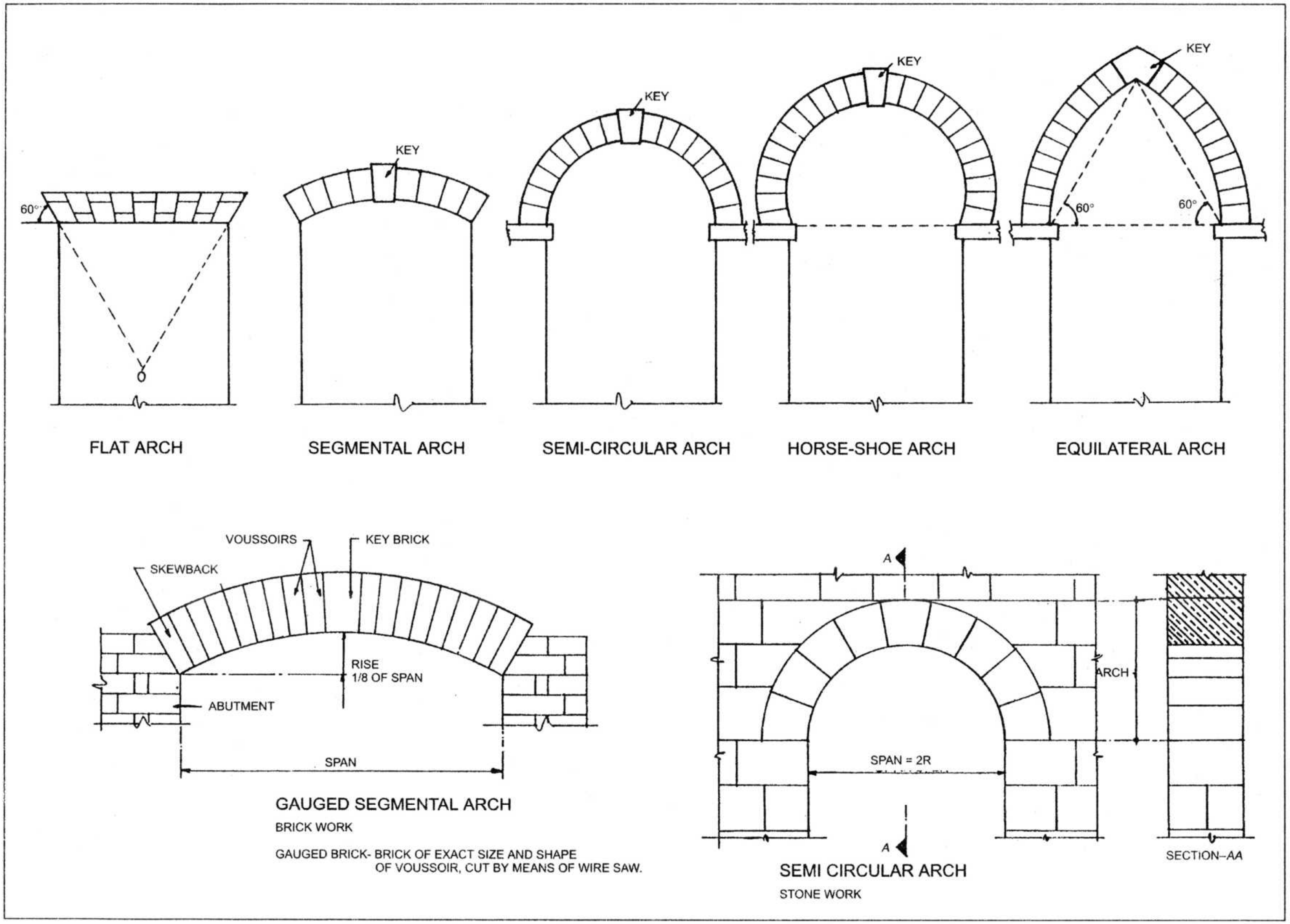


Figure 7.42 *Typical Examples of Brick/Stone Arches*

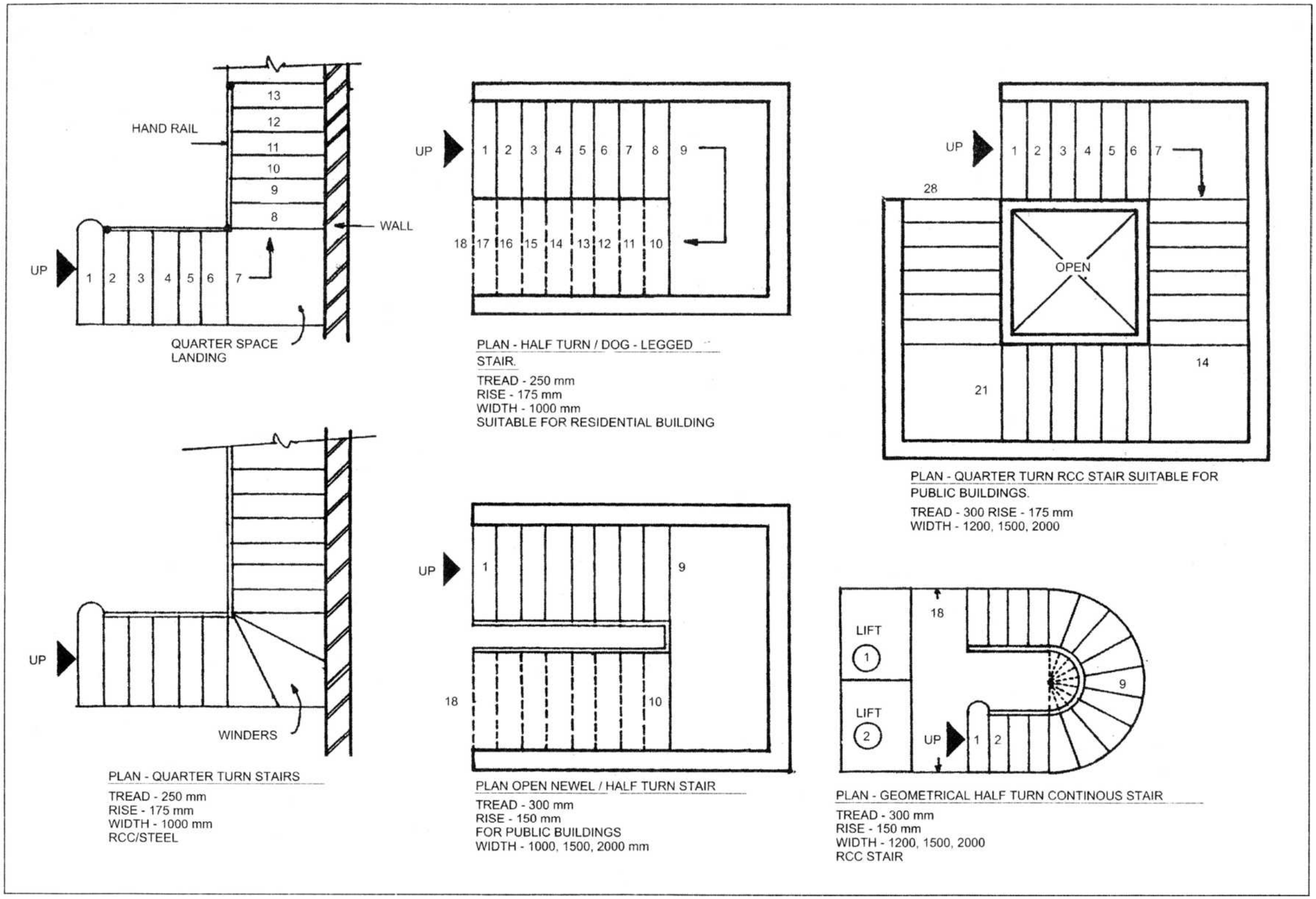


Figure 7.43 *Types of Stairs-Plans-Draw Sectional Elevations and Axonometric Views*

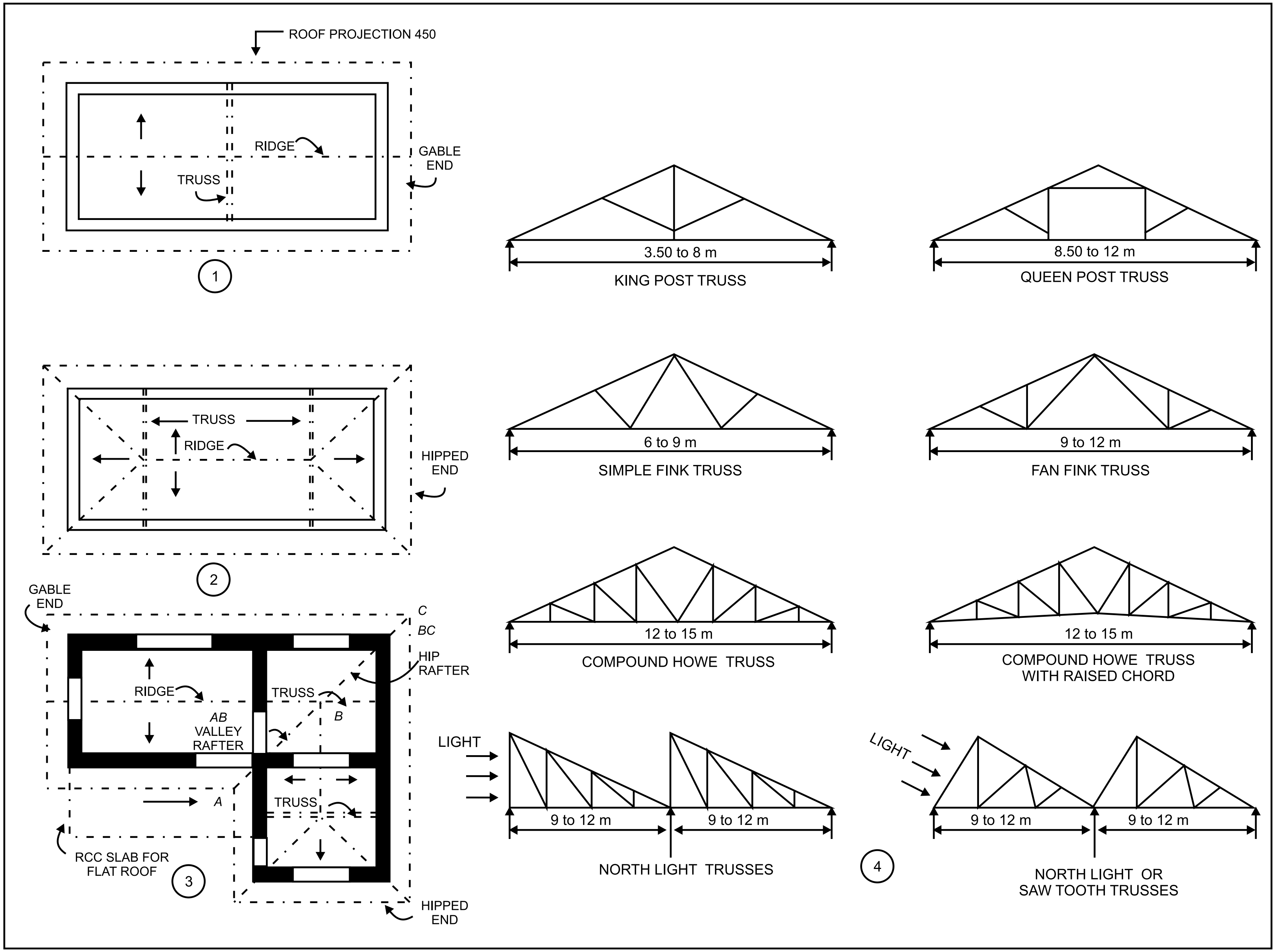


Figure 7.44 *Roof-Pitched Roof and Trusses for Different Spans*

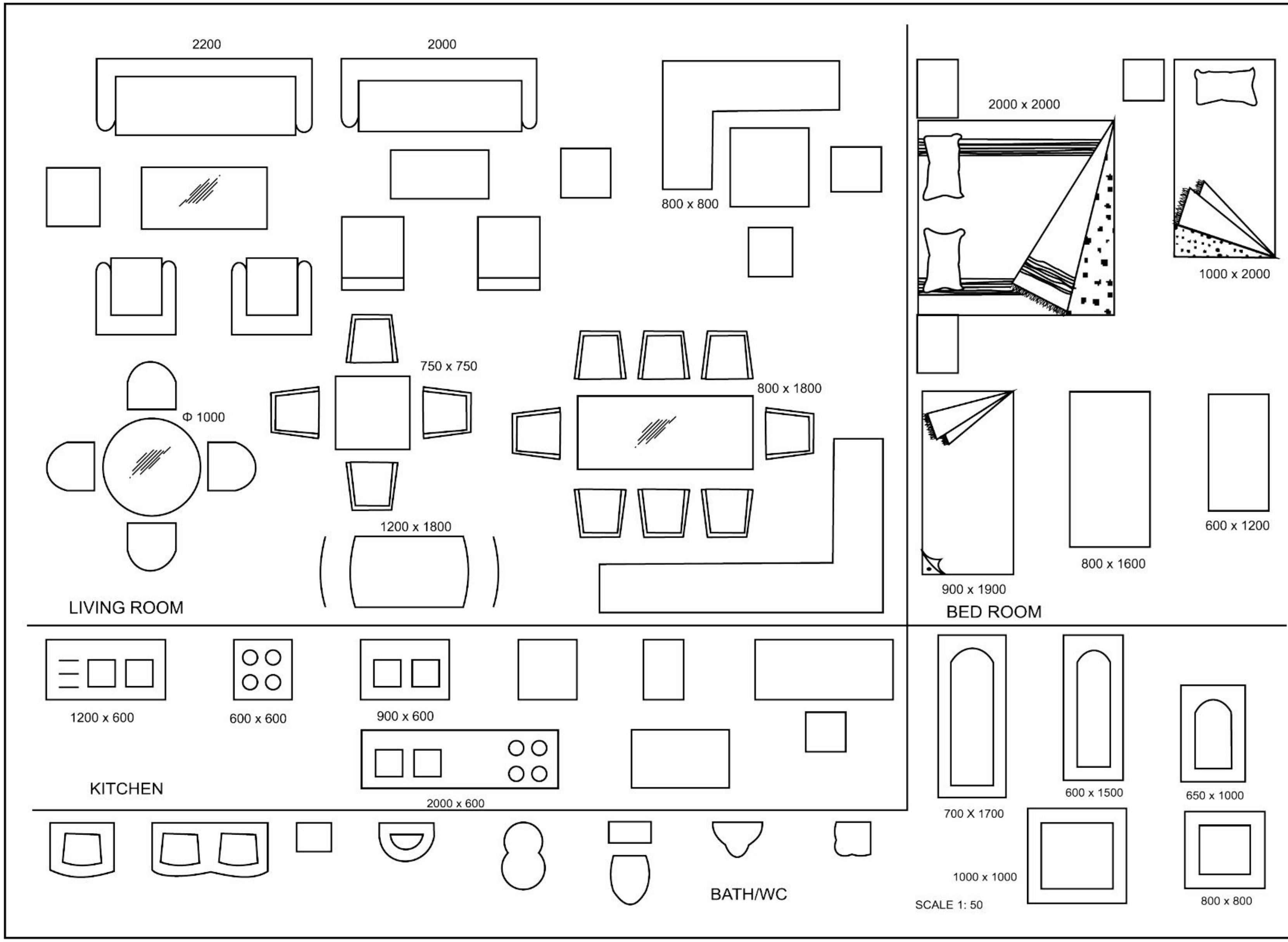
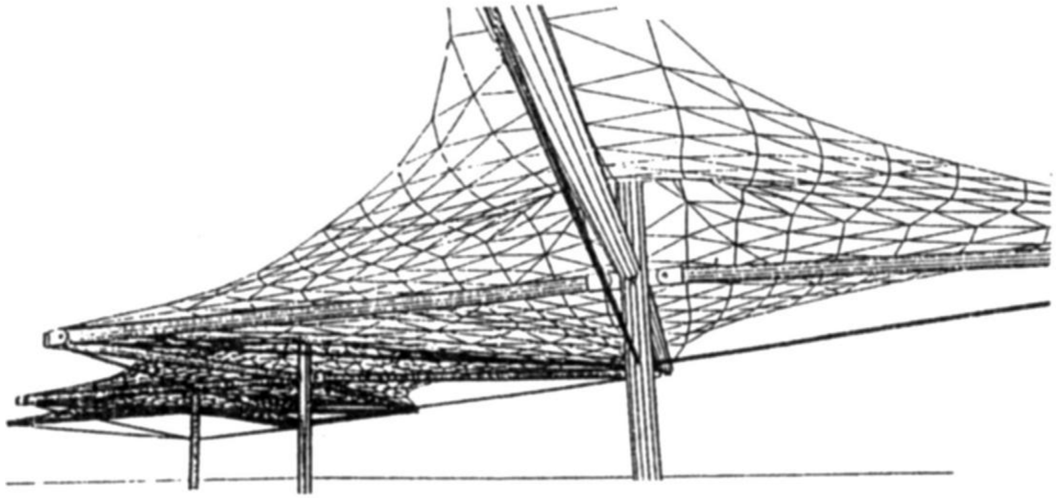


Figure 7.45 *Details for Interior Planning*

8 GENERAL INFORMATION, READING AND DRAWING EXERCISES



Engineering

"Engineering is the professional art of applying science to the efficient conversion of natural resources to the benefit of man.
An engineer is qualified by aptitude, training and experience to perform engineering functions."

Ralph J, Smit

Building Technology

"Technology refers to any process, application or system which makes use of the available resources to effect a product or to effect some impact on man's world.

Author: Vinita Shah
Human Resources Development in the Building Industry
—A Study in Bombay

Topics covered in this chapter

8.1 GENERAL INFORMATION

8.1.1 Maximum Safe Bearing Capacities

Rocks	(kN/m²)
Granite, trap	3300
Sand and lime	1650
Broken bed rocks and hard shale	900
Soft rock	450
Noncohesive Soils	
Gravel, sand and gravel compact	450
Coarse sand (compact and dry)	450
Medium sand (compact and dry)	250
Fine sand and silt	150
Loose gravel or sand gravel mix: loose, coarse to medium sand	250
Cohesive Soils	
Soft shale, hard or stiff clay	450
Moist clay and sand clay	150
Soft clay	50
Black cotton soil or other shrinkable or expansive clay in dry condition	100

8.1.2 Masonry Weight

	(kN/m³)
Brick masonry	19.2
Stone masonry	24.4–27
Partition Walls	
Brick 100 mm thick	1.95
Glass 100 mm thick	0.90
G I sheet	0.15

Thickness of Masonry Walls

Brick Work

Storey above ground	Height of wall up to (m)	Length of wall	Thickness of wall (mm)			
			Basement	Ground floor	1st floor	2nd floor
1	3.5	Any length	300	200	–	–
1	5	Any length	400	300	–	–
1	6.5	Any length	500	400	–	–
2	6.5	Less than 10 m	300	200	200	–
2	6.5	Greater than 10 m	400	300	200	–
2	9.5	Less than 10 m	400	300	300	–
2	9.5	Greater than 10 m	500	400	300	–
3	10.0	Less than 10 m	400	300	200	200
3	10.0	Greater than 10 m	500	400	300	200

Concrete Block

Storey above ground	Thickness of wall (mm)			
	Basement	Ground floor	1st floor	2nd floor
1	300	200	–	–
2	300	200	200	–
3	300	300	200	200

8.1.3 Safe Permissible Loads on Masonry

				(kN/m²)
1.	Random rubble	–	Lime mortar	330
			Cement mortar	880
2.	Coarsed rubble	–	Lime mortar	550
			Cement mortar	1320
3.	Ashlar/granite or trap	–	Lime mortar	1650
			Cement mortar	2000
4.	Brick	–	Mud mortar	140
			Lime mortar	350–550
			Cement mortar	660–770

8.1.4 Materials of Construction

Brick		
Size recommended (IS)		Size-including joints:
Length 190 mm		200 mm
Width 90 mm		100 mm
Height 90 mm		100 mm
Size in present practice (FPS–9″ × $4\frac{1}{2}$″ × $2\frac{3}{4}$″):		
Length 225 mm	or	225 mm
Width 112 mm		112 mm
Height 75 mm		60 mm
Compressive strength of brick:		
‘A’ Class–70 kg/cm²		
‘B’ Class–35 kg/cm²		
Water absorption		20–25% by weight.

Tiles	
Flooring cement tiles	
Size (mm × mm)	Thickness (mm)
150 × 150	18
200 × 200	20
225 × 225	22
250 × 250	22
330 × 300	25

Glazed earthenware tiles	
Size (mm × mm)	Thickness (mm)
99 × 99 148 × 148	6.5 8.00 9.5
Roofing tiles (Mangalore tiles)	
Effective length (mm)	Effective width (mm)
320	210
340	215
350	220

Concrete

Concrete grades for various purposes:
Foundation concrete, Bed concrete — M 7.5 and M 10
RCC work in–
slab, beam, column, wall, *chajja*, lintel — M 15 and M 20

RCC Slab

Usual thickness of slabs:
80, 100, 120, 150 mm – floors and roof
90, 100, 120 mm – chajja and parapet

RCC Beam

Usual sizes of beam	200 × 300	250 × 350	300 × 600
(All sizes in mm × mm)	200 × 400	250 × 500	
	200 × 500	300 × 500	

Note: Concrete is a mixture of coarse aggregate, fine aggregate (sand), cement and water. Grades of concrete represent the compressive strength of concrete. 'M' stands for mix and the suffix number being the compressive strength of 150 mm cubes expressed in N/mm^2, e.g. M : 10 – M is mix and compressive strength is 10 N/mm^2.

Usual sizes of column	200 × 200	300 × 300
(All sizes in mm × mm)	200 × 300	300 × 400
	200 × 400	350 × 450

Mortar

Masonry in foundation and plinth:
- Cement mortar — 1:6
- Lime cement mortar — 1:1:6, 1:1:7
- Lime mortar — 1:2
- Lime surkhi — 1:1:1, 1:2:1

Masonry in superstructure:
- Cement mortar — 1:6
- Cement lime mortar — 1:1:8

Arch work:
- Cement mortar — 1:3

Plaster
Internal and external:
- Cement mortar — 1:6
- Cement lime mortar — 1:1:7, 1:1:9
- Lime mortar — 1:2

Thickness of plaster:
- First coat – 12 mm brick work; 20 mm stone work; 10–16 mm concrete surface
- Second coat – 3 mm cement mortar; 6–10 mm lime mortar

Paints Water paints, distempers and oil bound distempers cover approximately 6–8 m^2 of surface area per kg.

Oil paint covers 9–13 m^2 of surface area per one litre, depending upon the surface area and the variety of paint.

8.1.5 Miscellaneous

Damp-proof coarse thickness	20 mm DPC 25 mm DPC
Height of plinth	450 mm 600 mm 750 mm 900 mm
Steps	150 mm × 300 mm 150 mm × 280 mm 180 mm × 280 mm
Parapet height	450 mm 600 mm 750 mm 900 mm 1000 mm

8.1.6 Sizes of Drawing Sheets and Boards as Per Indian Standards and Specifications

Sizes of Drawing Sheets

Designation	Trimmed size (mm × mm)	Untrimmed size min. (mm × mm)
A0	841 × 1189	880 × 1230
A1	594 × 841	625 × 880
A2	420 × 594	450 × 625
A3	297 × 420	330 × 450
A4	210 × 297	240 × 330
A5	148 × 210	165 × 240

8.2 OBJECTIVE QUESTIONS AND DRAWING

The subject 'Building Drawing' is generally taught along with other two subjects, i.e., Building Construction and Planning of Buildings. The work done by a student in building drawing will definitely show his/her understanding in the other two subjects. In order to judge his/her progress, questions should be set on the lines of questions given below. In some answers, there may be some alternatives out of which one is to be selected. Such questions and answers should be discussed in class. Objective type of questions will call into play his/her imagination, and increase one's power of decision when selection amongst many alternatives is to be done. Problems like fixtures and fastenings for doors and windows will increase his/her curiosity whenever new fixtures are observed and he/she will be in a position to compare advantages and disadvantages of different types.

Teachers should set such questions, and tests should be arranged periodically.

Reading Exercise

1. The line plan showing a living room and passage in a residential building is shown in Fig. 8.1. Which one of these plans would you select from the point of view of location of two door openings, considering utility of space? Select and draw plans showing furniture arrangement required for a living room. Take wall thickness as 200 mm and size of door opening 0.90 m × 2.10 m. Is there any other suitable location?
2. The sketches (A) and (B) (Fig. 8.2) show the line plan of a building and its roof plan, with hipped and gabled end. Wall thickness is 450 mm and the eaves projection is 450 mm.
   (i) Slope of the roof is 30°. Which is the correct plan?
   (ii) What are the dimensions of *X* and *Y*?
   (iii) What is the length of the hip rafter?
3. The sketch in Fig. 8.3 shows the plan of steps at entrance to a building. These steps have equal rise, with a tread of 300 mm. The height of the plinth above ground levels is 600 mm.
   (i) What is the rise of each step?
   (ii) Draw elevation and end view.
   (iii) Draw two point perspective. Take picture plane touching the corner *X*.
4. A dog-legged staircase is to be provided in a building, the floor to floor height being 3.15 m with a 150 mm slab as shown in Fig. 8.4. If the rise of each step is to be 175 mm, tread 280 mm and the minimum clear landing width 1.20 m, find:
   (i) The internal dimensions *X* and *Y*.
   (ii) Draw plans and sections, showing staircase details for RCC construction. Take wall thickness as 230 mm.
5. The sketch (Fig. 8.5) shows the line plan for the ground floor of a small residential building. All ground floor walls are 450 mm thick. First floor walls are 300 mm thick, except in staircase where it is 450 mm. First floor walls are centrally placed over ground floor walls except in the case of the external walls, where no offset should be visible on the external faces. What is the dimension of the room on the first floor?

Kitchen	A	3.300 *X* 4.600	B	3.225 *X* 4.675	C	3.390 *X* 5.350
Bed	A	4.425 *X* 3.150	B	5.100 *X* 3.750	C	4.350 *X* 3.225
Living	A	5.300 *X* 3.300	B	5.900 *X* 3.900	C	5.150 *X* 3.225

Tick mark the correct size of the room (dimensions in m).

6. The line plan of a gram panchayat office building is given (Fig. 8.6). The wall thickness is 450 mm. There is a parapet of 150 mm thickness on the verandah, the external face of the

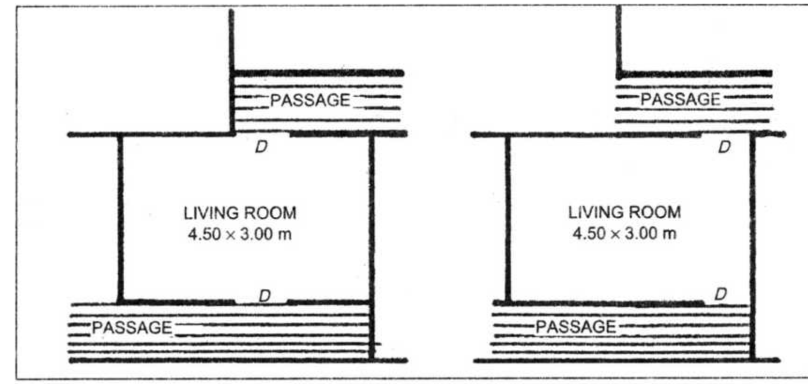


Figure 8.1 *Reading Exercise 1*

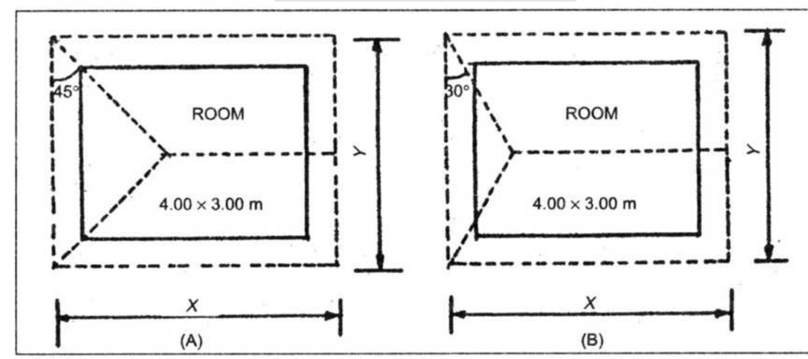


Figure 8.2 *Reading Exercise 2*

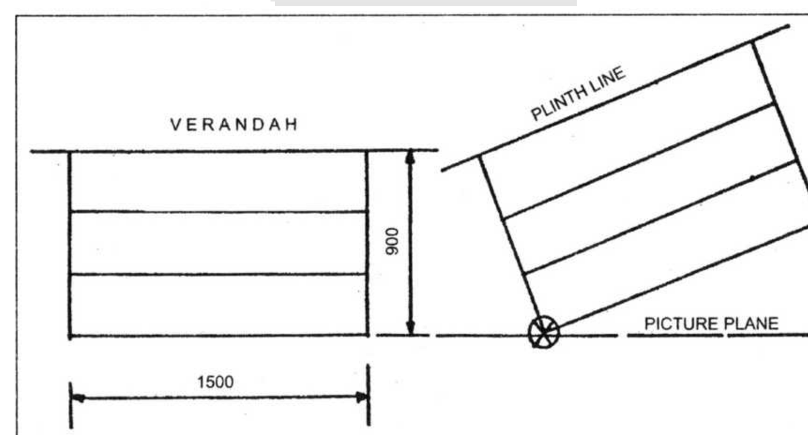


Figure 8.3 *Reading Exercise 3*

parapet being flush with the face of plinth masonry, there being no offset at plinth level externally. What are the clear dimensions of the verandah?

A 4.300 × 2.850

B 4.000 × 3.000

C 4.150 × 3.150

Tick mark the correct size (dimensions in m).

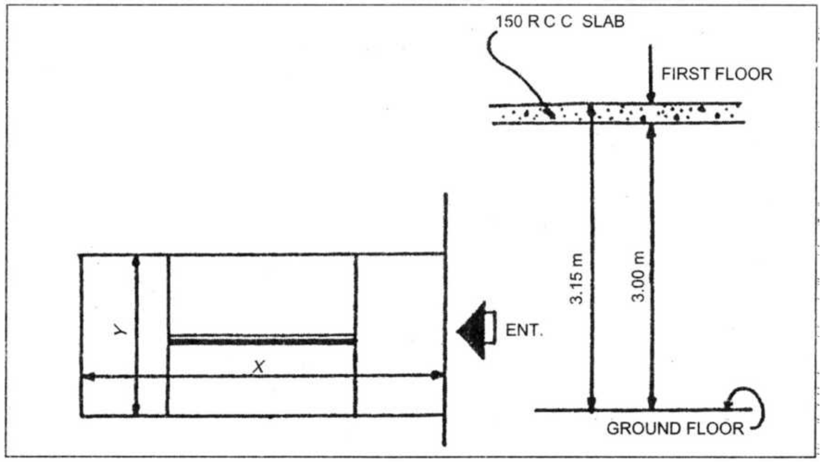


Figure 8.4 *Reading Exercise 4*

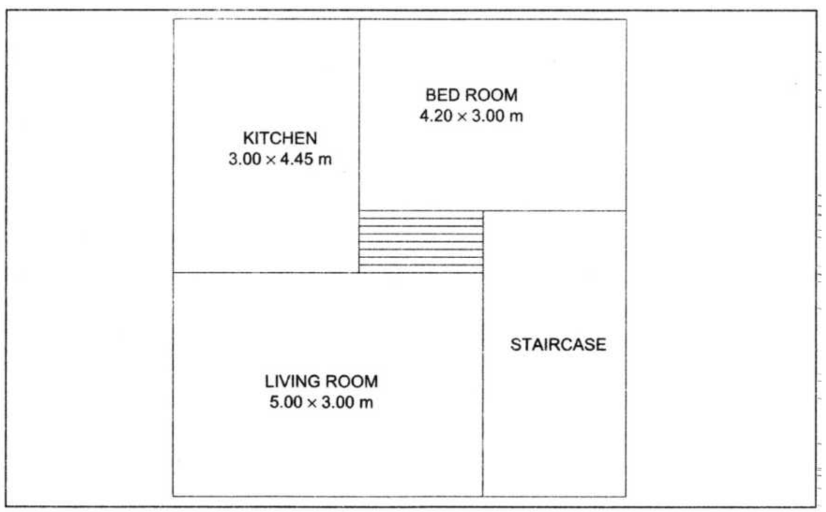


Figure 8.5 *Reading Exercise 5*

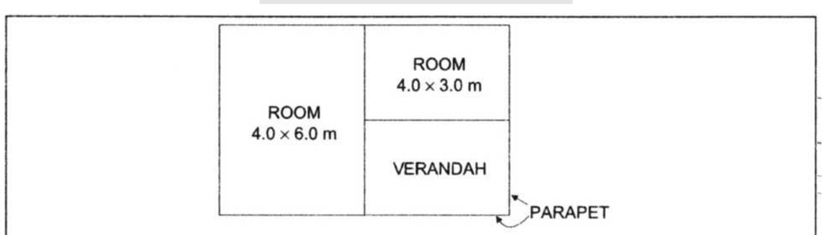


Figure 8.6 *Reading Exercise 6*

7. Figure 8.7 shows the plan of a bedroom in a residential building. Select the proper type of door giving maximum privacy.
   (i) Double-shutter door hinged at *P* and *Q*
   (ii) Single-shutter door hinged at *P*
   (iii) Single-shutter door hinged at *Q*
   (iv) Any one from (i), (ii) and (iii).
8. The line plan of a small building (ground floor plan) is shown in Fig. 8.8. The building is double-storeyed with first floor walls 200 mm thick and ground floor walls 300 mm thick, no offsets being visible on the external faces. Tick mark the correct section at *XX* at the junction of the first and ground floor.
9. Figure 8.9 is the line plan of a RCC staircase, the height from floor to floor being 3.15 m. The thickness of a landing slab is 200 mm. What clear head room will be available below the intermediate landing slab? Take tread = 300 mm and rise 175 mm. Draw the sectional view.
10. Figure 8.10 gives CCTW section of post for a door. (i) Which dimensions are not given in accordance with standards for dimensioning?, (ii) Draw sketch and show all dimensions as per IS recommendations.
11. The plan of WC is given (Fig. 8.11). Sketch the section *AA* directly above the plan showing the following clearly
    (i) WC seat-Orissa pattern,
    (ii) Flushing tank,
    (iii) Water tap, and
    (iv) Dado of white glazed tiles of 1 m height. What is the total area of white glazed tiles Dado?

    Take the following data:
    Ceiling height–2.10 m
    Door-CCTW panelled 0.75 m × 2.1 m with frame size 75 mm × 150 mm.
    Wall thickness–200 mm.
12. A line plan of a residential building is given in Fig. 8.12 along with the list of furniture. Complete the plan with layout of the furniture. The furniture should be placed in such a manner that there is space for movement within the room and access to other rooms. The position of beds should be such that cross ventilation over the beds is provided. Locate doors and windows. Assume suitable sizes.

    Furniture

    Living Room
    Sofa set – 1.50 m × 0.60 m
    Sofa chairs – 0.60 m × 0.60 m (2 Nos.)
    Centre table – 0.60 m × 0.45 m
    Side tables – 0.25 m × 0.25 m (2 Nos.)

    Dining Room
    Dining table – 1.50 m × 0.90 m
    Chairs (4 Nos.) – 0.45 m × 0.45 m

    Master Bedroom
    Double bed – 1.90 m × 1.8 m
    Dressing table – 0.90 m × 0.45 m
    Steel almirah – 0.90 m × 0.45 m

    Bedroom for Children
    Two beds – 1.90 m × 0.90 m
    Study table (one) – 0.90 m × 0.60 m
    Two chairs – 0.45 m × 0.45 m
    Book shelf – 1.20 m × 0.45 m

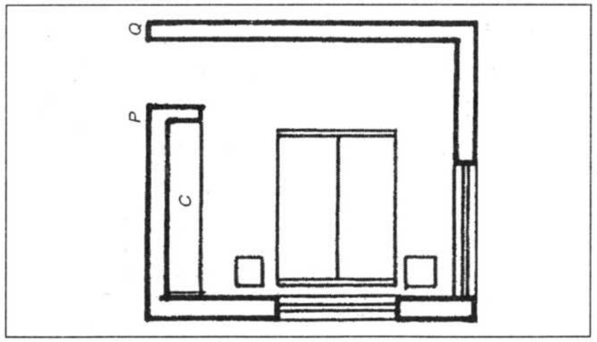


Figure 8.7 *Reading Exercise 7*

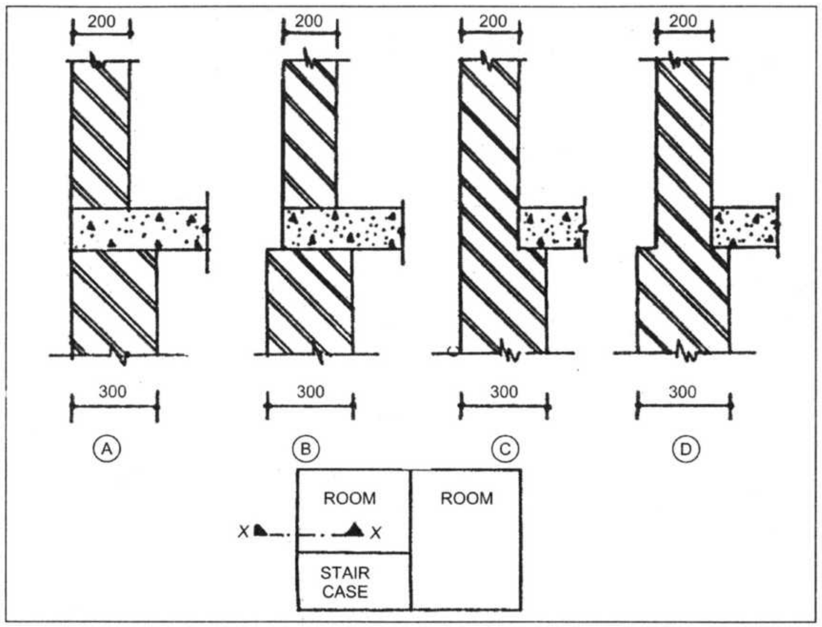


Figure 8.8 *Reading Exercise 8*

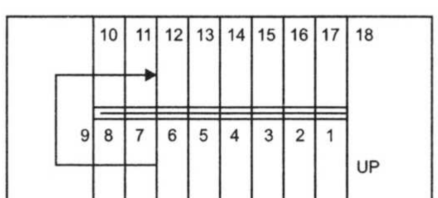


Figure 8.9 *Reading Exercise 9*

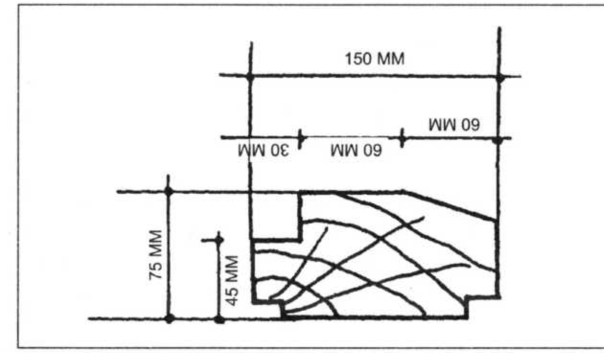


Figure 8.10 *Reading Exercise 10*

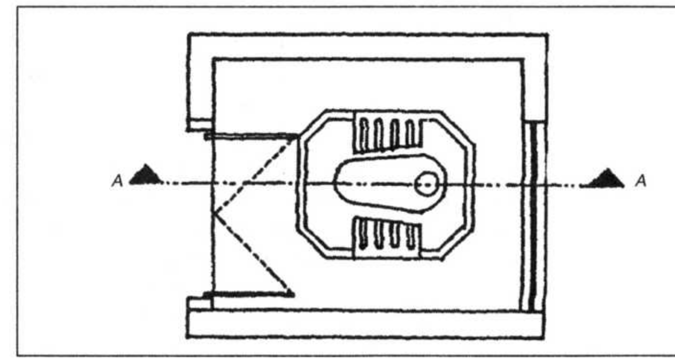


Figure 8.11 *Reading Exercise 11*

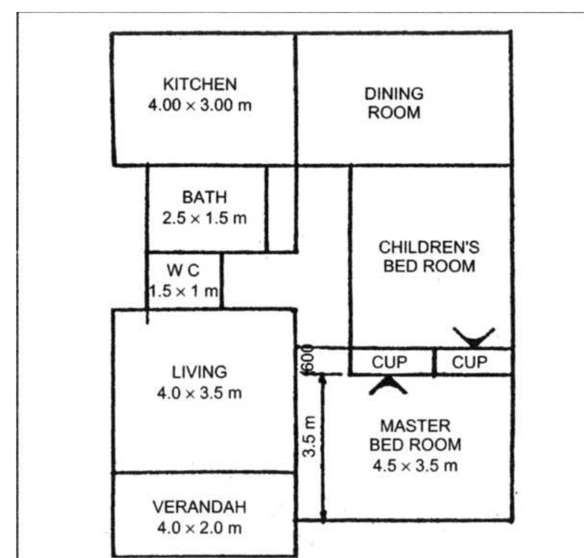


Figure 8.12 *Reading Exercise 12*

13. The plan of a residential building is shown in Fig. 8.13. The building has a pitched roof. Three elevations of the same building are also shown. Write below the elevations for which sides they are drawn. Draw the elevation of the building for the remaining side in the blank space left. Draw a plan of the roof in dotted lines over the plan.

14. The plan and two sections of a residential building are shown in Fig. 8.14. Study the sections carefully and mark the section lines on the plan at which the two sections are drawn.

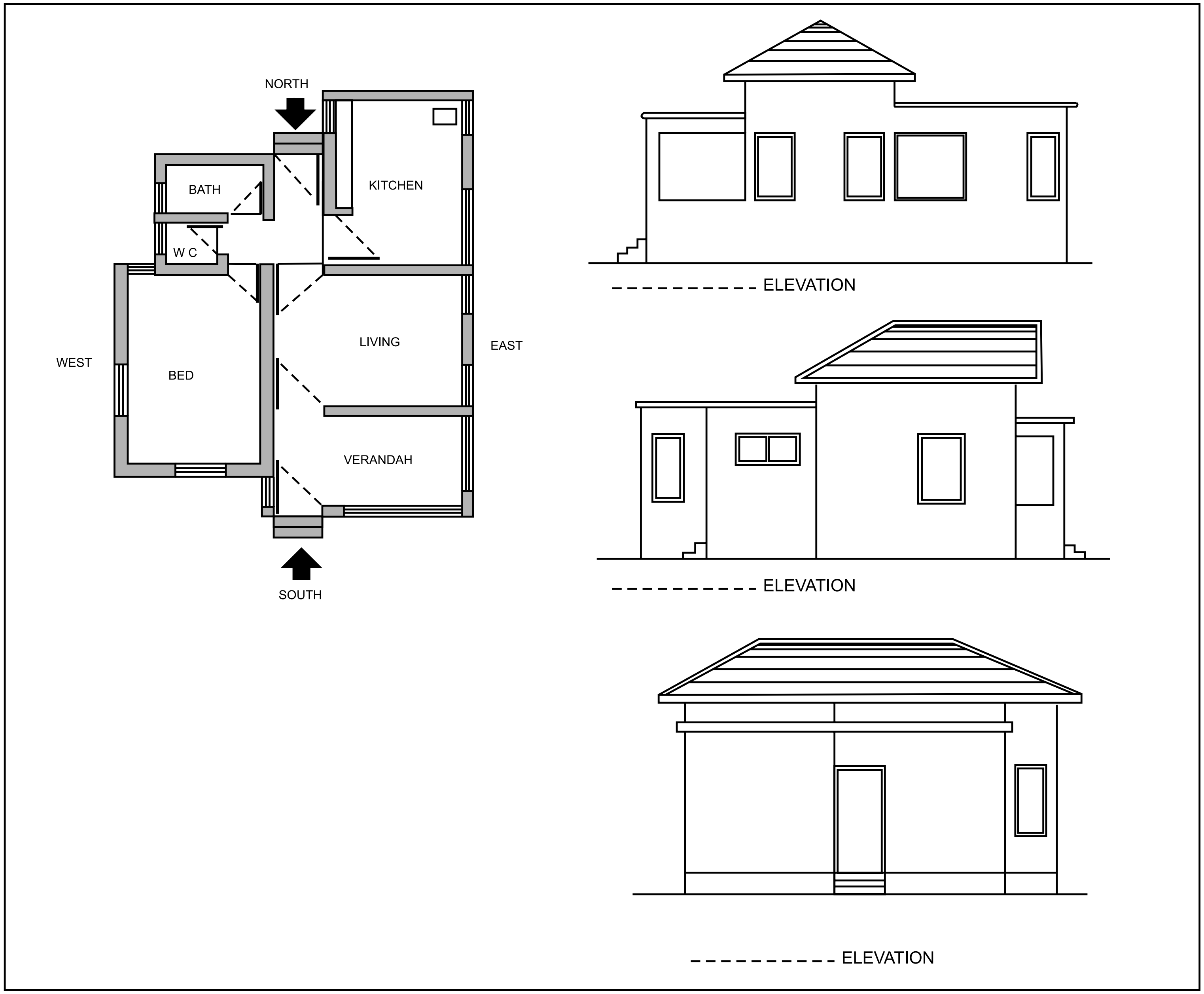


Figure 8.13 *Reading Exercise 13*

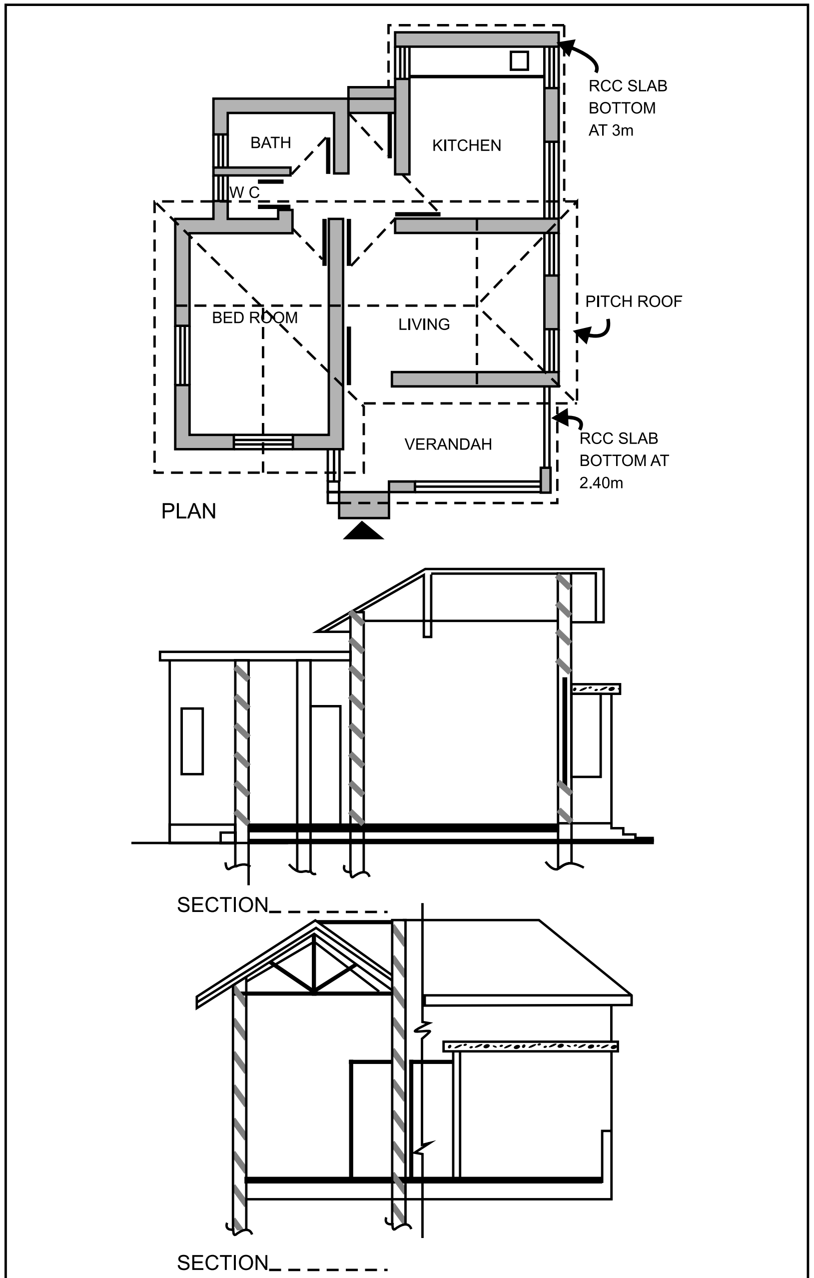


Figure 8.14 *Reading Exercise 14*

15. Two sketches showing staircase details are given in Fig. 8.15. Sketch A shows details for RCC. staircase, while sketch B shows details for a timber staircase. Various terms in connection with the staircase are given below. Write the correct serial number in the squares (for example, No. 13 for landing as shown):
    - (i) Tread
    - (ii) Rise
    - (iii) Going
    - (iv) Hand rail
    - (v) Balusters
    - (vi) Newel
    - (vii) Nosing
    - (viii) Line of nosing
    - (ix) Scotia block
    - (x) Riser
    - (xi) Waist thickness
    - (xii) Stringer
    - (xiii) Landing
16. Sketch symbols for:
    - (i) Rectangular bath
    - (ii) Shower stall
    - (iii) Wall wash-basin
    - (iv) Corner wash-basin
    - (v) Plain kitchen sink
    - (vi) Indian type WC
17. Symbols for sanitary installations are given in Fig. 8.16. Write the name of installations.
18. Sketch symbols for:
    - (i) Light plug
    - (ii) Power plug
    - (iii) Meter
    - (iv) Light bracket
    - (v) Fluorescent light (single)
    - (vi) Bell push
    - (vii) Buzzer
    - (viii) Ceiling fan
19. The sketch of a glazed and panelled (on both sides) window 0.9 m × 1.35 m, opening outside, is given in Fig. 8.17. Sketch on the given inside elevation the fittings you will provide at the proper locations. Complete the list of fittings in the given tabular form.
20. The plan and elevation of a partly glazed and partly panelled door with double leaf is shown in Fig. 8.18. Sketch the following fittings at the proper location on the elevation. Fittings to be fixed on the front of the shutters as shown in dotted lines.

    Fittings

    Tower bolts –250 mm (3 Nos.)

    Handles –150 mm (3 Nos.)

    Aldrop –300 mm (1 No.)
21. The plan for a bathroom without details is shown in Fig. 8.19. Draw the sectional elevation of the bathroom and elevations of four sides as seen from inside. Complete the plan with details.

    Show:
    - (i) Tap-direct and from storage tank.
    - (ii) Floor trap (Nahani)
    - (iii) Shower
    - (iv) Towel rail
    - (v) Soap rack
    - (vi) Geyser and power connection
    - (vii) White glazed dado–1.5 m high
    - (viii) Suitable window
    - (ix) Suitable door at convenient place
    - (x) Loft–150 mm thick and 2.1 m above
22. A plan showing WC, bathroom and kitchen sink is given in Fig. 8.20. Draw drainage and water supply connection details showing the size and type of pipes, various fittings and gully traps. Draw plan and elevation from side *A,* showing drainage and vent pipes. Wall thickness for walls X = 200 mm and Y= 150 mm.
23. In the given plan (Fig. 8.21) of a residential building, mark openings (positions) of (i) doors, (ii) windows, and (iii) ventilators.

    Calculate the size of windows as per bye-laws. The doors may be provided in a way that there is easy access to different rooms, privacy is maintained, and there is proper utilisation of living space.

    Try different alternatives for locating the openings with reference to north and wind direction. Number of doors should be minimum, considering economy and privacy. Draw a plan with the scale of 20 mm = 1 m. Prepare schedules of doors and windows. Prepare a plan for landscaping. Check window locations.

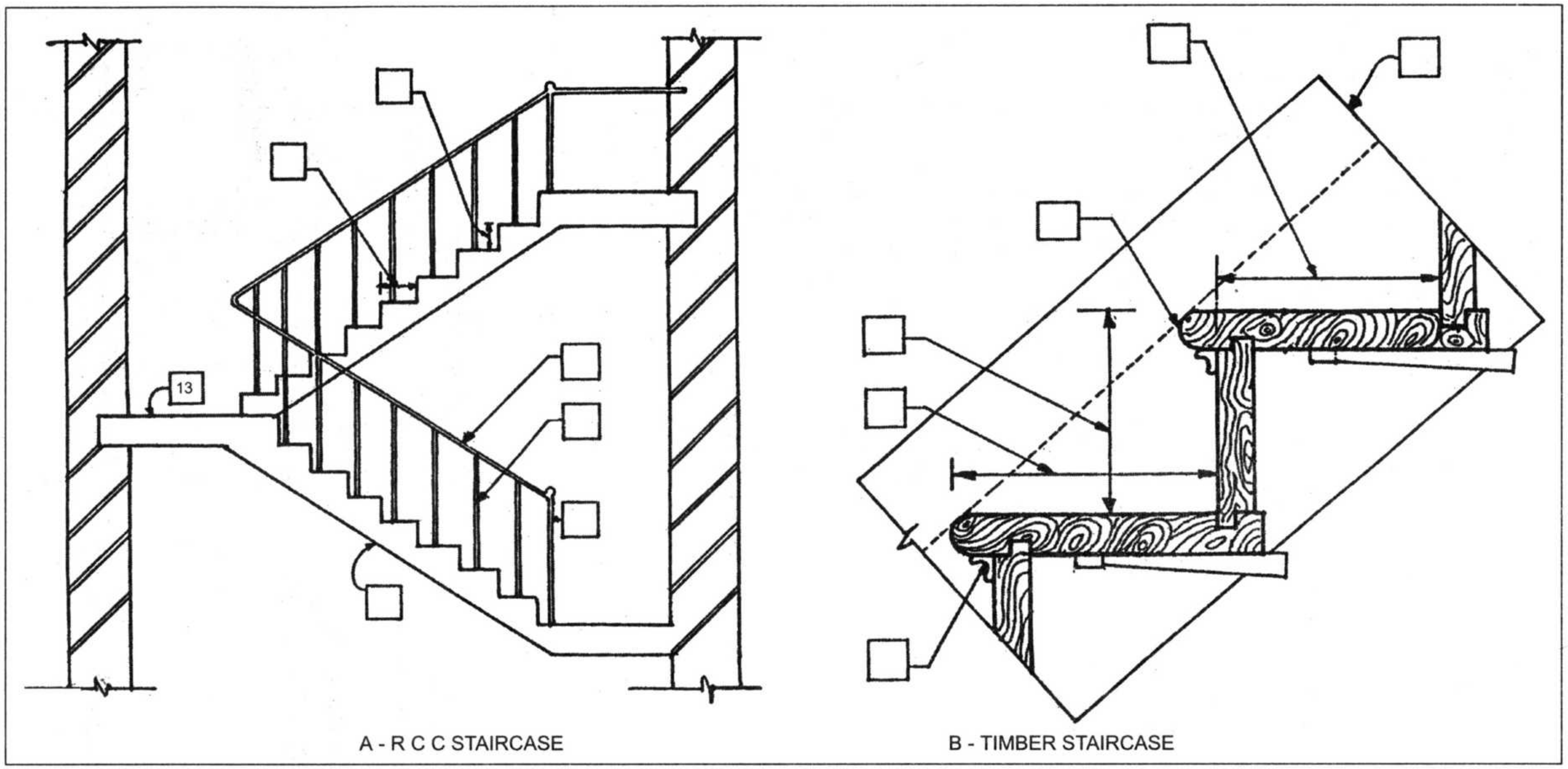


Figure 8.15 *Reading Exercise 15*

24. The line plans of a small residential building are given in Figs. 8.22 and 8.23. Prepare a full-dimensioned submission drawing, comprising the following views:
   (i) Ground floor plan
   (ii) Front elevation
   (iii) Section AA; Section BB–Assume section lines.
   (iv) Site plan and area schedule
   (v) Construction notes
   (vi) Schedule of doors and windows

   Specifications and other details are given as follows. All other dimensions and details may be adopted as per normal standards.

Foundations	–	On hard murum, at a depth 1 m below GL
Plinth	–	Height 450 mm-plinth and foundation masonry of UCR in CM 1 : 6.
Superstructure	–	All walls in BB masonry in CM 1 : 6 300 mm thick except partition walls between bath and WC which are 150 mm thick. The verandah has MS grills provided over parapets.
Height	–	Clear head room, 3 m for kitchen; 2.4 m for verandah, WC and bath;
Doors and windows	–	CCTW doors and steel windows of suitable size and at suitable place.
Roofs	–	RCC 150 mm thick with waterproofings of brick bat coba.

Assume additional data, if required.

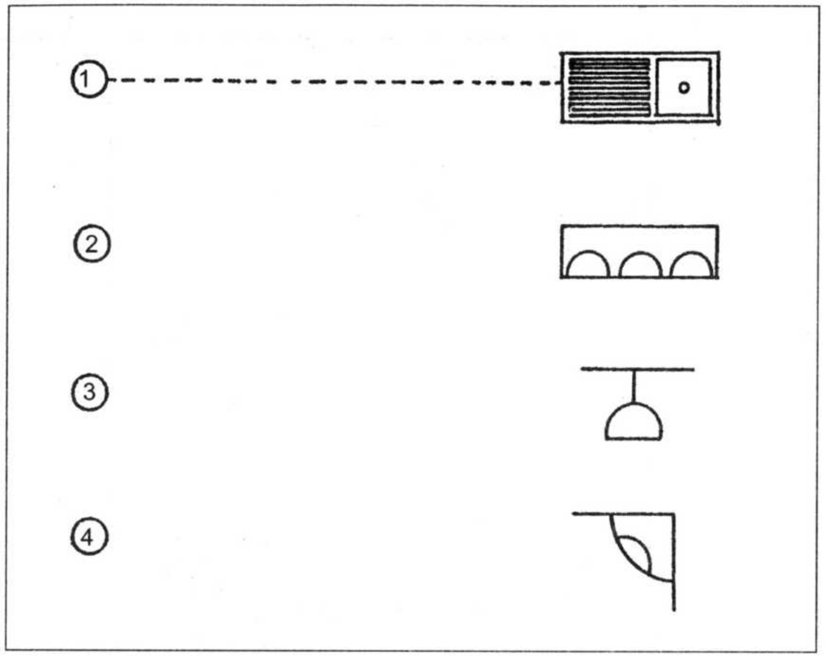
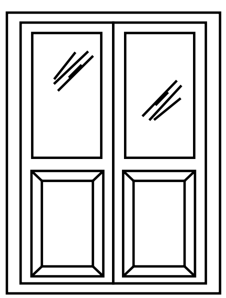


Figure 8.16 *Reading Exercise 17*



LIST OF FITTINGS

NAME	SIZE	NUMBER REQUIRED

Figure 8.17 *Reading Exercise 19*

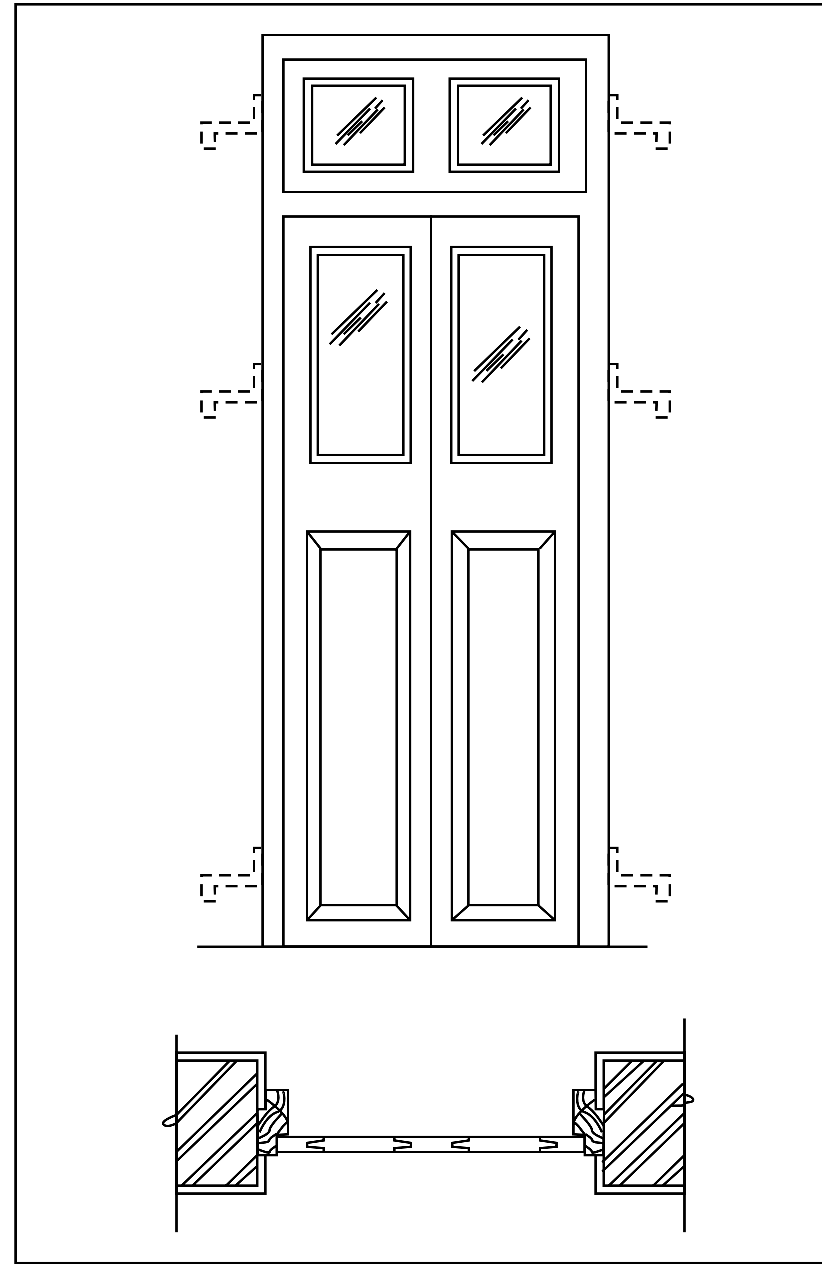


Figure 8.18 *Reading Exercise 20*

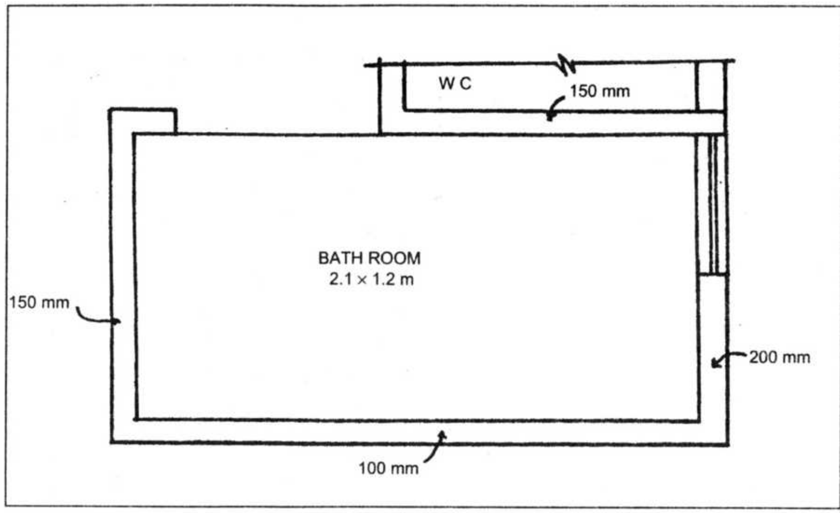


Figure 8.19 *Reading Exercise 21*

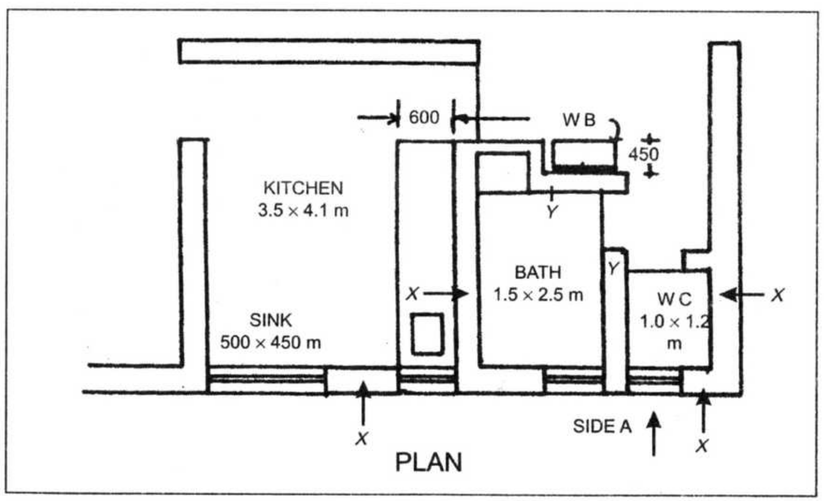


Figure 8.20 *Reading Exercise 22*

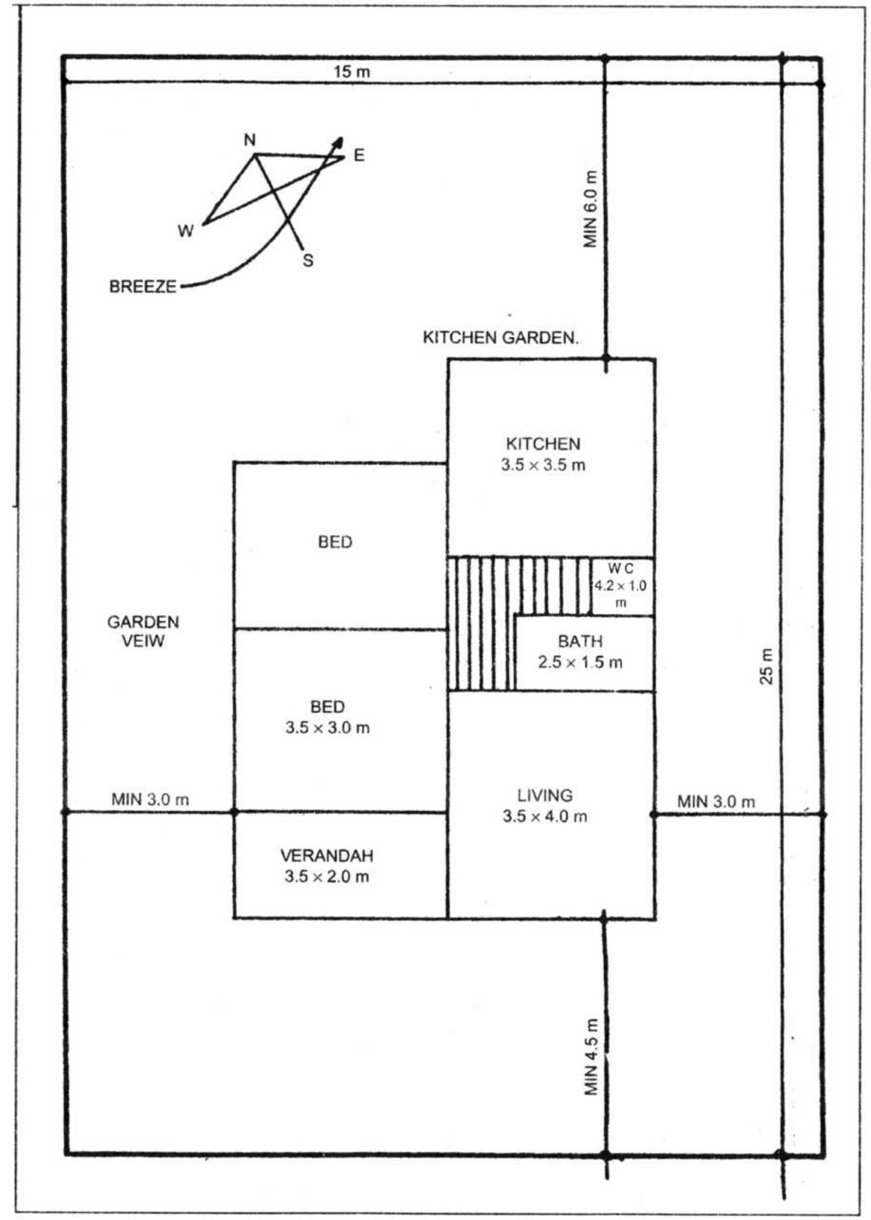


Figure 8.21 *Reading Exercise 23*

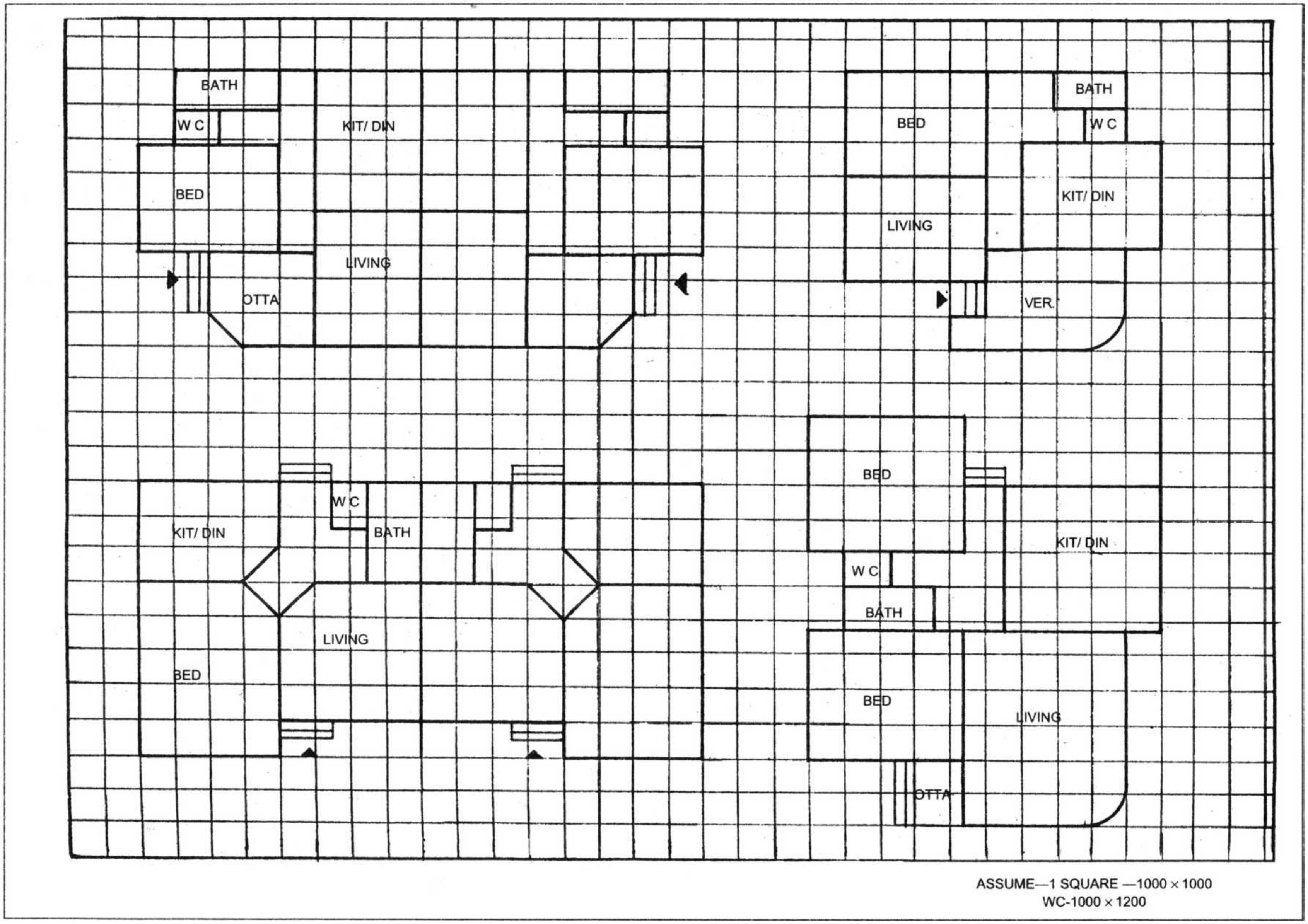


Figure 8.22 *Line Plans for Load Bearing Structures Reading Exercise 24*

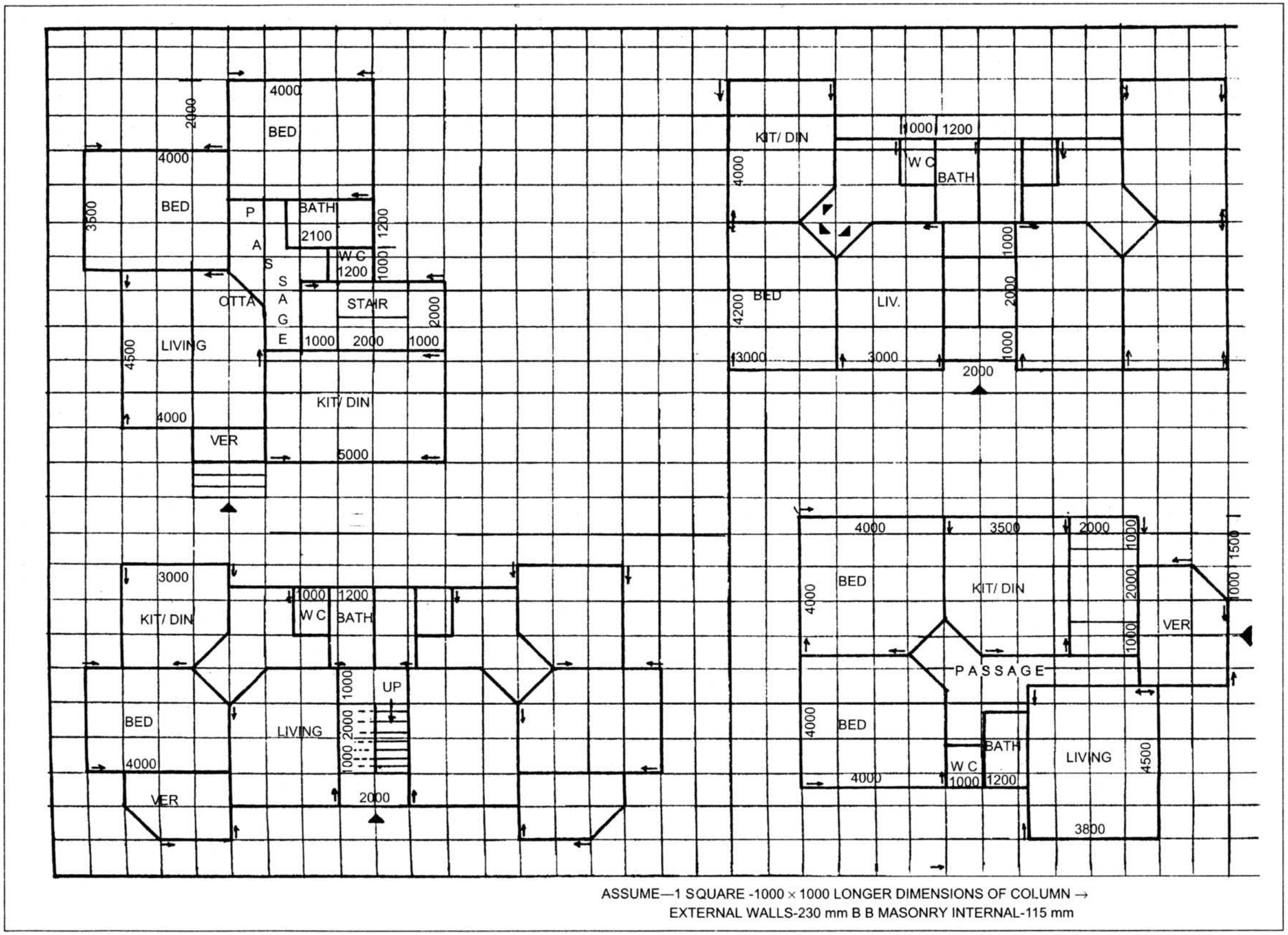


Figure 8.23 *Line Plans for RCC Framed Structure Reading Exercise 24*

APPENDIX I

LOW COST HOUSING

1. HOUSING FOR ALL

Low cost housing, innovative approaches for mass housing projects, affordable shelter to each and every section of the society, making cities livable and safe for all and *appropriate technology for shelter and infrastructure* are the subjects which lead to the search of cost-effective building technologies for different income groups and communities. In this connection, it is also essential to consider housing infrastructure services as an integral part of housing. Potable water supply, sanitation, streets, electrification, communication facilities have to be provided simultaneously for livability, i.e., creating better health conditions, acceptable environmental improvement in living conditions by planting trees, plants and kitchen gardens along with fruit bearing trees where land is available. All the sections of the society need psychological shelter with pleasing surroundings in harmony with the nature. The question is how to achieve this within minimum duration by using cost-effective building technologies.

Housing is essential for all the sections of the society. Different income groups need plans of variable built-up areas.

(a) Individual Units
(b) Twin Units
(c) Row Houses
(d) Three-storeyed structures with six or more number of flats suitable for rural and urban needs and high rise buildings with lifts.
(e) Mass housing with different types mentioned above.

Mass housing reduces individual cost of construction of one unit. Architects should be asked to prepare suitable plans for different climatic conditions and life style of users staying in different parts in the country. It is essential to finalise the details of the plan such as minimum number of rooms, their floor area, separate W C and bath, suitability for future expansion, courtyards or open verandahs, and kitchen garden, etc., with the climatic conditions in mind. Details of availability of traditional material for construction and alternative material along with cost-effective building technologies, life of building, essential maintenance programme for buildings are also essential.

In USA, architects have helped in publishing books with plans and perspectives stating planning and design considerations, suitable for different requirements of family, climate, locations, etc. A set of working drawings, estimates, specifications and information about local agencies/skilled workers is required for construction. Such a set of plan—working drawings and information—is made available on payment of suitable charges.

2. TOTAL COST OF CONSTRUCTION AND COST CONTROL

Total cost of construction includes

(a) Cost of land
(b) Cost of total development of infrastructure—streets, water supply, sanitation, electricity and common amenities
(c) Cost of construction of built-up area per unit
(d) Profits and fees of professionals
(e) Taxes
(f) Amount of interest
(g) Administrative charges
(h) Miscellaneous—common maintenance charges, tree plantation, etc.

Cost control is to be achieved in three different stages, i.e., planning, design and construction. Knowledge of cost-effective building technology and alternative building materials is useful while finalising the construction details. Acceptance of the specifications by the user should be considered as an important point for the success of the construction in the long run. Final product must be appreciated as an architectural creation giving occupational comfort creating feeling for utility and aesthetics. Herein lies the skill of total construction team of architect, structural designer, builders and landscape architect. Cost effective techniques are—

2A. COST CONTROL AT PLANNING STAGE

(a) "Building is container of activities"—it is true for all families, be it Low Income Group (LIG), Medium Income Group (MIG), or Higher Income Group (HIG). Built-up area between 40 m^2 to 50 m^2 would be required for the activities of a five-or six-member family. Assessment of total built-up area, total usable area and the ratio of built-up area to floor area to know the efficiency of plan will help in judging economy in planning. Shape of the building, built-up area and total length of walls are two factors to control the cost of the construction. Up to five percent saving is possible by keeping the length of walls minimum for the same built up area.
(b) Number of doors and windows to be minimum essential as per rules. Openings without door frame and shutters is found convenient in some cases for internal openings.
(c) W C and bath of minimum area, as separate units in one building for one family is essential. Additional cost of separate units is to be justified by convenience with utility. ,
(d) Door and window as one unit is found to be convenient for main and rear entrance for the ventilation and safety. It saves one window.
(e) Plan with minimum passage area as it reduces built-up area.

(f) Plan developed with, offsets in wall to accommodate cupboards/storage units is economical.
(g) Plan with modular dimensioning is useful for using precast units.
(h) Different alternative plans and layouts, plans for mass housing with amenities and minimum length of roads help for final economical solution.

2B. COST CONTROL AT DESIGNING STAGE

(a) Building should act as the second environmental filter while total layout plan should act as the first and foremost environmental filter. Occupational comfort in all seasons for twenty four solar hours to reduce temperature, control humidity and dust, and provide ventilation should be the main consideration. Mass tree plantation helps in using outdoor areas. Trees and plants are as much a part of the construction plans as the buildings, roads and other amenities.
(b) Plinth height 450 mm and plinth protection course in lean concrete or shahabad stone or suitable material is essential.
(c) Window sills of stone/tiles are useful in protecting the edge of plaster at sill level.
(d) Use of precast units for lintels, cupboard dividers.
(e) Brick arches, flat or semicircular, instead of RCC lintels.
(f) Pointing for external wall surface instead of plaster depending on the quality of bricks/blocks.
(g) Load bearing/framed structure depending on cost of foundation, cost of land and number of floors.
(h) Construction of roof, flat or sloping, suitable to the area.
(i) Cost up to foundation is variable in mass housing while cost of the super structure is the same.
(j) Decision regarding standard specifications with tolerable limits and training of workers is necessary to achieve quality with more output.
(k) Test results for safe bearing capacity helps in finalising type of foundation and problems, if any, during construction.
(1) Use of ferrocrete technology for different components.
(m) Uniform size of columns and beams to reduce cost of form work and to achieve more speed with quality.
(n) Use of different grades of concrete for keeping uniform size of column if required, for multi-storeyed buildings.
(o) Suitable replacement for sand and metal.
(p) Ready mixed concrete for mass housing project.
(q) Pre-cast units with high quality and timely output.
(r) Use of soil cement blocks/flyash bricks/cellular blocks/concrete blocks with aggregates on one side or other alternative materials for walling.
(s) Specifications to reduce cost of maintenance.
(t) RCC beams to be taken up to lintel level to avoid part brick work between lintel top and beam bottom.
(u) Use of shingle instead of metal in case of items for nonstructural RCC band at plinth.
(v) Use of innovative building materials, technologies, construction techniques for saving in cost in conventional methods.
- Foundations–Under reamed pile foundation and brick arch foundations.
- Superstructure Walling–230 mm thick wall in bricks for external walls, 115 mm thick internal walls, 150/200 mm block masonry, stabilised mud blocks, flyash bricks walls, hollow block walls.
- Roofings–85 mm thick sloping RCC instead of 100 mm flat RCC slab, 110 mm flat RCC slab, RCC planks over RCC joists, ferrocrete shell roofing, filler slab roofing, RCC channel units, jack arch brick roofing.
- Other components–RCC door frames instead of timber frames, frame-less doors, ferrocrete door shutters, RCC window frames, RCC jallies, precast thin lintels and sunshades, ferrocrete sunshades cum lintel, brick on edge lintels, ferrocrete water tanks and manhole covers.

2C. COST CONTROL AT CONSTRUCTION STAGE

After the design stage, cost per unit is known. Cost of land varies from place to place. Availability of land at minimum rate will reduce total cost of construction. Cost on account of interest is dependent on the duration of the project and need specific considerations in total planning. Cost on account of security, temporary utilisation cost, transportation cost and cost for administration also depends on total duration of construction. Modes of financing and unforeseen circumstances are other related factors. Hence, economic analysis and economic evaluation help in making the minimum risk decisions at various stages involved in the building project—mass housing as well as individual units. Other cost-effective techniques are:

(a) Use of machinery for excavation, casting of concrete blocks and precast units helps in speedy construction.
(b) Special control on wastage of material.
(c) Proper planning on site—working space, material stacking spaces, machinery spaces and location of site office helps in reducing longer unnecessary leads and carting of materials.
(d) Use of bar chart/CPM are some of the essential methods to reduce cost.
(e) Postponement of some items for slum housing—internal plaster, cowdung flooring, instead of costly flooring, plastic cocks instead of metal cocks, push cocks instead of flushing tank.
(f) Concreting is only 35% of total cost. Major cost is that of finishing items-65% walling material, doors, windows, toilets and flooring, Excess ordering, breakage and thefts of materials for these items are to be particularly avoided.

The work related to cost-effective building technology information is done by

1. ***Building Materials and Technology Promotion Council (BMTPC),*** Ministry of Urban Affairs and Employment, Government of India, 6, Wing Nirman Bhavan, New Delhi, 110011.

They are actively involved in:

(a) Developing machines for
- Precast Concrete door/window frame making machinery
- Finger jointing machine for plantation timber
- Flyash, sand-lime brick making machine
- Automatic coal stoker for the brick and tile industry
- Motorised compressed earth blocks making machine
- Machine for ferrocement roofing channels
- Hot press for manufacture of Bamboo mat corrugated roofing sheet
- Solid/hollow concrete block making machine
- Ferrocement door shutter making machine
- Clay flyash brick making machine
- Ferro cement wall panel making machine
- Precast concrete C-section beam (Rafters) making machine

The information includes cost of setting up a project with small, medium and large scale production unit, information about ancillary plant/machinery requirements, and use of the product, and consultancy services.

(b) Making educational films and publications
(c) Popularising information about innovative building materials from industrial waste.

- Phosphogypsum from fertiliser plants
- Red mud, i.e., bauxite residue generated from the aluminium industry
- Flyash from thermal power stations
- Blast furnace slag from steel plants
- Waste glass from glass plant
- Limestone waste from limestone quarry
- Bagasse from sugar industries, etc.

(d) Information about environment friendly materials for walling, flooring, partitions, door frames, rafter/purlin, roofing, false ceiling, panelling, shutters, cabinets, etc., is also provided. Information consists for:

- Wood substitution
- Garbage recycling
- Agro waste recycling
- Cellular light weight concrete
- Precast concrete frames
- Plantation timber doors/windows
- Ferrocement roofing components
- Compressed earth blocks

(e) *Performance appraisal certification scheme*: It is a third party operated voluntary scheme for providing performance appraisal certificate to a manufacturer/supplier/installer of a building product which includes building material, product, component, element and system, etc. after due process of assessment.

2. *Central Building Research Institute (CBRI),* Roorkee-247667 UP (India) is useful for further study.

Information about the research carried out to check the efficiency of the proposed building for comfortable environment, through proper orientation, thermal insulation, window design and noise isolation. Energy conservation achieved through maximum utilisation of natural ventilation, daylight and solar energy for satisfying energy needs in buildings and creating comfortable environmental conditions inside the building. Earthquake resisting structures-design and development.

(CBRI provides) laboratory facilities for:

(a) Low speed wind tunnel for ventilation and wind pressure distribution in buildings.
(b) Standard guarded hot plate apparatus for thermal conductivity including cryostat.
(c) Standing wave apparatus for sound absorption coefficient at normal incidence.
(d) Reverberation chamber for sound transmission loss and sound absorption coefficient at random incidence.
(e) Dome type of artificial sky for day lighting studies.
(f) Ultrasonics and acoustic emission set-up for nondestructive testing of building components.
(g) Photometric lab, for characteristics of light sources and glazing materials.
(h) Laboratory to assess the suitability of polymers, plastics, decorative and protective and design data.
(i) BIS handbook titled *Functional Requirements of a Building.*
(j) Recommendations and simplified design aids-
    - Assessment of solar radiation
    - Tropical summer index for thermal comfort
    - Thermal performance of building components
    - Day lighting and natural ventilation of Building
    - Chimney design for domestic kitchen
    - Solar space heating and water heating system
    - Roof surface evaporative cooling system
    - Impact noise reduction in multistoreyed buildings

3. *Housing and Urban Development Corporation Ltd. (HUDCO),* India Habitat Centre, Lodhi Road, New Delhi 110003.

HUDCO provides information for the variety of technology options to cater for housing in India, a country of immense geo-climatological variations and local resources in the area of foundation, walling, roofs, partition, ceilings, panels, doors, windows and other items.

The national network of building centres is useful for technology transfer and delivery systems. Institutions and students are advised to collect addresses of various building centers in India.

Colleges/polytechnics related to the education of Engineering and Architecture, young professionals and students interested in advance study should collect information from them to update information/syllabi from time to time.

List of innovative Building Materials/Technologies/Construction Techniques being adopted in the Nirman Kendras and their savings against conventional methods is useful for planning, designing and construction.

FOR LEARNERS TO BECOME THINKERS FOR PERSPECTIVE PLANNING WITH A VISION OF FUTURE

The various Charts given in different chapters of the book and A to T in this appendix will help students and fresh teachers to know the nature of the multidisciplinary subject 'Built Environment' in detail from 'whole to the part'. It is useful for self-study and to know various considerations in interrelated areas and to collect information about new projects, materials, equipment, machinery and design concepts to develop interest in the profession along with vision and skill for appropriate creation.

Charts are based upon different considerations expressed by thinkers in their books, and articles about their projects published in magazines, and views expressed in seminars mentioned in the bibliography.

Human Resource Development needs many experts related to many areas having knowledge of interdependent subjects. Study of charts will inspire selection of different areas in related subjects for elective subjects, in post graduation courses and further research.

Charts will also help while writing articles in journals along with additional information.

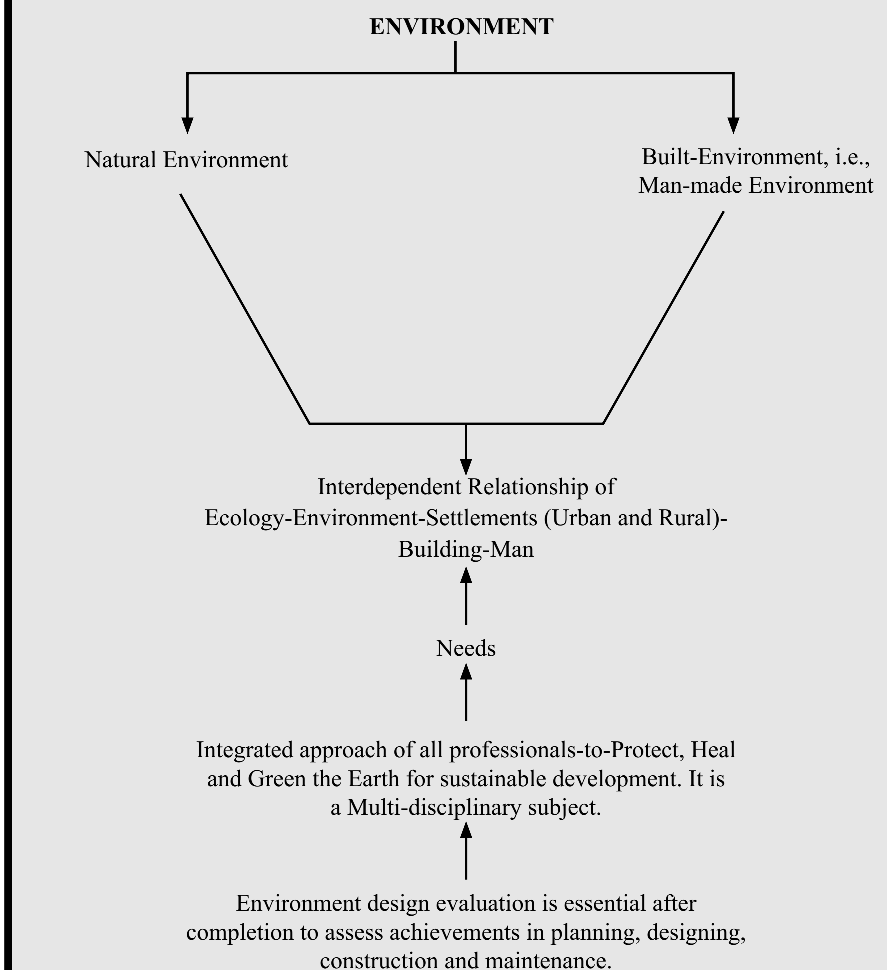
Chart S will be useful in assesing completed building with reference to planning, designing, construction and cost. Such assessment by the student is essential for his exposure in the field of creation.

"One of the greatest responsibilities we face today is to hand down a world that is safe and pleasant for future generations in the 21st century".

Planning for the 21st Century

"Safer Cities", 1998 - BMTPC, New Delhi Publication

Chart A



"Environs, the word implies all that surround us. The built and the unbuilt, combine to form Space."

"Environment is related to the surroundings and all the conditions affecting life and human behaviour".

Chart B

NATURAL ENVIRONMENT TO BUILT ENVIRONMENT

Transformation of the Natural Environment into Built Environment by man for the purpose of:

- Urban and Rural Settlements
- Water and Sewerage Systems
- Transportation Systems
- Electrical Power Stations and Supply Systems
- Irrigation Systems
- Gardens, Parks
- Buildings to live, work and for other purposes and
- Quality of life to all

"Human beings are at the centre of concerns for Sustainable Development. They are entitled to a Healthy and Productive life in Harmony with the Nature".

Reo Declaration, 1992

Chart C

ENCROACHMENT ON NATURE BY BUILT ENVIRONMENT

Encroachment on Nature due to:

- Population growth
- Urbanisation
- Industrialisation

Effects of Encroachment on Nature:

- Depletion of resources
- Environmental Degradation
- Global warming
- Acid Rains
- Reduction in Forest area
- Pollution of air, water and soil
- Noise

Creation of Built Environment is the Integration of:

- Functional
- Psychological
- Climatic and
- Aesthetic Aspects

To please eye and mind with Sustainable Development.

Remember:

"We have got only One "Earth",
"So there is a new task, to understand the way the world works"…

Landscape Architect : Ian L McHarg

Chart D

BUILT ENVIRONMENT-EXPECTATIONS FROM URBAN AND RURAL SETTLEMENTS

- National parameter for progress
- Modern capitals of economic growth
- Growth of supply centres in rural regions to meet the demands of urban centres.
- Cities for all sections of the society
- Safer cities with quality of life and dignity
- Physiological, psychological and social conditions for health and well being for all.
- Health-Environment relationship
- Transportation system with safety-roads, ring roads, elevated railways, etc.
- Protection from fire, floods, earthquakes, subsidence, etc., by disaster management
- Reduction in the gap between demand and supply of urban and rural services
- Regional, urban and rural development
- Housing for all
- Town planning, architecture and landscape architecture are inter-related subjects.
- Good urbanisation makes money, bad urbanisation loses money.
- To control unauthorised construction.

Family in building, then, is the essence that underlines residential architecture. Through family, building becomes house and through family the house lives.

Author: Heinrich Engel
Book: *The Japanese House*

Chart E

EFFECTS OF POPULATION GROWTH AND RAPID URBANISATION

- Increase in poverty
- Increase in environment degradation
- Inhuman socio-economic conditions, insecurity and rising rate of crime, less use of public transport, streets and public spaces.
- Fire, industrial and natural hazards.
- Unemployment, homelessness, illiteracy, injustice and social disintegration
- Urban poor, not recognised and serviced by city authorities.
- Homelessness which affects privacy and family life.
- No formal access to finance and loan schemes for economically weaker section
- Growth in slum area, illegal constructions.
- Deprivation of women, their needs being different from men.

There has been an annual increase in population of 5 to 8 million in last 40 years. It is expected that by the year 2025,61% of the total population will be living in the cities whereas in 1947 only 20% population was urban.

It is said that:
"City should not boast by the number of beds in the hospital and number of hospitals in the city but the number of connections of potable water per thousand persons".

Chart F

SAFER SETTLEMENTS-URBAN AND RURAL

- For the the benefit of poorest of the poor.
- To transform present settlements into psychologically safe shelters, livable and sustainable with adequate housing for all with well maintained infrastructure.
- Use of innovations and affordable technologies on environmental conditions.
- Use of innovations and affordable technologies on environmental conditions.
- Use of cost-effective and environment friendly technologies.
- Inclusion of women, youth, elder persons, minorities in decision-making and management process.
- Uniting the divided city in different sections, religions, income groups, cast and professionals.
- To reduce the widening gap between demand and supply of all urban services, housing and social infrastructure.
- Human resources development related to urban and rural design, townscape, creation of urban forest, disaster management, maintenance and preservation, transportation and communication.
- Remote sensing technique to be used for preparation of maps, to know resources, forests, etc.
- Citizens should respect laws related to construction, cleanliness, during travel, while using vehicals on roads, garbage disposal and control of noise and pollution.
- Our cities will become more livable by law abiding citizens, its a measure of 'culture'.

"Our cities must be places where human beings lead fulfilling lives in dignity, safety, happiness and hope".

United Nations Conference on Human Settlements
(Habitat – II) Istanbul Declaration

Chart G

URBAN SPACE AND URBAN DESIGN

It deals with total space, built and unbuilt, along with buildings, roads, trees and plants, footpaths, advertisements, etc.

We need:

- Pleasing relationship of all
- Comfort
- Convenience
- Safety

with due consideration of Nature, Topography and Climate.

"Town should act as environmental filter number one".

"Town planning and landscape architecture is a long term investment".

" Town should act as psychological shelter".

"Rural housing and settlements need livable transformation so as to slop flow towards urban centres".

Chart H

DEVELOPMENT OF ARCHITECTURAL VISION AND AESTHETIC SENSITVITY

It is essential:

- To make human life possible.
- To create humanised space.
- To appeal to human mind.
- To create intimacy in the design.
- To create controlled space in all dimensions - lengths, width and height for human purpose.
- To create space with light and shade, line and contour, texture and colour.
- To connect room to room, exterior to interior through openings.
- To create feeling of safe space, void, for happiness and satisfaction for individual, his family and society.
- To develop space for the progress of mankind, arts, science and craft.
- To create space for physical convenience and ever-increasing psychological sensitivity of man.
- To create comfortable conditions considering Man's diminishing physical ability to resist climatic extremes.
- To understand laws of 'Nature' and develop love for 'Nature'.

It is stated that:

"Architecture is the art that creates space while other arts – sculpture, gardening, furniture, etc., occupies space".

Chart I

ELEMENTS OF ARCHITECTURE

Architect's basic task is to "shape" the "space' into appropriate and practical form through the arrangement of:

Space	• Universal	• Uncontrolled
Space in Buildings	• Utilitarian, Aesthetic and Architectural	• Captured and controlled human space, i.e., void
Plane and Curved surfaces to enclose the space	• Horizontal Planes • Vertical Planes • Inclined planes • Curved surface	• Floors and ceilings • Surface of walls • Surface of roof • Curved Walls, Domes, Shell roof, etc.
Openings	• Doorways • Windows • Archways	

"Space is the ultimate luxury, the one thing which can't be stolen from you".

Architect : Sir Terence Conran

Chart J

BUILDINGS

Building is not only a "SHELTER" but:

- It is Built Environment
- It is a Container of Activities
- It is an Environmental Filter
- It is a Land Value Changer

Expectations

- Energy Saving
- Efficiency Improving
- Environment Friendly
- Users Friendly
- Building can be defined as the three-dimensional shape or form in the space, resting on the earth, secured to the earth by foundation for stability.
- Building is an integrated object which consists of architectural space and stable structure for enclosing the space.
- Building should act as an Environmental Filter Number Two
- Building should be seen as an organic structure, rising from, and at-on-with the land. They should teach us how one can design and build, without despoiling the area.

"Tradition can be the starting point for creativity, but it must not be the point to which it returns".

Kazoo Shinohara
Japanese Architect

Chart K

CLASSIFICATION

Classification of buildings as per National Building Code of India SP: 7-1970.

1. Residential
2. Educational
3. Institutional
4. Assembly
5. Business
6. Mercantile
7. Industrial
8. Storage
9. Hazardous

Buildings are creations of architectural humanised space for functional and occupational comfort with livability. Steps in creation—

- Determining space as per function
- Shaping space
- Enclosing space
- Spanning space
- Enriching space for the purpose of expected utilisation with controllable comfort-to live, work, entertain and for leisure, with-
  - Interior Designing
  - Environmental services: plumbing and building services.
  - Indoor plants
  - Landscaping

It is said that:
"Man shapes his environment but he is also shaped by it".

Chart L

DIFFERENT STAGES IN THE LIFE OF BUILDINGS

Planning: Decides the initial form

Designing: Decides the final form

Drawing: Tool to convert requirements into reality.

Construction: Conversion of two-dimensional drawings into three-dimensional structure. It is engineering in action, hence, needs Construction Management.

Occupation: Environmental Design Evaluation is essential after occupation to assess achievements in planning, designing and construction by observing behaviour of user and by obtaining user's views.

Maintenance and Preservation: Preparation of maintenance programme to maintain livability throughout the life of the building by observing effect of Sun, Rain, Wind and Human Behaviour on building materials and construction.

"Construction in building demonstrates architectural growth in its transformation and evolution. Architecture began with purposeful construction of human shelter and developed in direct interdependence with technical development".

Author: Heinrich Engel
Book: *The Japanese House*

Chart M

SPACE-FORM-STRUCTURE

Space: Built Environment should not exhaust us, it should renew life with Enthusiasm and support the regeneration of the body and soul.

Form: The form of the Building arises from human purposes.

- Form is the product of the Space requirements and floor pattern of the required space units for different activities.
- Form showing awareness of relationship of architecture to culture, climate and life style of user is the real expectation.

Structure: It is the construction, essential to create and maintain the desired form and support the elements of the space enclosure-RCC framework with substructure and superstructure, walls, doors, windows, etc.

Types: Minimal, Adequate, Sculptural, Pretentious.

Axonometric, perspective views and model shows the final form with site planning along with buildings and surroundings – roads, entrance and landscaping.

"Architecture is defined as a performing art, it is for the performance of the man".

Architect: James Andrews

Chart N

STRUCTURAL ENGINEERING

Structural Engineering deals with the effects of

1. Gravity
2. Vibration
3. Wind
4. Water
5. Temperature and
6. Earthquakes

Needs

1. Good Practice
2. Robustness
3. Ductility
4. Durability
5. Stability
6. Strength and
7. Stiffness or Flexibility

And analysis as per the

1. Requirements of Plan and Form
2. Soil Investigation Report
3. Gravity Load Systems
4. Necessity of Lateral Stiffening Elements
5. Study of IS code

"Structural Engineering is a form finalising exercise".

"Skill and Art in structural engineering stems from the conceptual design which complements the architecture and brings it to completeness".

Denis J McMullan
Consulting Engineer

Chart O

DESIGN OF BUILDING

- Design means DE-SIGNING, making out the building, i.e., physique of space.
- To decide space forming and occupying elements.
- It DE-SIGNS, SPACE-FORM-CONSTRUCTION, i.e., idea of building.
- It translates architectural conception into material form.
- Design provides firmness-commodity and delight.
- Design in building is the creative process of intellectually developing the building to give and establish artistic unity and to tie the building to the realities of the locality and time.
- Designer should take into consideration practicality - to link the design to IS code and standards, materials, components in the market and the workmanship as per standard specifications.
- Computer aided planning, designing, drawing, estimating is a tool to save time and energy of the designer.

Measure in building is the order that controls the scale, proportion, and form of the building. It relates the parts to the whole and in turn makes the whole dependent on its part.

Author: Heinrich Engel
Book: *The Japanese House*

Chart P

DESIGN OF ENVIRONMENTAL SYSTEMS

1. Water supply and drainage system
2. Fire safety system
3. Electrical and lighting system
4. Heating and air conditioning system
5. Acoustics and noise control
6. Communications
7. Solar system for heating and lighting
8. Specific services for intelligent buildings
    - Functional needs to be translated into design decisions.
    - Designed to function as per expected standards.
    - To be co-ordinated with building's structural system.
    - It is an integrated approach of all concerned professionals/consultants.
    - Interior designers are concerned with the appearance of elements for visual quality of space, air diffusers, switch plates, lighting and plumbing fixtures.

Check for Total Design by an Architect

Co-ordination of all working drawings, specifications, estimates related to designs of various consultants.

Chart Q

BUILDING SERVICES FOR INTELLIGENT BUILDINGS

Planning for Productivity

- Reduction in the cost of building services, construction and maintenance.
- Optimum utilisation of space
- Functional efficiency of buildings. Trouble free functioning and ease in maintenance.

Productivity depends on

- Management
- Job satisfaction
- Income
- Status
- Time spent in Buildings
- Internal refreshing environment with comforts
- Trouble free working of men and machine avoiding health hazards
- Security to data and records.

Comfort Factors

- Good controlled lighting
- Comfortable furniture
- Good circulation of air at the right temperature
- Reference materials within easy reach

Intelligent building is planned and constructed for assured performance of the work place based on the tools of information technology.

Chart R

BUILDING INTELLIGENCE

Dimensions of Building Intelligence

- Office Automation
- Advanced Telecommunications
- Building Automation: for building management, security, powersupply, fire protection, energy conservation.
- Building to know what is happening inside and immediately outside environmental changes.
- Building to devise a system for a convenient, comfortable and productive environment for the user.
- Integrated approach in planning by the architect, building services, and hardware Engineers specialised in office and building automation.
- System design and performance-temperature, humidity, illumination, air-quality, distribution and circulation, acoustics.
- Work stations to fulfil human needs in an office-anthropometric, sensory, social, privacy, territory and status.
- Integration of various systems, voice and data communications and other building functions.
- Effective management of resources, in a co-ordinated mode, to maximise occupant's performance, investment and operating cost savings and flexibility.

Chart S

EVALUATION OF BUILDINGS

- Analysis of elements for balanced architectural creation.
- Environmental design evaluation after occupation by the user.

Function

- According to the classification of buildings and principles of planning
- Use of interior, exterior space and openings
- Plumbing and building services with energy conservation
- Access points
- Provision for future expansion if any.

Appearance

- Shape
- Proportion and projections
- Openings: solids and voids
- Design of fenestration
- Choice of materials for external and internal finish
- Texture and colour of material
- Size and shape of the building to blend with its site and surroundings
- Aesthetic conceptions

Durability

- Livability
- Foundation
- Plinth protection
- Specifications and workmanship for wear, damp proofing
- Water proofing of terrace, toilets, etc.
- Schedule for standard maintenance.

Total Cost

- Cost of land, development and construction
- Cost of Plumbing and Building Services
- Cost of Interior Designing, Landscaping
- Fees for Professionals, etc.
- Estimate for yearly maintenance

Chart T

MAN

"Man as a species has a particularly acute need of stimuli from his surroundings".

Author: Desmond Morris
Book: *Human Zoo*

Surroundings

Environment can be stimulating in the following ways:

Physical

Nature, world of inspiring design and colours to refresh man. Settlements and buildings with essential amenities for welfare and growth.

Social

Different systems for welfare and growth.

Inspiring and Motivating

To stimulate man to learn and strive hard for development of self, society and nation. History, Literature, Arts, Research, Education - all help to create love for the subject and profession.

"Modern ecology sees man simply as a part of the nature".

Five arts for Man's Welfare

1. Painting
2. Music
3. Dance
4. Sculpture
5. Architecture

Principles stated by Stapathy for the above arts:

1. Sukhadarshanam — सुखदर्शनम्
2. Ramyam — रम्यम्
3. Bhogodhayam — भोगोद्यम्

DEVELOPMENT CONTROL RULES FOR DEVELOPMENT PLAN OF THE MUNICIPAL CORPORATION AREA

Suggestions based on views expressed by Architects, Promoters and Builders.

Development rules and regulations along with building bye-laws should be simple, easy to understand and interpret, should be practical and uniform. Minimum waste of time during the preparation of the scheme, its sanction and completion should be kept in mind while finalising these rules. Owner should know what is permissible and what is illegal to avoid waste of money and material due to demolition of illegal construction work. The booklet containing the rules should be published by authorities both in English and in regional languages also. Skills of an architect is at test while preparing the plans within the rule. It is learnt that some corporations are accepting the proposals in a green file submitted by the architect for sanction within a week as submission in green file assures the full responsibility regarding rules and regulations is accepted by the architect as well as structural stability of the design done by the structural designer is assured by the structural designer. This system should be encouraged by all municipal corporations to avoid delay in the sanction of the proposal.

The booklet needs clarification with reference to:

1. Development of land—size of plots, open areas, width of roads, rules for tree plantation, water supply and drainage systems, etc.
2. Separate rules for residential buildings for different size of plots.
3. Rules for ownership flats and apartments.
4. Rules for ownership flats, complex with shopping, swimming pool, club house, etc. and Rules for Townships. and Resorts.
5. Rules for public buildings for different types of occupancy.
   Rules for 2 to 5 should give detailed information for—FAR, Height, Built up area, marginal distances, set back, number of tenements, minimum area of room, head room, staircase area, and rise, trade, width for the stairs, water supply and drainage system, tree plantation, parking areas, mezzanine floor, permissible architectural projections, balconies, canopies, etc., Eco-Friendly construction and Assessment, Rebate on property tax.
6. Rules for submission of structural stability design; Earthquake design considerations.
7. Rules for fire safety.
8. Standards for lifts.
9. Rules for transferable development rights.
10. Rules for standards of materials as per ISI Mark.
11. Zoning regulations and rules for different types of buildings in different zones.
12. Rules for parking areas in different types of buildings.
13. Definitions of various technical terms related to the buildings, building permission, commencement and completion certificate procedure, qualifications of architects, engineers, structural engineers and promoters and builders.
14. Rules for structural modifications for interior designing work responsibility of owner, architect and the structural designer along with municipal supervisors/engineers.
15. Rules for maintenance of campus, society premises, building structures, plumbing and building services, trees and gardens.

Self-explanatory booklet should create confidence in the minds of all owners, users and all professionals responsible for creating built environment. Such booklet may need revision periodically according to the experience of the authorities. Revised booklet with modifications is the necessity for the development with speed and safety.

APPENDIX IV

ADDRESSES OF PROFESSIONALS

Urban Designers

1.	Shri Sanjay Puri, Architect	20, Famous Studio Lane, Opp. Star TV off Dr. E. Moses Rd. Mahalaxmi (W), Mumbai 400 011.
2.	Paranjape Schemes. Flagship Infrastructure (P) Ltd. Website: *www.blueridge.in*	Blue Ridge, Near Cognizant, Rajiv Gandhi, Infotech Park, Phase 1. Hinjewadi, Pune 411057.

Architects/Promoters and Builders/Consultants

1.	Shri Laxman Thite, Architect	18, Shivaji Nagar, Opp. S.T. Bus Stand, Exit Gate, Pune, 411005.
2.	Shri Vishwas Kulkarni Architect Website: www.vkarch.com	5, Agarkar Bhavan, Lal Bahaddur Shastri Road, Navi Peth, Pune, 411030
3.	Shri Vikas Bhandari, Architect	Gokul Nagar, Fergusson College Road, 1184, Shivajinagar, Pune, 411005.
4.	Beri-Architects and Engineers Pvt. Ltd. Shri Pramod Beri	Gumpha, Tarabai Park, Kolhapur, 416 003
5.	Shri Ravi Gadre, Architect	'Rutu', Plot No. 23, Mandar Co. Op. Hsg. Soc. Sahakarnagar No. 1 (Near Padmavati Temple) Pune, 411 009.
6.	Shri Kiran Kalamdani and Mrs. Anjali Kalamdani Architect, Valuer, Urban, Designer.	Flat No. 1-C1 Building Shantiban, Chinchwad, Pune, 411033.
7.	Shri Ram Paradkar Architects and Interior Designers	4, Laxmi Park Colony, LB Shastri Road, Near IDBI Bank Pune 411 030
8.	Shri Amar Manjrekar Amar Builders	Amar House, 892, Bhandarkar Road, Goodluck Chowk, Pune 411004
9.	Shri M B Chaudhari and Associates Architects, Interior Designers and Consultants	301, Laxmivihar Society, 892, Bhandarkar Road, Behind Amar House, Pune 411004.
10.	Subhash Shah and Associates Architects Pvt. Ltd.	1/3, Kumar City, Kalyani Nagar, Pune 411014
11.	Shri Raju Mahagaonkar Architects, Planners and Interior Designers	204, Om Chambers, Jangli Maharaj Road, 711, Shivajinagar-Pune 411 005.
12.	Shri Arun Kaduskar, Architect	183, Somwar Peth, Pune 411011
13.	Shri Sunil Bhosale "Sankalp" Architectural and Environmental Design	26/343, Netaji Nagar Wanwari, Pune 411 040
14.	Shri R B Nagpal Nagpal Consultants Pvt. Ltd. Architects, Engineers and Industrial Consultants.	Kanchanjunga RTO Road, Aurangabad, 431005.
15.	Shri D V Divekar Chartered Engineer, Approved Valuer	Flat No 401 + 404 Patar Complex, above Saraswat Bank Samarth Path, Karve Nagar Pune 411 052.
16.	Shri Anand Joshi S N Joshi Consultants Pvt. Ltd.	CTS 1869, FP 47/1, 2(a) Near Sakhar Sankul, Narveer Tanajiwadi, Shivajinagar, Pune 411005
17.	M/s Shamkant Kotkar	Nandan Buildcon Pvt. Ltd. 82/2, Erandvane, Prabhat Road, Pune 411004
18.	Shri Adil Kapuswala, Architect	AEC-PAD Studio G-15, Supermall Salunke Vihar Road, Vanawri-Pune 411040
19.	Dr. OmPrakash G Kulkarni	4, Malini Gardens, Near Sumangal Medicals, Opp. Tel. Exchange Canada Corner, Nashik, 422 002
20.	Global Green Energy and Sustainability Solutions Pvt. Ltd. Shri Santosh Padmanabhan Website:_*www.environment.ae*	Oscan House 203/4, Winner Court, Lulla Nagar Junction Ext. M.G. Road, Pune 411040

21.	Airobix Packaged Sewage Treatment and Recycle Plant Website: www.airobix.net	Jalshree Corporation 12-1467, Sadashiv Peth Pune 411030

Landscape Architects

1.	Mrs. Shobha Bhopatkar Architects and Landscape Designers	1202/17 E Dream Presidency, Behind Santosh Bakri Apte Road, Shivajinagar Pune 411005.
2.	Shri Jayant Dharap "Forethought" Design Consultants.	Ravi Building First Floor, Near Alka Talkies, Pune 411 030
3.	Shri Pradeep Devarchetti Landscape Architect "The Span Group"	15, Ganeshdarshan, 24/11, Shivajinagar, Pune 411005

Structural Designers

1.	Shri Yo So Sane J + W Consultants, formerly YS Sane Associates	Sneh classic Near Padalkar Hospital Erandwane, Pune 411004
2.	Late Shri Ro No Bhat	33/8 Shramsaphalya, Apartments Prabhat Road, Pune 411004
3.	Shri V V Ruikar Ruikar and Associates Consulting Engineers and Structural Designers	11, Bhosale Heights, FC Road Pune 411005
4.	Shri C E Godse Chartered Structural Engineer	Vinayak Smriti 114 A, Prabhat Road, Pune 411004.
5.	Shri D V Dake Construction Catalysers Space Structure Consultants	"Vedh" 484/37 Mitramandal Colony, Parvati, Pune 411009
6.	Shri Kishor P Jain Consulting Structural Engineer	Mahavir Darshan Complex Timber Market Road Office No. 9, near Jain Temple Pune 411042
7.	Shri Edsel Pereira Octamec Engineering Ltd. Website: *www.octamec.com* E-mail-*info@octamec.com*	Octamec House, 18, Subhash Road, Vile Parle (East) Mumbai 400057, India
8.	Shri Gandhi Tayoun Managing Director Website: *www.zamilsteel.com* Email-*zsIndiaMarketing@zamilsteel.com*	Zamil Steel Office No. 101, 1st Floor, A1-Monte, Software Park, Plot No. 2. S. No. 8 Kharadai, Pune-411014
9.	Er. Abhijeet P. Kale Lloyd Insulations (India) Ltd. E-mail-*lloydinsul@vsnl.com*	386, Veer Savarkar Marg, Prabhadevi, Mumbai 400 025

Interior Designers

1.	Shri Vivek Patki Patsons-Engineers, Interior Designers	12/46, Ajantha Society, Durganagar Off. S.B. Road Model Colony, Pune 411016
2.	Kitchen Grace (1) Pvt. Ltd. Shri Snehal Vasani-Architect	Gat No. 116, Village Dhanore Alandi Markal Road, Taluka-Khed Dist. Pune 412 105.

Computer Software

1.	Shri Nevgi Newton Computers	A-2, Meenal Apartment Nalstop, Erandwana, Karve Road, Pune-411004
2.	Ensoft Consultants	C-509, Bhaveshwar Plaza, L.B.S. Marg, Ghatkopar (W) Mumbai, 400086
3.	Shri Vinay Kasture "Kanix"	'Yashashri' Apts. Lane No. 3, Bhandarkar Road, Deccan Gymkhana, Pune 411004
4.	Shri Chandrashekar Chougule CalQuan.com India Website: www.calQuan.com	CalQuan India C-7, Anant Smruti, 127, Katraj, Pune-411046
5.	Shri Ganesh Chafekar Director Website: *www.edss.co.in*	EDSS- 8/12, Kedar Empire, 2nd Floor, S. No, 42 A/1A/2Y, S. No. 179 Near Dashbhuja Ganpati, Karve Road, Erandwane, Pune 411004
6.	Shri Deepak Warad GM Marketing Website: *www.softtech-engr.com*	SoftTech. The Pentagon, Unit No. 5A, 5th Floor Next to Pune Satara Road, Telephone Exchange, Pune 411 009
7.	Mr. Nirmalya Chatterjee Head-Business Process and Operations Website: *www.tekla.com*	TEKLA India Pvt Ltd. Unit No: 106, Building No. 3 Millennium Business Park, Sector 3 Mahape, Navi Mumbai, 400 710
8.	Shri Neelesh B. Zende Email: *cadsense@india.com*	CADSense Technologies Gurukrupa, Laxmi Colony, Vitthal Nagar, Nr. Kotawal's Girls Highschool, Hadapsar Pune 411028
9.	Neil Automation Technology Ltd. Infrastructure Software Division	30, Shivaji Nagar, KB Joshi Road Opp. Krishi Bhawan, Pune 411005
10.	Datapro Infoworld Limited	Datapro House 2/32/1, B1, Erandawane Pune 411004
11.	Autodesk-Total CAD solution	B-5, Akshay Apartments Opp. Vishal Cinema Hall Pimpri Chowk, Mumbai Pune Road Pimpri-Pune 411018

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