1
Drawing Standards & Planning Principles

Before starting for drawing, students should know some standards and drawing office practices which are followed in different Civil Engineering Departments of our country.

Clauses, tables and figures on pages 1 to 4 are being reproduced with the permission of I.S.I. from I.S. 962 : 1967 ("Indian Standard Code of Practice for Architectural and Building Drawings") so that the students may be familiar with the drawing standards and practices.

Layout of Drawings

The layout of drawings shall be such as to facilitate the reading of drawing and make it possible for essential reference to be located easily, especially when drawings are presented by several offices. The standard arrangements shall include all relevant informations and sufficient margins shall be left from the edges of finished drawings to facilitate filing and binding whose prints are taken from the original drawings by photographic process, an indication shall be given of this method of reproduction by inserting the word photographic" below the border line at the bottom right hand corner.

Title Block

The title block is an important feature in a drawing since it facilitates obtaining uniformity and present details like title of drawing, name of organisation or firm, drawing number, scale, date of drawing etc. in a definite manner. The title block shall be placed at bottom right-hand corner of the sheet where it is readily seen when the prints are folded as indicated in Fig. 1.1.

Size of Title Block

The size of the title block shall be 150 × 100 mm for A_1 (840 × 594 mm drawing sheet) size. Typical layout of the title block is illustrated in Fig. 1.2.

Additional Informations

Where appropriate additional informations and notes on the following items may be included to make drawings complete and self contained as far as possible.

Material List

This shall be immediately above the title block and may include such items as schedule of reinforcements, quantity required etc.

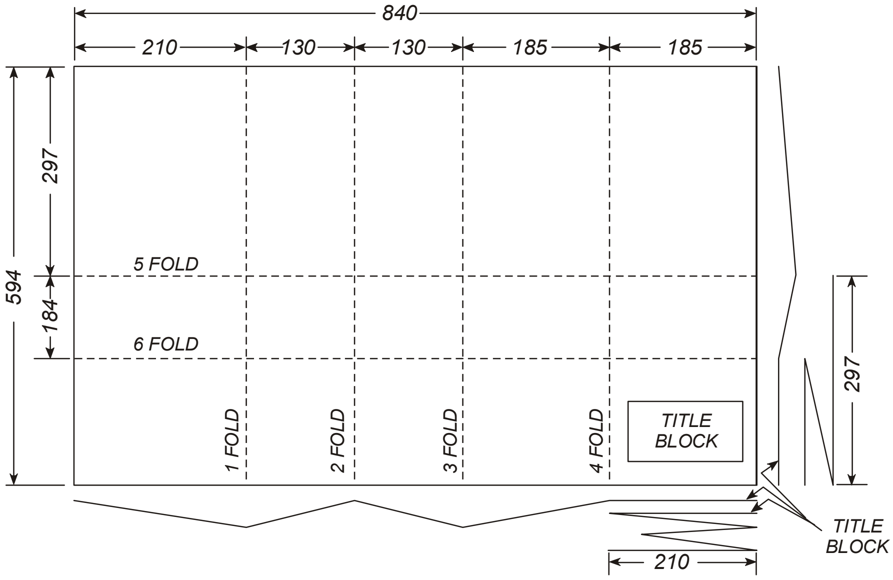


Fig. 1.1

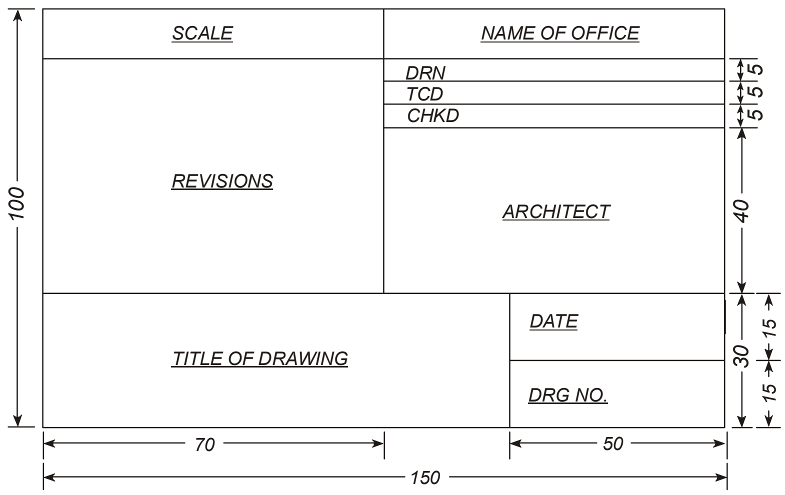


Fig. 1.2.

North Point

North point shall be clearly indicated. In cases where it may be necessary to make rough bearings from the north point, a suitable type shall be used in which the north point is placed in relation to the site plan or ground plan so that the bearing may be readily transferred. North point shall preferably be drawn on the right-hand top corner of the drawing. Specimens of north point are illustrated in Fig. 1.3. It is recommended wherever practicable, plans shall be drawn with north in the direction of the top of the sheet. The same orientation shall be adopted in all the drawings for a particular job.

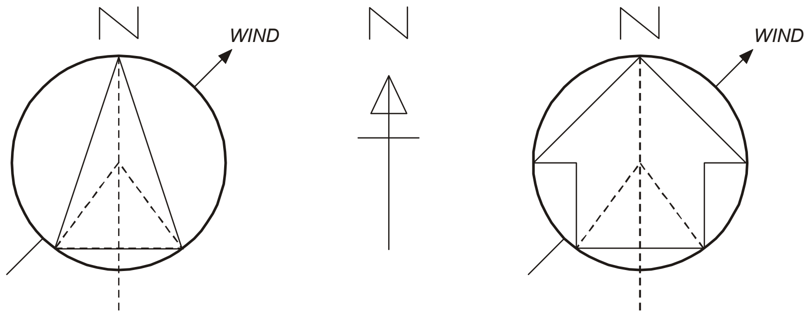


Fig. 1.3.

Scale Indications

The scale of drawings shall be indicated in the appropriate place in the title block. If more than one details drawn to different scales occur on a sheet, the corresponding scale shall be shown under each relevant detail. Typical methods of expressing numerical scales on drawings are as follow :

1 cm = 10 metres or 1 : 1000 (more in practice)

1 cm = 2.5 km or $\frac{1}{250000}$ Metric scales for architectural and building drawing shall preferably be as follows :

Working Drawings, Plans, Elevation and Sections

1 : 200 1 : 100 1 : 50

Large scale Drawing–General Details

1 : 20 1 : 10

Lines of Drawings

Centre Lines. Centre lines shall project for a short distance beyond the outline to which they refer but where necessary to aid dimensioning or to correlated views, they shall be suitably extended so that the dimension figures are clear of the drawing outlines. Alternate lines and short lines shall have a proportion ranging from 6 : 1 to 4 : 1 closely and evenly spaced but in any one drawing the ratio once adopted shall be maintained.

Hidden Outlines. The lines, consisting of short dashes, closely and evenly spaced, should be used to represent hidden lines and materials to be removed.

Table Showing Different Lines

Uses	*Illustration*	*Description*
Outline of parts	0.6, 0.8 and 1.0 mm (thick)	The outline to be outstanding in the drawing.
Dimension extension construction and hatching line.	0.2 and 0.3 mm (thin)	For hatching, lines to be spaced evenly to make a shaded effect.
Hidden Lines	0.4 and 0.5 mm (medium)	Short dashes, closely and evenly spaced.

Centre Lines	0.2 and 0.3 mm (thin)	Alternate long and short dashes in proportion ranging from 6 : 1 to 4 : 1 closely and evenly spaced in any one drawing : the ratio selected should be maintained.
Cutting Plane Lines	0.6, 0.8 and 1.0 mm (thick)	One long and two short dashes alternately “and evenly spaced.
Break Lines for Short Break	0.6, 0.8 and 10 mm (thick)	Free hand lines.
Break Lines for Long Break	0.2 and 0.3 mm (thin)	Ruled lines and free hand zig-zags.

Dimension, Extension and Hatching Lines

Dimension, extension and hatching lines shall be thin full lines so as to contrast with the heavier outlines of the drawings and should be placed outside the figure wherever possible. Extension lines shall start a little away from the outline and extend a little beyond the dimension line. Hatching lines be spaced evenly to give a shaded effect.

Lettering

Lettering shall 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 shall be so written as to be read when viewed from the right-hand edge of the drawing.

Size of letters and numerals for drawings

Purpose	*Size of Letters and Numerals (mm)*				
Main title and drawing number	6	8	10	&	12
Sub-title and heading	3	5	&	6	
Notes, such as legends, schedules, materials and dimensions.	3	4	&	5	

Dimensioning

Arrow heads or dots as shown in Fig. 1.4 are used to terminate, dimension lines, the **length of arrow head is about three times the depth.** The space in arrow head should be filled in. When dot is used it should be placed at the intersection of the extension line and dimension line.

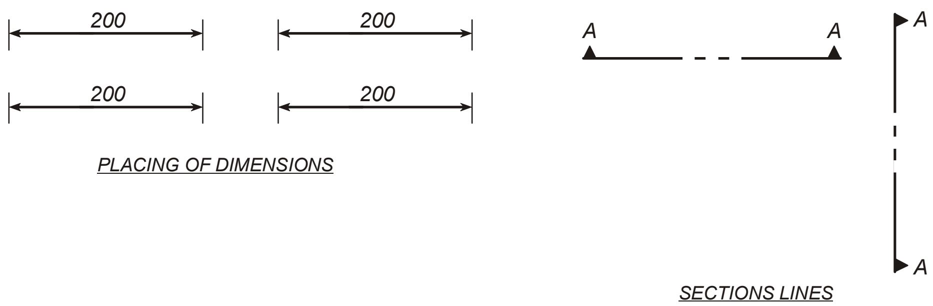


Fig. 1.4.

The dimension figures shall be placed near the centre either in the space of the broken line or immediately above the unbroken line. All dimensions should be so arranged that they may be read either from the bottom or right-hand edge of the drawing.

Units of Dimensioning

"Dimensioning shall be done normally in millimetres".

The symbol for the unit mm., may be omitted provided that a prominent note is added stating the unit in which all the dimensions of the drawing are expressed. In case other units of dimensions are used "these shall be denoted by specific notations.

GUIDELINES FOR BUILDING DRAWING

The main aim of building drawing is to give sufficient informations by the designer to the construction engineer. In order to give sufficient informations about the building following views are generally drawn. (*a*) Plan, (*b*) Elevation, (*c*) Section along any particular plane or several planes.

(*a*) **Plan.** Plan drawn in building drawings is not simply the top plan seen from the top of the building.

The building is imagined to be cut by a horizontal plane at the sill of the window. The upper portion is removed. Now building is seen from top. A projection of the remaining portion on a horizontal plane below the building will be known as plan.

Let us take a small room as shown in Fig. 1. of Plate No. 1.1. For taking plan, the room has been cut by a horizontal plane *EF* as shown in the Fig. 2. Now portion of the room above the plane *EF* has been removed. The remaining portion of the room is shown in part *B* of Fig. 4. The remaining portion *B* of Fig. 4 is seen from top and we get projection on a horizontal plane as shown in part *C* of Fig. 4. The part *C* of Fig. 4 is properly oriented and we get the plan of the room as seen in part 1 of Fig. 6.

(*b*) **Elevation.** Generally front elevation is drawn but in some cases side elevation is also drawn. For drawing front elevation of the building imagine to stand in front of it. Whatever portion of the building is visible above ground level, take its **first angle projection** on a vertical plane behind the building. It will be elevation of the building. Front Elevation of the room shown in Fig. 1 has been shown in part 2 of Fig. 6.

(*c*) **Section.** The building is cut by a vertical plane as shown in Fig. 3 of Plate No. 1.1. The room is being cut by a vertical plane *XY*. Its representation in plan has been given in part 1 of Fig. 6 by line *XY*. Arrow is given towards the direction in which details is required. When the building has been cut by the vertical plane *XY*, the part of the building on rear portion of the arrow is removed as in Fig. 5. Now standing in front of remaining part (as shown in Fig. 1.5) projection is taken on a vertical plane behind the building. The product will be sectional elevation of the building as shown in part 3 of Fig. 6. The sectional view of a building along a plane is taken to furnish details of the work to be executed such as details of foundation (width, depth and number of footings), height of building, doors, windows, thickness of lintels and beams, position of ventilators, cup-boards and details of flooring etc. Names of different components of the building have been given in part 3 of Fig. 6. Students are generally required to draw plan, elevation and section at a particular sectional plane as shown in Fig. 6.

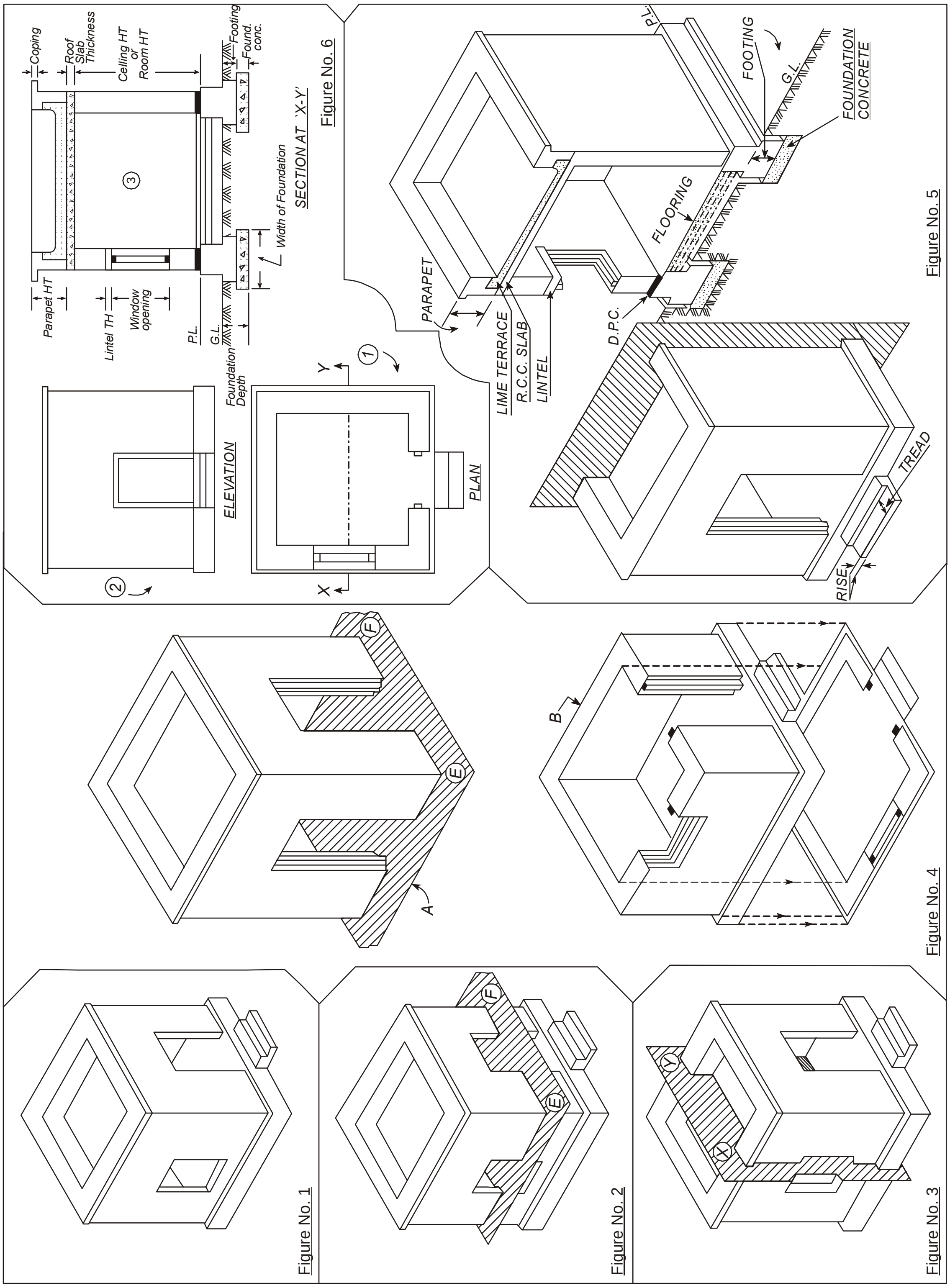


Figure No. 1
Figure No. 2
Figure No. 3
Figure No. 4
Figure No. 5
Figure No. 6
A
B
E
F
X
Y
ELEVATION
PLAN
SECTION AT 'X-Y'
Coping
Roof Slab Thickness
Ceiling HT or Room HT
Footing
Found. conc.
Parapet HT
Lintel TH
Window opening
P.L.
G.L.
Foundation Depth
Width of Foundation
PARAPET
LIME TERRACE
R.C.C. SLAB
LINTEL
D.P.C.
FLOORING
FOOTING
FOUNDATION CONCRETE
TREAD
RISE

PLATE NO.1.1

DEFINITIONS OF ITEMS USED IN BUILDING CONSTRUCTION

Balcony. A horizontal projection, cantilevered or otherwise including a parapet handrail to serve as a passage or sit out place.

Basement or Cellar. The lower story of building, below or partly below the ground level with one or more than one levels.

Building Height. The vertical distance measured.

(*i*) In case of flat roofs from the average level of the front road and continuous to the highest point of the building.

(*ii*) In case of pitched roofs upto the point where the external surface of the outer walls intersects the finished surface of the sloping roof.

Building Line. The line upto which the plinth of building adjoining a street or an extension of a street may lawfully extend and includes the lines prescribed. The building line may change from time to time as decided by the Authority.

Canopy. Means a cantilevered projection from the face of the wall over an entry to the building at the lintel a slab level provided.

(*i*) It shall not project beyond the plot line .

(*ii*) It shall not be lower than 2.3 m (7′–6′′) which measured from ground.

(*iii*) There shall be no structure on it and the top shall remain open to sky.

Carpet Area. The covered area of the usable rooms of dwelling unit/at any floor excluding the area of the walls.

Chajja. A sloping of horizontal structural overhanging provided over opening on external walls for protection from rain and sun. (Weather)

Cornice. A sloping or horizontal structural overhang usually provided over openings or external walls to provide protection from sun and rain.

Courtyard. A space permanently open to sky, enclosed fully or partially by buildings and may be at ground level or any other level within or adjacent to a building .

Covered Area. The ground area covered immediately above the plinth level covered by the building but not included by garden, compound wall, gate canopy and area covered by chajja.

Damp Proof Course. A course consisting of some appropriate water proofing material provided to prevent penetration of dampness and moisture.

Floor Area Ratio (FAR). The quotient obtained by dividing the combined covered area (plinth area) of all floors, excepting areas specifically exempted under these regulations, by total area of the plot and multiplying quotient 100.

$$\text{FAR} = \frac{\text{Total covered area on all floors}}{\text{Plot area}} \times 100$$

Table : Building Control in Residential Premises

Sl. No.	*Plot Area (Sqm.)*	*Max. ground coverage (%)*	*FAR*	*No. of dwelling units*	*Max. Height (M)*
1	30	75	150	1	8
2	30 - 50	75	150	2	8
3	Above 50 to 100	65	180	3	12
4	Above 100 to 250	65	180	3	12
5	Above 250 to 500	55	165	6	15
6	Above 500 to 1000	45	120	8	15
7	Above 1000 to 1500	40	100	8	15
8	Above 1500 to 3000	33.5	100	12	15

Foundation. A substructure supporting an arrangement of columns or walls in a row or rows transmitting the load to the soil.

Footing. A foundation unit constructed in brickwork, stone masonry or concrete under the base of a wall or column for purpose of distributing the load to a larger area.

Ledge and Tand. A self like projection, supported in any manner whatsoever except by means of vertical supports within a room itself but not having projection wider than 1 m.

Mezzanine Floor. An intermediate floor between two floors of any storey forming an integral part of floor below.

Parapet. A low wall built along the edge of roof or a floor.

Plinth. The portion of a building between the surface of the surrounding ground and surface of the floor immediately above the ground. The height of plinth shall not be less than 450 mm from the surrounding ground level.

Plinth Area. The built up covered area measured at the floor level of the basement or any story.

Porch. A covered surface supported on pillars or otherwise for the purpose of a pedestrian or vehicular approach to a building.

Road/Street Level a Grade. The officially established elevation a grade of the centre line of street upon which a plot fronts and if there is no officially established grade, the existing grade of street at its mid-point.

Row Housing . A row of houses with only front, rear and interior open spaces.

Room Height. The vertical distance measured from the finished floor surface to the finished ceiling surface. The height of rooms is not be less than 2.75 m.

Set-back Line. A line usually parallel to plot boundaries or centre line of a road and laid down in each case by the Authority.

Site Depth. The mean horizontal distance between the front and rear site boundaries.

Verandah. A covered area with at least one side open to the outside with the exception of high parapet on the upper floors to the provided on the open side.

Water Closet (W.C.). A water flushed plumbing fixture designed to receive human excrement directly from the user of the fixture.

Window. An opening to the outside other than door, which provides all or part of the required natural light or Ventilation or both to an interior space.

Maximum Height of a Building. As a general rule maximum height of a building shall not exceed 1.5 times the width of road.

Size of Rooms. The area of habitable rooms should not be less than 9.5 m^2 having minimum width of 2.4 m if only one room is there. Where there are two rooms one of these shall not be less than 9.5 m^2 and the other not less than 7.5 m^2 with minimum width of 2.1 m .

GENERAL CONVENTIONS FOR SHOWING DIFFERENT MATERIALS IN SECTIONS

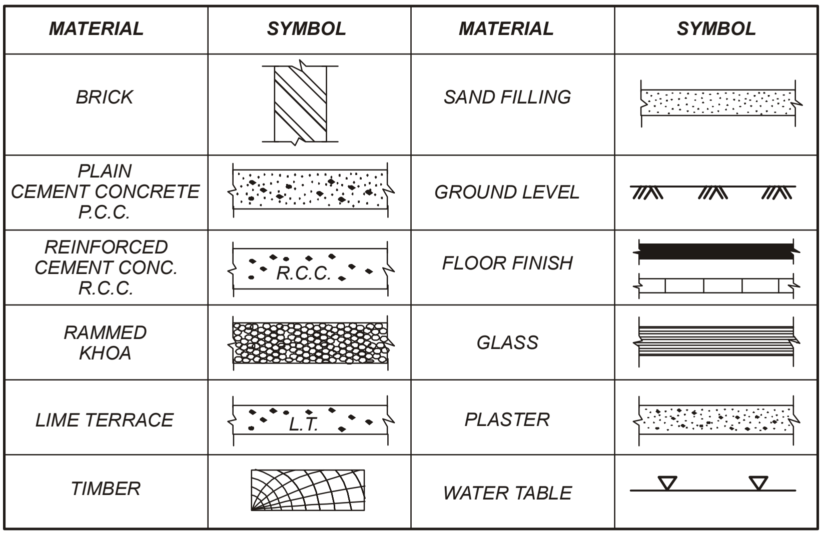


Fig. 1.5.

PLANNING PRINCIPLES

PLANNING A HOUSE

For planning a house there may be two cases :

(*a*)Fund is unlimited and the planning is done as per requirements.

(*b*)Fund is limited and within the limited fund requirements of owner has to be met.

Next to the cost, the planned house can be classified in two categories :

(*a*) *Government Quarters*–In which depending upon the status of the employee the planning is done.

(*b*) *Private House*–In which the owner's requirements have to be met within his available resources.

The planning should be functional planning which means designing a house on function or requirements and not on some traditional style.

While planning following points should be kept in mind :

(*i*) A double storeyed building providing same floor area that of a single storey is cheaper by about 15% to 20%.

(*ii*) A square plan is cheaper than oblong. The area occupied by walls of a square building may be 15% to 25% less than a rectangular plan.

(*iii*) A square plan makes a house compact. It makes the house cooler in summer season and warmer in winter season since less walls are exposed. Hence a square plan is always preferred.

ORIENTATION

When the site and requirements of a house have been finalised, the next step is orientation of the house which means fixing the direction of the building in such a way that it derives maximum benefit from the sun, air and nature. We know that man's health and happiness are influenced directly by his environment. Faulty housing conditions cause poor health and spread of various types of diseases. Resistance to disease may be increased by living in fresh air and exposing the body to sunshine. Proper orientation of a house increases fresh air and sunshine in the house and decrease possibility of direct infection.

Sunlight is one of the most important aids to health. It furnishes illumination which helps in cleanliness, prevents accidents and facilitates good vision. It kills micro-organisms, being one of the most effective bacterial agents. It also causes beneficial chemical changes in the skin and blood and acts as a general tonic to health. Good sunlight also promotes cheer and sense of well being.

But sunshine inside a house is desirable till it keeps inner surrounding of the room comfortable. When a room starts becoming warmer the heat has to be reduced without the reduction in light and closing the windows.

Before discussing the methods of above control a knowledge of mechanics of the sun's movement and location of the place on earth's surface is necessary. For example if a place lies between 5° latitude of Equator the region will be equatorial with high temperature and heavy rainfall. Similarly if a place lies between 23½° to 30° latitude, the region is tropical having high temperature and less rainfall, between 30° to 40° latitude a warm temperature region with moderate temperature and rainfall, between 40° to 66½° latitude—a cool temperature region with moderate temperature and rainfall and above 66½° latitude—the polar region with low temperature and snow falls. In cool temperature regions the sun light is required to stay for more time and the glass area has to be kept about 15% of the floor area. But for tropical or warm temperature region if sun rays stay even for a shorter period (about half an hour) it is sufficient to kill the micro-organism.

If the place lies in hot zone it is better to place shorter walls facing East-West. In this case less heat will be absorbed by the walls. But walls will receive more heat if longer walls are facing East-West direction as shown in Fig. 1.6.

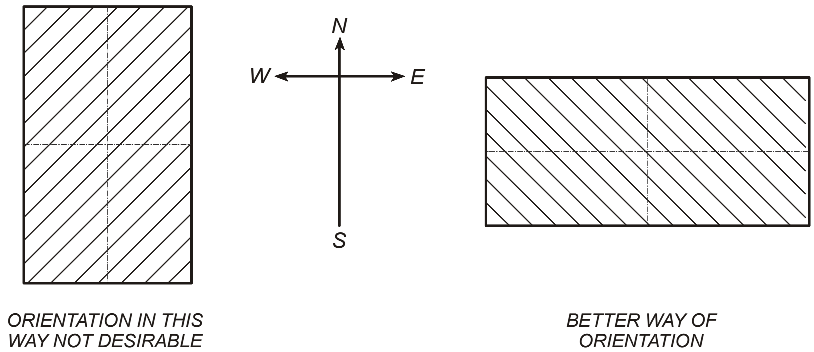


Fig. 1.6.

If the place is situated in cold zone the house has to be oriented in such a way, that it gets sun rays for maximum period of the day. In this case if the longer axis of the building makes 30° with East-West direction it receives sun heat for maximum duration as shown in the Fig. 1.7.

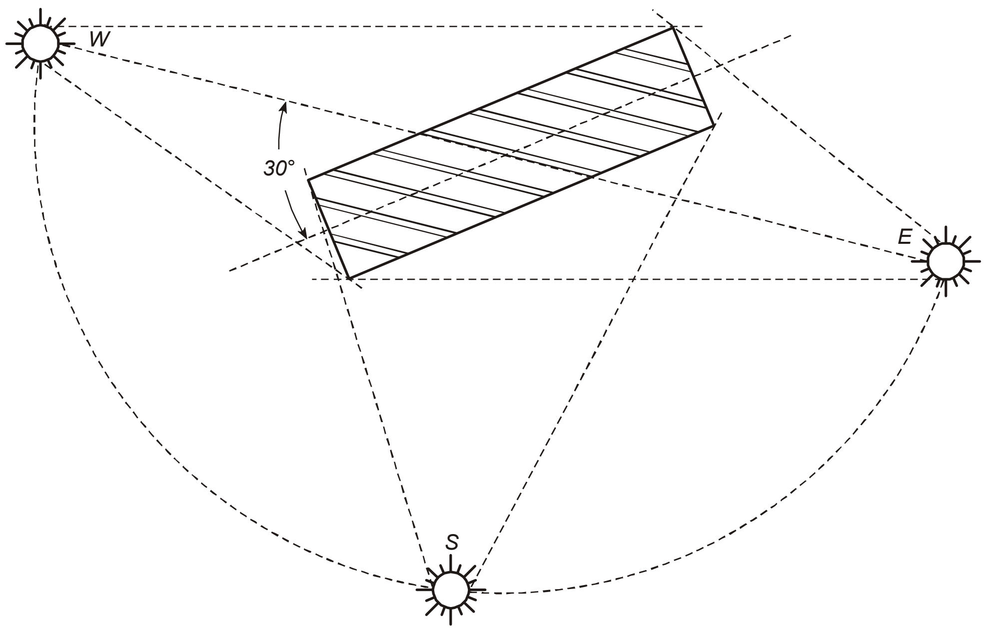


Fig. 1.7.

Now we shall have a brief idea of sun's movement which is necessary for proper orientation of a house. The change in seasons is caused due to the earth's axis being tilted to the plane of revolution and due to this sun seems to move towards the north in summer and towards south in winter. At a place of 40 degrees north latitude the path of sun throughout the year is shown in Fig. 1.8. On June 22 the sun rises north-east and sets north-west and it is above the horizon for about 15 hours. On September 22 and March 22 the sun rises in the east and sets in west and it is above horizon for 12 hours. But on December 22 it rises south-east and sets south-west and it is above horizon only for about 9 hours. The altitude of the sun in summer noon is much higher than winter noon as shown in Fig. 1.8.

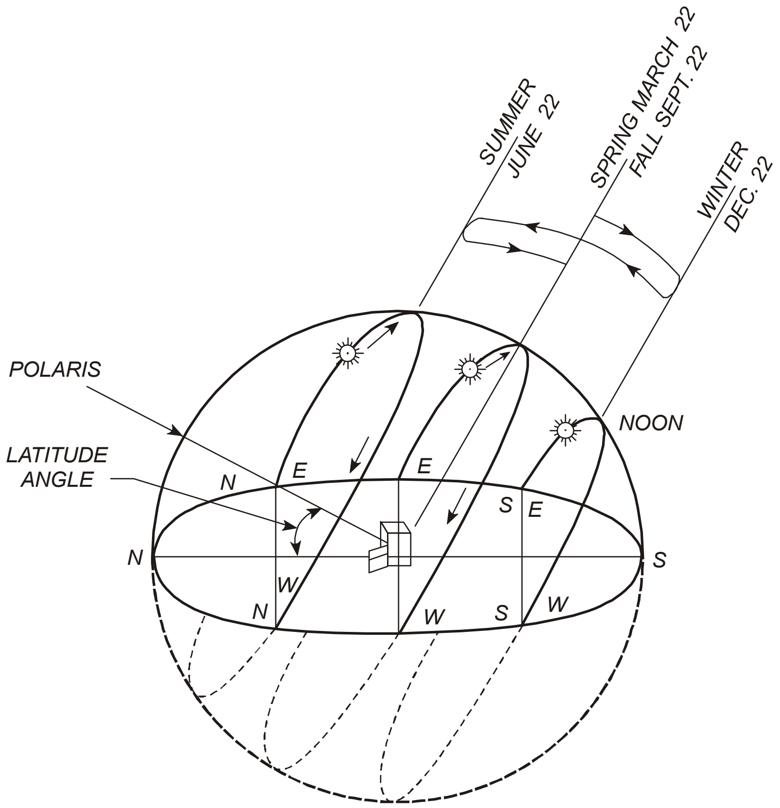


Fig. 1.8.

The maximum summer altitude and minimum winter altitude of sun for a place of any latitude is = complement of latitude $\pm$ 23½. (+) sign applies for maximum summer altitude and (–) sign for minimum winter altitude.

Therefore if a place has altitude of 40° then maximum summer altitude of sun

$$= (90° - 40°) + 23\tfrac{1}{2}° = 73\tfrac{1}{2}°$$

and minimum winter altitude of sun

$$= (90° - 40°) - 23\tfrac{1}{2}° = 26\tfrac{1}{2}°$$

Andre Halarz has developed universal sun chart which gives sun's altitude on different dates for places of different latitudes.

Andre Halarz Sun Chart

Zones	1	2	3	4	5
Latitude	25° – 30°	30 – 35°	35°– 40	40° – 45°	45 – 50°
Dec. 22	39°	34°	29°	24°	19°
Jan. 22 & Nov. 22	42°	37°	32°	27°	23°
Feb. 22 & Oct. 22	51°	46°	41°	36°	31°
Mar. 22 & Sept. 22	62°	57°	53°	43°	42°
April. 22 & Aug. 22	74°	69°	64°	59°	54°
May 22 & July. 22	81°	77°	73°	67°	62°
June 22	85°	81°	76°	71°	66 °

With the help of altitudes of sun an effective planning can be done for summer control. Let there be a place at 39° latitude (north). We want that direct noon sun ray entry should not be there during March 22 to September 22 which is the summer season. In winter the sun ray is allowed to come inside. Now from the above table critical altitude angle is 53°. This angle (53°) is drawn from the bottom of the window. The point A at which this line intersects an extension of the projection (*chajja*) determines the correct amount of overhang as shown in Fig. 1.9.

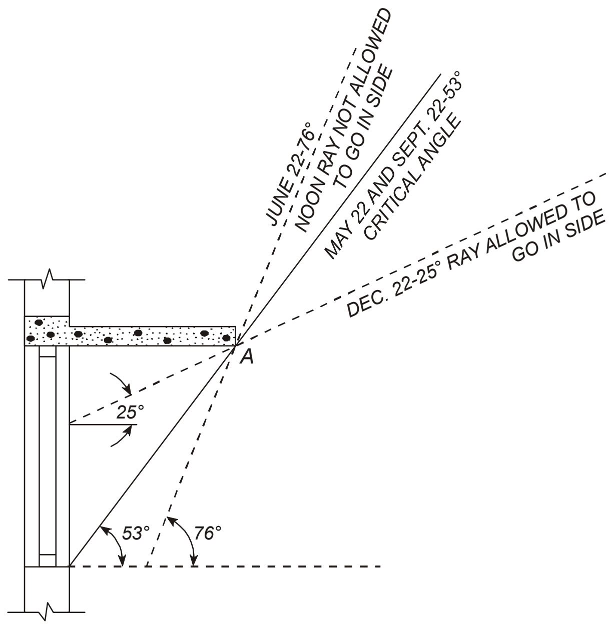


Fig. 1.9.

For perfect orientation all rooms which are usually used in day time should be placed on East and North side. Bed rooms should be placed in the direction of prevailing wind. Direction of wind in summer when it is needed his usually west and south. But rooms facing south and west will be warmed up by sun in summer season. Therefore to protect bed rooms from afternoon sun deep open verandah may be provided. Another way to protect south and west facing rooms is to have concrete framework projecting from the wall. They allow sun ray when it is at low altitude and hence pleasant but when sun altitude is high it gives shadow and thus protects the wall from bearing heated.

If the orientation of the building becomes necessary in a particular direction the following points should be considered for solar control in relation to exposure.

1. East sun exposure is sustained and is too low to be controlled by wide overhangs. Early sun is good but latter part can be controlled by chajja or a portico in front of the building. As per Indian climate it is always better to orient the building facing East. In this case there will be projection from westerly wind.
2. West sun exposure is short but intense. Since the sun is low in the sky, medium-sized trees may be planted in front of the building which will shade walls and windows.
3. Northwest and Northeast sun exposure is short and cool. Small trees, fences, louvers or walls may be put for solar control.
4. Southeast, South and Southwest sun is constant and intense, but high in the sky in summer. A wide roof overhang provides sufficient control. On a surthern exposure large expenses of concrete or other paving materials should be shaded by trees or other means to minimise glare and heat build-up.

Ventilation

Man's health and happiness are influenced directly by his environment. Human beings react to their environment. If the environment is good the product will also be good. Therefore when a house is being planned it should be kept in mind that environment of the house should be pleasing. The house should be planned such that number of persons occupying a room should be less. There have been different types of diseases due to overcrowding. Overcrowding means increased opportunity for the communication of disease. Due to overcrowding chances of housing diseases" such as colds, influenza, bronchitis, pneumonia are more.

Hence for healthy living more sunlight, less overcrowding and fresh air are necessary for a house. Adequate amount of sunlight can be obtained by proper orientation. If a space of 8.5 cubic metre $\approx$ 300 cft for an adult and 5.67 cubic metre ($\approx$ 200 cft) for a child is provided it will not cause overcrowding. Translated into room sizes this means a space of 1.5 m × 1.8 m (5′ × 6′) for an adult and a space of 1.2 m × 1.5 m (4′ × 5′) for each child if the ceiling is about 3.1 m ($\approx$ 10′) high. Experience shows that chances of spreading of communicable diseases are more if the distance between adjoining cots is less than one metre.

Fresh air inside the house can be obtained by good ventilation arrangements. The ventilation conditions inside a building are among the primary factors that determine the human health, comfort and well being. They have a direct bearing on the human body through the physiological effect of air purity and motion and an indirect effect through their influence on the temperature and humidity of the indoor air and surfaces. The main functions of ventilation can be summarised as follows :

(*a*) To maintain the quality of air inside the building at a certain minimum level, by replacing indoor air vitiated in the process of living and occupancy by fresh out door air. In rooms occupied by small number of persons, 20 m^3 to 30 cm^3 of air space is required for each person.

(*b*) To provide thermal environment which will assist in maintaining the heat balance of the body in order to prevent discomfort and injury to health. Excess heat either from increased physical activity or gains from hot environment has to be offseted to maintain normal body temperature (37°C).

(*c*) To cool the structure of the building when the inside temperature is above that of outdoor.

(*d*) To remove toxic gases, body odours, bacteria, smoke etc. from the air inside the room.

(*e*) During winter, to prevent stagnation of air in enclosed spaces to make it agreeable to breathe and to keep humidity as low as possible.

(*f*) To protect workers in factories and industrial plants from excessive heat, dust, moisture etc. and to supply fresh air for breathing.

Types of Ventilation

If the air change is caused by natural conditions such as open windows, roof ventilators etc. it is natural ventilation. While ventilation produced by mechanical means like central ventilating systems, unit ventilators, fans etc. is known as mechanical ventilation. While designing the house the planner always aims at getting the natural ventilation because no extra cost is involved for running fans or any machinary.

Natural Ventilation

The wind affects ventilation in two ways :

(*a*)By perflation or blowing through.

(*b*)By aspiration or drawing through.

In perflation the wind blows through any opening facing its direction such as open windows doors cracks, etc.

Aspiration takes place when the wind blows across the end of an open tube such as the top of a chimney. Its effect is to induce a reduction of pressure in the tube so as to cause a fairly strong upward current in the tube.

Following are the two forces producing natural ventilation in buildings :

(*a*)Air movement produced by pressure difference.

(*b*)Air change caused by difference in temperature.

Depending upon atmospheric conditions and building design above forces may act alone or in conjunction.

A house placed in the air stream slows down and piles up the moving air at its windward side and a area of relatively high pressure is caused. The flow enveloping the building creates low pressure areas on the sides adjacent to the windward side. At the leeward side a wind shadow with relatively low pressure is produced. This pressure difference on windward and leeward side contributes the air flow inside the building.

Temperature difference existing between the air inside and that outside the building due to the weight disparity causes the warmer air column to rise by displacement. The higher the temperature difference, the lower the height between the inlet and outlet and greater the size, the more vigorous will be the stack effect”. The rate of air change is given by the relation.

$$Q = 640 \times C_e \times A\sqrt{H.t}$$

where, Q = the rate of air flow in m^3/hour.

C_e = Coeff. of effectiveness ranging from 0.65 t o 0.50.

For favourable conditions value of 0.65 is taken.

A = free area of inlet opening in m^2

H = vertical distance between inlets and outlets in metre.

t = The temperature difference between inside and outside air in °C.

A relatively large ratio of outlet to inlet size secures the speediest and most cooling air flow within the building. The location of the outlet is irrelevent to the pattern of incoming flow. The placement of inlet governs the flow pattern within rooms. If the air flow is to be effective and produces a cooling effect for the occupants the stream has to be directed to the living zone by keeping the inlets at the height of living zone. The velocity of wind entering through two smaller windows will be greater than that entering through the single large window of same area. Thus provision of two smaller windows in place of a single window with same inlet area produces a considerable increase in the indoor air motion. It has also been observed that the average velocity inside a room increases by increasing the separation between two windows. By putting sashes on windows air movement in the desired zone can be enhanced.

A good ventilation inside a room is provided mainly by suitable arrangements of openings *i.e.* doors and windows. Following points should be kept in mind while providing windows.

(*a*) If the inlet and outlet openings are of same dimensions, the average indoor velocity increases significantly by increasing the width of the openings. But any increase in the window width beyond the value of 2/3 of the room width affords only a slight improvement in the inside room ventilation.

(*b*) For a room of common size, 1.1 metre is an optimum value of window height for getting maximum air movement at normal living level. Because it is seen that the average indoor velocity increases as the window height is increased but beyond the optimum height there is a slight decrease in the value of available wind velocity which reduces the ventilation.

(*c*) The indoor air motion increases with increase in window area upto 25% of the floor area. Beyond this value air motion is independent of the area of the openings.

Procedure for Window Design

The design considerations for ventilation involves the knowledge of the requirements of ventilation which depends upon the type of occupancy and the climate of the region in which the building is to be located. The climate of a particular region suggests the type of construction suitable for the purpose. For example in cold regions provision of large openings is undesirable which will unnecessarily reduce the indoor temperature. In hot and arid regions the design of buildings for comfort depends not only on the number of air changes but also on the distribution of air flow inside the building.

In a cold region the mechanical heat in the house is supplemented during the day by infra-red rays which pass through the glass of the windows on a short wave length, strike in turn re-radiate on longer wave lengths not possible to pass through glass. Therefore in cold regions putting glass window panes is helpful but in dry and hot region if windows are having glass panes it will increase the room temperature as explained above. Therefore glass windows have to be avoided in hot regions.

Knowledge of following climatic design data are necessary. Dry bulb temperature, relative humidity, wind speed and wind direction. The desired wind speed is determined with the help of following table which is based on the effective comfort temperature of 24°C. Thus knowing the desired wind velocity the size of the opening can be determined from Fig. 1.10.

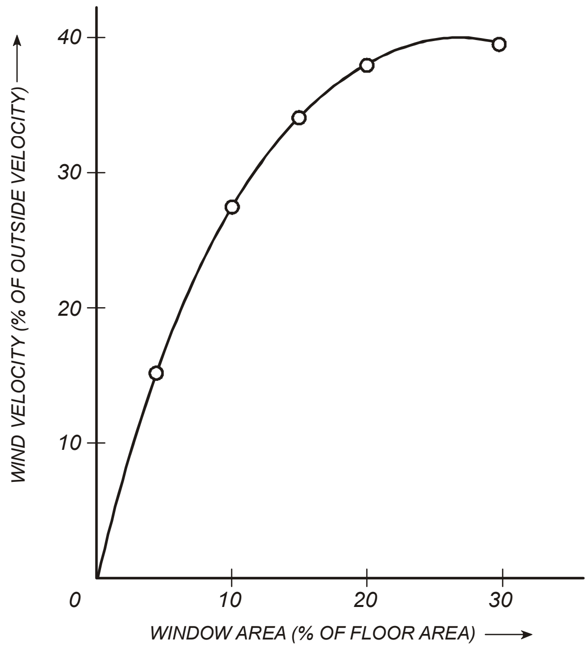


Fig. 1.10. Designed Wind Speed For Comfort (Effective Temperature 24°C)

Dry Bulb Temp. °C	27°C							30°C			
Relative Humidity %	60	65	70	75	80	85	90	30	40	50	60
Desired wind speed m/sec.	0.25	0.55	0.75	1.00	1.25	1.45	1.70	1.30	1.00	2.00	3.00

Effects of Building Layouts on Ventilation

When the building stands in an open space there may not be interferance on wind motion and requirements of ventilation can be estimated from local wind directions and speed. But in build up areas the air motion around the building is generally modified by the location, distance, size and shape of near constructions. Following are the factors which affect the ventilation conditions :

(*i*) Direction and effective width of the main and secondary streets with respect to wind.
(*ii*) Distance between buildings along the streets.
(*iii*) General height of buildings.
(*iv*) Presence of high rise buildings among lower buildings.
(*v*) Layout of building blocks.

How layout of building blocks affects ventilation, is discussed in brief. Buildings positioned perpendicular to the wind direction receive on their exposed sides the full sweep of the velocities. It is observed that **buildings spaced at a distance equal to seven times their respective heights secure satisfactory ventilation effect for each unit.**

Buildings planned in row arrangements cause a wind shadow over the subsequent units. An arrangement of staggered unit takes advantage of the bouncing pattern of wind since the houses direct the flow to subsequent structures. The row arrangement is desirable for avoiding wind effects while the staggered arrangement secures equal summer breeze distribution.

CEILING FANS AND AIR FLOW PATTERNS

Ceiling fans are the most common machinery used for mechanical or forced ventilation. Almost every house contains electric fans is necessary. Fig. 1.11 shows the overall flow pattern and Fig. 1.12 the typical velocity distribution at a plane 1.3 metres above the floor. It is observed that about 30 cm. above the floor the flow at most of the point is virtually horizontal and air moves radially in all directions forming a 30 cm. stream.

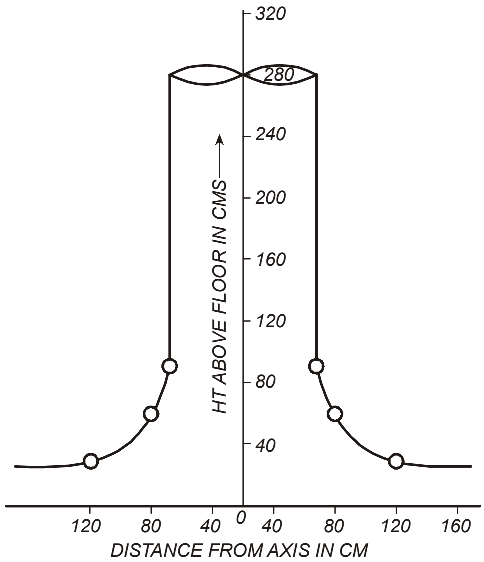


Fig. 1.11.

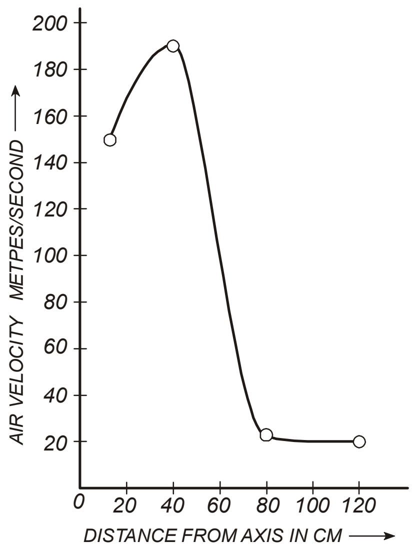


Fig. 1.12.

Relationship between Room Size and Fan Size

With study of air flow pattern a relationship between the size of the fan and its effective area can be obtained. **In humid air climate velocity of comfort is about 1 metre per second.** The amount of air displaced through a 30 cm. thick layer over a circular area of dia D is about 55 D cubic metre per minute. Thus a fan with capacity of 55 D cubic metre/ minute will be sufficient for a room with longer dimension of D metres. The table below gives the size of fan required for different sizes of rooms.

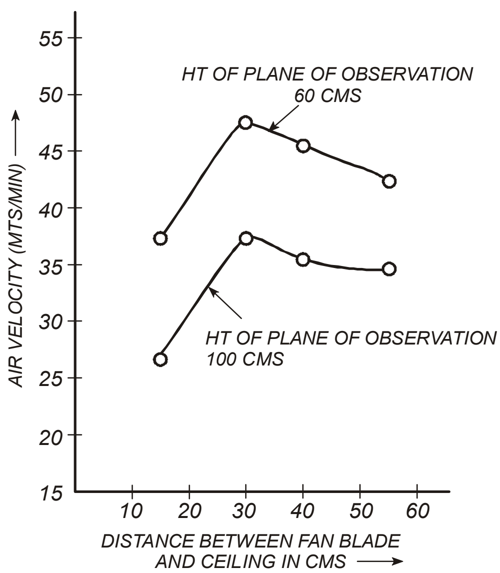


Fig. 1.13.

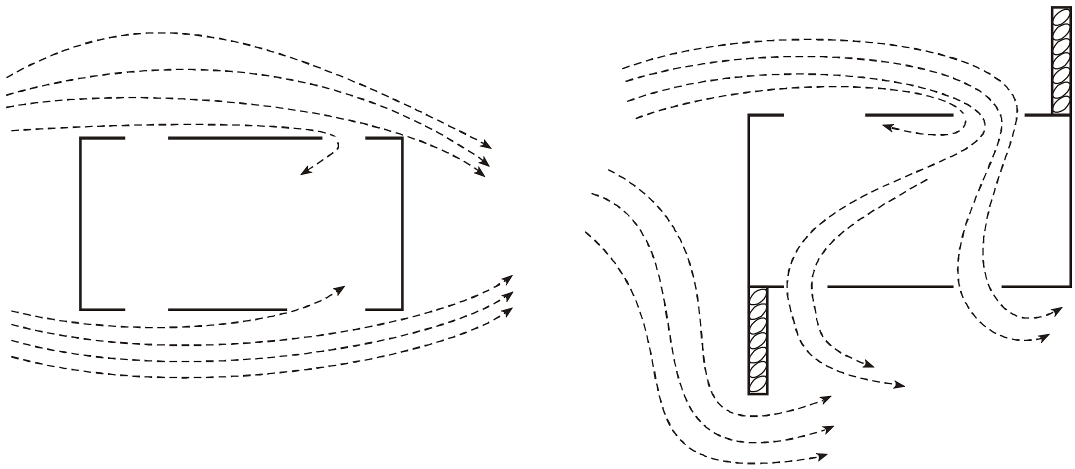
Room size	*Desired capacity of fan cu. m/min.*	*Fan size*
3.05 m × 3.05 m (10′ × 10′)	167.8	900 mm (36″)
3.70 m × 3.05 m (12′ × 10′)	203.5	1200 mm (48″)
4.30 m × 3.70 m (14′ × 12′)	236.5	1200 mm (48″)
4.90 m × 4.30 m (16′ × 14′)	269.5	1400 mm (56″)
6.10 m × 4.90 m (20′ × 16′)	335.5	1500 mm (60″)

Effect of Clearance between Fan Blades and Ceiling

From Fig. 1.13 it is clear that if clearance is less than 30 cm. the air movement produced by fan is considerably reduced. This happens due to obstruction offered to recirculation by the ceiling. Therefore a minimum space of 30 cm. must be provided between the fan blades and the ceiling.

A FEW TYPICAL EXAMPLES OF EFFECTIVE VENTILATION

Example 1. *Consider the situation A. In this case a windowless wall is perpendicular to the path of the breeze. Openings are provided on two walls which are parallel with the direction of the breeze but there is no air flow into the room because of the equal pressures in the areas adjoining the openings.*



(*a*) (*b*)

Fig. 1.14.

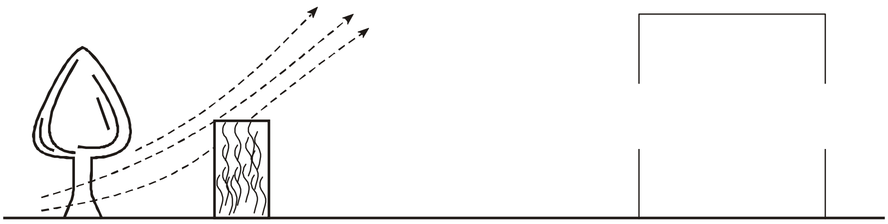
But in situation B some landscaping elements have been added. On one side a hedge has been added which builds up the pressure, while on the other side the hedge added is to create a relatively low pressure area and so the breeze flows through the room.

Example 2. *In the sketch C it is shown how the wind hops over the room because of a poor arrangement of a row of trees and a continuous hedge.*

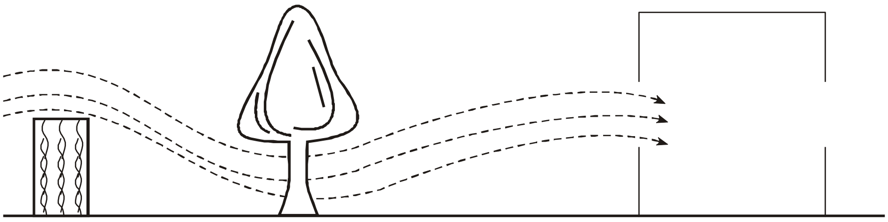
But in sketch D it is shown how the wind can be diverted into the room by a reverse arrangement of the trees.

Example 3. *How to get good natural ventilation in both summer and winter ?*

Occupants of the house should be protected from the heat and glare of the sun. During hot months the incoming air should be allowed to blow across the bodies of the occupants but during cold months the incoming air should be allowed to blow upward over the heads of the occupants.



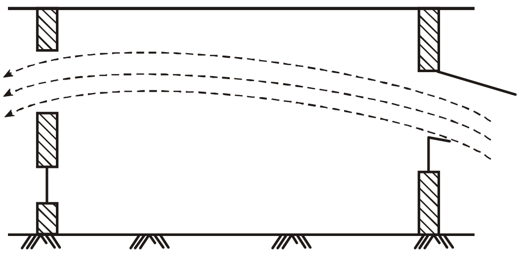
(*a*)



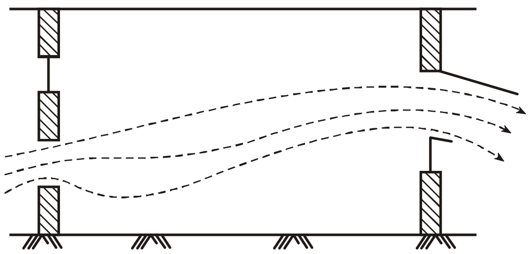
(*b*)

Fig. 1.15.

For getting such conditions a overhand should be provided on the south side of the building to keep the sun out of the rooms. Large projecting windows may be used on the north side of the building with minimum outlet during the hot months. The cold winter wind desired in the room for air circulation may be directed up towards the ceiling. In Fig. 1.16 A and B indicate air flow pattern for cold month ventilation and hot month ventilation respectively.



(*a*)



(*b*)

Fig. 1.16.

NOISE CONTROL AND SOUND INSULATION

Planning against noise should be an integral part of the planning, because it effects the human health. Noise presents more stimuli to the nervous mechanism of the body, produces more fatigue and presents greater possibility of vexation and frustration. There is scientific evidence that our reaction to noises take their toll in fatigue and consequently in health. After constant living in a noisy area the noise may not be irritating to a person who might have felt in the beginning but laboratory tests indicate that his nervous system is adversely affected. Constant impact of noise increases fatigue and irritability and men do not get sound sleep.

Therefore for effective planning the consideration should be taken into account that living zones or residential areas should be away from the noisy area such as highways, railways, railway platforms and factories. If at all the building has to be situated in such areas some remedial methods should be applied. At the same time to reduce the noise level in a room the room density *i.e.*, number of persons occupying a room should be less. Two persons per room is an ideal room density.

The best approach for effective planning is to locate the residential buildings away from noisy areas. In case the building has to be located near the noisy areas the sound reflection can be minimised by putting more plantation and grassed areas around the buildings. Heavy plantation also protects the building from air pollution. The orientation of the building should be planned in such a way that non-critical areas such as corridors, kitchen, bath-rooms, staircases may be located on the noisy side and the critical areas such as bed rooms, study rooms, etc. on the quiet side.

Window and doors should be kept away from the noisy side. As per recommendations of National Building Code when the bedroom windows of building has to face roads carrying heavy traffic the building should be located at a distance of about 30 metres from the road but 45 metres or more will be more suitable. If the windows are at right angle to the direction of the above type noise source the distance from road may be 15 metres to 25 metres. If boundary of other buildings, trees and plantation intervene then the above distances may be reduced.

When a twin quarter or a twin house is being planned, kitchen, staircase hall and bath, W.C. should adjoin each other.

For multi-storeyed buildings the floor above bedrooms and living rooms should have impact insulation. These can be obtained if the floor is made of concrete. For another type of sound insulation the floor can be covered by sound insulators such as rubber mats, linoleum or carpet.

Partition walls between rooms should extend upto roof. If the partition wall is non-load bearing wall the gap between wall and roof should be filled up with some filled materials. To make the wall soundproof sometimes it is made hollow and filled with some granular or cohesionless materials.

ILLUMINATION

For all types of buildings good lighting is a must. It helps in promoting different activities in the building, safety of the people using the building and creating pleasing atmosphere in different parts of the building. When illumination is sufficient, there is less tension on brain, heart rate is closer to normal and general sensitivity of the visual sense is greater. If the illumination is not sufficient, children bring the reading material closer to their eyes which in turn effects their eye sight. But excess illumination is also harmful. Therefore for effective planning consideration should be given to provide illumination sufficient for different activities and distribute the light in proportion to their requirements. While planning the opening in the rooms and fixing the position of the rooms the aim of the designer is to place the openings and room positions in such a manner that required amount of illumination is available inside rooms for different purpose by sunlight itself. There may not be requirement of any artificial light during day time. This is not difficult. Because through openings (even smaller) required amount of illumination can be obtained for different types of works. About 10,000 foot-candles (200,000 lux) of light occur in sunshine and 1,000 foot candles (20,000 lux) in the shade of a tree on a sunny day. About 5 foot candles (100 lux) of light fall on a book directly underneath a 40 watt lamp. About 10 to 20 foot candle (200-400 lux) is suitable for kitchen work; 25 to 50

(125-250 lux) for close work like studying, sewing, and 50 to 100 foot candle (250-500 lux) for close work over a long period and these amounts of illumination can easily be obtained in day times through openings in rooms left for ventilation.

Glare and its effects

Glare is any brightness within the field of vision of such a character as to cause discomfort, annoyance or eye fatigue. It is objectionable because its continued effect injures the eyes, and interferes with clear vision. When glare is present small details cannot be perceived. Glare is of two types : Direct and indirect.

Direct glare is produced by light coming from a bright source located directly in the field of view. It is also produced when total volume of light is too much and contrast with the background is great.

Indirect glare is produced by light reflected from an object which is not a primary light source. Example of indirect glare is reflected bulb light from the shiny desk surface or glazed writing paper. Indirect glare is sometimes more annoying because it remains in the central part of the visual field.

Following are the main causes of glare :

1. The light source may give too high candle power per square of unit area.
2. The light source may give off too great a total candle power in the direction of eye. For example an unshaded window often causes glare due to large volume of light rather than to the high brightness of the sky.
3. The light source may be located at too short distance from the eye. Glare of this type can be avoided by keeping the light source well above eye level.
4. The contrast may be too great between the light source and its darker surroundings. When a part of field of view is more illuminated than the other the viewer will feel difficulty due to strain in his eyes while moving his eyes from one field to other.

Following are the methods adopted to reduce glare :

(*a*) *By diffusing the light through frosted or etched glass.* If the diffusion is perfect light will be uniform and shadowless.

(*b*) *By use of Indirect lighting.* The beam of light from the source is directed to the wall or ceiling and from there rays are reflected to the other parts of the room. For this an idea of reflection value of floors, walls and ceiling is necessary.

Floor reflect 10% to 20% of light, wall reflect 35% to 55% of light and ceiling reflect 65 to 80% of light. Similarly reflection factors of different colours should also be taken into account:

Colour	*Percent of light reflected*
White	85
Light Yellow	75
Light Green	65
Light Blue	55
Dark Grey	30
Dark Red	13
Dark Blue	8
Dark Green	7

(*c*) *Combination of semi-direct and semi-indirect lighting.* A luminous bowl allows some of the light to be diffused downward and some to be thrown on the ceiling for reflection.

General Principles of Design for Good Lighting

Glare discomfort should be minimised as far as possible. A gradual transition of brightness from one portion to the other within the field of vision minimises glare discomfort.

Illumination of rooms which open off to corridors, passages and stair cases should be fairly high. In day time outdoor illumination is quite high. So at entrance, verandah is necessary which acts as a transition between very high illumination of outside to low illumination value within room. If direct entry from outside to room is there then the room should be well lighted providing window. For night time verandah lighting should not be high. Because a transition is required from room lighting to outside lighting which may have low illumination.

Taller openings give greater penetration while broader openings provide better distribution of light.

Openings on two opposite sides give greater uniformity of internal day light illumination. They also minimise glare. But cross-lighting with openings on adjacent walls increases the diffused lighting within the room. Lighting from side openings at corners is not so effective if the width of the room is more than two to two-and-half times the distance from the floor to the top of the opening. To avoid direct entry of the sunlight deep into the room chajjas should be provided with openings.

Artificial Lighting

For effective planning the rooms should be so placed and openings should be provided such that no artificial lighting is required in day time. But if the recommended illumination level is not reached in a few rooms then arrangements for artificial lighting is necessary. In night the rooms have to be lighted by artificial lighting so some idea about the artificial lighting is necessary.

Lighting fixtures distribute its light in the following manners :

Direct Lighting

Direct lighting emits light in the highest percentage downward and provides the highest foot-candles per watt over the areas beneath. But creates varying density and harshness of shadow. It is used only for specific eye task.

Diffuse Lighting

Diffuse lighting emits light in equal proportions in all directions. To prevent glare the glass globe should cover the light source completely.

Semi-indirect and Indirect Lighting

In such type of arrangement the light is emitted upward to the ceiling for reflection downward. It provides less foot-candles per watt in the centre of the room but illumination is spread over a larger area and has less shadow and greater softness.

To insure adequate light of good quality for all rooms careful attention should be given for the proper distribution of light. Glare should be minimised as far as possible.

To provide proper distribution of light, giving the recommended contrast value ten to one there should be overhead fixtures in all the principal rooms such as dining room, bedroom, study room etc. Preferably this should be diffused light from the invisible source *i.e.* the source of light should be covered by glass globe etc. Local lighting for reading, sewing, work or at dressing table should be supplied by portable lamps. While putting lamps at dressing tables in the bed rooms and near wash basins, mirrors in bathroom care should be taken that light falls on face and not on mirrors. The general lighting of the bed room should be soft and of restful nature. Passage and staircase should be well lighted. The kitchen should have strong light and lights in the dining room should be directly over the table and the light should be diffused one otherwise it will produce glare. An idea of reflection coefficient of different colours and walls, floor and ceiling helps in planning of proper distribution of light inside the room.

Light sources which are used in house lighting are mainly of two types. Filament lights and Fluorescent lights. Fluorescent tubes burn about two times more than filament lights and provide about twice as much light as filament bulb for the same power.

But, if a radio receiving set is kept in a room having fluorescent tubes for illumination care should be taken to put radio set at least 2 metres away from the tube.

Some idea about the effect of colours on the two types of the lighting source is also necessary. Colours which tend to fade by filament light are blue, green and violet while red and yellow are increased in their warmth. Fluorescent light has relatively less red rays as compared to day-light and filament light has much more red in its make-up than day-light. Therefore under fluorescent light blue, green and some yellow become intensified and some warmer colours fade out. Sometimes to neutralise the effects on colours both types of light sources may be used in a room.

Amount of illumination required for general lighting of Dining rooms, Bed rooms, Bath rooms, Living room, Entrance hall and Staircase is 5 foot-candles in F.P.S. system or 100 lux in metric system and for Kitchen it is 10 foot-candles or 200 lux. Supplementary local lighting in Bathrooms at mirrors, in kitchen for some specific works, in Bed rooms near the mirrors and in Living rooms and Bed rooms for reading should also be provided.

SOME THUMB RULES FOR EFFECTIVE PLANNING

(*i*) In general for different types of plots for residential houses the maximum covered area *i.e.* area on which the building can be constructed is given below.

Type of Plot	*Area of Plot*	*Permissible covered area*
A Type	More than 1000 sq. m.	33% of site area
B Type	501 sq. m. to 1000 sq. m.	40% of site area
C Type	201 sq. m. to 500 sq. m.	50% of site area
D Type	Upto 200 sq. m.	60% of site area

In towns the permissible covered area may be 66% of the site area

(*ii*) *Minimum space to be left.*

Front–3000 mm., Sides–1500 mm., Back–4500 mm. In some cases more frontage may be kept.

(*iii*) A standard residential house should have Drawing or Living room. Dining room, Bed rooms, Guest room, Kitchen, Stores, Bath room, Water closets, Front and Rear verandahs and a stair case if the building is double storeyed.

(*iv*) If considerable formality is not observed in a family, the Drawing room and Dining room may be combined and the two may be isolated by a sliding curtain and the whole room can be utilised on some special occasions.

If the house belongs to a Professor or an Advocate a study room should also be provided.

(*v*) The carpet area should be 50% of 65% of the floor area.

(*vi*) In order to be free from weathering effects, generally the foundation of a house is kept 1000 mm. below ground level. The width of foundation should be such that the stress on the soil is within its bearing capacity.

(*vii*) Plinth height may be 300 mm. to 600 mm. but 450 mm. is more common.

(*viii*) Ceiling height for main rooms of the building should be 3300 mm. to 3600 mm. For bath and W.C. the ceiling height may be 3000 mm.

(*ix*) Thickness of wall in superstructure for single storeyed house should be 200 mm. and for double storeyed 300 mm. In some cases wall thickness for single storeyed house is kept as 300 mm.

LOCATION OF ROOMS AND THEIR COMMON SIZES

Drawing or Living Room

Drawing room is a common, comfortable and attractive place for sitting of family members and to receive friends and guests. Sometimes it is used as a reception room and dining room on special occasions. It should be located in the middle of the building and should be connected to the front verandah and dining place. It should be well-lighted and ventilated. Generally this is the biggest room of the building so that it can be utilised for some ceremonial functions in the house. Its size should be determined by type of furniture to be used.

Its size may range from :

4200 mm. × 4800 mm. to 5400 mm. × 7200 mm.

The doors should be placed such that minimum space is taken in crossing the room.

Bed Rooms

Bed rooms should be so located that they are well ventilated and at the same time provide privacy. Generally they should be located on the sides of the building so that at least one wall is exposed for well ventilation and lighting. They should have cross-ventilation, if possible, and should be exposed to the breeze for cool outside air to come in.

They should be located on the side of the direction of prevailing wind. The location should be such that sun should shine in bed room during morning hours. The minimum window area will be one-tenth the floor area. In bed rooms 9.5 cubic metre per adult and 5.5 cubic metre per child space should be available and suitable allowance should be made for furniture.

While planning bed rooms position of bed should be planned in such a way that it would be the direction of cross-air currents.

If good water supply and drainage system is available, a bedroom should have attached bath and W.C.

Their size may range from :

3000 mm. × 3600 mm. to 4200 mm. × 4800 mm.

Guest Room

This room should be well lighted and ventilated. Should be located on one side of the building, generally by the side of the drawing room. It should be disconnected from inside of the house and should have separate bath and W.C. Its size may be :

3000 mm. × 3600 mm.

Verandah

The verandah protects the walls of the house from being heated by exposure to the sun rays. The best location for verandah is South and West. But if the frontage of building is East then they are located in East also. The verandah also serves the purpose of a waiting room. It segregates the private apartment from the entrance area. The verandah should shade the walls of the building during greater part of the day. And for this it is necessary that it must not have openings of a height greater than two-third of the floor-width.

Each house should have one front and one rear verandah. If space does not permit the rear verandah may be ommitted. They have width ranging from 1800 mm. to 3000 mm.

Verandah opening should always have a *chajja* projection for protection from sunlight and rainwater.

Office Room

This should be on one side of front verandah, disconnected from other rooms. Sometimes an office room serves the purpose of guest room and *vice-versa*. Its size may be :

3000 mm. × 3600 mm.

Dining Room

Generally the dining room should be provided in rear of the drawing or living room and near the kitchen. In modern houses drawing room and dining room are combined to have a big room for special occasions. For orthodox families dining room is kept separate. Its size may range from

3600 mm. × 4200 mm. to 4200 mm. × 4800 mm.

Kitchen

The kitchen should be provided in rear corner of the building but N.E. corner is the best. It should be connected with dining room and should have one approach from outside also. If possible, the kitchen should be so located that morning sun comes into the kitchen at the time when it is used most. It should have windows for well ventilation and chimney for smoke escape. The window space should be minimum of 15% of floor area. Sink should be provided for washing and sufficient number of selves should also be provided. Sometimes store room and kitchen are combined together if less space is available. Its sizes may range from

2500 mm. × 3900 mm to 3000 mm × 3000 mm.

Height shall not be less than 2.75 m.

Store Room

It should be located near the kitchen and should have sufficient number of racks. Its size may range from

2500 mm. × 2500 mm. to 3000 mm. × 3000 mm.

Pantry

This is a small room adjacent to dining room for keeping cooked food. It should have sufficient numbers of cup-boards and shelves. For ordinary building kitchen serves the purpose of pantry. Its size may be 2500 mm × 3000 mm.

Parapet

Parapet walls and handrails shall be 1.0 m to 1.2 m high.

Bath and W.C.

Now-a-days it has become common practice to provide attached bath room and W.C. with each bedroom. This is preferable only when good drainage and water supply is available.

It not attached to the bedrooms, bath and W.C. should be provided in rear of the building separately so that the two can be used at a time. Good ventilation should be provided for bath and W.C.

There should be two windows in a bathroom. One for ventilation at a height of 2000 mm, above outside ground level and other at the usual low level with frosted glass shutters for admitting light and maintaining privacy. Sometimes ceiling height is kept low (2100 mm) and upper space is used for storage purpose.

Common sizes

Bath and W.C. (combined) :
1800 mm. × 1800 mm. to 1800 mm. × 2500 mm.
Bath (separate) : 1200 mm. × 1800 mm.
W.C. (separate) : 1200 mm. × 1200 mm.

Garage

The height shall not be less than 2.4 m and minimum size 3 m × 6 m.

BUILDING BYE-LAWS

For a planned development of towns and cities, planning authorities of the area lay down certain norms for construction of buildings in the area, which are known as Building Bye-Laws." Plans of proposed buildings are to be prepared as per the bye-laws, which are checked and approved by the concerned authority. In fact the building bye-laws are prepared keeping in mind the recommendation of National Building Code. Of course Floor Area Ratio (F.A.R.) varies from place to place depending upon location of the plot.

Floor Area Ratio (F.A.R.) :

It is quotient obtained by dividing the total covered area (plinth area) on all floor divided by the area of the plot and multiplying the quotient by 100.

i.e., FAR = (Total covered area of all floors/Area of plot)*100

In fact Building Bye-Laws govern the following aspects of a building:

(*a*) Building frontage lines
(*b*) Built-up area of the building
(*c*) Height of the building
(*d*) Open space to be left on sides and back
(*e*) Size and roof height of rooms
(*f*) Provisions for openings in rooms, bath, W.C. etc. for proper light and ventilation
(*g*) Provisions for water supply and disposal of waste water
(*h*) Finally structural design of the building for its safety.

Building Line :

Building Line is also known as get back or front building line. It is a line parallel to the plot boundaries beyond which no construction work is permitted. The building line is prescribed by the local authorities keeping in view the future widening of the roads. The distance is taken from the centre line of the road or lane.

For various types of roads Table below gives the building line.

Type of roads	*Building Line*
Village Roads	9.0 m
Other District Roads	9.0 m
Major District Roads	15.0 m
National and State Highways	30.0 m

Open Space Around Buildings

The National Building Code of our country has recommended following open space around buildings of varying heights.

Description of building	*Front Space (width in m)*	*Side space (width in m)*	*Back or Rear space (width in m)*	*Remarks*
Building having height Less than 10.0 m	3.0 in no case less than 1.8 m	3.0	3.0 in no case less than 1.8 m	Minimum building line 7.5 M
Building having height more than 10.0 m and less than 30.0 m	3.0 + A	3.0 + A	3.0 + A	The value of A is 1 m for every 3 m beyond 10 m height of building
Building having height more than 25 m and less than 30.0 m	10.0	10.0	10.0	
Building having height more than 30.0 m	10.0 + B	10.0 + B	10 + B	The value of B is 1.0 m for every 5 m beyond 30 m

Built up Area for Residential Buildings :

(As per N.B.C.)

Area of Plot	*Maximum permissible built up or Covered area of plot*
More than 1000 sq. m	33.3%
Between 500-1000 sq. m	40%
Between 200-500 sq. m	50%
Below 200 sq. m	60%

Above data is having an average value.

In fact maximum built up area limitations are governed by the authorities depending on the type of construction, occupancy, width of lane facing building, density of locality and parking facilities. For example for business area maximum covered area allowed is 75%.

EXCERPTS FROM DELHI BUILDING BYE-LAWS

There should be no construction beyond set back line.

Canopy : Cantilever projections known as canopy of size limit 4.5 m (15´) long and 2.4 m (8´) will not be considered as covered area.

Balcony : Open space of balcony which projects 0.9 m (3´) beyond the set back line and is provided at the roof level should not be covered by more than 30%.

Loft : Loft is defined as subsidiary roof between two main roof or floor, and is provided for keeping unwanted households. Its height should not be more than 25% of the roof.

Mezzanine : Mezzanine floor is provided between two main floors and its height should not be less than 2.2 m (7´ 3´´) and more than 2.7 m (9´). Area of mezzanine floor/floors should not be more than 25% of the covered area of the building and it will have no partitions. It must have window area of atleast 10% of its floor area for proper ventilation.

Staircase : In all residential buildings staircase will not be having width less than 0.9 m (3´) and risers should not be more than 19 cm (7.5´´) and treads less than 25 cm (10´´). A spiral staircase should not be less than 75 cm (2´ 6´´) wide.

Corridor and Passage : In a residential building a corridor or passage and a verandah will not be less than 1 m (3´ 3.5´´).

Bath room : A bathroom in a residential building will not be having its floor area less than 1.8 sq. m (19.37 sq. ft.). The smaller dimension will not be less than 1.2 m (4´). If a bathroom is combined with toilet then its floor area should not be less than 2.8 sq. m. (30.13 sq. fit.). The roof height should not be less than 2.2 m (7´ 3´´) and window less than 0.37 sq. m. (4 sq. ft.).

Latrine, W.C. : Latrines or water closets will not be having floor area, smaller side and height less than 1.1 sq. m (11.84 sq. ft.), 0.9 m (3´) and 2.2 m (7´ 3´´) respectively. The walls will be having dado upto 1 m (3´ 3´´).

Kitchen : A kitchen floor area will not be having size less than 4.5 sq. m. (48.42 sq. ft.) and width will not be less than 1.5 m (5´).

Garage : Personal garage will be having size not less than 2.75 m* 5.4 m (9´ * 18´) and height should not be less than 2.4 m (8´).

Store : Floor area of the store will not be less than 3 sq. (32.28 sq. ft.). If the store is having floor area more than 3 sq. m then openings for light will be atleast 10% of the floor area.

Minimum size of a Residential room : A residential room will not be having floor area less than 9.5 sq. m. (102.22 sq. ft.) and height of the roof should not be less than 2.75 m (9´) and more than 4 m (13´ ½´´). The width of the room will not be less than 2.4 m (8´ . 0´´).

Provision of light and air in the rooms : For external air and light every residential room should have one or more window, ventilator etc. which should open in outside air or atleast in verandah or balcony. The area of openings should not be less than one-tenth area of room floor.

Basement : Basement should not be used for residential purpose. Inflammable materials are not to be stored in the basement. Minimum roof height of the basement (distance between floor of the basement and ceiling above) should not be less than 2.4 m (8´). Basement should not have partitions. Roof height above floor of the basement should not be less than 0.9 m (3´) and more than 1.2 m (4´) above surrounding level, outside the building.

Shaft : If latrines and bathrooms are not having direct light from outside of the building or through courtyard, then shafts are to be provided for air and light. Shafts should not be less than 1.5 sq. m (16.14 sq. ft.) in area and 1 m (3´ 3´´) in width. For buildings above 9 m (29´ 6´´) height its minimum size should be 3 sq. m (32.28 sq. ft.) and minimum side of 1.2 m (4´ 0´´).

Excerpts from Building Bye-laws set up by Haryana Urban Development Authority (For erection of Buildings in urban estates)

"Schedule of permissible covered area for Residential Buildings"

Size of plot	*Covered Area*
1. Upto 225 sq. m, 55%	
2. More than 225 sq. m and less than 450 sq. m	55% of first 225 sq. m. & 35% of remaining
3. More than 450 sq. m	55% of first 225 sq. m, 35% of 226 to 450 sq.m and 25% of remaining

Minimum size of rooms :

Types of Rooms	*Width*	*Area*	*Height*
1. Rooms	2.4 m (7´ 10.5´´)	9.5 sq. m (102.22 sq. ft.)	2.75 m (9´0´´)
2. Kitchen	1.8 m (5´ 10.75´´)	5.5 sq. m (59.18 sq. ft.)	2.75 m (9´ 0´´)
3. Latrine	0.85 m (2´ 9.5´´)	1.1 sq. m (11.84 sq. ft.)	2.40 m (7´ 10.5´´)
4. Bathroom	1.2 m (3´ 11.25´´)	1.8 sq. m (19.37 sq. ft.)	2.40 (7´ 10.5´´)
5. Toilet	1.2 m (3´ 11.25´´)	3.0 sq. m (32.28 sq. ft.)	2.40 m (7´ 10.5´´)

Arrangement for Light and Ventilation :

Each residential room, kitchen, latrine, bathroom, toilet etc. must have openings (windows, ventilation and doors) for ventilation and light. Openings should open in open air or at least in verandah. Including a door, openings should not have area less than $1/4^{th}$ the area of floor.

A toilet should have an additional ventilator of atleast 0.2 sq. m in addition to the $1/4^{th}$ floor area. The ventilator should be kept open for most of the time.

Staircase : The staircase in a residential building should've width not less than 0.8 m (2´ 7.5´´). The riser should not be more than 20 cm (7.75´´) and tread less than 25 cm (9.75´´).

Corridor and Passage : In a residential building a corridor, a passage or a verandah will not be less than 0.9 m (3´).

Mezzanine : A mezzanine floor is a floor between two main floors (storey). Its height should not be less than 2.3 m (7´ 6.5´´) and its floor area will not be more than 1/3 of the floor area lying below.

Basement : The area of basement will be equal to the approved area of ground floor but its use can not be done for residential purpose. It can be used for storage purpose or as parking provided it satisfies structural and environmental requirements.

Excerpts from Building Bye-laws of Patna Regional Development Authority

Ratio between open and covered space : Ratio between open and covered space will be 1:1 meaning that maximum covered space will not be more than half the area of the plot.

Height : The height of the building will not be more than available width of the open space in front of the building. Width of available open space means open space in front of the plot and width of road or lane.

Balcony: Balcony will not be provided in the minimum prescribed setback.

Chajja : At the lintal level chajja will not be more than 2´6´´ wide.

Porch : The porch at the lintal level should be having maximum size of 10´ × 22´.

Staircase : Width of staircase hall will not be less than 6´. Width of staircase will not be less than 3´ and risers will not be more than 7.5´´ and tread less than 10´´.

Rooms : Rooms will not be having area less than 100 sq. ft. and minimum width will be 8´. Each room will be having at least one wall towards the outer wall of the building.

Guest/Study Room : Area will not be less than 60 sq. ft. and width less than 6´.

Bathroom : Area will not be less than 5´*4´ and width less than 4´.

Toilet : Area will not be less than 7´*4´.

Shaft : If window/ventilator of the toilet is not opening through outer wall of the building, then shaft provided will be of size not less than 3´*2´ 6´´.

Kitchen : Minimum area will not be less than 30 sq. ft. and width less than 4´ 6´´.

Store/Puja Room : Minimum area not less than 20 sq. ft. and width less than 4´.

Dining Room : Floor area will not be less than 6´*8´ *i.e.,* 48 sq. ft.

Set Back : Residential buildings will be having minimum front and back setback as 10´. Side set back will depend on type and locality of the building.

BUILDING PERMIT

A person or a society or an organisation who intends to erect or re-erect a building or intends to make additions and alternations in an existing building has to apply to the concerned authority in prescribed form with prescribed fees along with plans in ferro prints and statements in triplicate. The permitting authorities are Notified Area Committee, a Municipality, Corporation, or an Area Development Authority depending upon the location of the land where the house or a building is to be erected.

Plan : The Plan should consist of the following :

(*a*) Site drawn to a scale not less than 1 : 800 (1 cm = 8 m or 1´´ = 64´) showing boundaries of the site along with information of details existing on all the four sides of the plot and north direction preferably on right hand top corner of the drawing.

(*b*) Building plans, elevations and sections drawn to a scale not less than 1:100 (1 cm = 1 m or 1´´ = 8´) and all new constructions to be coloured red. The drainage and sewer lines are to be shown in red dotted lines. Structure (if any) to be dismantled are to be shown in yellow colour. Location of W.C., sink, drains etc. to be shown clearly. Section drawing should show the size of footings, walls, roofs, slab beams etc. All plans are to be signed by the owner and a qualified architect or an engineer.

The application should consists of specifications giving kind and grade of materials (bricks, flooring, reinforcement, doors, windows etc.) and proportions (plaster, concretes, lime terracing etc.).

The authority may sanction or refused the sanction application within 45 days. If the authority fails to intimate the applicant any objection or refusal, the application and plans may be deemed sanctioned.

The duration of sanction mostly is for three years unless specified. If the construction is not started within a year of the sanction, renewal of the permit is required with a formal application.

While permitting the construction objective of the permitting authority is to check whether Bye-Laws" of the area has been followed or not and design is structurally safe which means that all structures should be designed, built and maintained such that stresses in materials of construction should not exceed the safe permissible stresses as laid down by Indian Standards.

Minimum Recommended Floor area and height of rooms of Residential Buildings

Rooms	*Minimum Floor Area (m^2)*	*Minimum height (m)*
Drawing room	9.5	2.75
Bed room	9.5	2.75
Living room	9.5	2.75
Dining room	7.5	2.75
Kitchen	5.5	2.75
Bath and Latrine (combined)	2.8	2.2
Bath (separate)	1.8	2.2
Latrine (W.C.)	1.1	2.2
Servants room	9.5	2.75
Garage	12.0	2.50

DESIGN DATA FOR COMPONENTS OF BUILDINGS

THICKNESS OF WALLS

Thickness of walls for residential buildings may be taken as follows :

Walls covered with roof			*Walls without roof*		
Cement mortar 1:3	*Cement mortar 1 : 6*	*Mud mortar*	*Cement mortar 1:3*	*Cement mortar 1:6*	*Mud mortar*
$\frac{H}{24}$	$\frac{H}{18}$	$\frac{H}{16}$	$\frac{H}{12}$	$\frac{H}{9}$	$\frac{H}{8}$

Minimum thickness of slab in CM for different spans and support condition :

(For mix proportion 1 : 2 : 4)

Support condition	*Short span in metre*										
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
(*a*) Simply supported slabs spanning in one direction (*L*/*B* > 2)	10	10	10	12	13.5	15	17	18.5	20	22	23.5
(*b*) Simply supported slabs spanning in two direction (*L*/*B* < 2)	10	10	10	10	11.5	13	14.5	16	17.5	18.5	20
(*c*) Continuous slab spanning in one direction (*L*/*B* > 2)	10	10	10	10	11.5	13	14.5	16	17.5	18.5	20
(*d*) Continuous slab spanning two direction (*L*/*B* < B)	10	10	10	10	10	11.5	12.5	14	15	16.5	17.5
(*e*) Cantilever slab	17	21	25	29.5	33.5	37.5	42	46	50	54.5	58.5

B is the short span and L the longer span. Cantilever slab more than 4.0 m span is avoided. If at all it is to be provided, supporting beam with proper design should be given.

Thickness of beams :

(For mix proportion 1 : 2 : 4)

Support condition	*Span in metre*								
	2.5	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1. Simply supported	12.5	15	20	25	30	35	40	45	50
2. Continuous	10	12	16	20	24	28	32	36	40
3. Cantilever	25	30	40	50	60	70	80	90	100

Safe axial load on square Columns (Mix proportion 1 : 2 : 4)

Column size (cm)	*Longitudinal steel*			*Load carried by the columns in tonnes.*
	Nos.	*Dia (mm)*	*Area (cm²)*	
15 × 15	4	12	4.52	14.2
	4	20	12.57	24.35
	4	22	15.21	28.15
20 × 20	4	12	4.51	21.20
	4	20	12.57	31.35
	4	25	19.63	40.30
	4	32	32.17	56.50
25 × 25	4	16	8.04	34.65
	4	28	24.63	55.50
	8	28	49.26	86.60
30 × 30	4	16	8.04	45.65
	4	36	40.72	86.80
	8	32	64.34	116.60
35 × 35	4	20	12.57	64.35
	8	25	39.27	98.20
	8	36	81.43	151.60
40 × 40	4	22	15.21	82.80
	8	36	81.43	166.00
	8	45	127.32	224.00

Stirrups will be provided as per normal procedure.

Safe Load and details of Reinforcement for simply Supported slabs :

Total depth of slab (cm)	*Safe load including self weight of slab kg/m² for different spand in metre*								*Details of slab*					
	1.5	*2.0*	*2.5*	*3.0*	*3.5*	*4.0*	*4.5*	*5.0*	*Effective depth (cm)*	*Area of steel/m (cm^2)*	*Clear cover (cm)*	*Moment of Resistance kg.m.*	*Reinforcement*	
													Main reint diameter in mm @CTC in cm	*Distribution reinforcement dia. in mm @CTC in cm*
7.5	935	528	340						5.5	3.94	1.6	264	8@12.5	6@25
9.0	1515	850	545						7.0	5.00	1.6	425	8@12.5	6@25
10.0	2000	1120	720	500					8.0	5.72	1.5	560	10@13.5	6@ 19
12.0		1740	1110	773	570				10.0	7.15	1.5	807	10@11.0	6@15.5
14.0		2500	1600	1110	820	625			12.0	8.58	1.4	1250	12@13.0	8@ 24
15.0			1880	1310	960	735	580		13.0	9.30	1.4	1470	12@12.0	8@22
16.0			2180	1500	1100	850	670		14.0	10.00	1.4	1700	12@11.0	8@21
18.0			2500	1980	1460	1100	890	712	16.0	11.45	1.4	2225	12@9.5	8@18.5
19.0				2222	1640	1250	1000	800	17.0	12.15	1.4	2500	12@9.0	8@17.5

Assumptions taken in the above data :

Live load = 200 kg/m², Unit weight of R.C.C. = 2400 kg/m³

Concrete Mix 1:2:4 [M-15 *i.e.,* cube comp. strength after 28 days of curing = 15 N/mm² or 150 kg/cm²]

f_c = 5 kg/cm², t = 1400 kg/cm², M = 18.7.

APPROXIMATE COST OF DIFFERENT COMPONENTS OF A BUILDING

For getting an approximate idea about the cost involved in different components of a building a preliminary estimate of quantities of various materials and labour is required. Following table gives an approximate idea. However, exact cost depends on location of building and specifications followed.

Percentage break up of building parts

(Excluding electrical, water supply and sanitary work)

(*i*)	Earth work in excavation including filing :	0.5%
(*ii*)	Concrete work in foundation :	4.5%
(*iii*)	D.P.C. work :	1.0%
(*iv*)	Brick work :	35.0%
(*v*)	Flooring :	6.0%
(*vi*)	Doors and Windows :	13.0%
(*vii*)	Flyproofing in doors and windows :	2.5%
(*viii*)	Window grills :	0.5%
(*ix*)	Roof slab :	17.5%
(*x*)	Roof terracing, insulation layer, construction joints and tarfelting at joints :	2.5%
(*xi*)	Pastering and painting :	10.0%
(*xii*)	White-washing, colour washing and painting :	2.0%
(*xiii*)	Simple Architectural work :	1.5%
(*xiv*)	Apron around building :	1.5%
(*xv*)	Miscellaneous works :	2.0%

Percentage Cost of materials and labour :

(*i*)	Cost of materials	65% to 70%
(*ii*)	Cost of labour	35% to 30%

Percentage cost of Water Supply, Sanitary and Electrical Installations :

(*i*)	Water supply and sanitary works	8% to 15%
(*ii*)	Electrical installations without fan and A.C.	10% to 20%
(*iii*)	Electrical fans and coolers	5%

Percentage overhead cost for design, super vision etc. :

(*i*)	Preparation of drawings, design and estimate	4%
(*ii*)	Supervision of work	10% to 12%
(*iii*)	Direct cost of work	85%

Percentage cost of sub-structure and superstructure :

(*i*)	Sub-structure (foundation and plinth)	10% to 15%
(*ii*)	Super structure	85% to 90%

Percentage cost of Main Materials :

(*i*)	Cement	10% to 15%
(*ii*)	Bricks	20% to 22%
(*iii*)	Steel	10% to 11%
(*iv*)	Timber	10% to 20%

SPECIFICATIONS

Specifications may be defined as written instructions/procedure describing in detail the construction work to be undertaken. It provides a clear and concise description of the material to be used and construction procedures to be followed for different items of work.

Normally following types of specifications are used :

(*a*) General Specifications.

(*b*) Detailed (particular) Specifications.

General Specifications. These include nature of the work, the qualities of materials and workmanship. They form a part of the conditions of a contract.

Detailed (particular) Specifications. For an item mentioned in the schedule of quantities, detailed specifications are given. They specify the materials to be used, the workmanship to be followed and results to be obtained. The specifications for items are written in the same serial order in which the items are taken for construction.

The specifications are in fact written to supplement the information shown on the drawings and they cover those features of the work which can be described in words. The specifications serve following purposes :

(*i*) Contract document between the owner and the contractor describing their responsibilities.

(*ii*) *Guide to bidders* : Enabling the estimators of the work to arrive at a fair price for the work involved.

(*iii*) *Guide to supervisors* : Providing a guide for fabrication and installation of materials, equipment and works.

As specifications are instructions, (to be followed for construction) it is not necessary to give reasons for what is specified in the specifications. Although for each and every item of construction, specifications are available, in the following paragraphs specifications of some important items of work which are used in building construction are described as guide for taking a work of building construction.

Buildings are classified in four class depending upon materials used and construction procedure followed. They are classified as :

(*i*) First class Buildings (*ii*) Second class Buildings

(*iii*) Third class Buildings (*iv*) Fourth class Buildings.

Although buildings have been classified in four classes but mostly First Class and Second Class are in practice. Third Class and Fourth Classes are made as village housing or buildings which are temporary and are made for temporary purpose.

The following table gives a general specifications of Ist and 2nd class buildings and a comparison will show the difference in the two classes.

Third class Buildings are mostly of temporary type and cheap construction materials are used for construction.

Fourth class Buildings are mostly used in rural housing and local construction materials are used for construction. They are also considered to be a temporary construction.

GENERAL SPECIFICATION OF BUILDINGS

Item	*First Class*	*Second Class*
1. Foundation and Plinth	Shall be of First Class brick in cement mortar (1:6) over line concrete of 1:3:6 or 1:4:8 Cement Concrete. For single/double storeyed building 1:4:8 Cement concrete may be used.	Same as Class I
2. Damp Proof Course (D.P.C.)	Shall be 2.5 cm thick cement concrete (1 : 1½ : 3) one kg. of Impermo or any other standard water proofing material is to be mixed with the concrete for each bag of Cement used. Finally it shall be painted with two coats of bitumen.	2 cm thick in cement concrete 1:2:4 mixed with 1 kg of water proofing material per bag of cement.
3. Superstructure	Shall be of First Class brick work with lime mortar or 1:6 Cement Mortar. Lintels over doors and windows shall be of R.C.C.	Second Class brick work in C.M. 1:6 or 1:8. Lintels over doors and windows shall be of R.B. (Reinforced Brick).
4. Roofing	Shall be of R.C.C. slab with an insulation layer of lime concrete terracing. The roof of large span will be supported on R.C.C. beams as per design. Height of roof shall not be less than 3.7 m.	R.B. slab with 7.5 cm lime concrete terracing above roof. The roof shall be supported over battens and beams. Varandah roof shall be of asbestos sheating.
5. Flooring	Drawing and dining room floors shall be of mosaic. Bathroom and W.C. floor and dado shall of mosaic. Bedroom floors shall be coloured and polished having 2.5 cm cement concrete over 7.5 cm lime concrete. Floors of other rooms shall be of 2.5 cm cement concrete over 7.5 cm lime concrete and polished.	2.5 cm cement concrete over 7.5 cm lime concrete.
6. Finishing	Inside and outside walls shall be 12 mm cement plaster (1:6). Inside walls of drawing,, dining and bedrooms will be distempered and other inside walls white washed 3 coats. Outside walls shall be coloured snow cem washed two coats over one coat of white wash.	Inside and Outside walls shall be having 12 mm thick cement mortar plaster (1:6) ceiling shall be cement plastered (1:3). Inside shall be white washed 3 coats/colour washed two coats over one coat of white wash.
7. Doors and Windows	Chaukhats (Frames) shall be seasoned teak wood. Shutters shall be teak wood 4.3 mm thick fully panelled or partly panelled and partly glazed as per requirement. Fittings shall be of brass. Doors and windows shall be varnished or painted two coats with high class enamel paint over one coat of priming. Windows shall be provided with grills.	Chaukhats shall be of R.C.C. or well seasoned sal wood. Shutters of shisham 4 cm thick. Panelled/glazed as per requirement. Fittings will be of iron. Doors and windows shall be painted two coats over one coat of priming.
8. Miscellaneous	Rain water shall be of cast iron or asbestos cement. Building shall be provided with first class sanitary and water fittings and Electrical installations. An apron all round the building will be provided 1 metre wide and 7.5 cm thick in cement concrete 1:3:6.	Rain water pipes shall be of cast iron fully painted Electrification,, sanitary and water fittings as per requirement.

DETAILED SPECIFICATIONS

When tendering is done for a project (Housing or other Civil Construction) by the Government or other Agencies, Detailed specifications are prepared so that details of construction is clear to all concerned. Therefore detailed specification describes the item of work in detail complete in all respects with reference to the drawings of the work. Following details are usually provided in the detailed specifications.

(*i*) Qualities of materials to be used.
(*ii*) Methods of measurement of quantities of materials.
(*iii*) Quantities of some specific materials to be used.
(*iv*) Properties of mortars and concrete and methods of mixing.
(*v*) Details of shuttering and centring.
(*vi*) Methods of laying mortars and concrete.
(*vii*) Different tests to be conducted at various stages of the work.
(*viii*) Curing period and method.
(*ix*) Methods of execution and measurement of completed items.
(*x*) General precautions and observations to be taken after construction (if any).

For more details of detailed specification of different items of works, CPWD or Railway specifications may be referred or a standard text book of estimating and costing may be referred. In the present text details of standard specifications are not given but to give an idea about some important items of building construction, procedure of their construction are given.

1. Excavation in Foundation Trenches :

All excavation operation includes excavation and taking out excavated materials. Taking out includes throwing the excavated earth at of least one metre or half the depth of excavation which ever is more and clearing off the edge of excavation. The excavation is to be done to the exact dimensions as shown in the drawing.

Rate includes following :

(*a*) Excavation and depositing earth as specified.
(*b*) Setting out works and profile.
(*c*) Site clearance.
(*d*) Bailing out or pumping of water in excavation from rains, subsoil etc.
(*e*) Initial lead of 50 m and a lift of 1.5 m.

2. Cement Concrete :

The cement concrete is prepared by mixing graded stone or brick aggregate of specified size with fine aggregate (sand) and cement in specified proportions with required quantity of water. The grading and quantity of aggregate are such as to give maximum compressive strength of 140 kg cm^2 at 7 days for a mix proportion of 1:2:4. For small works proportioning is done by volume. Boxes of generally 35 × 25 × 40 cm are used for measurement of sand and aggregate. The unit of measurement for cement is a bag of cement of 50 kg and this is taken as 0.0347 cum. While measuring aggregate, shaping, ramming, heaping is not done. The proportioning of sand is done on the basis of its dry volume and in case sand is damp, allowance for bulking is done as per standard procedure.

Brick aggregate (if used) is well soaked with water for a minimum period of 2 hours and stone aggregate is washed with water to remove dirt dust or other foreign materials. For bigger work, mixing is done in mechanical mixers. Mixing by hand is done for small work (where volume of concrete is not much).

The materials are mixed for a period of not less than 2 minutes in machine mixing and it is seen that mixture is of uniform colour and required consistency is obtained.

The hand mixing is done on a smooth, water tight, clean platform of suitable size.

Quantity of water to be used for each mix of 50 kg cement to give required consistency is not more than 34 litres for 1:3:6 mix, 30 litres for 1:2:4 mix and 27 litres for 1:1.5:3 mix.

The entire concrete to be used in the work is laid gently (not thrown) in layers not exceeding 15 cm and after laying the concrete is thoroughly vibrated by means of mechanical vibrators till a dense concrete is obtained. In absence of mechanical vibrators, hand mixing is done with the help of tamping rods so that concrete is thoroughly compacted. The layers of concrete is so placed that bottom layers does not finally set before top layer is placed. Compaction is to be completed before the initial setting starts *i.e.,* 30 minutes of addition of water in the dry mixture. During hot weather care is to be taken than temperature of wet concrete does not exceed 38°C. In cold weather concreting is not to be done if temperature is below 4.5°C.

It is preferable to concrete whole pannel of a roof or bar of an isolated foundation continuously. However if the work of placing the concrete is to be suspended, roughening at the surface for jointing future work is to be dome before the concrete sets. Before resuming the work, the previous work is to be cleaned thoroughly, rough ened, watered and a grout of neat cement slurry (1 kg of cement mixed with 2 litres of water) is applied uniformly before placing the fresh layer.

The laid concrete should be protected from damage and rain during construction. The green work is protected from rain by suitable coverings. After 1-2 hours of laying the concrete, it shall be protected with gunny bags, sand or other material against drying till 24 hours after laying of the concrete. The surface is then cured by flooding with water of at least 25 mm depth or by covering with wet absorbent materials. The curing is done for at least 14 days.

In case of foundation concrete the masonary work is started after 48 hours of its laying but curing of cement concrete along with the masonary is continued for a minimum period of 14 days.

Finishing the Concrete Work

In case of roof slabs, the top surface is made even and smooth with wooden trowel before the concrete starts setting. After removal of forms the R.C.C. work is examined properly.

If the concrete has got so much honey combing or it has sagged so much that it may be detrimental to the safety of the structure, then the concreting has to be rejected it means concreting has to be re-done but before rejecting the work, Engineer-in-charge has to be get assured about the poor quality by utrasonic test or hammer rebound or load test.

Minor or other surface defects are accepted and rectifications are done with following procedures :

(*i*) Shallow patches are first treated with grout consisting of one part of cement and one part of sand and then filled with mortar similar to that used in the concrete in layers not exceeding 1.0 cm thick. Each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by pressing the form material against the patch while the mortar is plastic.

(*ii*) Bulges and ridges are removed carefully by chipping and the surface is rubbed with grinding stone. Honey-combing and other defects are chipped out taking care that edges are as straight as possible and perpendicular to the surface, so that a key may be provided at the edge of the patch.

(*iii*) Patches generally appear darker than the surrounding concrete owing to the presence of lesser cement laitance on their surface. To make the patches uniform with the surrounding concrete, 1 to 20 percent of white portland cement is added to the patching mortar. The exact quantity of portland cement is determined by trial.

(*iv*) To prevent early drying, curing of the finished patched mortar should be started as early as possible.

(*v*) Holes left by bolts are filled with mortar having mixture as dry as possible (having just enough water) to give maximum compaction when forced into place.

(*vi*) Large and deep patches are filled with concrete held in place by forms. Deeper patches are reinforced and carefully dowelled to the hardened concrete.

The exposed surface of R.C.C. work is plastered with cement mortar 1:3 of thickness not more than 6 mm to give a smooth and even surface true to line and form.

The surface which is to be joined with brick masonary is properly roughened immediately after shuttering is removed. Before plastering, the surface is cleaned and wetted to give a good bond between concrete and the plaster.

MATERIALS USED IN CEMENT CONCRETE

Cement concrete is a very important item in Building construction. Hence to get better result it is essential to know well about materials used in cement concrete. If reinforcement is used in concrete then it is reinforced cement concrete (R.C.C.) otherwise it is plain cement concrete (P.C.C.). Materials used are cement, sand, stone aggregate and water in P.C.C. and addition of reinforcing bars in R.C.C. In following paragraphs some important points will be discussed about materials used in concrete.

Cement

Cement is the most important material used in plain as well as reinforced cement concrete. In India cement is manufactured under different brand names under standards of Bureau of Indian Standards popularity known as BIS and earlier known as Indian Standard Institution (ISI). IS code numbers for different types of cement are :

33 Grade OPC Conforming to IS 269 : 1989

43 Grade OPC Conforming to IS 8112 : 1989

53 Grade OPC Conforming to IS 12269 : 1987

Portland Pozzolana Conforming to IS 1489 (Part 1) : 1991

Cement (PPC) Fly-ash based and calcined clay based IS 1489 (Pt ii) : 1991

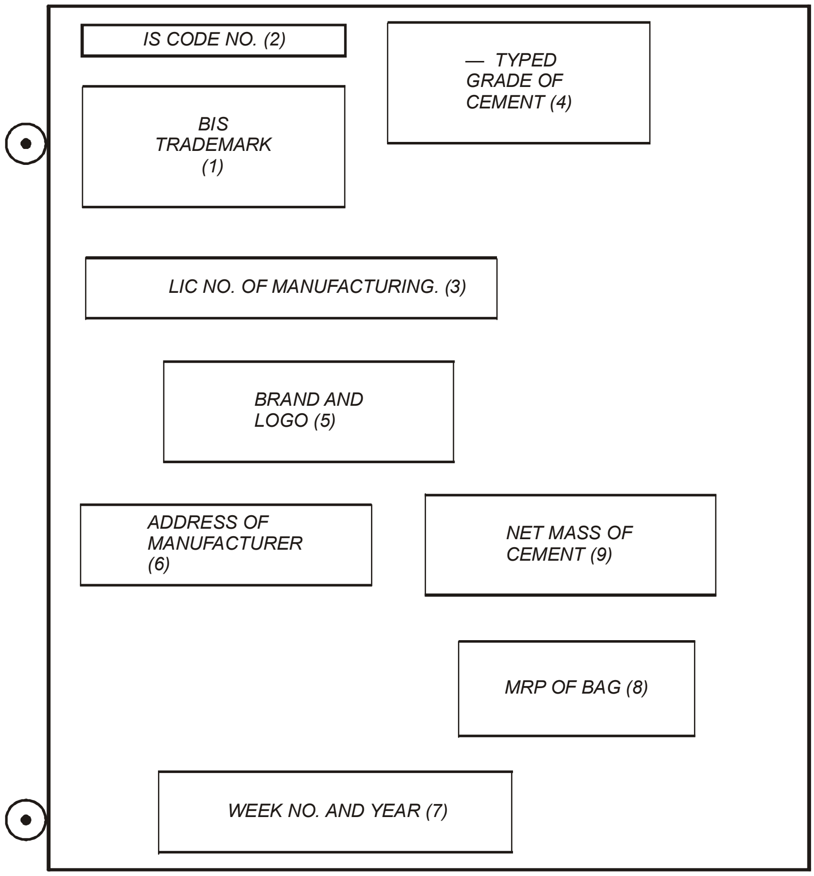


Fig. 1.16A.

Sulphate Resisting Cement (SRC) conforming to IS 12330 : 1988 and Portland Slag Cement (PSC) conforming to IS 455 : 1987. 33 grade of cement means that the compressive strength of cement when tested as per IS procedure at 28th day should not be less than 33 N/mm^2 or 33 MPa (or 330 kg/cm^2). For proper use of cement there is statutory requirement to print following informations on each bag of cement.

(1) BIS Trade mark, (2) IS code number, (3) Licence No. of manufacturer, (4) Type of cement, (5) Brand of cement, (6) Address of Manufacturer, (7) Week no. and year of manufacture, (8) Maximum retail price of bag, (9) Net mass of cement. Thus a typical bag of cement is having above informations printed as shown in Fig. 1.1.

Before using a cement bag following should be checked :

(*i*) Number and year of manufacturing of cement bag marked on each bag. First week starts from 01 January of the year. Cement looses its strength gradually with the period of storage and storage conditions as given in following table :

Period of storage of the cement	*Expected reduction in 28 days strength*
Fresh	0%
3 months	15% to 20%
6 months	25% to 30%
1 year	35% to 30%
2 years	50% and above.

Cement should be used within 90 days of its manufacture. If due to some unavoidable reasons, it has been in storage for longer period then it should be tested before use.

(*ii*) The markings on the cement bag as per B15 requirements.

(*iii*) Whether the company's original packing is intact.

(*iv*) After opening the bag immerse hand inside the bag. No lumps should be present in the bag.

(*v*) Taking a handful of cement put it slowly in a bucket full of water. Cement particles should float for some time. Subsequently there should be complete sinking of cement particles.

(*vi*) Make cubes of 5 cm size (5 × 5 × 5 cm) from the cement paste. Keep them immediately in water. After 24 hours the edges of the cubes should remain sharp and it should gain some strength.

(*vii*) Cement should feel silky smooth when squized between fingers and should not be gritty.

If the cement is not stored properly then it may loose its strength hence following care should be taken while storing cement bags.

(*a*) It should been ensured that floor, wall sand ceiling of the godown are dry before storing cement bags.

(*b*) Cement bags should be stocked on wooden planks or a tarpaulin.

(*c*) More than 12 bags should not stacked in height.

(*d*) Bags should be stacked in such a way that it can be removed on "First in First out" method.

(*e*) At least 30 cm gap should be left between cement bags and walls and 60 cm gap between ceiling and the top of pile.

(*f*) For temporary storage of 1 tonne cement (20 bags) approximately 0.5 m^2 or 5 square feet area is required.

Stone Aggregates :

(*i*) Stone aggregates should conform to IS 383 : 1970.

(*ii*) Stone aggregates must be clean and free from clay, weeds and other organic materials.

(*iii*) Should not be porous. When immensed in water for 24 hours, the water absorption should not be more than 1%.

(*iv*) Elongated and flaky aggregates should be avoided as they reduce the strength of concrete due to improper compaction and water demand goes up. They should be well graded to give maximum dry packing density. Angular and cubical aggregates are best.

(*v*) When the sand is in moist condition its volume is increased compared to volume of dry sand. The increase in volume in sand is known as bulkage. Volumetric proportions of concrete such as 1:2:4 etc. are based on volume of dry sand. Bulkage depends on fineness of sand (fine sand bulking more) and its moisture content. A moisture content of 2% to 5% increases the volume of sand by 10% to 20% or some times even 30% if sand is fine.

(*vi*) Generally sand is brought to the site in moist condition. Hence, correction for bulkage is necessary. If correction for bulkage is not done, concrete will be under sand proportion. It will be of low workability and more porous. The yield of concrete per bag of cement will also be less.

Correction for Bulkage :

Mix required is 1:2:4 (volumetric) Dry volume of different ingredients ;

Cement	*Sand*	*Stone Aggregates*
35 litres	70 litres	140 litres
(1 bag)	(dry sand)	(dry aggregate)

Let sand is moist and bulkage is 20%.

Hence, material required

Cement	Sand	Stone Aggregates
35 litres	$70 \times (1 + 0.2)$	140 Litres
Corrected volume		
35 litres	84 litres	140 litres.

For R.C.C. Work :

(*v*) Normal size of aggregates for RCC work are 20 mm and 10 mm. For mass concrete work 40 mm can be used for concretes up to M-20 grades. However, strength of concrete is reduced for M.35 and above grades if 40 mm size aggregates are used.

Fine Aggregates (Sand)

(*i*) Sand should be free from silt, clay, salts and organic materials. If present, silt and clay should not be more than 7% (by volume) and not more than 3% (by weight).

(*ii*) The grading patterns of sand is found by sieve analysis, as per IS 383 : 1970.
Sand is graded in four Zones : 1 to IV.
Zone I is coarsest and zone IV is finest.

Type of sand	*Zone*	*Fineness Modulus*	*Recommendations for use in concrete*
Fine sand	IV	2.2 to 2.6	+ 1.5% for zone I
Medium sand	II to III	2.6 to 2.9	– 1.5% for zone III
Coarse sand	I	2.9 to 3.2	– 3.0% for zone IV

(*iii*) For R.C.C. work zone (*II*) or (*III*) sand is used (preferably zone (*II*)). If zone (*II*) sand is not available, correction in the quality of sand should be done as per table given above.

(*iv*) Sand having a fineness modulus more than 3.2 is unsuitable for use in concrete.

Water for Concreting :

Water for concrete should be free from impurities such as oil, alkalies, acids, salts, sugar, organic Materials and any other substance which may be deleterious to concrete and steel.

Generally potable water is fit for making concrete.

Reinforced Cement Concrete (R.C.C.) :

Mixture of cement, sand and stone aggregate without reinforcement is plain cement concrete (P.C.C.) and if reinforcement is added to P.C.C. it is reinforced cement concrete (R.C.C.). Properties of cement, sand and stone aggregate to be used have already been discussed. Properties of steel to be used in R.C.C. will be having following properties.

Steel Reinforcement :

Steel reinforcement to be used in R.C.C. are round mild steel bars or deformed (twisted) steel bars conforming to I.S. 432 (Pt *ii*)-1966, 1786-1966 and 1139-1996 respectively. The bars are to be free from corrosion, loose rust scales, oil, grease, paint etc. Bars should be round and capable of being bent without fracture. Bars are to be hooked and bent accurately and placed in position as per design and drawing and bound together tight with 20 S.W.G. anneled steel wire at their point of intersection. Joints in the bar are to be avoided as far as possible. But if at all needed, an overlap of 40 times diameter of the bar is to be given with proper hooks and ends. When provided, joints are to be staggered. Bigger diameter bars should be joined by welding. While concreting steel bars are given side and bottom covers of concrete by placing precast cover blocks underneath.

Blocks are in cement mortar 1:2 of size 2.5 cm × 2.5 cm (1′′ × 1′′) in section and thickness as per requirement (4 to 5 cm for beam and 1 cm 2 cm for slab). During laying and compacting of concrete care is to be taken that reinforcing bars do not move from their boiston. Concrete after laying is compacted by mechanical vibrating machine until a dense concrete is obtained. Compaction should be completed before initial setting starts *i.e.,* within 30 minutes of addition of water to the dry mixture. Concrete should be laid continuously. If laying is to be suspended for rest of the following day, the end should be sloped at an angle 30° and made rough for future jointing. When the work is resumed, the previous sloped position should be roughened, cleaned and watered and a coat of neat cement is applied and the fresh concrete is laid.

Measurement is done in cubic m or cu ft. for the finished work and no deduction is made for the volume of steel. Steel reinforcement is measured under a separate item in quintal or kg. Plastering if any is not included in the measurement. The rate for R.C.C. work is complete work including centering and shuttering and all required tools and plants but excluding steel.

Cement Mortar :

The cement mortar is prepared by mixing cement and sand in required proportion of 1:3, 1:4, 1:5, 1:6 etc. The unit of measurement for cement is one bag of cement weighing 50 kg and is taken as 35 litres. Measurement is done by a wooden box known as forma. Sand in required proportion is measured in the forma on the basis of its dry volume. If the sand is damp, volume is suitably increased for bulkage.

Measured quantity of sand will be taken and levelled on clean masonary platform and cement bags emptied on the top of sand taken. The cement and sand is thoroughly mixed dry by turning over and over backward and forward till the mixture becomes uniform. Water is added only to that quantity of the mixture which can be used within two hours of adding water. Amount of water to be added is just to give the mortar to a consistency of a stiff paste.

Brick Work :

The brick work is classified according to the class of bricks used. First class bricks are used for important construction and building where as second class bricks are used for inferior type of work.

For first class brick work bricks are made of good brick earth and thoroughly burnt. Bricks are to be regular in shape having sharp edge and deep cherry red or copper colour. They should emit clear ringing sound when struck and have to be free from cracks, chips, flaws and lumps of any kind. Water absorption should be not be more than one sixth of their weight after one hour of immergence in water. First class bricks are supposed to have minimum crushing strength of 105 kg per sq. cm. Proportion of cement sand mortar are 1:3 to 1:6 depending upon type of work. Generally for brick work in foundation, cement sand mortar used is 1:3 or 1:4 where as for superstructure common mortar proportion is 1:6.

Before use, bricks are fully soaked in clean water by submerging in a tank for a period of 12 hours immediately before use. In no case soaking should be discontinued till air bubbling is continuing. Bricks are laid and well bonded mostly in English bond. Every course is to be truly horizontal and wall will be truly in plumb (*i.e.,* vertical). Vertical joints of consecutive two course should not come directly over one another. Vertical joints in alternate course come directly over one another. Mortar joints are not to exceed 6 mm in thickness and joints are to be filled with mortar. Bricks are to be laid such that frogs are upward in the top course. Brickwork will not be done more than 1 m in height at a time. When a part of the wall is to be discontinued, stepping are provided at an angle of 45°. Where projections are made, it should not be 1/4 brick projection in one course. All joints are to be raked and faces of wall cleaned at the end of day's work. The brick works are to be kept wet for a period of at least 10 days after laying.

Cement Plaster :

Before plastering, joints of the brick work are to be raked out to a depth of 18 mm and surface of the wall kept wet for two days before plastering cement and sand is to be of standard specification. Sand and cement are first dry mixed in required proportions measuring with measuring boxes and then water mixed slowly and mix mixed thoroughly. Thickness of plaster commonly is 12 mm which is applied in two or three coats. For ensuring unfirom thickness of plaster, patches of 15 cm × 15 cm 1 mm apart are applied first to act as a guide. External plastering is started from top and worked down. Ceiling plastering is completed before starting of wall plaster. All corners and edges are to be rounded off. Curing is to be started as soon as the plaster has hardened sufficiently keeping in view that plasters may not be damaged when watered. The finish plaster is kept wet for at least 10 days. Common proportions of mortar are: 1 : 3, 1 : 4, 1 : 5 and 1 : 6.

For ceiling plastering proportion is 1 : 3.

Cement Concrete Flooring :

The proportion which is most commonly used is 1:2:4. The cement being fresh portland cement, sand of coarse quality but 5 mm maximum size and down and aggregate of hard stone of 20 mm gauge but well graded. The floor is first levelled and divided into panel of size 1 metre in smaller dimensions and 2 metres in larger dimensions. Sometimes panels of 1 m × 1 m are also provided. Glass or aluminium strips of 3 mm thickness and depth equal to thickness of floor is fixed on the cement mortar base. Required slope is given in the floor for draining wash water.

After dry mixing of cement, sand and aggregate water is to be added slowly but not to exceed 30 litres per bag of cement. Concrete for one panel is mixed in the lot. Alternate panels are laid on alternate days. Laying of concrete will be in two layers. Lower layer of 22 mm thickness and the upper one in 3 mm thickness. Final surface is finished with wooden floats. Care is to be taken that whole process of laying is completed within 30 minutes. After laying, surface is left undisturbed for 2 hours and then covered with wet bags. After 24 hours curing is done by flooding with water for 7 days. Finally surface of the floor is polished as specified. For polished floor the thickness of surface cement finishing is to be 2.5 mm to allow for grinding and polishing.

Mosaic or Terrazo Flooring :

Mosaic or Terrazo flooring consists of two layers. The bottom layer of 2 to 2.5 cm cement concrete of 1:2:4 proportions and the top layer of 6 mm thickness consisting of marble chips and cement in the proportion of 1:1½. One part of cement and 1½ parts of marble chips. The top layer is laid on the following day. The minimum thickness of topping is not to be less than 1½ times the minimum size of the chip. When large size of chips (20 mm or 25 mm) are used they are to be used only with flat shape and beded on the flat face so as to keep the thickness of the wearing layer to be minimum. The maximum thickness of the top layer for various sizes of marble chips are as given in the following table.

Sl. No.	*Code No.*	*Size of marble chips in mm*	*Minimum thickness of top layer in mm.*
1	00	1-2	6
2	0	2-4	9
3	1	4-7	9
4	2	7-10	12

Cement concrete is prepared by mixing ingredients as per standard practice. The base is made rough and watered and given a cement wash and then the concrete is laid in 2 cm thick layer in panels of 1 m × 2 m or 1 m × 1 m bounded by 3 mm thick glass or aluminium strips. After laying, the concrete is compacted by beating and tamping and levelled with wooden float. The marble chips and cement is mixed by measuring with boxes to have the required proportion in dry condition. After thorough dry mixing water is added gradually to give a uniform plastic mix. The mosaic or terrazo topping is to be laid when the under layer is still plastic but has hardened sufficiently to prevent cement from rising to surface. This is normally achieved around 18 to 24 hours after laying the under layer. A cemed slurry of the same colour and brand is to be brushed on the surface immediately before laying. The top layer is to be laid to a uniform thickness but slightly more than specified so that required finished surface is obtained after rubbing. The surface of the top layer is to be travelled over, and brought to the required level by a straight edge and steel floats in such a manner that the maximum number of chips come up and are spread uniformly over the surface.

Preferably polishing is to be done by machine. After 36 hours of laying the top layer the surface is to be watered and grounded evenly with machine fitted with carborundum stone of coarse grade No. 60 till marble chips are evenly exposed and the floor is smooth. After first grinding the surface is to be thoroughly washed to remove all grinding mud and covered with a grout of cement in the same mix and proportion as the topping in order to fill any pin holes that may appear. The surface is to be allowed for curing for 5 to 7 days and then grounded with polishing machine filled with grit block of No. 120. The surface is to be again cleaned and repaired and allowed to cure again for 3 to 5 days and finally the third grinding is to be done with the polishing machine fitted with fine grade grit block of No. 320 to have an even and smooth surface.

After final polishing, oxalic acid is to be dusted over the surface @ 33 gm/sq. m sprinkled with water and rubbed hard with a pad of wooden rags. The next day the floor is to be wiped with a moist rag and dried with a soft cloth and finished clean.

During summer if the temperature exceeds 38°C, concreting is not to be done because there are chances of appearance of shrinkage cracks in the concrete.

Damp Proof Course

The damp proof course consists of cement, coarse sand and stone chips in proportion 1 : 1½ : 3 with 2% of cement weight of some water proofing material such as impermo, cem-scala Acco proof. It means per bag of cement 1 kg of water proofing material is added to dry cement and mixed with sand and then stone aggregate and finally water is added to prepare the mix of required consistency. The damp proof course is to be applied on the wall at the plinth level in a horizontal layer of 25 mm thickness. As per normal practice for concrete, material cement is to be fresh, sand clean and coarse (5 mm size and down) and stone chips of 20 mm maximum size well graded free from dust and dirt. The damp proof course is to be cured by watering and kept wet for 7 days and after that construction of wall above is to be started.

Sometime, to be more sure about damp proofing two coats of asphalt painting is applied on the upper surface of the damp proof course. The first coat of hot asphalt is applied uniformly at rate of 1.5 kg per sq. m when the concrete is dry and painted surface is to be blinded immediately with coarse sand and the surface tamped lightly. Next second coat of hot asphalt is applied at the rate of 1 kg per sq. m. After putting the second coat the surface is to be immediately blinded with coarse sand and tamped lightly.

Doors, Windows and Ventilators :

Timber for frames (chaukhats) and leaves (shutters) for doors, windows and ventilators are to be of good quality well seasoned and free from sap, knots, warps, cracks and other defects. For chaukhats shisham or sal wood is best where as for shutters teak is best.

Chaukhats are to be properly framed and joined by mortise and tenon joints. Common sections of chaukhats are 75 × 100 mm, 100 × 100 mm, 80 × 120 mm depending on openings. Larger opening having bigger section. Concealed faces of Chaukhats are to be painted with two coats of coaltar and other faces painted with a´ coat before fixing in position.

Shutters may be panelled, partly panelled and partly glazed or fully glazed in case of Windows and Ventilators. Thickness of shutters are 30 mm to 50 mm depending upon size of opening and number of leaves in an opening. The styles and rails and framed properly and accurately with mortise and tenon joint and fixed with wooden pins. Common thickness of panels are 12 mm to 25 mm. All doors are provided with handles on both sides and all windows with handles on the inner side. Necessary hinges, tower bolts, hook bolts, stops for keeping leavers open are to be provided. Fittings are of iron, brass or oxidized as per finance available. The surface of shutters are to be painted with two coats of approved paint over a coat of priming.

MIX DESIGN OF CONCRETE (VOLUMETRIC)

A guide-line is given for design of mix on the volumetric basis :

(*i*) Assume a mix design for 1:2:4.

(*ii*) Bulkage of sand 20%.

Oversize particles in sand 5% (retained on 4.75 mm sieve).

Absence of fine particles in sand (*i.e.,* below 600 microns).

(*iii*) Sand :

70 litres of oven dry sand is required for 1 bag of cement (which measures 35 litres).

Accounting for 20% bulkage

Volume of sand = 70 + 70 × 0.2 = 70 + 14 = 84 lit.

Accounting for 5% oversize in sand

= 84 + 84 × 0.05 = 84 + 4.20 = 88.2 lit say 88 lit.

(*iv*) Aggregate :

140 lit of aggregate is required

4.2 lit, say 5 lit will be coming from sand

20 mm (3/4´´) metal = 90 lit

10 mm (1/2´´) metal = 35 lit.

(*v*) Stone Dust :

10 lit stone dust is recommended.

This gets absorbed volumetrically and does not increase quantity of sand and takes care of absence of fine particles (*i.e.,* below 600 microns) in sand.

(*vi*) Therefore, the recommended size of farma (size of measurement box) and quantity of material will be:

Cement - 1 Bag (35 lit) forma size = 35 cm × 40 cm × 30 cm

Sand - 2 farmas full and one farma halfAggregate - 3 farmas full and one farma less by 10 cm.

(*vii*) Therefore, actual proportions by volume = 1 : 2.5 : 3.7.

VASTU SHASTRA

Vastu Shastra is an ancient Indian Science which capitalises on the concept of prosperity. It links person's health and happiness directly with layouts and construction of a building.

Promoters of Vastu Shastra propagate that it is the most authentic and proven editice science. They say that nature consists of five basic elements energy of planets, air, water, fire and earth. Each carries its own set of dynamics and with Vastu one's home and business can be synchronised. As per promoters of the shastra it creates a tremendous impact over all facts of life, *i.e.* health, life, education, thinking, prosperity, marriage and peace of mind.

In fact 'Vastu Shastra' is the science of the ancient Vedic Ages" of India under the guidance of which one can construct building of structures on a particular plot of land. For some people these principles are still relevant today alow. As per their belief the scienec of Vastu Shastra" controls forces of gravity and magnetic power of the earth.

Existance of roads on the Northern or Eastern side of the house improves the health and progress of the members of the house.

But if a house has roads on three sides, its inhabitants suffer tension and tension related problems.

The plot at the end of a road is also not good for its inhabitants.

It is good to have main door on East, Northern and North Eastern corner of the house. A house having main door at the South-West end provides less peace and perpetually tense atmosphere.

A house having massive main door gives a lot of unsavary events and members residing suffer health problems.

Walls of house should have soothing and soft colours on walls as this gives a tension free atmosphere. Deep yellow, Red or Orange coloured walls give irritation to the occupants.

All water-related appliances/resources of the house should be placed on North East area. This provides prosperity. A well or a tube well should never be provided on South-East end of the house. A well of tube well at centre of the house brings good luck to its Head.

Presence of plants of 'Tulsi', Banana, Champa, Ashoka, Aawla outside the house keeps inhabitants healthy, happy and peaceful.

SOME TIPS OF VASTU FOR FLATS

With scarcity of land in urban areas construction of flats has became a common practice. Flats are economical and have some added benefits such as security, common recreation centres, shopping area etc. Therefore in urban areas purchase of flats are more common than constructing a house on a plot which becomes quite expensive.

In fact construction of flats as per Vastu is difficult still satisfactory results could be if one follows principles of vastu meticulously in selection of plot and construction of building.

As per Vastu shastries maximum benefits to the flat owners can be achieved keeping in mind following principles of Vastu".

The site should be a square or a rectangle. If possible south-west corner should have 90 degree.

The main road should be on North, East or North-East side of the plot. Two gates are preferable one on east and the other in the north. In addition to this North-East, South-West or North West blocks are also good.

Ground level should slope towards north-east and levels in south west should be higher than all other sides. A borewell should be provided in North-East before the construction takes place.

More space should be provided in the east and north compared to West and South of the complex.

Balconics towards north, east and north east are preferable.

Kitchen is advisable in south-east or north-west but never in north east.

Stair case should be provided in south, west or south-west and should be avoided in north-east because head room of the staircase higher than south west is not acceptable.

Main entrance into the flat should be from east, north, south north-east, west and north-west.

Wells and bore wells should not be provided in south-east north-west or south-west.

Underground room or space (Cellar) should be kept under the north-eastern or eastern portion of the complex or in southern or western side.

Parking in north-east cellar should be used for light vehicles (cars, scroters ecc.) and not for heavy vechicles (heavy trucks etc.)

Open area in north and south should be used for lawns, and sumps if required.

A.C. equipment should be kept in south-east of the complex and it should never be installed in north-east under any circumstances. Electrical Generators and Transformers should be installed in south-east direction.

Wash basins should be provided in north or east or north-east of the hall.

LIMITATION OF VASTU

A general recommendation from Vastu Shastra" has been provided for information of readers. While going through these recommendations they will conclude that most of the recommendations are governing the principles of good orientation and ventilation which our National Building code also has recommended. Since the principles of Vastu are coming from vedic period, to encourage people to get more benifits from nature, the principles have been associated mythologically so that people will follow them. Many examples could be cited to show that if principles of Vastu followed in constructing one's house one could be quite happy and prosperous.

EVALUATION OF A BUILDING WITH RESPECT TO VASTU SHASTRA

With help of following tables evaluation of a Building/House can be done based on principles of Vastu Shastra. Evaluation is out of 150 points. Maximum point is 15 for each item.

Table : VS-1

S.No.	*Shape of the house, Feeling of Residents position of Main entrance and different rooms*	*Maximum Point 150*
1.	Shape of Building	15
2.	How residents feel in the Building	15
3.	Position of Main Entrance (door)	15
4.	Master Bed Room	15
5.	Children's Bed Room	15
6.	Guest Room	15
7.	Kitchen	15
8.	Bath Room and Toilet	15
9.	Tube Well	15
10.	Servant's Room	15

Table. VS–2

S.No.	*Shape of Building*	*Point*	*S.No.*	*Residents Feeling*	*Point*
1.	Square-Extending North-East	15	1.	Happiness	15
2.	Square	13	2.	Healthy	12
3.	Rectangular	12	3.	Friendly	11
4.	Hexagon	9	4.	Ill Health	6
5.	Octagon	8	5.	Engaged in lawsuits	5
6.	Circular	7	6.	Mental Agony	6

Table VS-3
Points of different components of Building with respect to Directions

S.No	*Direction*	*Main Direction*	*Master Bedroom*	*Children's Room*	*Guest Room*	*Kitchen*	*Bath room / toilet*	*Tube-well*	*Servent's room*
1.	North-East	15	5	10	12	4	3	15	4
2.	East	13	9	11	11	8	6	12	8
3.	North	12	4	13	10	6	5	13	10
4.	North-West	10	10	15	10	13	15	8	15
5.	West	9	12	7	8	7	13	6	6
6.	East-South	8	—	—	—	—	12	4	—
7.	South-East	—	7	12	9	15	—	—	12
8.	South	6	13	6	6	10	9	5	5
9.	South-West	4	15	5	5	5	2	2	3

Table VS-4

Evaluation of Buildings with respect to Vastu Shastra

S. No.	*Points*	*Evaluation*
1.	150	Excellent
2.	149 — 120	Very Good
3.	119 — 100	Good
4.	99 — 76	Average
5.	Up to 75	Below Average

SPECIFICATION FOR AN OFFICE BUILDING

Specifications for Plate No. 1.3

With the following specifications and linesketch of a small office building, draw to a suitable scale (1 : 50) the following views :

(*a*) Ground Floor Plan
(*b*) Front Elevation
(*c*) Section at *ABCD*
(*d*) Section at *EFGH*.

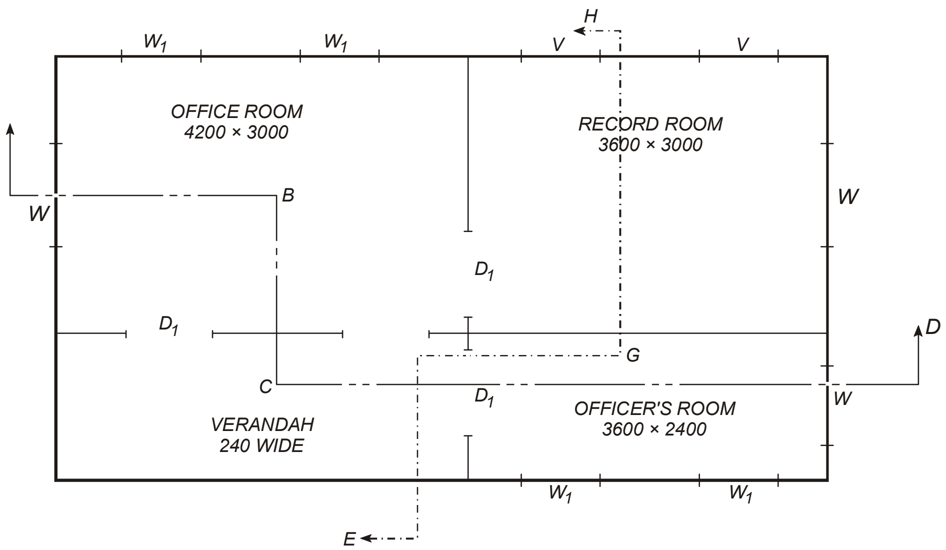


Fig. 1.17.

Foundation. The depth of foundation will be 900 mm. below ground level. The concrete course will be 1000 mm. wide and 200 mm. thick and will be in cement concrete 1 : 3 : 6. The first and second footing will be of brick masonry with 1st class brick in cement mortar 1 : 4 having width of 600 mm. and 800 mm. respectively. Thickness of each footing will be 300 mm.

Plinth. The height of plinth will be 600 mm. above ground level. Thickness of wall in plinth will be 400 mm. A damp proof course 50 mm. thick in cement mortar 1 : 3 will be provided all round the building.

Superstructure. Thickness of walls above plinth level (superstructure) will be 300 mm. Box type sunshade will be provided for all exterior windows. The sunshade for all exterior windows. The sunshade to be combined with lintels over all windows which will be 150 mm. thick. Projection of the sunshade will be 450 mm. from wall. Verandah opening will be 2250 mm. Above the verandah opening there will be 200 mm. thick R.C.C. beam which will support the brick-work upto the lower portion of the roof slab.

The R.C.C. beam over verandah opening will be supported on pillars. Pillar will be 300 mm. square but it will be Lashaped at the corner having thickness of 300 mm.

Ceiling height for rooms as well as verandah will be 3300 mm.

Roofing. The roof-slab will be of reinforced cement concrete (1 : 2 : 4) having thickness of 100 mm. Thickness of lime terrace over the roof-slab will be 100 mm. Parapet height will be 450 mm. Coping will be provided all-round the building (50 mm. × 50 mm.)

Flooring. 20 mm. thick floor finish of patent stone will be provided over 100 mm. rammed khoa over 150 mm. sand filling.

Doors and Windows

W – 1000 mm × 1200 mm

W_1 – 1500 mm × 1200 mm

D – 1500 mm × 2000 mm

D_1 – 1200 mm × 2100 mm

Ventilator – 1000 mm × 600 mm

Door and window frames – 100 mm × 75 mm

The drawings in the Plate 1.3 have been made as per the specification given above. To give a clear picture of section a perspective view also has been given.

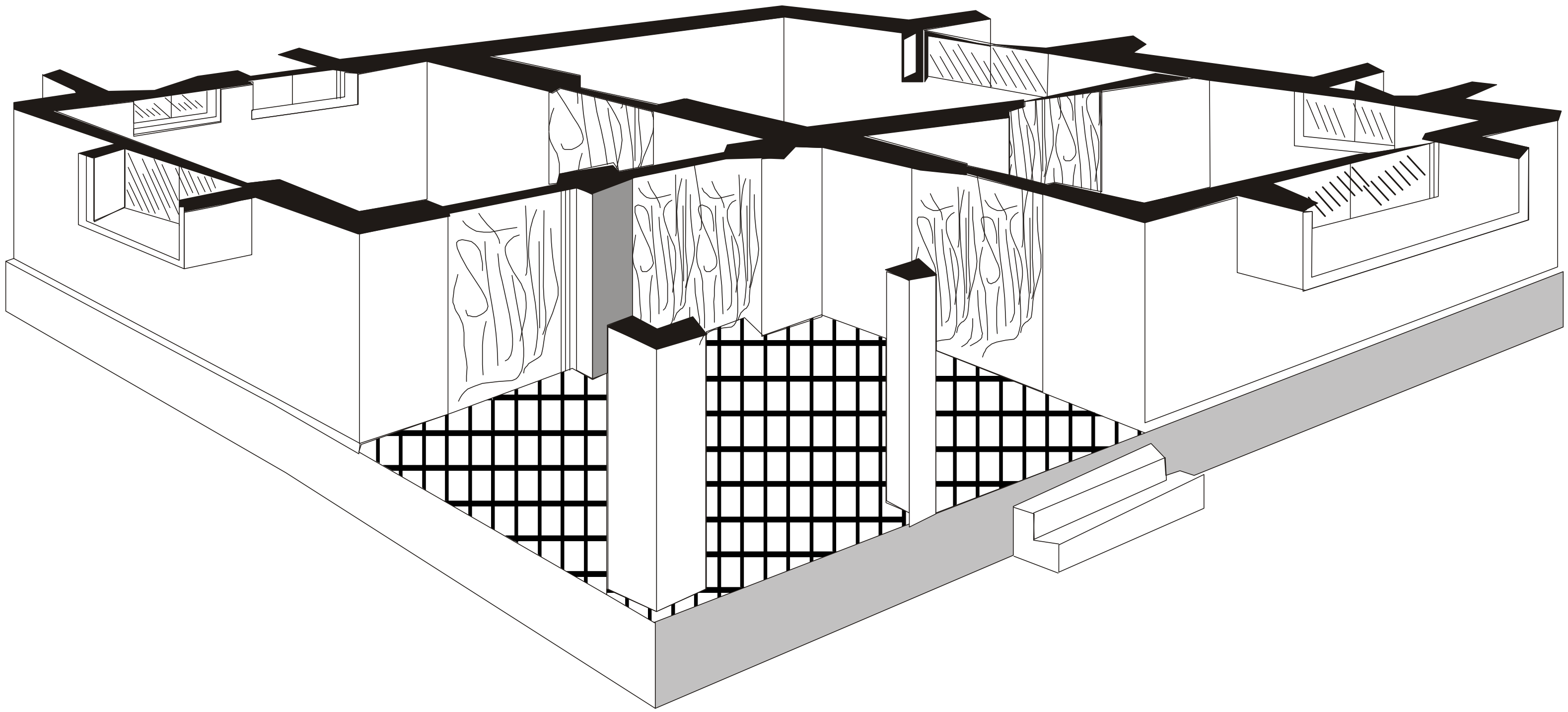
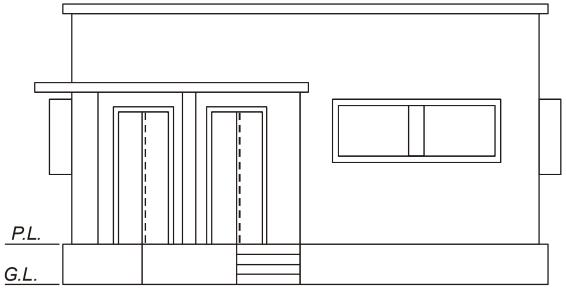
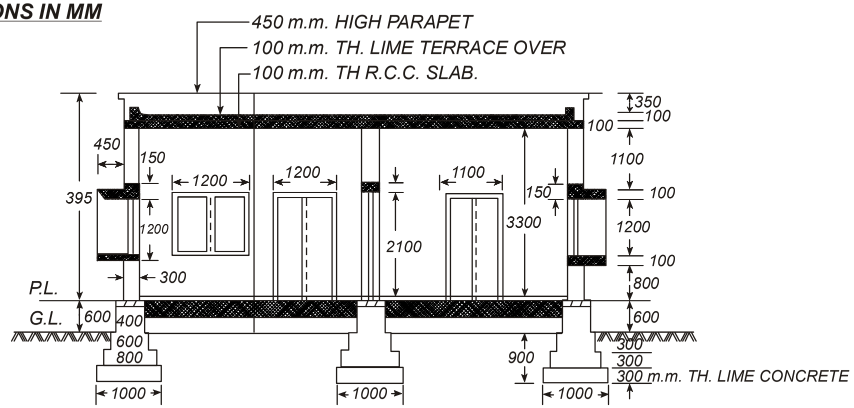


Plate No. 1.2.

A SMALL OFFICE BUILDING SCALE :— 1:100
ALL DIMENSIONS IN MM

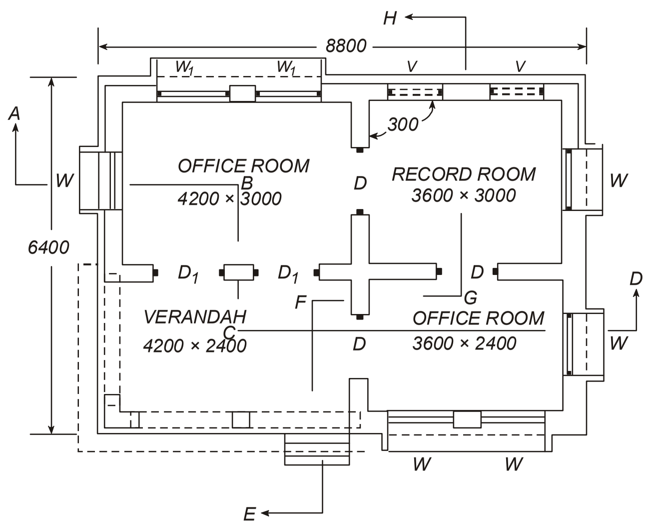


FRONT ELEVATION

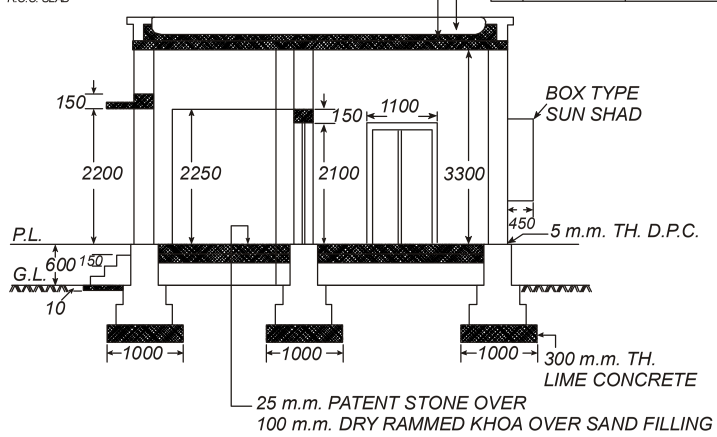


SECTION AT ABCD

SCHEDULE OF DOORS. WINDOWS & VENTILATION			
D	DOOR	PANNELED	1100 × 2100
D_1	DOOR	PANNELED	1200 × 2100
W	WINDOW	PANNELED	1000 × 1200
W	WINDOW	PANNELED	1000 × 1200
W_1	WINDOW	GLAZED	1200 × 1200
V	VENTILATION	GLAZED	1000 × 600



PLAN



SECTION AT EFGH

Plate No. 1.3

Problem for Practice

With above specification draw to a scale of 1:50 the following views of office buildings as shown in above Fig. 1.18 and Fig. 1.19 (a) Plan (b) Front elevation and section at ABCDE.

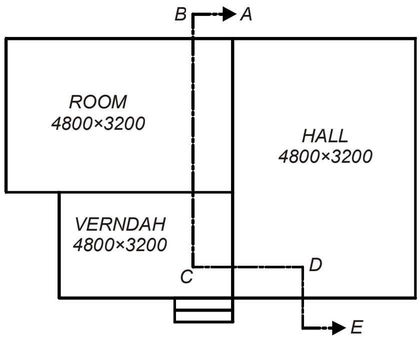
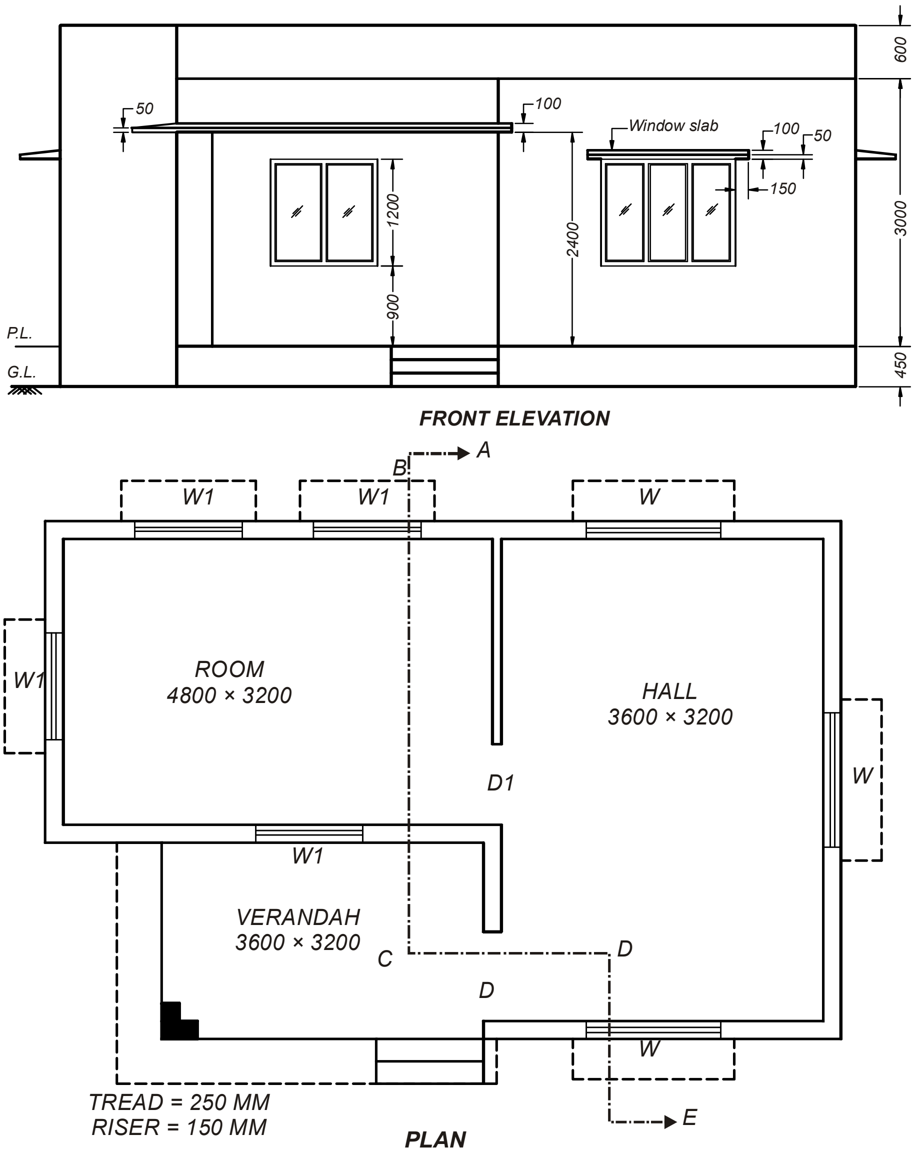
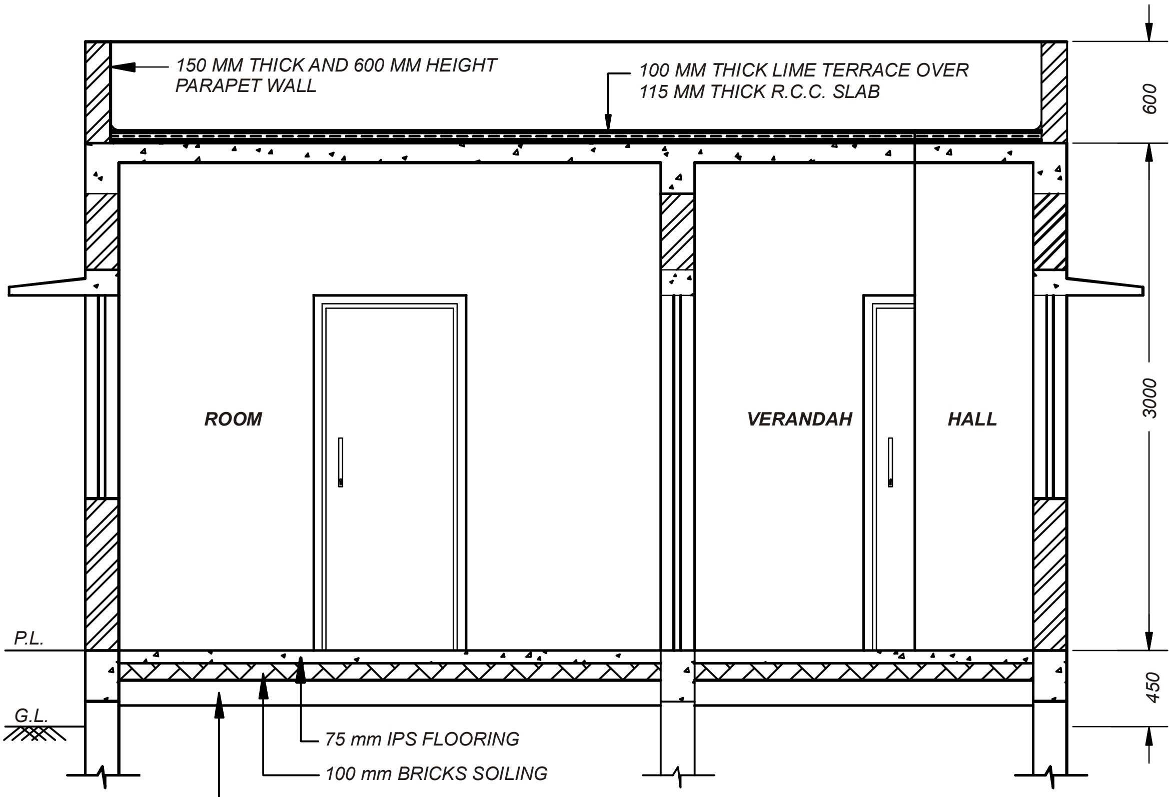


Fig. 1.18. LINE PLANE

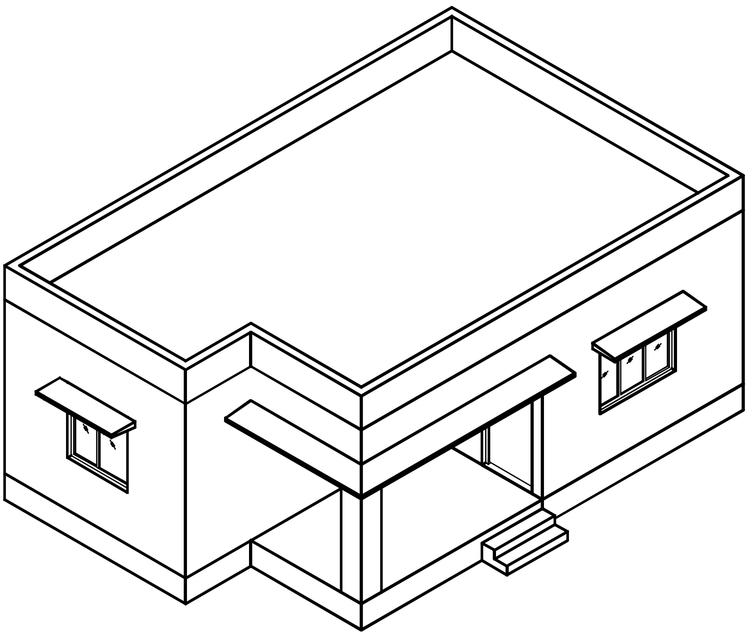


OPENING SCHEDULE		
DOOR	D	1000×2100
	D1	900×2100
WINDOW	W	1500×2100
	W1	1200×2100

Plan and Front Elevation of Fig. 1.18.



SECTION AT ABCDE



ISOMETRIC of Fig. 1.18.

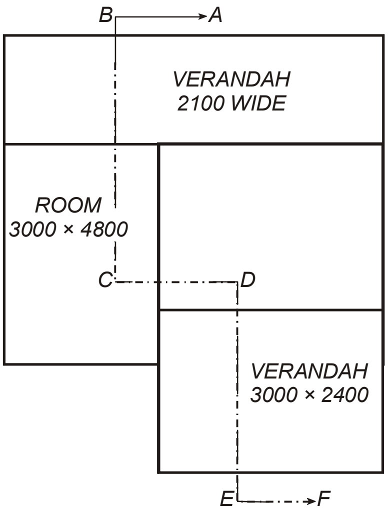
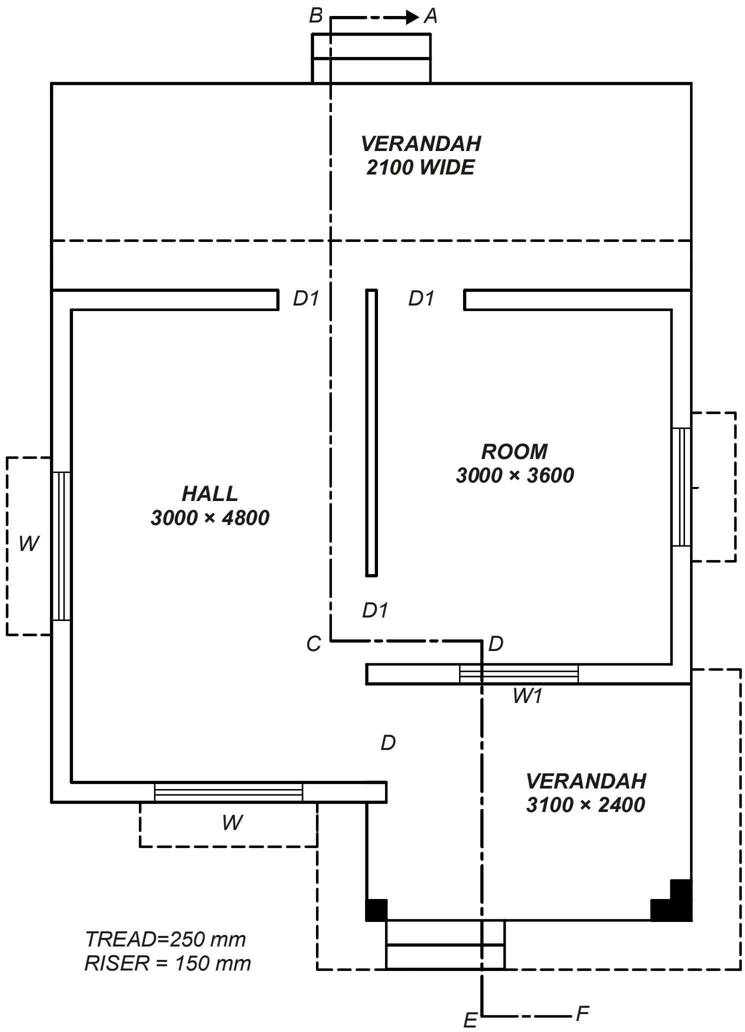
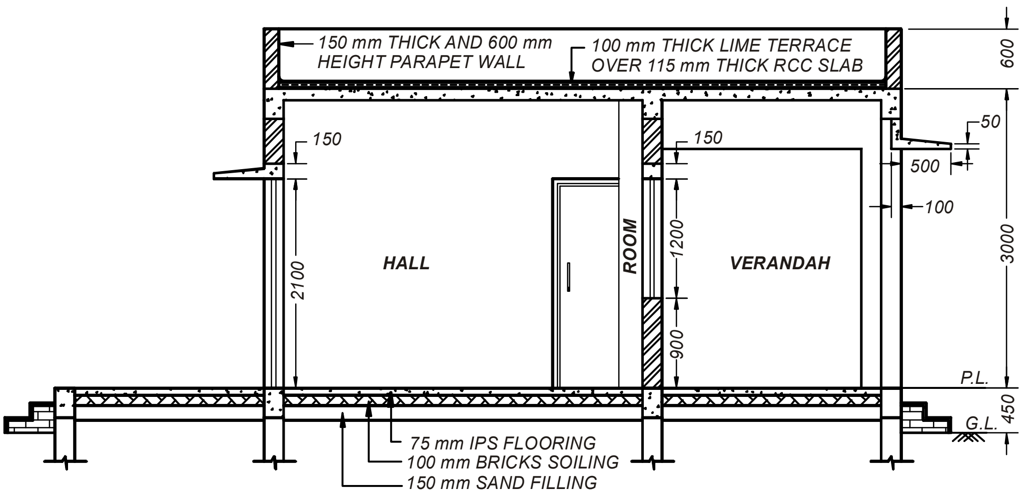


Fig. 1.19.



PLAN



SECTION AT ABCDEF

PLAN and SECTION of Fig. 1.19.

SPECIFICATIONS FOR A RESIDENTIAL BUILDING

Specifications for Plate No. 1.4

With the following specifications and line sketch (Fig. 1.20) of residential building, draw to a suitable scale (1 : 60) the following views (*a*) Plan, (*b*) Front elevation, (*c*) Section at *ABCD*, and (*d*) Section at *EFGH*.

Foundation. The depth of foundation will be 750 mm. below ground level. The concrete course at the base of the foundation will be 1000 mm. wide and 150 mm. deep. The footings will be of brick masonry with 1st class brick in cement mortar (1 : 4). Width of 1st and 2nd footings will be 500 mm. and 700 mm. respectively and each having thickness of 300 mm.

Plinth. The plinth height will be 450 mm. above ground level. Thickness of wall in pinth will be 300 mm. A D.P.C. will be provided 50 mm. thick in C.M. 1 : 3.

Superstructure. The wall in supper structure will be of 1st class brick in C.M. 1 : 6. Thickness of all walls will be 300 mm. except the partition wall between W.G. and bath, which will be 200 mm. thick. All exterior windows and the verandah opening will be having a chajja projection of 600 mm. The kitchen will be having shelves (as shown in the line sketch) in there tier. Projection of shelves will be 450 mm. beyond the wall. A cooking platform of 750 mm. width will be provided at a height of 750 mm. from floor level. Width of the sink will be 450 mm. Size of the cupboard will be 1050 mm. × 300 mm. × 2100 mm. The verandah opening will be 2250 mm. Height of wall for the courtyard–2300 mm.

Roofing. Roofing will be of R.C. (1 : 2 : 4) 125 mm. thick. Provide lime terrace of thickness 100 mm. over the roof slab. The parapet height will be 450 mm. Coping will be provided all-round the building (50 mm. × 50 mm.). Ceiling height will be 3600 mm. except for dining space, kitchen, W.C. and bath which in turn will be having ceiling height of 3150 mm. Ceiling height for verandah will be 3000 mm.

Flooring. Provide patent stone flooring of 25 mm. thickness over 100 mm. thick rammed *khoa* over sand filling.

Steps. Rise 150 mm. and Tread 200 mm. Door and window frame–100 mm. × 75 mm.

Size of Doors and Window

D – 1000 mm. × 2100 mm.
D_1 – 750 mm. × 2100 mm.
D_2 – 1100 mm. × 2100 mm.
D_3 – 600 mm. × 2000 mm.
D_4 – 1200 mm. × 2100 mm.
W – 1800 mm. × 1200 mm.
W_1 – 1500 mm. × 1200 mm.
W_2 – 900 mm. × 1200 mm.
W_3 – 600 mm. × 900 mm.

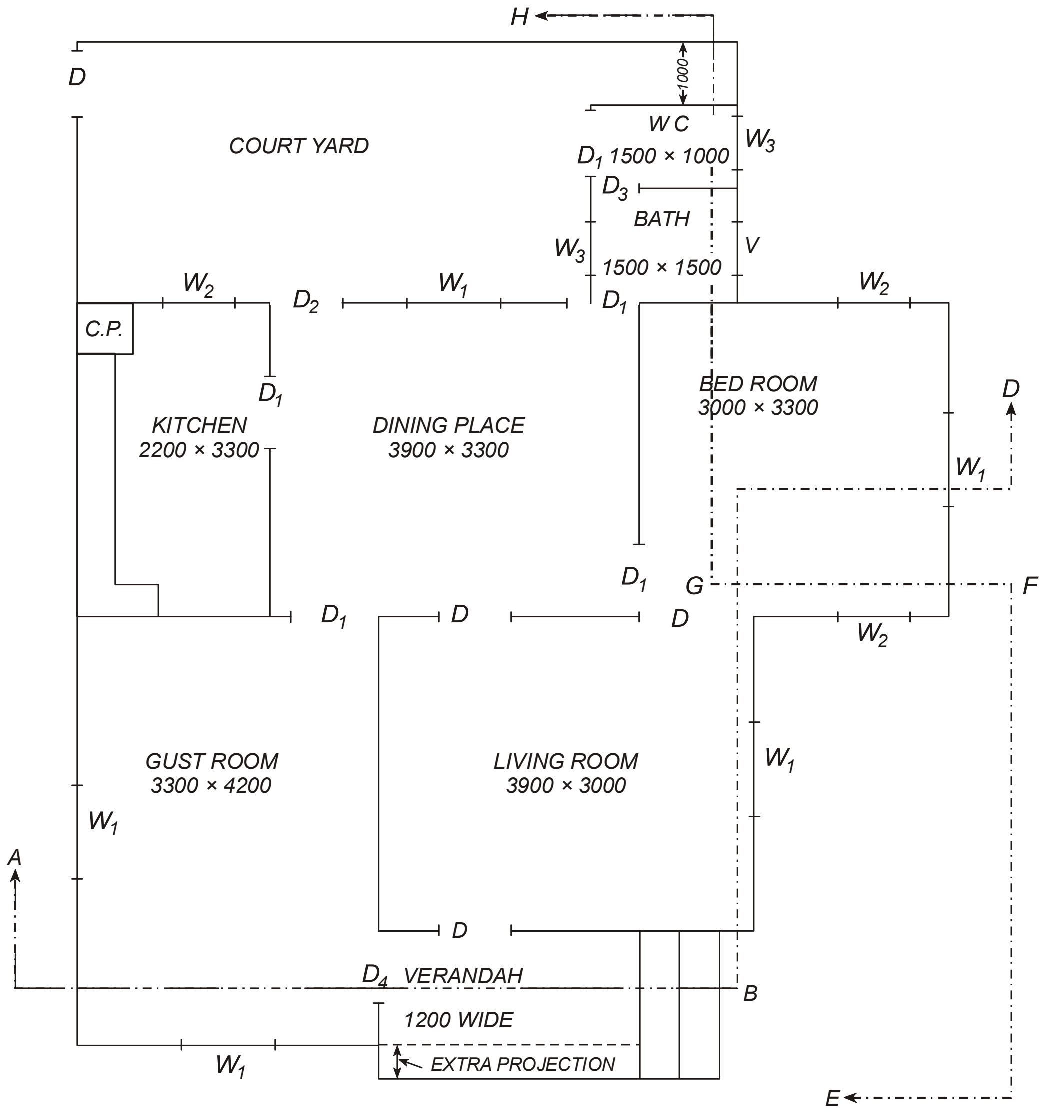
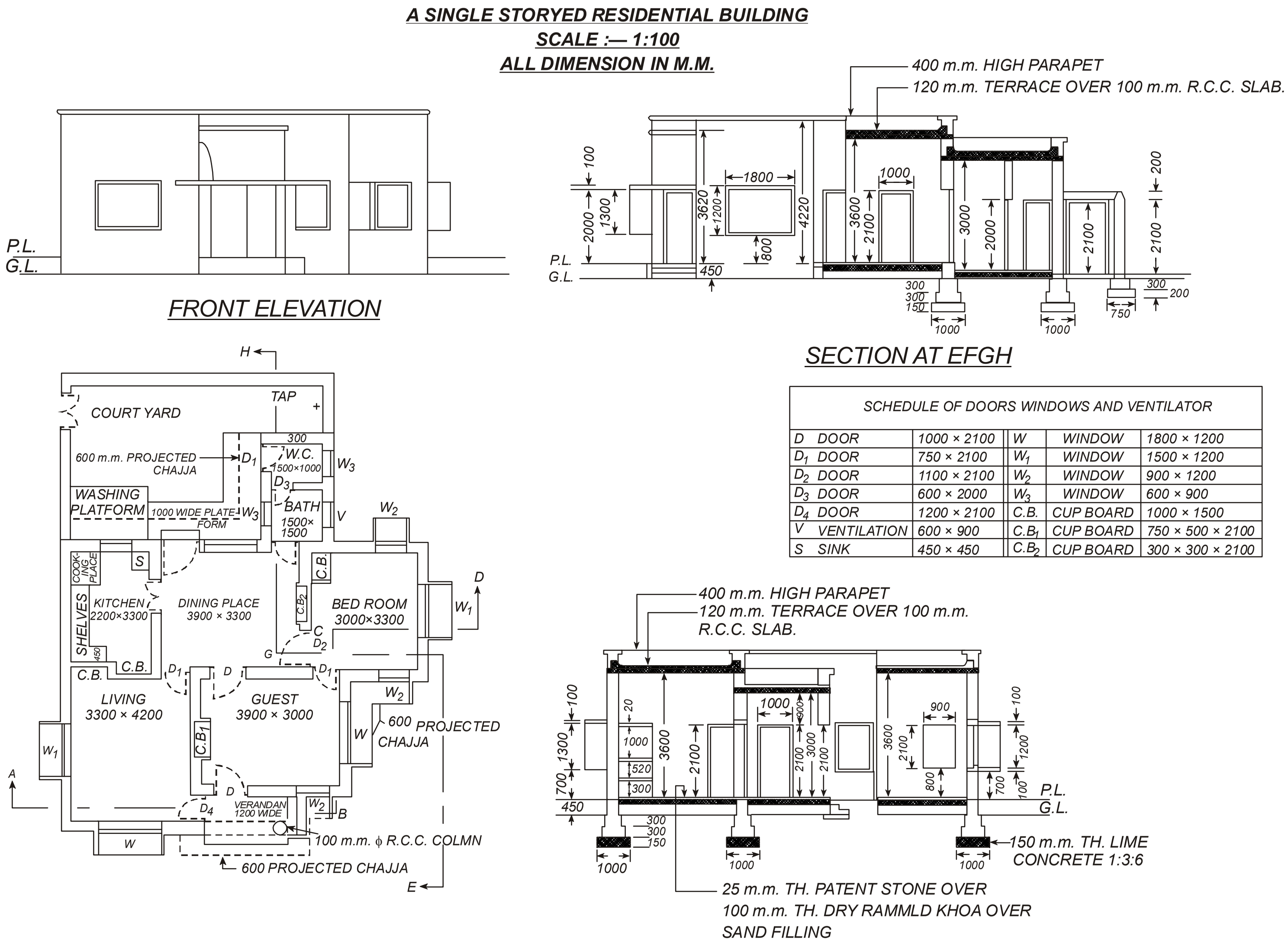

H
D
1000
COURT YARD
W C
D1 1500 × 1000
W3
D3
BATH
W3
V
1500 × 1500
W2
D2
W1
D1
W2
C.P.
D1
BED ROOM
3000 × 3300
D
KITCHEN
2200 × 3300
DINING PLACE
3900 × 3300
W1
D1
G
F
D1
D
D
W2
GUST ROOM
3300 × 4200
LIVING ROOM
3900 × 3000
W1
W1
A
D
D4 VERANDAH
B
1200 WIDE
W1
EXTRA PROJECTION
E

Fig. 1.20.



SCHEDULE OF DOORS WINDOWS AND VENTILATOR

D	DOOR	1000 × 2100	W	WINDOW	1800 × 1200
D_1	DOOR	750 × 2100	W_1	WINDOW	1500 × 1200
D_2	DOOR	1100 × 2100	W_2	WINDOW	900 × 1200
D_3	DOOR	600 × 2000	W_3	WINDOW	600 × 900
D_4	DOOR	1200 × 2100	C.B.	CUP BOARD	1000 × 1500
V	VENTILATION	600 × 900	$C.B_1$	CUP BOARD	750 × 500 × 2100
S	SINK	450 × 450	$C.B_2$	CUP BOARD	300 × 300 × 2100

Plate No. 1.4

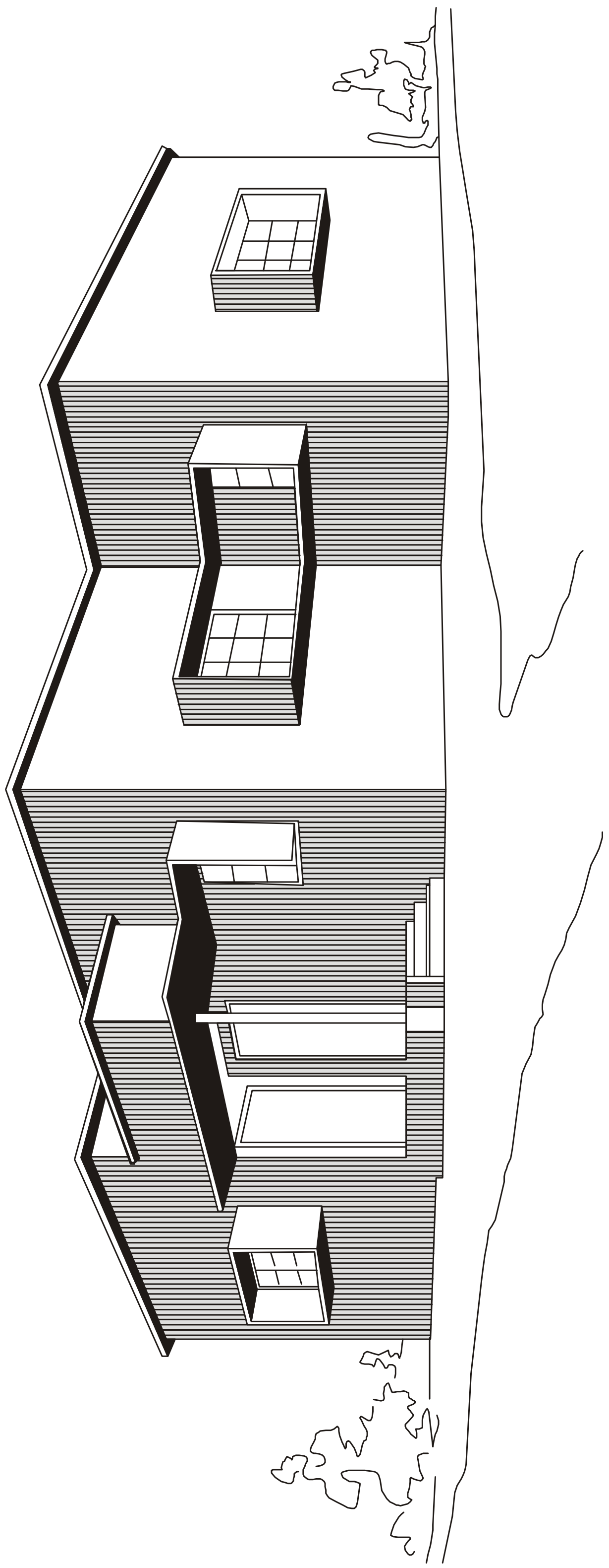


Plate No. 1.5

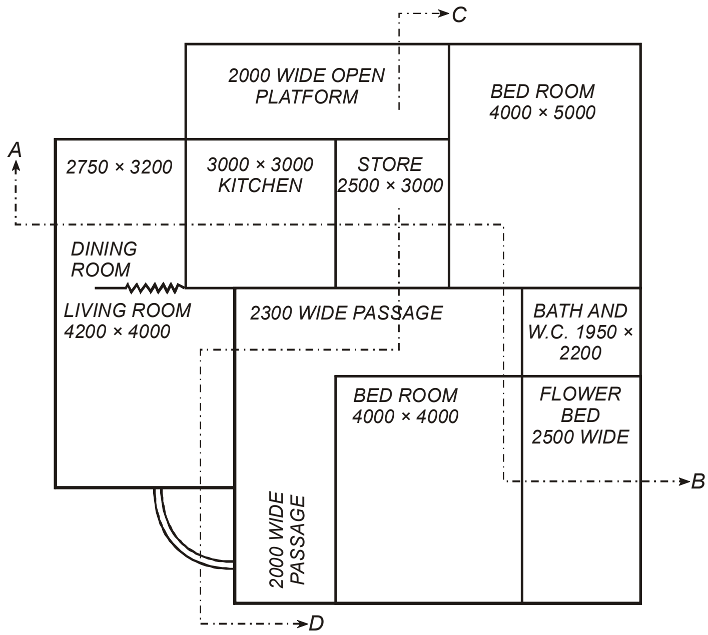


Fig. 1.21.

The Drawings in the Plate 1.4 have been made as per above specifications. A perspective view of the building also has been given.

Problem for Plate No. 1.6

With the above specifications draw the following views from line sketch given in Fig. 1.21.

(*a*) Plane, (*b*) Elevation, (*c*) Section at *AB*, and (*d*) Section at *CD*.

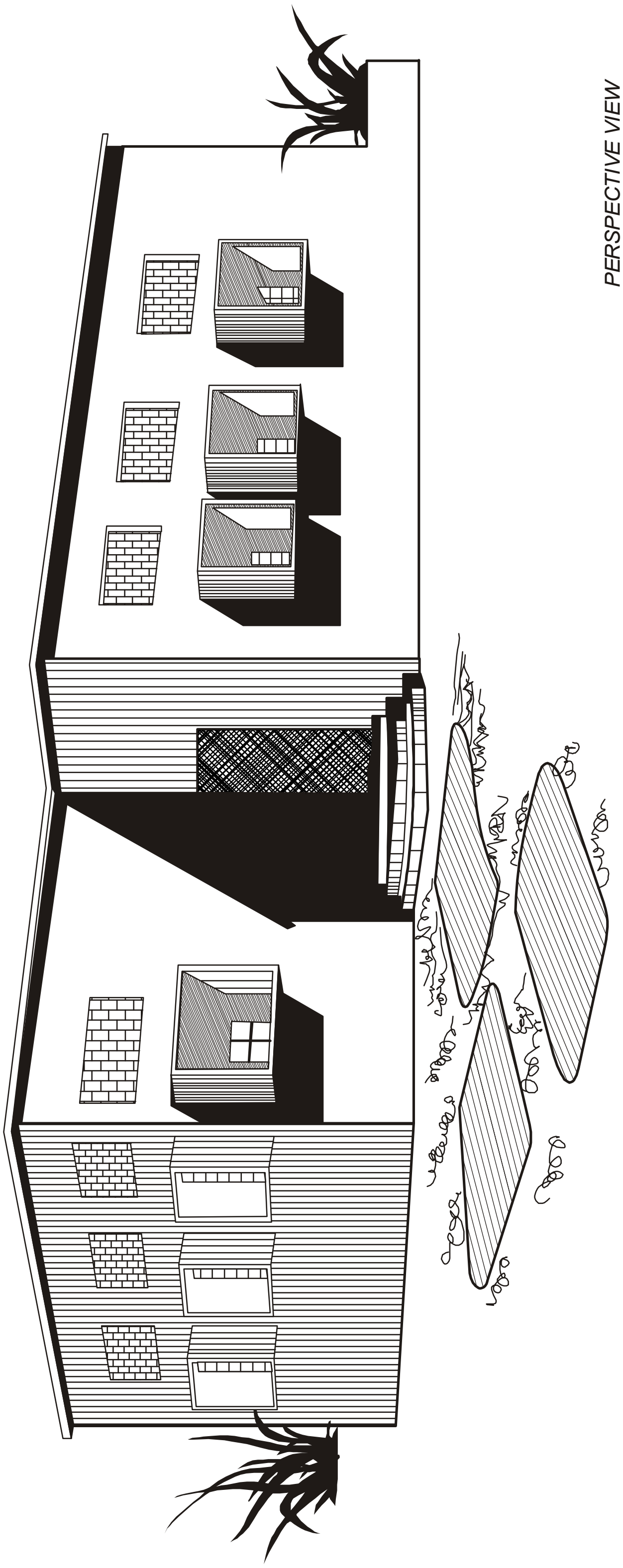
Problems for Practice

1. With the specifications given for Plate No. 1.4 draw to a scale of 1 : 50 the following views of Residential buildings shown in Figs. 1.22, 1.23, 1.24 and 1.25.

   (*a*) Plan ; (*b*) Front Elevation, and (*c*) Section at *AB*.

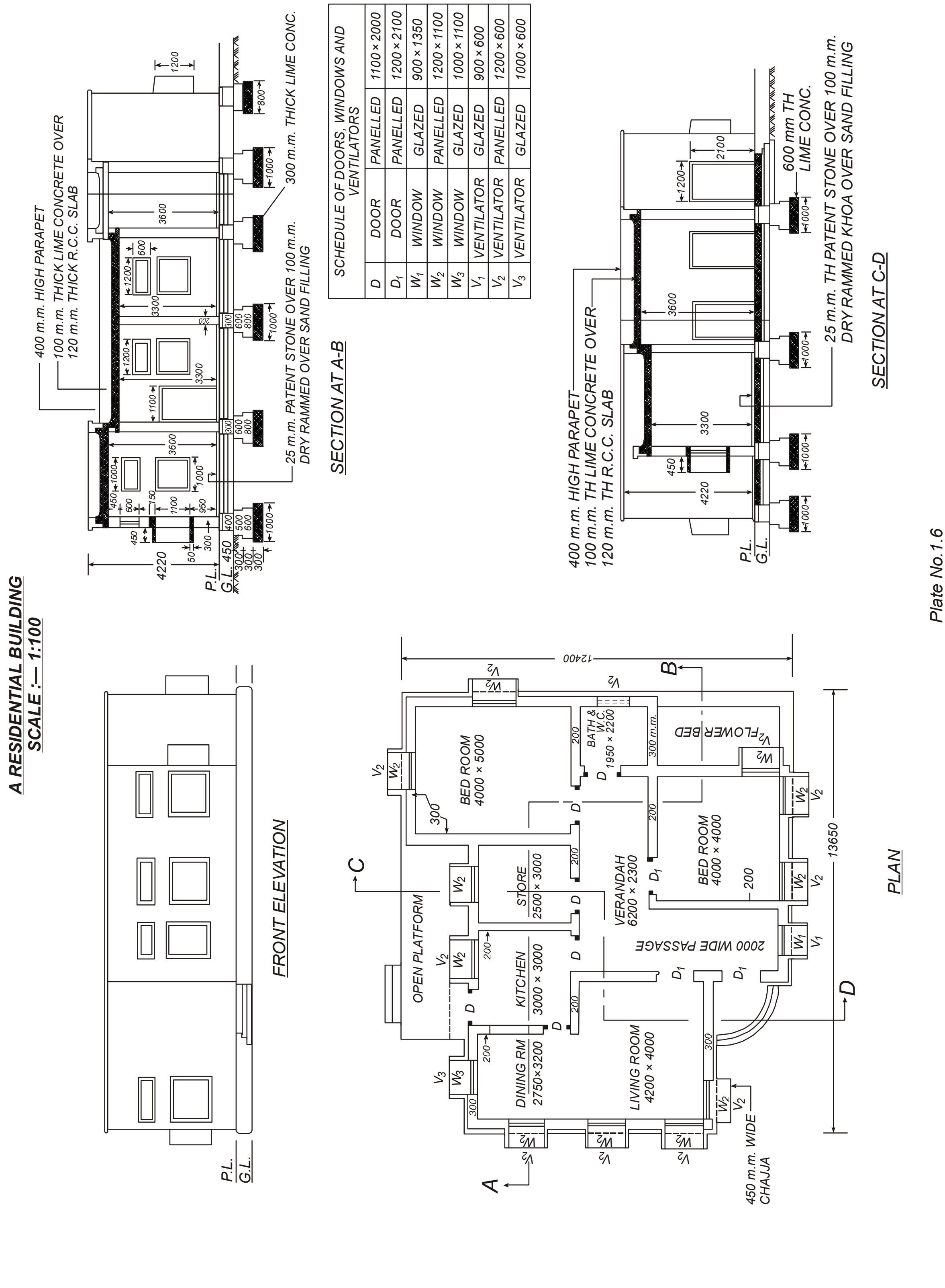
2. With the given line the sketch in Fig. 1.30 draw to a scale of 1 : 100 the plan, elevation and section at *AB*.

The views have been drawn in Plate 1.8 and 1.9 and to give a clear understanding of the drawings a prospective view also has been drawn in Fig. 1.31.



PERSPECTIVE VIEW

Plate No. 1.6A



SCHEDULE OF DOORS, WINDOWS AND VENTILATORS

D	DOOR	PANELLED	1100 × 2000
D_1	DOOR	PANELLED	1200 × 2100
W_1	WINDOW	GLAZED	900 × 1350
W_2	WINDOW	PANELLED	1200 × 1100
W_3	WINDOW	GLAZED	1000 × 1100
V_1	VENTILATOR	GLAZED	900 × 600
V_2	VENTILATOR	PANELLED	1200 × 600
V_3	VENTILATOR	GLAZED	1000 × 600

Plate No.1.6

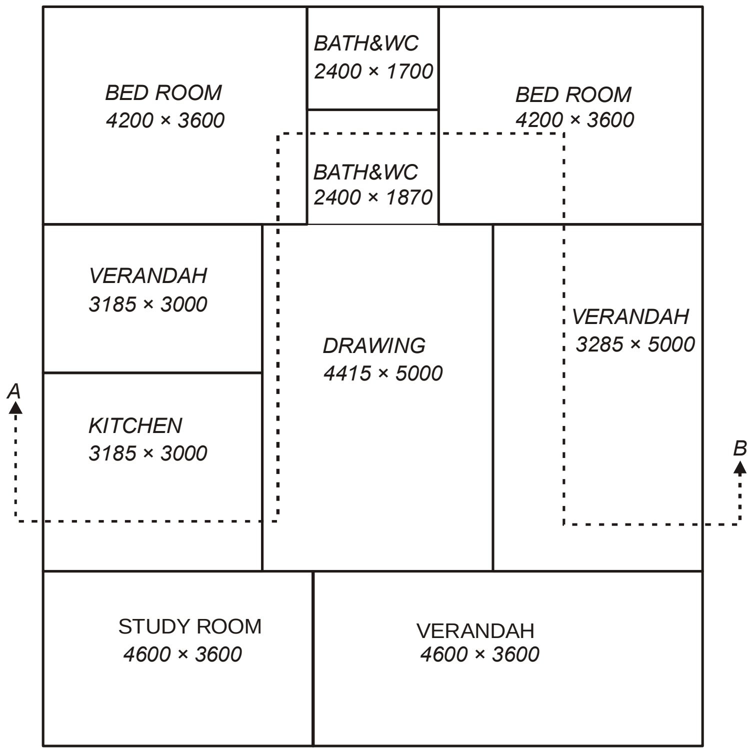
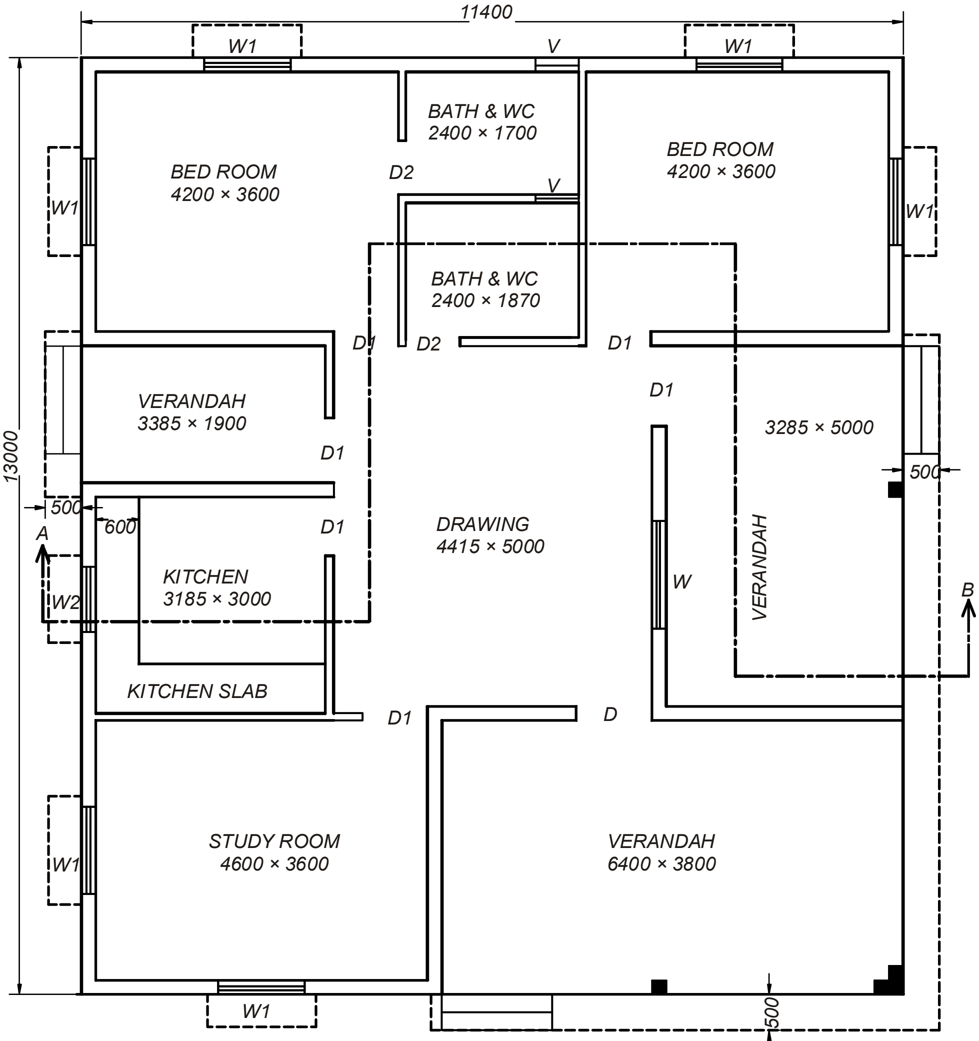
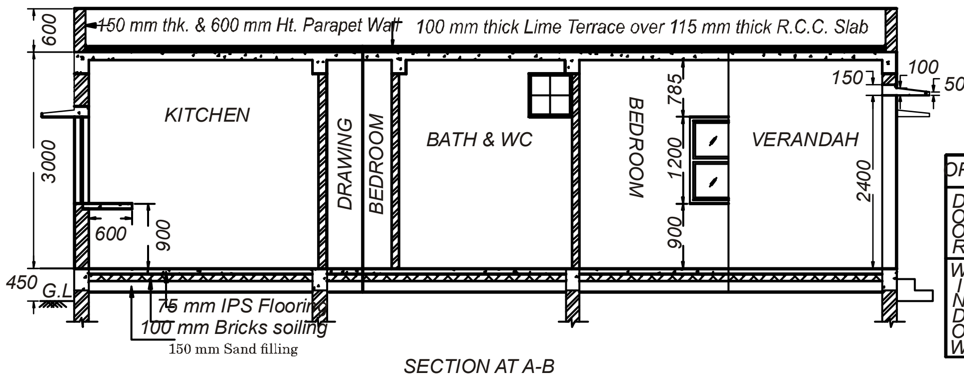


Fig. 1.22. Line Plan



PLAN

TREAD = 250 MM
RISER = 150 MM



OPENING SCHEDULE		
DOOR	D	1000 × 2100
	D1	900 × 2100
	D2	750 × 2100
WINDOW	W	1500 × 1200
	W1	1200 × 1200
	W2	900 × 1200
	V	600 × 450

SECTION AT A-B

PLAN & SECTION OF Fig. 1.22

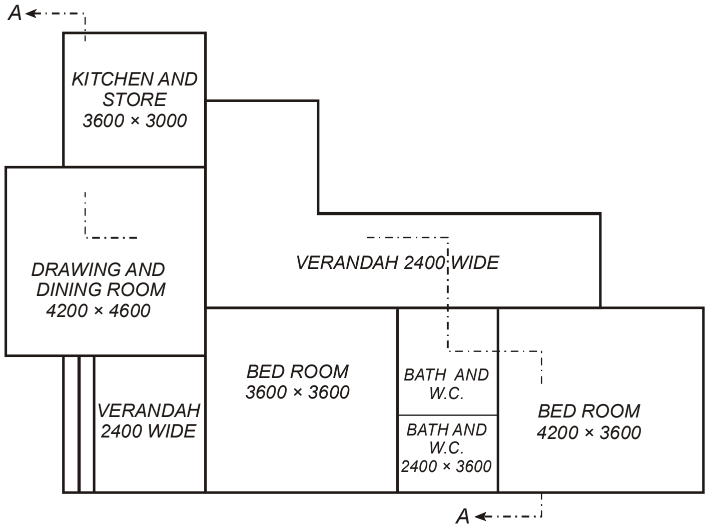
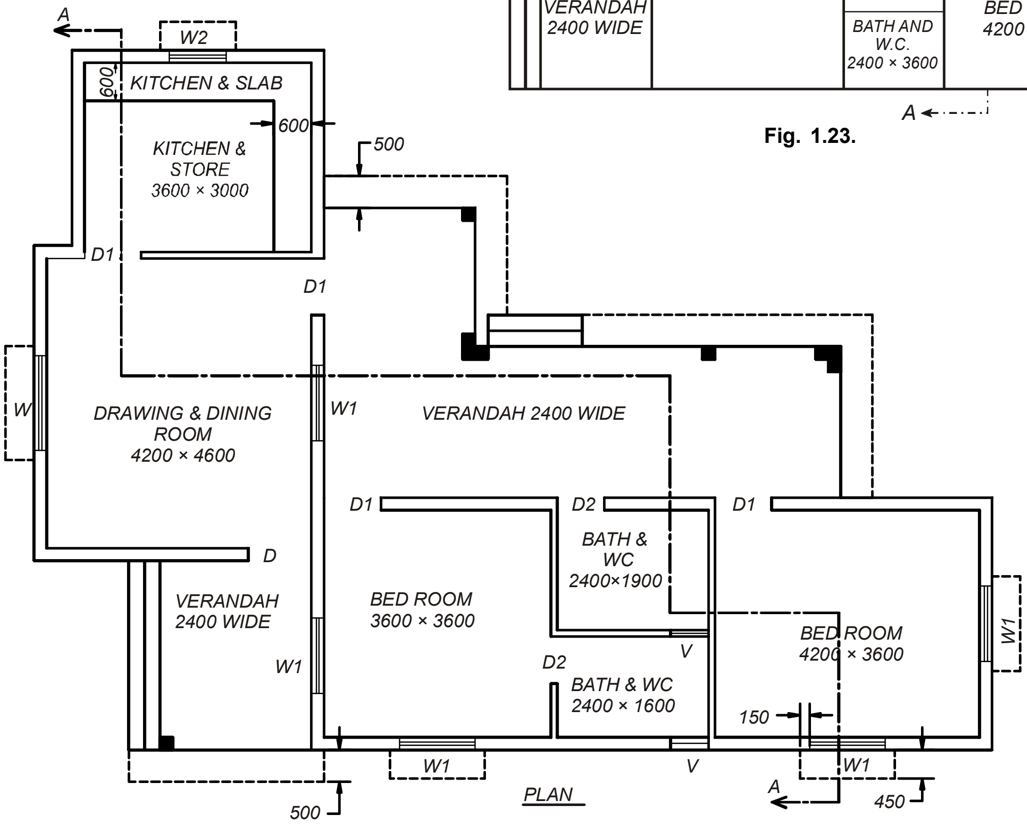
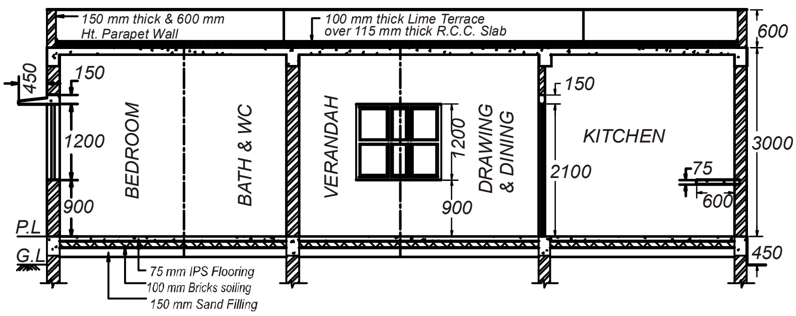


Fig. 1.23.





SECTION AT A-A

OPENING SCHEDULE		
DOOR	D	1000 × 2100
	D1	900 × 2100
	D2	750 × 2100
WINDOW	W	1500 × 1200
	W1	1200 × 1200
	W2	900 × 1200
	V	600 × 450

PLAN and SECTION of Fig. 1.23

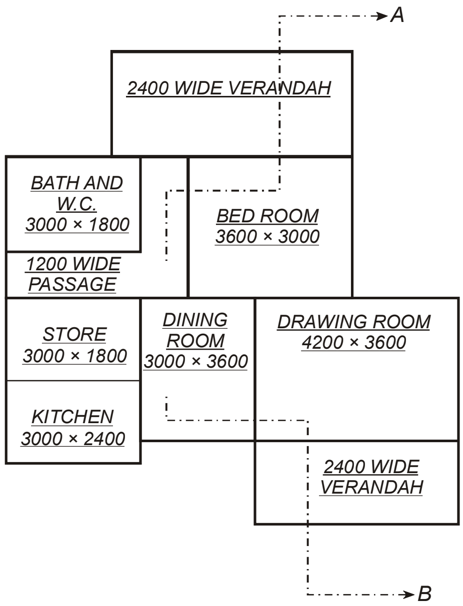


Fig. 1.24.

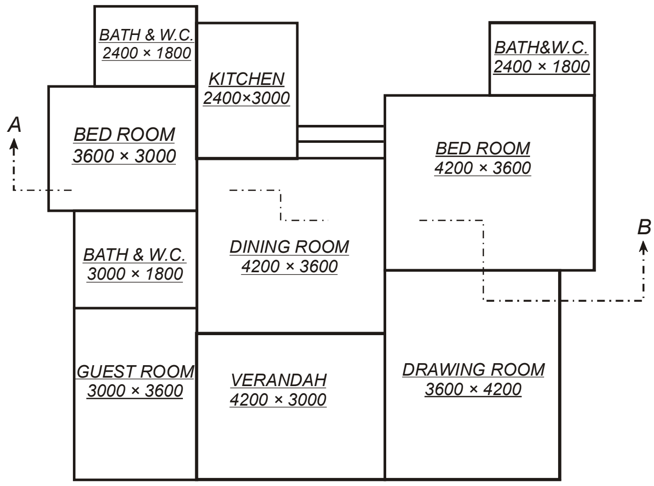


Fig. 1.25.

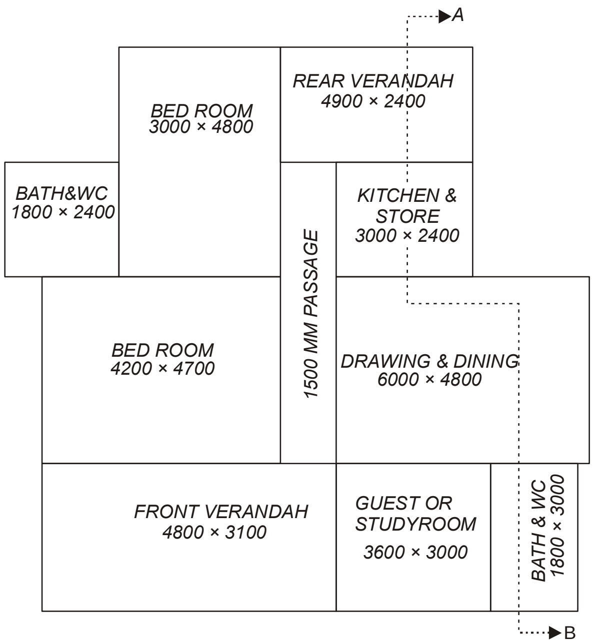
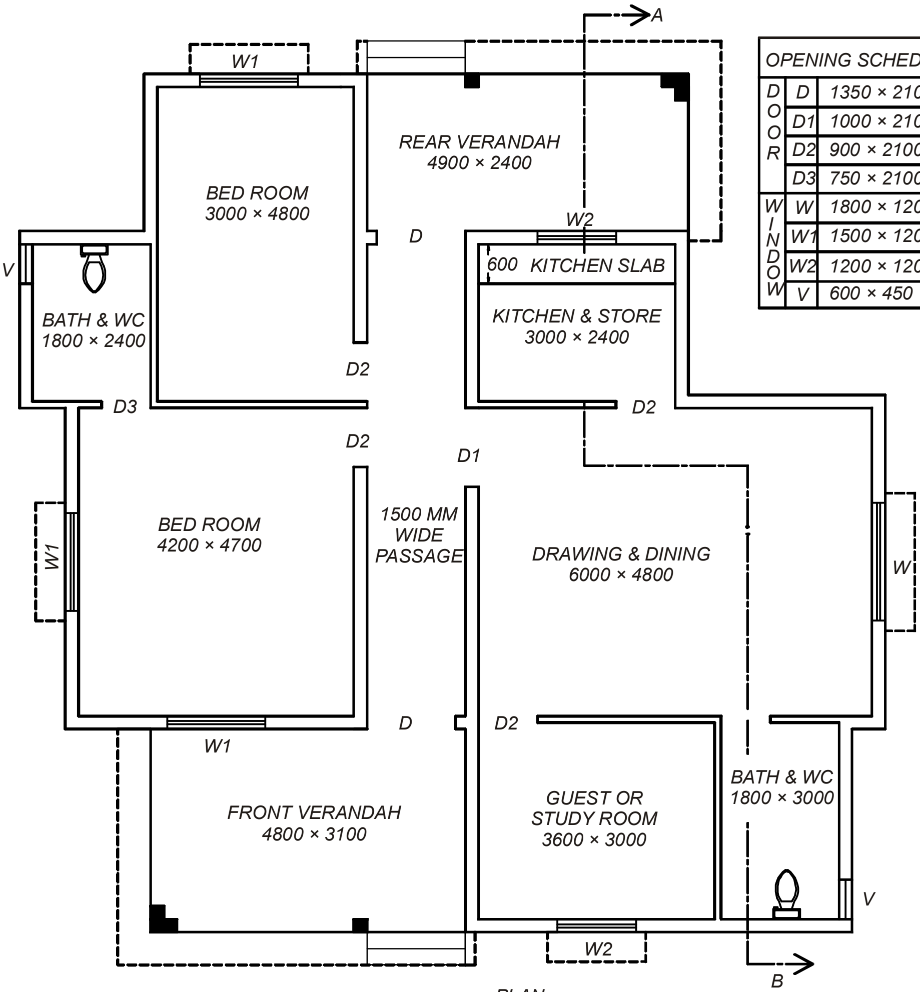
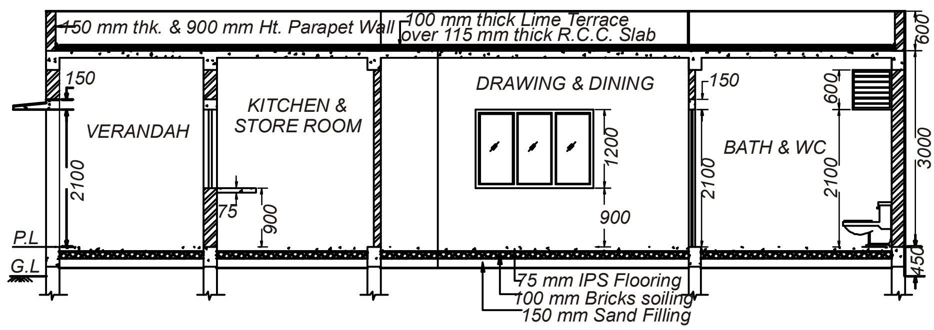


Fig. 1.26.



OPENING SCHEDULE		
DOOR	D	1350 × 2100
	D1	1000 × 2100
	D2	900 × 2100
	D3	750 × 2100
WINDOW	W	1800 × 1200
	W1	1500 × 1200
	W2	1200 × 1200
	V	600 × 450



Plan and section of Fig. 1.26

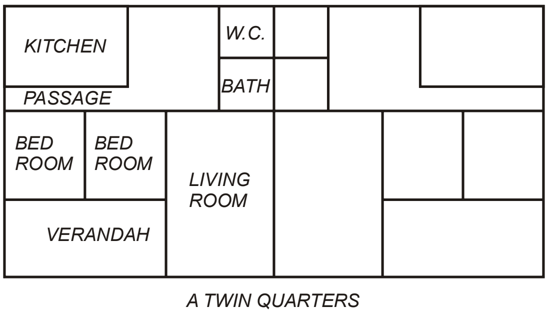


Fig. 1.27.

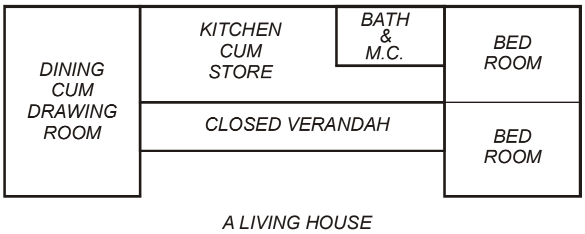


Fig. 1.28.

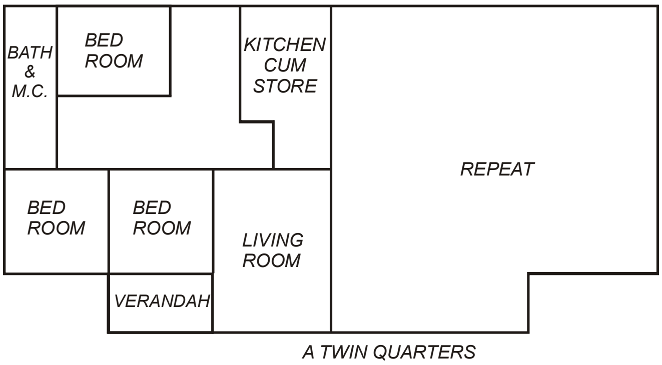


Fig. 1.29.

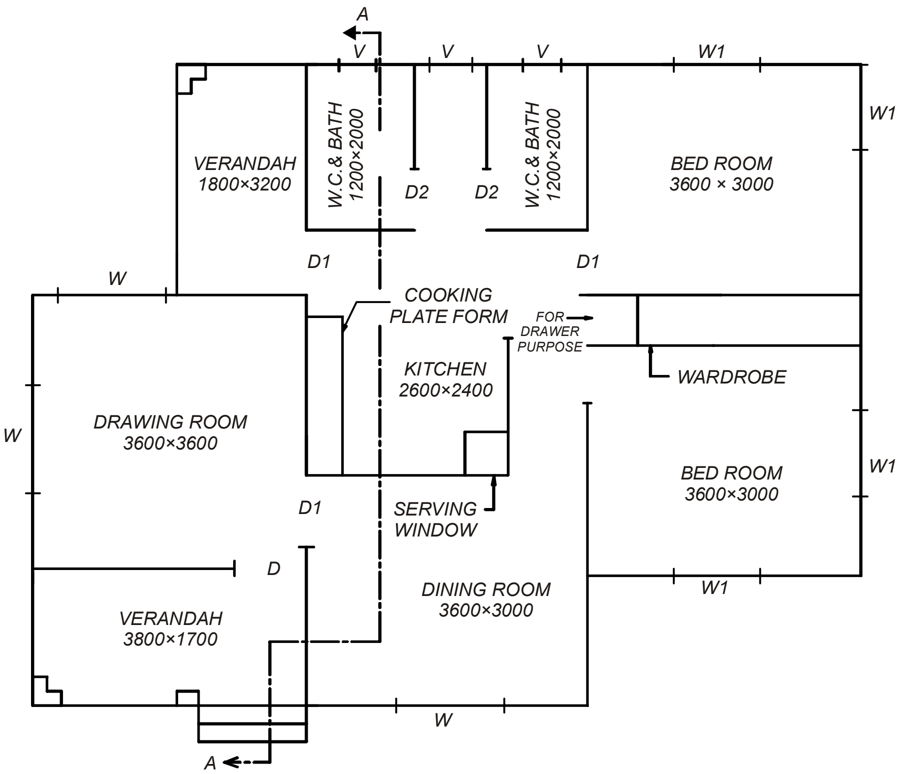
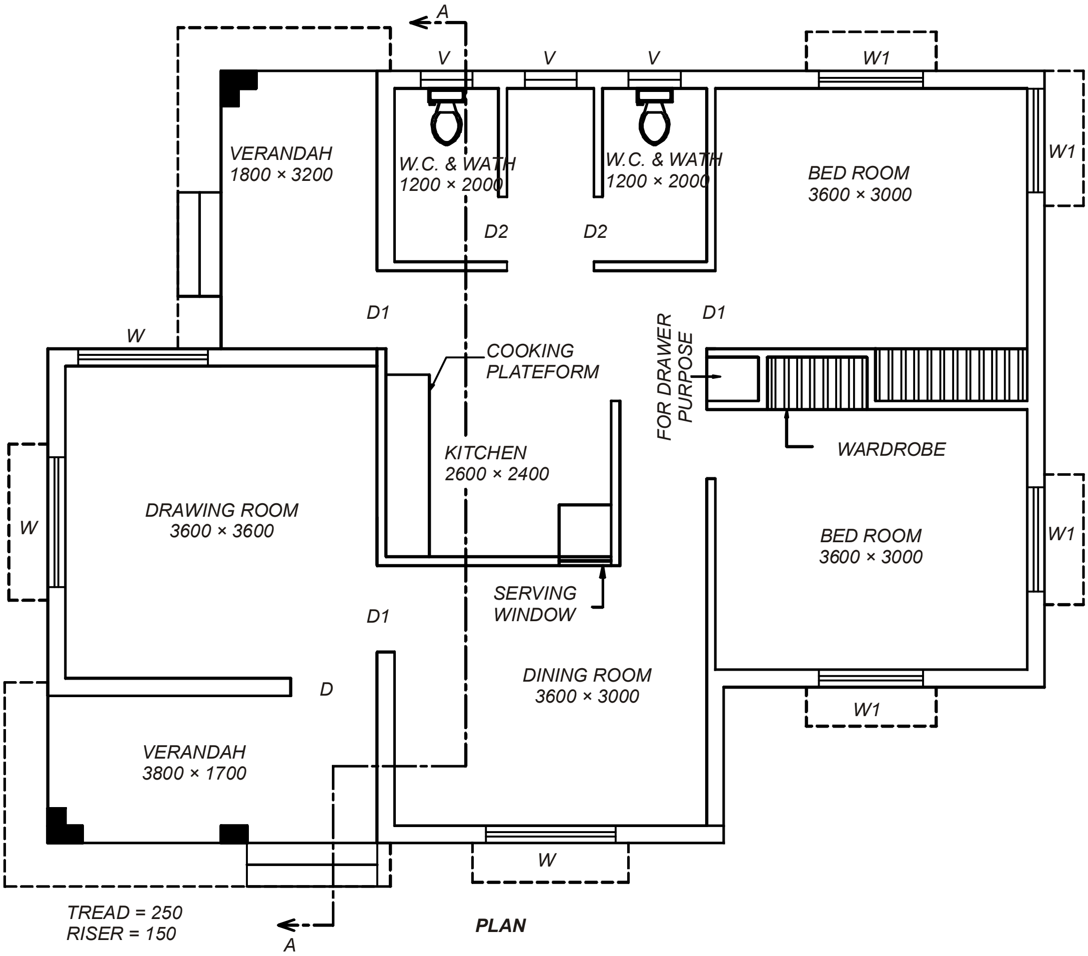
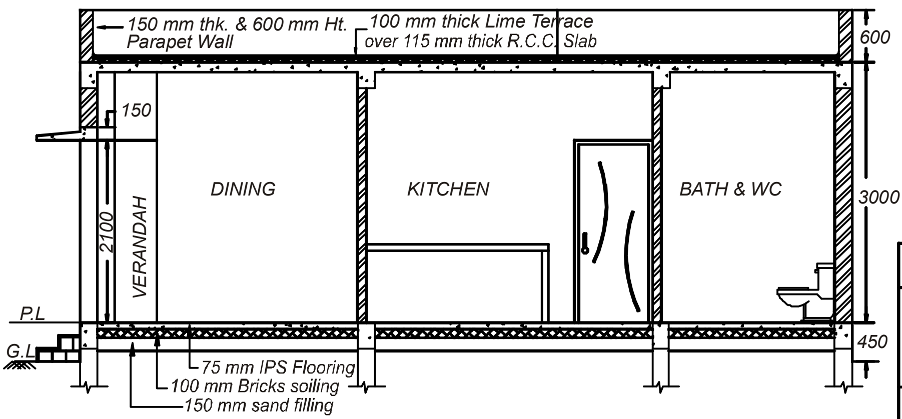


Fig. 1.30. Line Plan.



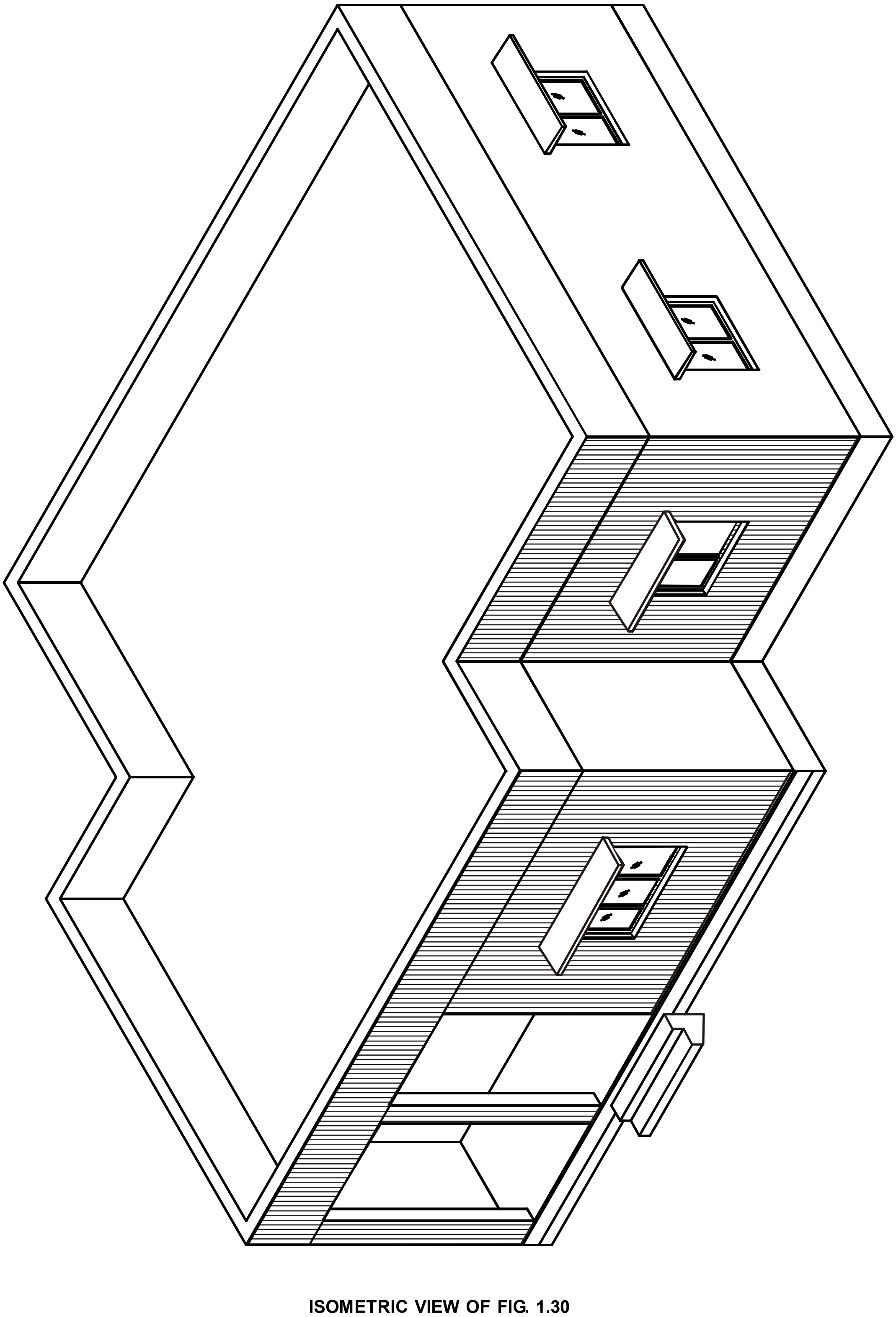
PLAN



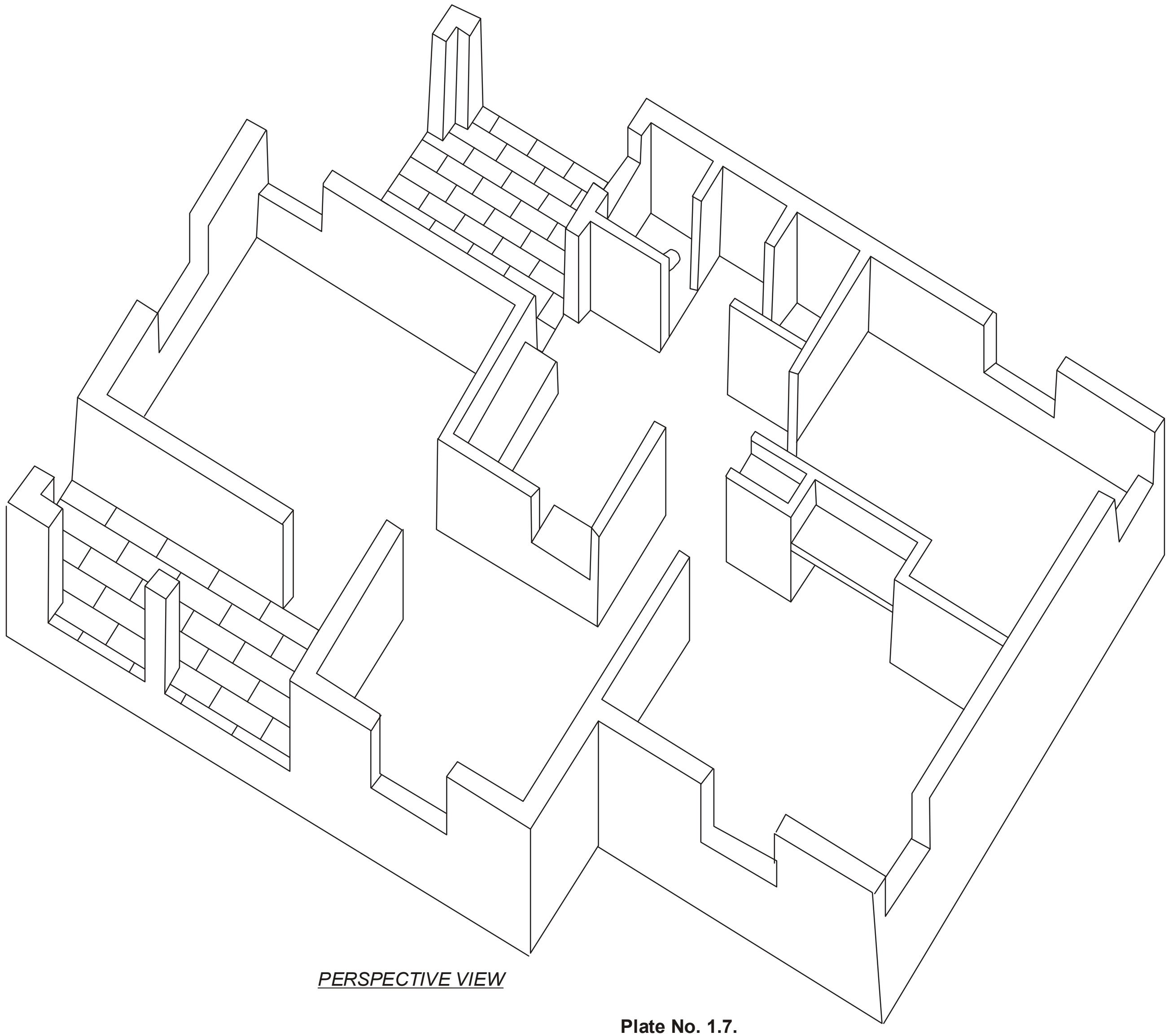
Section AA

OPENING SCHEDULE		
DOOR	D	1000 × 2100
	D1	900 × 2100
	D2	750 × 2100
WINDOW	W	1500 × 1200
	W1	1200 × 1200
	W2	900 × 1200
	V	600 × 450

PLAN and SECTION of FIG. 1.30.



ISOMETRIC VIEW OF FIG. 1.30



PERSPECTIVE VIEW

Plate No. 1.7.

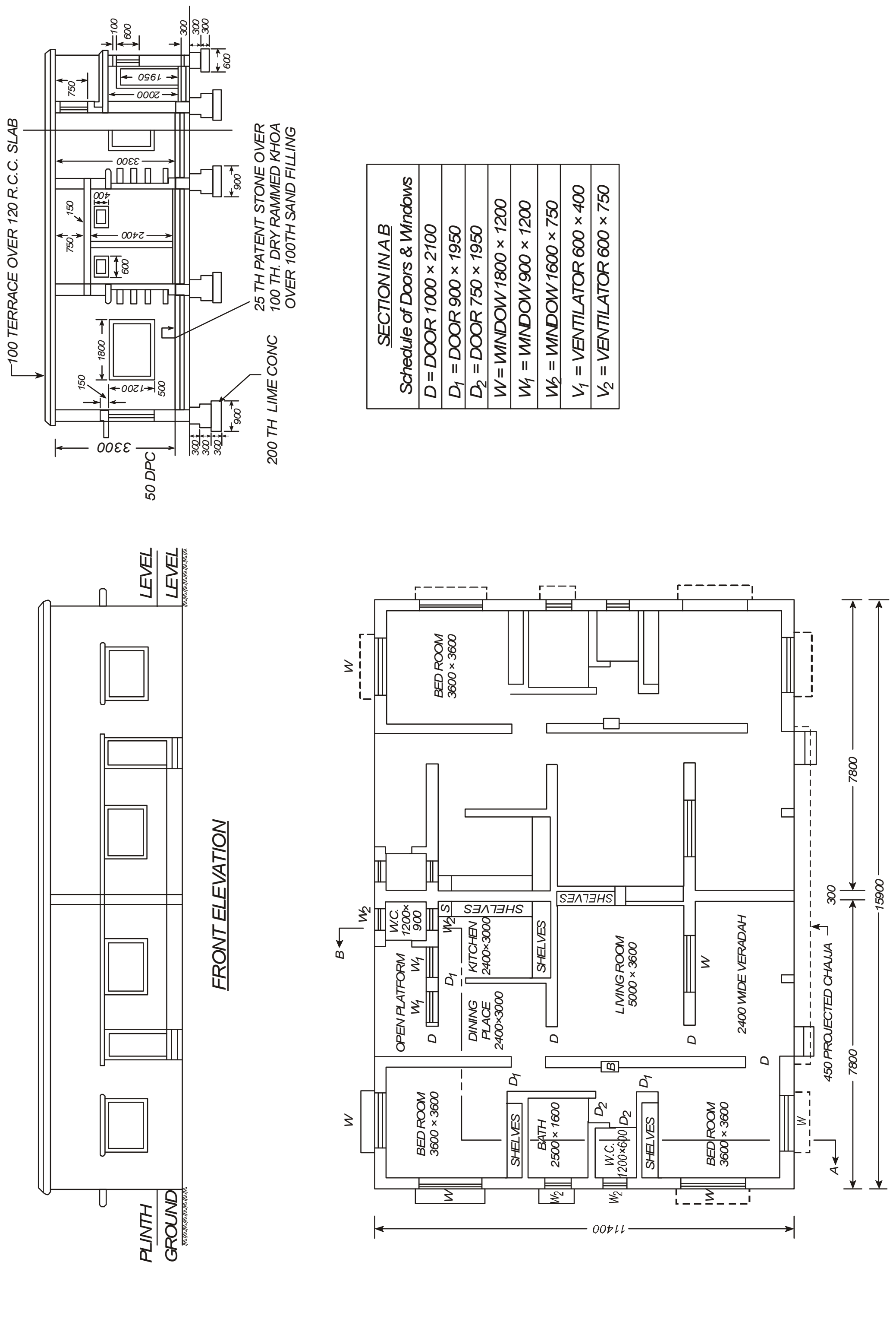
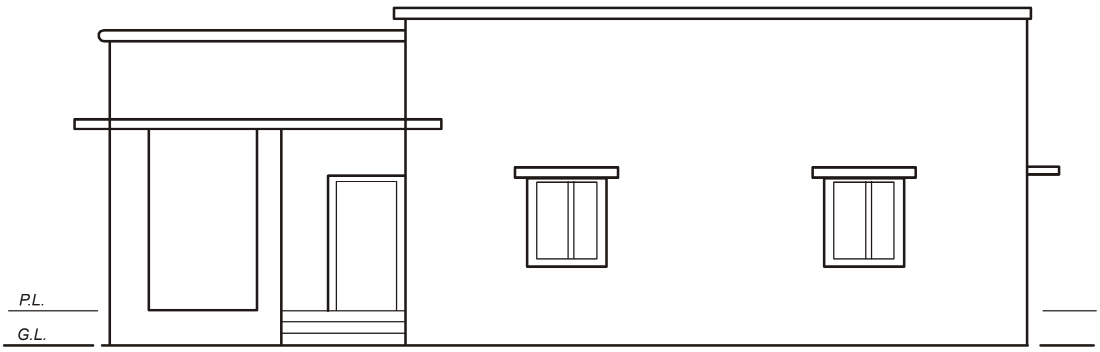
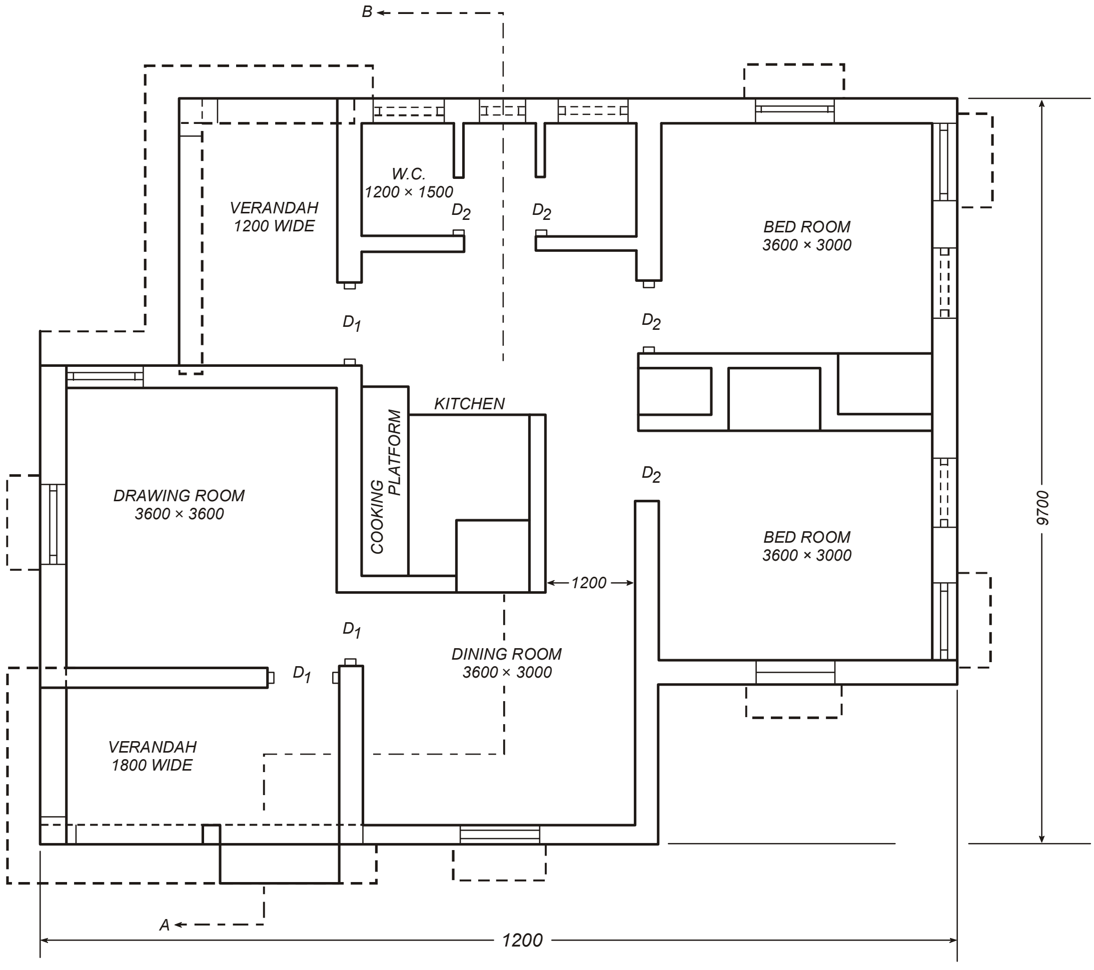

100 TERRACE OVER 120 R.C.C. SLAB
25 TH PATENT STONE OVER
100 TH. DRY RAMMED KHOA
OVER 100TH SAND FILLING
200 TH LIME CONC
50 DPC
3300
2400
1950
2000
1800
1200
SECTION IN A B
Schedule of Doors & Windows
D = DOOR 1000 × 2100
D1 = DOOR 900 × 1950
D2 = DOOR 750 × 1950
W = WINDOW 1800 × 1200
W1 = WINDOW 900 × 1200
W2 = WINDOW 1600 × 750
V1 = VENTILATOR 600 × 400
V2 = VENTILATOR 600 × 750
LEVEL
LEVEL
PLINTH
GROUND
FRONT ELEVATION
BED ROOM 3600 × 3600
W.C. 1200× 900
KITCHEN 2400×3000
SHELVES
OPEN PLATFORM
DINING PLACE 2400×3000
LIVING ROOM 5000 × 3600
2400 WIDE VERADAH
BATH 2500 × 1600
W.C. 1200×600
450 PROJECTED CHAJJA
7800
300
15900
11400

Fig. 1.31.

A RESIDENTIAL BUILDING
SCALE — 1 : 100



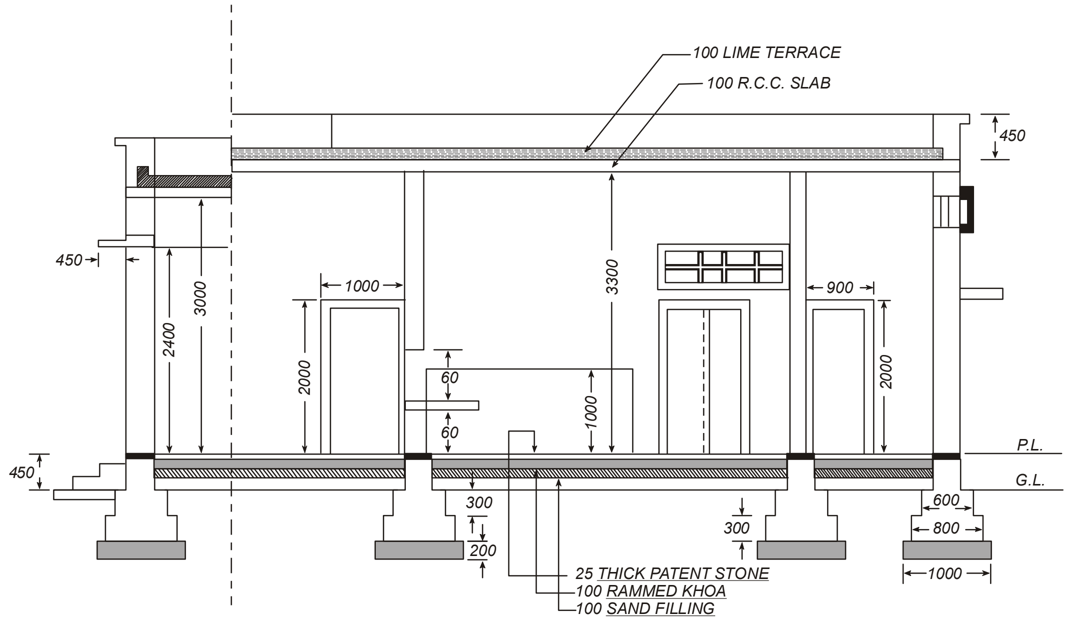
ELEVATION



PLAN

Plate No. 1.8

D_1	DOOR	1000 × 18000
D_2	DOOR	900 × 1800
W_1	WINDOW	1000 × 1200
V_1	VENTILATOR	1000 × 600
V_2	VENTILATOR	600 × 600
	FRAMES	80 × 60



SECTION AT A B

Plate No. 1.9

SEPTIC TANK

In unsewered urban and rural areas septic tanks are suitable for disposal of night soil. But sufficient water should be available as water is required for flow of the night soil from latrine to the septic tank and for proper functioning of the septic tank. The size of the septic tank is so designed that the sewage is retained in the tank for 24 hours during which certain biological decomposition by the action of aneorobic bacteria takes place which liquifies and breaks and night soil leaving small quantity of solid which is known as sludge and settles at the bottom of the tank and clear water known as effluent flows out of the tank. The effluent from the septic tank is usually disposed by absorption in the soil through soakpit if no municipal drainage system is prevailing in the area. It municipal drainage line exists in the area, the effluent is discharged to the drain.

It is to be noted that no disinfection agent such as bleaching powder, phenyl etc. should not be used in cleaning laterins as disinfectant entering the septic tank kills the bacteria growth as a result of which rate of biological decomposition is retarted. For proper cleaning and functioning, about 15 litres of water should be flushed from a flushing cistern or through bucket if flushing cistern has not been provided with the water closet.

DESIGN OF SEPTIC TANK

The capacity of septic tank depends on number of users and interval of sludge removal. Normally sludge should be removed every two years. The liquid capacity of tank is taken as 130 litres to 70 litres per head. For small number of users 130 litres per head is taken.

A septic tank is usually provided with brick wall in rich cement mortar [not less than 20 cm (9´´)] thick and the foundation floor is of cement concrete 1 : 2 : 4. Both inside and outside faces of the wall and top of the floor are plastered with minimum thickness of 12 mm (1/2´´) thick cement mortar 1 : 3. All inside corners are rounded. Water proofing agent such as impermo, cem-seal or accoproof etc. is added to the mortar at the rate of 2% of the cement weight. It means that per bag of cement 1 kg of water proofing agent is added to dry cement and mixed with sand thoroughly before putting water to the mortar. Water proofing agent is to be added in similar proportion to the concrete also for making floor of the tank. For proper convenience in collection and removal of sludge, the floor is given a slope of 1 : 10 to 1 : 20 towards the inlet side. Which means that floor of outlet side will be on higher elevation than the floor at inlet side.

Dimensions

(*i*) Width = 750 mm (minimum)

Length = 2 to 4 times width

Depth = 1000 to 1300 mm (minimum below water level) + 300 to 450 mm free board.

Maximum depth = 1800 mm + 450 free board. Capacity = 1 cubic meter minimum.

(*ii*) Deterntion period 24 hours (mostly). The rate of flow of effluent must be equal to the rate of flow of influent.

(*iii*) **Inlet and outlet pipes.** An elbow or T pipe of 100 mm diameter submerged to a depth of 250 to 600 mm below the liquid level. For out let pipe : an elbow or T type of 100 mm diameter submerged to a depth of 200 to 500 mm below the liquid level. Pipes may be of stone ware or asbestos.

(*iv*) **Baffle walls**. For small tanks, R.C.C. hanging type scum baffle walls are provided. Baffle walls are provided near the inlet. It is optional near the outlet. The inlet baffle wall is placed at a distance of $L/5$ from the wall, where L is the length of the tank. The baffle wall is generally extended 150mm above to scum level and 400 to 700 mm below it. Scum being light, generally floates at the water level in the tank. Thickness of wall vary from 50 mm to 100 mm. For large tanks lower portion of wall are having holes for flow of sludge.

(*v*) **Roofing slab.** The top of the tank is covered with a R.C.C. slab of thickness 75 mm to 100 mm depending upon size of the tank. Circular manholes of 500 mm clear diameter are provided for inspection and desludging. Incase of rectangular opening clear size is kept as 600 × 450 mm.

(*vi*) **Ventilation pipe.** Every septic tank should be provided with ventilation pipe of at least 50 mm dia. The top of the pipe shall be provided with a suitable cage of mosquito proof wire mesh. The ventilating pipe should extend to a height which would cause no smell to any building in the area. Ventilating pipe should extend to a height of about 2 m when the septic tank is at least 15 m away from the nearest building and to a height of 2 m above toip of the building when it is located closer than 15 m.

Starting a new septic tank

A septic tank first should be filled with water to its outlet level before night soil is allowed to enter the tank. It is to be then seeded with sludge obtained from the neighbourhood septic tank in use. In absence of the sludge a small quantity of decaying organic matter such as decomposed cowdung may be introduced.

Suitable sizes of septic tanks for use of 5, 10, 15, 20 and 50 persons are given in the following table and Fig. 1A gives the cross-sectional details of the septic tank and Fig. 2A gives typical layout of a septic tank sewerage system.

No. of users	*Length L (metre)*	*Breadth B (metre)*	*Liquid depth D (metre)*	*Liquid capacity to be provided m^3*	*Free board (min) (metre)*	*Sludge to be removed (m^3)*	*Interval of cleaning*
5	1.5	0.75	1.0 1.05	1.12 1.18	0.30 0.30	0.36 0.72	1 year 2 year
10	2.0	0.9	1.0 1.4	1.8 2.5	0.30 0.30	0.72 1.44	1 year 2 year
15	2.0	0.9	1.3 2.0	2.3 3.6	0.30 0.30	1.08 2.16	1 year 2 year
20	2.3	1.1	1.3 1.8	3.3 4.6	0.30 0.30	1.44 2.88	1 year 2 year
50	4.0	1.4	1.3 2.0	7.3 11.2	0.30 0.30	3.60 7.20	1 year 2 year

DESIGN OF A SEPTIC TANK FOR 20 USERS

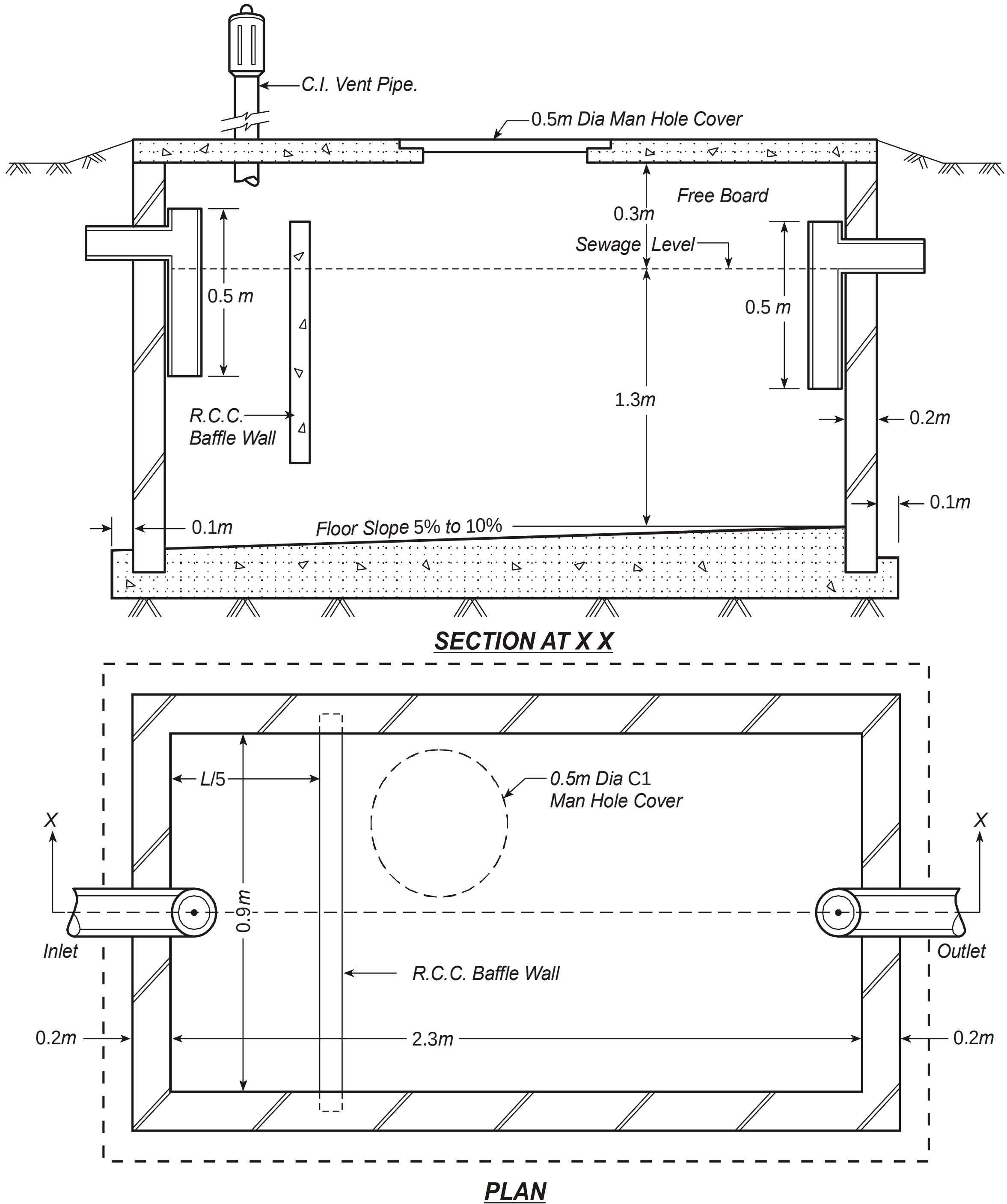
Liquid Capacity of the tank : @ 120 litres per user = 0.12 × 20 = 2.4 cum.

Take liquid depth as 1.3 metre.

$$\therefore \text{ Floor area of the tank} = \frac{2.4}{1.3} = 1.85 \text{ m}^2$$

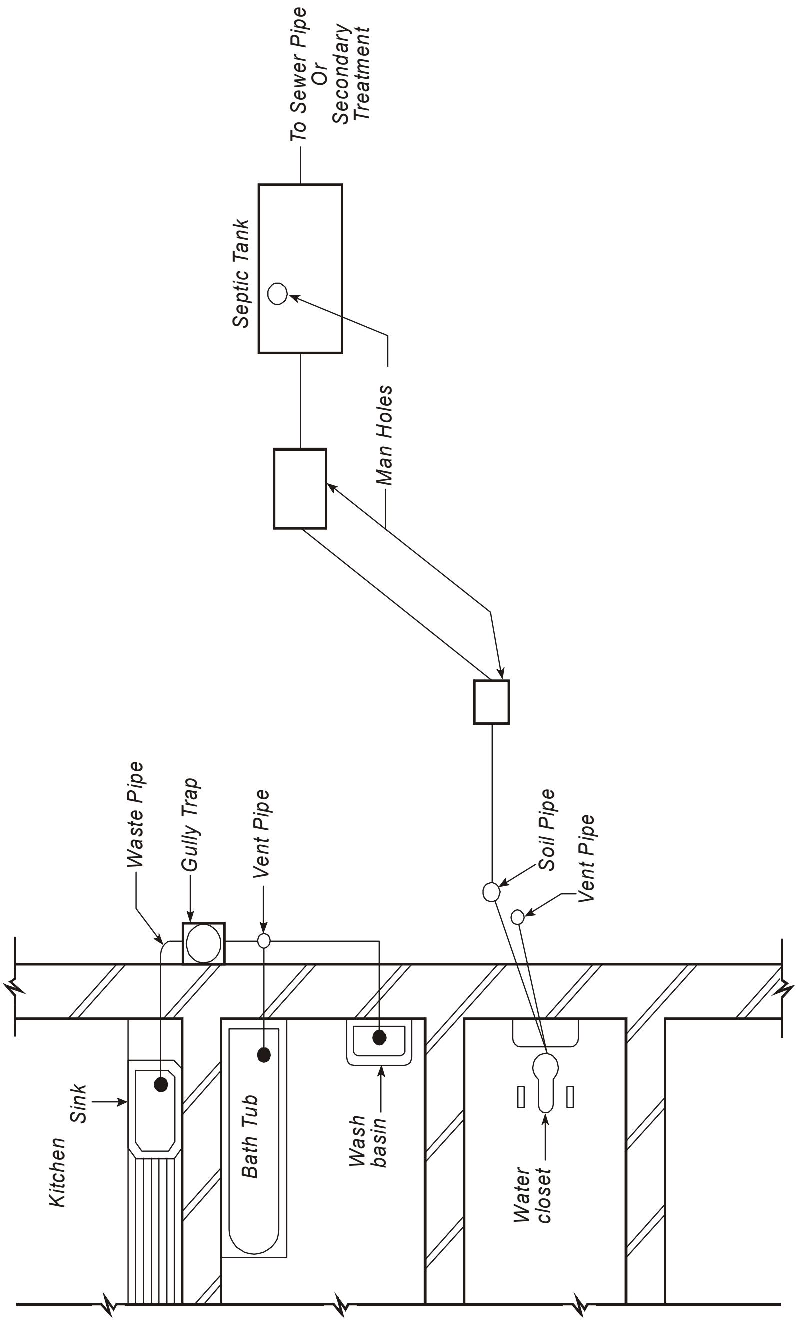
Taking length as 2.5 times the breadth L × B = 1.85 or 2.5 B × B = 1.85

$\therefore$ B = $\sqrt{1.85/2.5}$ = 0.86 m say 0.9 m.



DETAILS OF A SEPTIC TANK

Fig. 1A.



LAY OUT OF SEWERAGE SYSTEM WITH SEPTIC TANK

GUIDELINES TO THE STUDENTS APPEARING FOR EXAMINATION IN BUILDING DRAWING

In some of the universities a paper Engineering Drawing" has been kept at First Year level of Four Year Degree course. This paper is compulsory to the students of all branches of Engineering.

The paper Engineering Drawing" consists of three parts :

(*a*) Geometrical Drawing

(*b*) Machine Drawing

and (*c*) Building Drawing.

Building Drawing generally consists of 25% waitage of the paper. This syllabus consists of Plan, Elevation and Section of simple buildings with flat roof (one or two roomed building) and details of doors, windows and lintels.

Details of doors, windows and lintels have been discussed in chapters 3 and 4.

A few typical examples of small buildings are given for practice of the students.

The same pattern as stated above is being followed in *A.M.I.E. Examination* also for Building Drawing portion in the paper Engineering Drawing. But in A.M.I.E. Examination mostly plan and elevation of a simple building are required to be drawn.

Example is a typical university question of Building Drawing-Expected time to complete the drawing is *one hour.*

The drawing of the question has been drawn in plate 1.10 and then some important points have been discussed.

Example 1. *The line plane of a residential house having one bed room is shown in the Fig. 1.32.*

Some of the specifications are as under :

Level of the plinth above ground	= 450 mm
Wall thickness	= 300 mm
Windows :	W = 1.0 m × 1.2 m
Doors :	D = 1.0 m × 2.0 m
	D_1 = 0.8 m × 2.0 m
Ventilators :	V = 0.8 m × 0.6 m

Draw 1 : 50 scale

(*a*) the plan of the building at window sill level,

and (*b*) the front elevation.

Solution. The required plan of the building at window sill level and the front elevation have been drawn in the plate No. 1.10.

Some important points which students should keep in mind :

(*i*) It is a common practice in Building Drawing to draw the sectional plan. The section plane being a horizontal plane at the sill of the window. The sectional plan is known as plan" simply. Hence in the question if only plan is to be drawn, in that case also the sectional plan at sill of the window is to be drawn.

(*ii*) In some questions, instead of front elevation" it is asked to draw the elevation" which means the front elevation.

(*iii*) In the question following dimensions have not been given. They are required for the drawing. Suitable dimensions needed for the drawing is given below :

Parapet height	= 600 mm
Coping	= 50 mm × 50 mm
Window Frame (chawkhat)	= 100 mm × 75 mm
Door Frame (chawkhat)	= 100 mm × 100 mm × 80 mm
Ventilator Frame	= 80 mm × 60 mm

Steps :

Rise	= 150 mm
Tread	= 300 mm
Ceiling Height	= 3.3 m
Thickness of Roof slab	= 45 mm
Lime terrace	= 45 mm
Chajja Projection	= 450 mm
Pillars	= 300 mm × 300 mm

In the question if full specification is not given then the student has to assume suitable dimensions for the items required for the drawing.

(*iv*) In the line plan inner dimensions of rooms are given. More common practice is as shown in Fig. 1.36.

But some times rooms dimensions are given as shown in Fig. 1.33.

In the present question the dimensions are given in some unusual manner as shown in Fig. 1.32.

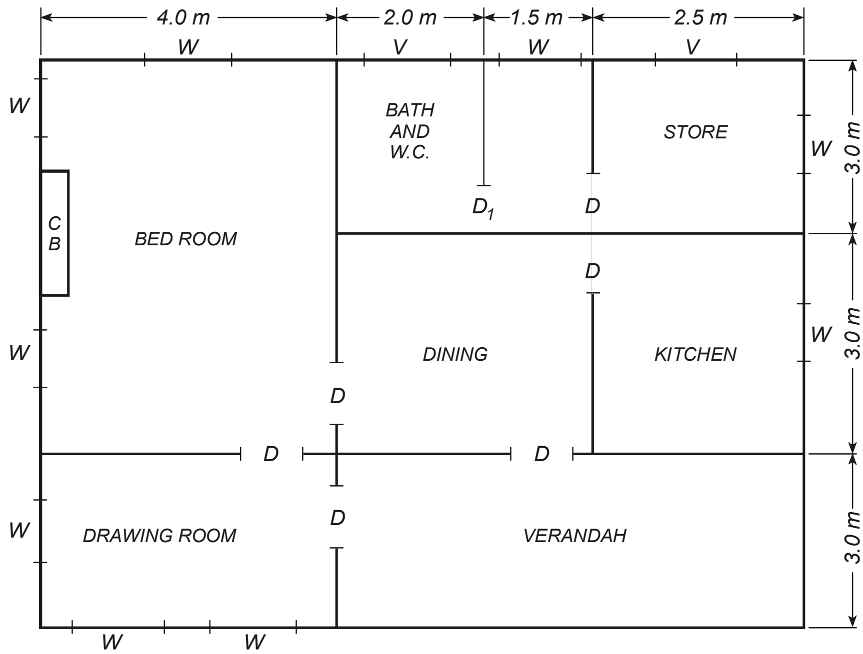


Fig. 1.32.

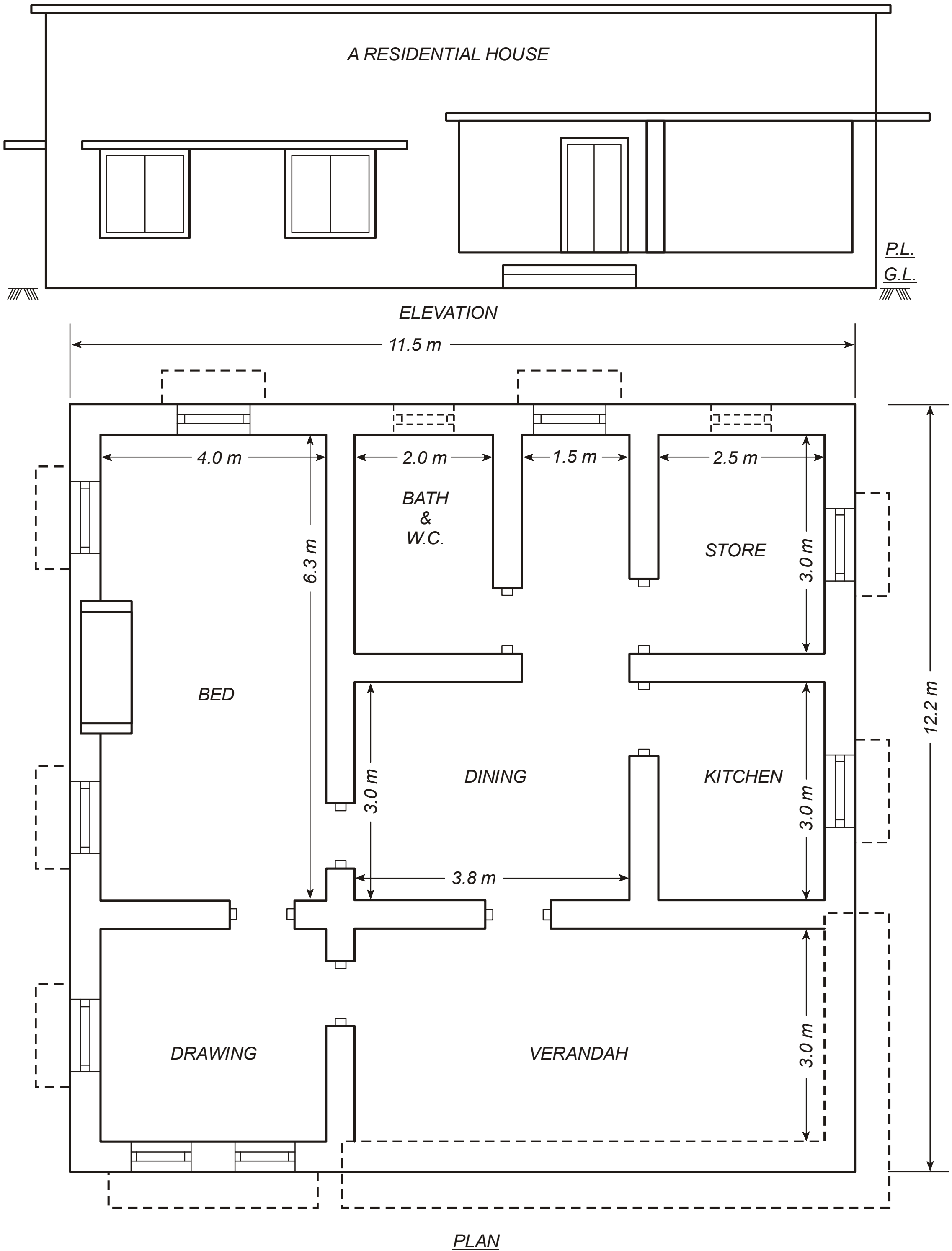
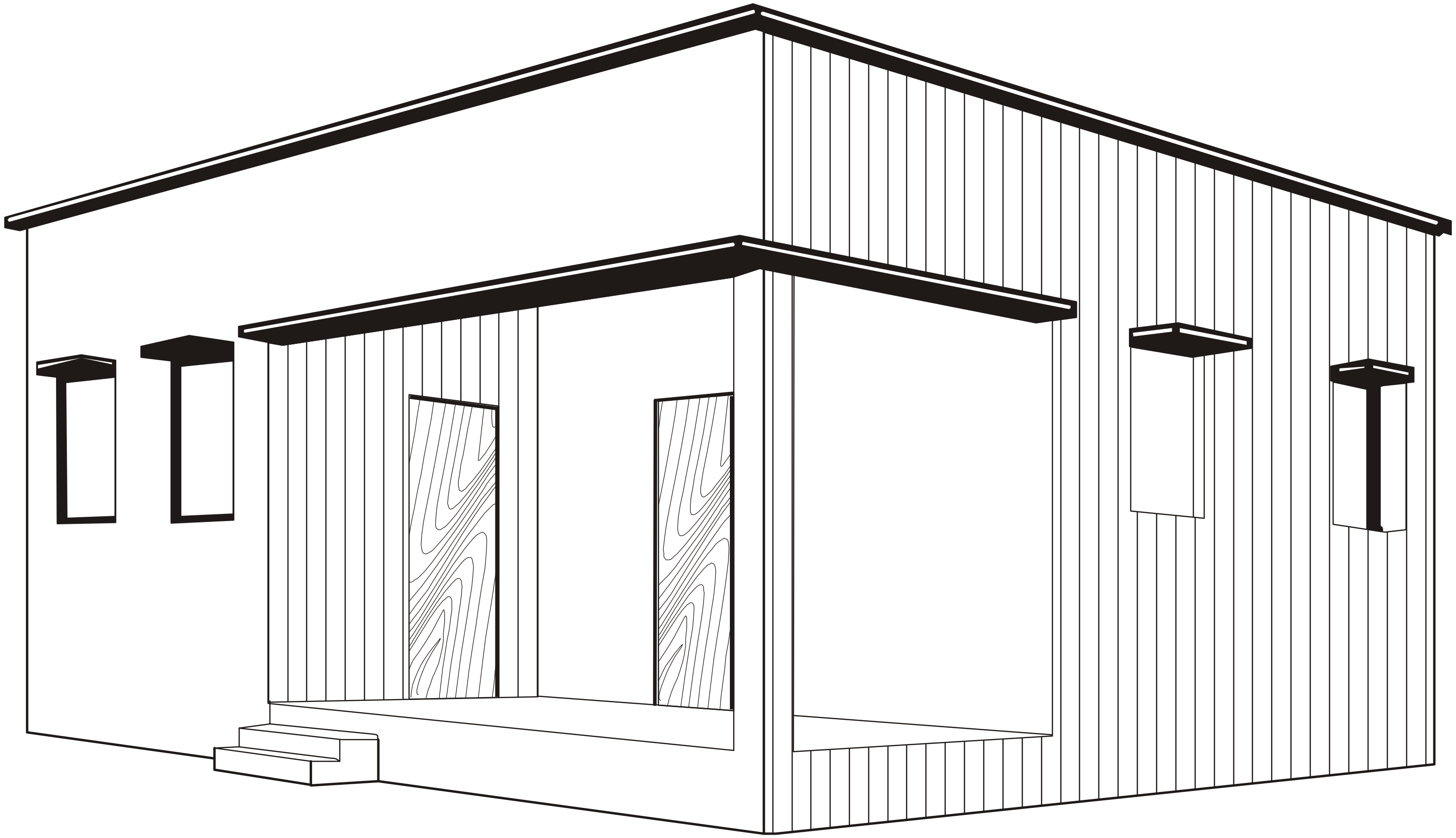

A RESIDENTIAL HOUSE
P.L.
G.L.
ELEVATION
11.5 m
4.0 m
2.0 m
1.5 m
2.5 m
BATH
&
W.C.
STORE
6.3 m
3.0 m
BED
DINING
KITCHEN
3.0 m
3.0 m
3.8 m
12.2 m
DRAWING
VERANDAH
3.0 m
PLAN

Plate No. 1-10



PERSPECTIVE VIEW
Plate No. 1.11.

The dimensions given should not be misunderstood with centre to centre distance of the walls. They are to be taken as inner dimensions of the rooms. For example, inner dimension of the Drawing room will be 4.0 m × 3.0 m, store room 2.5 m × 3.0 m, kitchen 2.5 m × 3.0 m and so on. But inner dimension of the bed room will be 4.0 m × 6.3 m (3 m + 0.3 m + 3 m). 0.3 m increase will be due to thickness of wall between store and kitchen.

The correct dimensions of different rooms have been shown in Plate No. 1.10.

(*v*) In single storey building outer walls are 300 mm thick and inner walls are 200 mm thick. But for simplicity in the drawing all walls have been taken as 300 mm thick.

(*vi*) All dimensions should be given in mm. Dimensions in cm should be avoided.

PROBLEMS FOR PRACTICE

Example 2. *The line plan for a small club is shown in Fig. 1.33. The dimensions shown are in metres.*

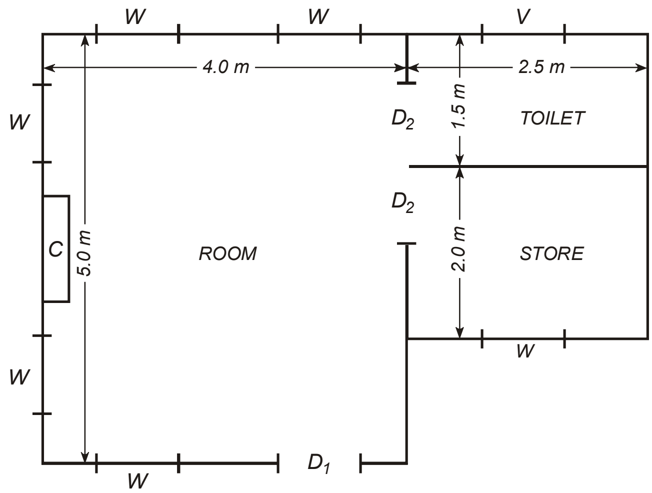


Fig. 1.33.

Some of the specifications are as follows :

Level of plinth above the ground = 450 mm

Height of ceiling from floor :

Main room = 3.0 m

Toilet and store = 2.5 m

Thickness of the wall = 300 mm

Doors–Panelled : D_1 = 1.1 m × 2.1 m

D_v = 1.0 m × 2.0 m

Windows–Glazed : W = 1.0 m × 1.2 m

Ventilators–Glazed : V = 0.8 m × 0.6 m

Roofing–reinforced cement concrete 150 mm thick over main room and 100 mm thick over others.

Cup board C'' = 1 m wide, 0.4 m deep and 1.5 m high.

Suitable steps, sun-shades etc. to be provided.

Draw the plan of the building at the window sill level and project the front elevation.

Scale = 1 : 25.

Example 3. *The line plan of a small guest house is shown in Fig. 1.34.*

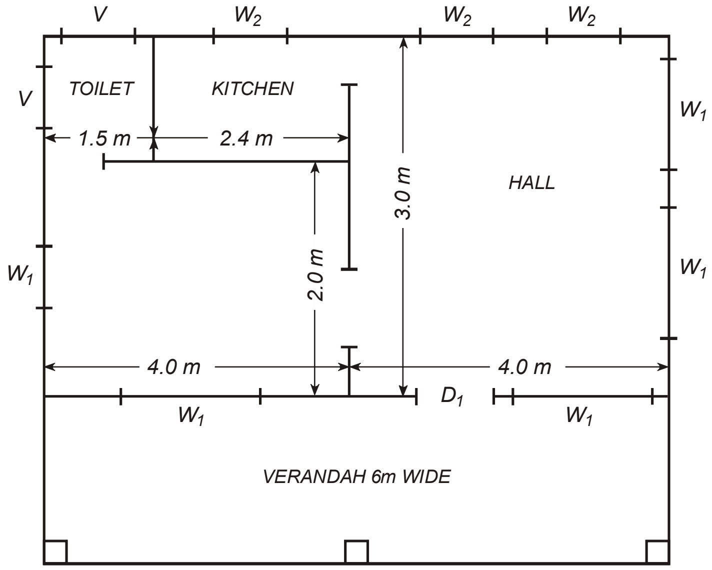


Fig. 1.34.

Draw the sectional plan at window sill level and the front elevation with the following details :

Scale : 1 : 50

Plinth level from ground	= 800 mm
Height of roof from plinth	= 3.0 m
Thickness of R.C.C. roof	= 150 mm
Wall thickness	= 200 mm
Height of parapet wall	= 800 mm

D_1 = 1.0 m × 2.0 m

D_2 = 0.8 m × 2.0 m

W_1 = 1.8 m × 1.35 m

W_2 = 1.0 m × 1.35 m

V = 1.0 m × 0.5 m .

The front verandah is 1 m wide, the doors are panelled and the windows are glazed.

Provide sun shades where necessary.

[**Note.** Sunshades are to be provided over all the exterior windows to prevent the rain water from entering the room].

Example 4. *Fig. 1.35 shows line plan of a small residential block. Draw to suitable scale:*
(*a*) Sectional plan (*b*) Front view.

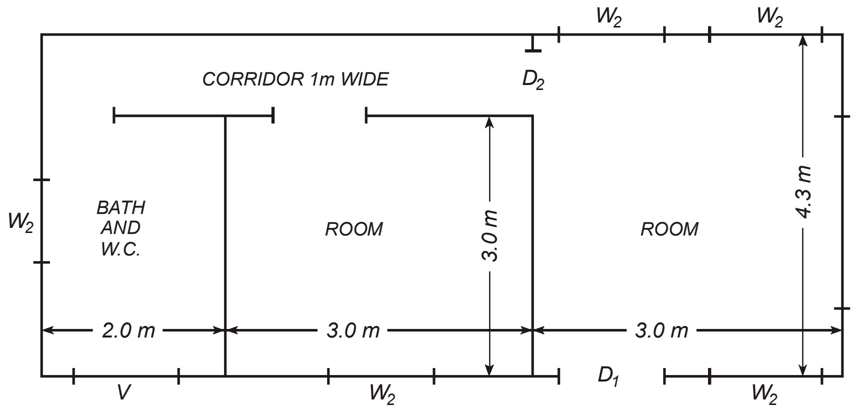


Fig. 1.35.

Enter dimension on the view. Select your own data for doors, windows and plinth. Roof consists of R.C.C. slab of 150 mm thickness.

[**Note.** In front elevation dimensions are not provided].

Example 5. *The line plan of a heath centre is shown in Fig. 1.36. Draw the plan and elevation with following details* :

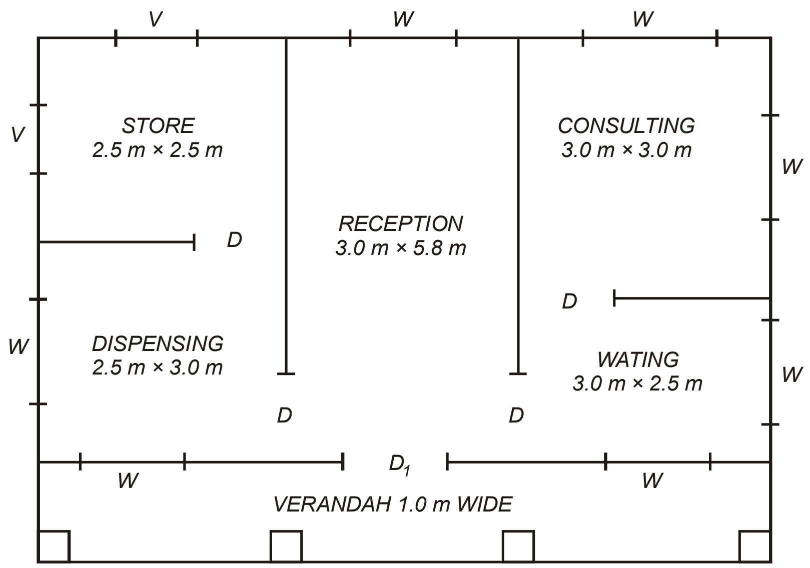
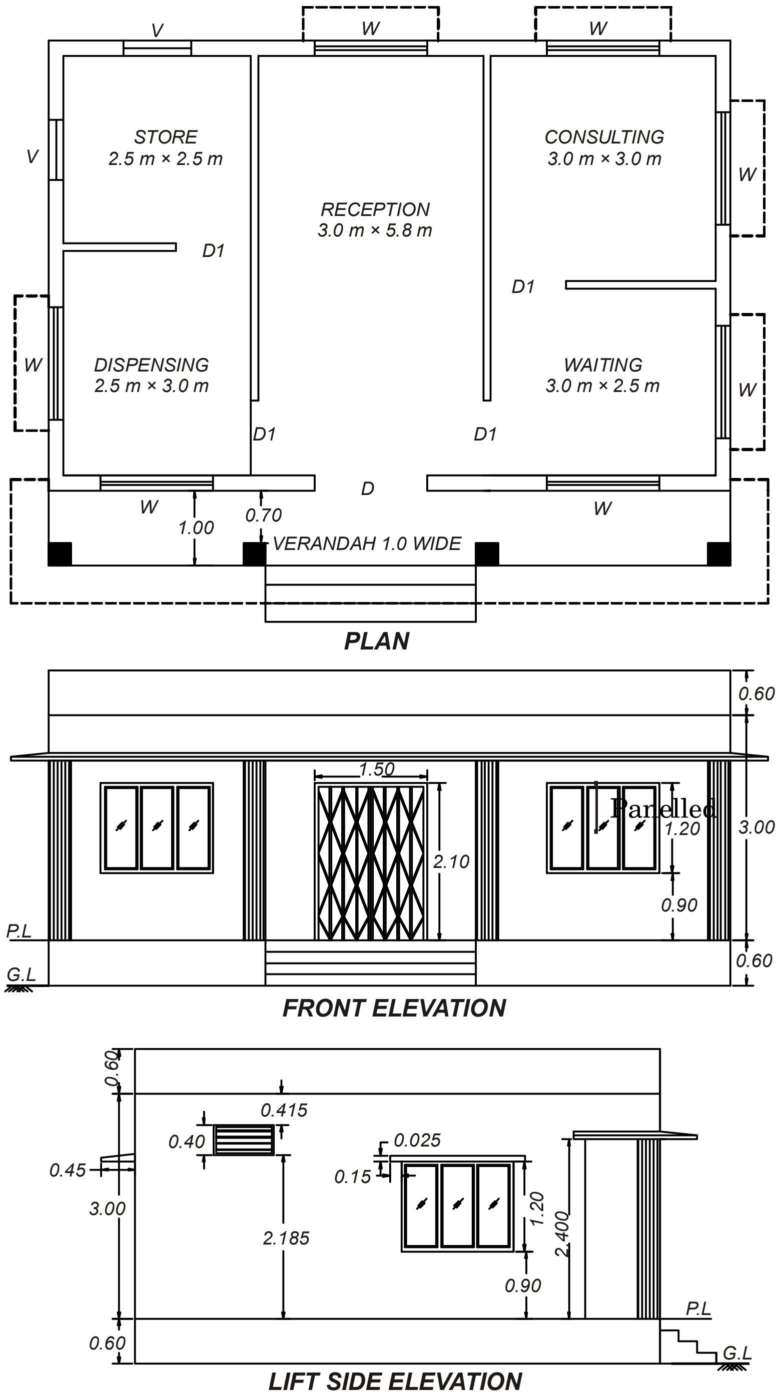


Fig. 1.36.

Plinth level from ground = 600 mm
Height of roof from plinth = 3.0 m
Thickness = 300 mm
D_1 = 1.2 m × 2.0 m
D = 1.0 m × 2.0 m
W = 1.5 m × 1.2 m
V = 0.8 m × 0.4 m

The doors are panelled and the windows and ventilators are glazed.



PLAN, FRONT AND SIDE ELEVATION OF FIG. 1.36.

Example 6. *The line plane of a lower income group house is shown in Fig. 1.37.*

Some of the specifications are as follows :

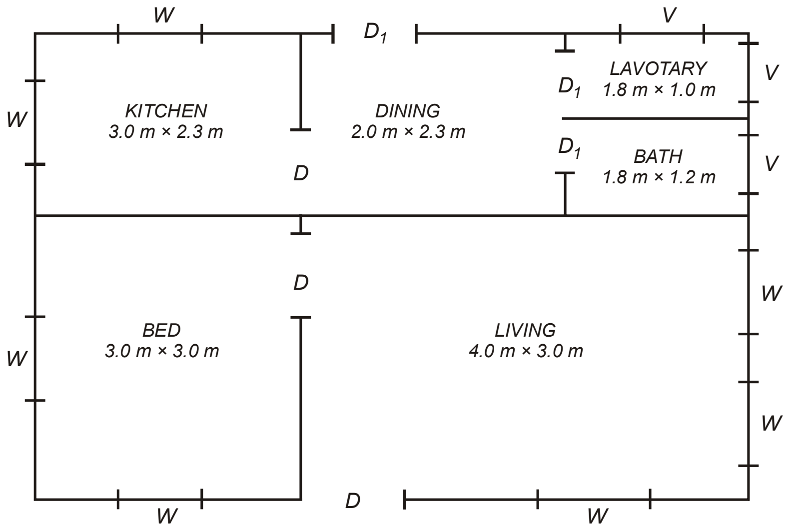


Fig. 1.37

Level of plinth above the ground	= 450 mm
Thickness of main walls	= 300 mm
Thickness of partition at bath and lavatory	= 200 mm
Height of ceiling above the floor	= 3.0 m
Doors D	= 1.1 m × 2.2 m
	D_1 = 0.8 m × 2.0 m.
Windows	W = 1.2 m × 1.4 m–Panelled
Ventilators	V = 0.8 m × 0.6 m–Glazed

Roofing–Reinforced concrete 150 mm thick

Parapet wall = 1 m high and 200 mm thick.

Suitable steps and sunshades are to be provided.

Draw to a scale 1 : 25

(*a*)The plan of the building at window sill level

(*b*)The front elevation.

Example 7. *Draw a suitable plan and elevation showing important details such as doors, windows, steps etc. for a community hall" of inside dimensions 10 m × 20 m × 4 m height. The building is to have 150 mm thick R.C.C. roof and 1½ brick wall. Scale 1 cm = 1 m.*

[**Note.** The scale with which drawing will be made is 1 : 100 and wall thickness will be 300 mm.]

Example 8. *With the given line plan (Fig. 1.38) and specifications of a bus garage draw the plan assuming missing data if any, suitably. (Take suitable scale).*

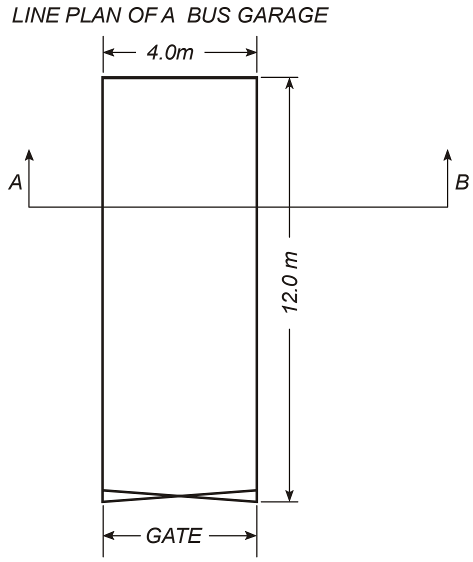


Fig. 1.38.

Specifications :

Foundation.

Depth of foundation	= 1 m
Width of foundation	= 1 m
Thickness of lime concrete	= 150 mm
Height of first footing	= 350 mm
Second footing	= 500 mm
Width of first footing	= 600 mm
Second footing	= 500 mm
Plinth height	= 450 mm
Wall in plinth	= 400 mm
Wall in superstructure	= 300 mm
Ceiling height	= 5.0 m

Roofing :

100 mm lime terracing over 150 mm R.C.C. (1 : 2 : 4) slab.

Parapet–200 mm thick and 300 mm high.

Flooring–50 mm patent stone flooring over 150 mm thick rammed lime concrete.

Door–The gate is fully open in the front, *i.e.* gate covers total width.

Example 9. *Draw the sectional view for the given garage whose line plan is given in the Fig. 1.38.*

Section line for the sectional view will be *AB*.

Specifications will be same as that given in example 8.

[**Note.** Example 8 is an university question on Building drawing and example 9 is alternative to 8. Although foundation details will be required for example 9].

Example 10. *Draw the plan and elevation of a car garage having internal dimension as 6.5 m × 3.0 m. Ceiling height is 3.0 m and wall thickness in superstructure will be 300 mm. Assume suitably any other data required for two views.*

UNIVERSITY QUESTIONS

1. It is proposed to construct a Rector's Bungalow. Following are the requirements :
   (*a*) Drawing Hall–about 25 m^2
   (*b*) Kitchen–about 10 m^2
   (*c*) Dining Room–about 15 m^2
   (*d*) Two bed rooms–about 15 m^2 (each) (with attached toilet)
   (*e*) Study room about 12^2
   (*f*) Office room about 12 m^2.

   Passages, extra toilet, entrance etc. may suitably be provided.

   Assume suitable plot size required for the purpose but clearly mention the same. Draw the following views giving detailed dimensions.

   (*i*) Plan to a scale of 1 : 100
   (*ii*) Elevation to a scale 1 : 100
   (*iii*) Cross section to a scale 1 : 100.
2. What is the necessity of the foundation plan ? Draw the foundation plan of the above bungalow.
3. Beauty, comfort, convenience and health are the four essential requirements of a well planned town. Enumerate the salient rules that you would specify to control the construction of buildings in a developing town.
4. Draw to a suitable scale, the cross-sectional view of the main wall of a building taken across the door, from the following specifications :

   Foundation–Depth 1.20 m, width 1.20 m, lime concrete 300 mm thick.

   Plinth–Height 1.0 m, thickness of wall 400 mm.

   Super structure–Thickness of wall 300 mm ceiling height 3.60 m.

   Flooring–25 mm thick patent stone over a suitable sub-floor.

   Roofing–100 mm. terracing over 150 mm R.C.C. slab.

   Provide suitable door, lintel, band, parapet and foundation footings.
5. State briefly how would you provide natural ventilation in a residential building ?
6. What is the unit of measurement of light ? State values of illumination you would recommend to be provided for various working conditions.
7. Explain the necessity of showing furniture pieces in a room. In a neat sketch, show the various furniture pieces in the consulting room of a physician/advocate/a drawing room of a residential building.

8. State the principles of planning of building and explain the necessity of restricting the built-up area over a lot of land and the height of building. 9.
9. (*a*) Briefly discuss Orientation" and ventilation planning of residential building.
   (*b*) Show the furniture arrangement in the kitchen with storage considerations for the female of Indian origin.
10. A residential building is to be planned over a plot of 260 sq. m. The built up area should not exceed 40% of the plot area. A margin of 5 m is the front and 3 m on the other sides are to be left.

    Assuming suitable dimensions of the plot, draw a fully dimensioned plan for the above building and show the furniture arrangement in the drawing room. Adopt a scale of 1 : 100.
11. Plan a Nursery School for 200 pupils and draw a fully dimensioned plan to a scale of 1 : 100, showing the position of doors and windows and their sizes.
12. Draw a vertical section of the building in Q. 11, selecting the section line to show maximum details. Take a scale of 1 : 50.
13. Plan a single-storeyed, semi-detached, residential building for two families on a plot of 18 m × 22 m size, if the built-up area is to be limited to 40% of the plot area. In front 5 m is to be left and for remaining three sides 3 m space is to be left. Draw a dimensioned plan to a scale of 1 : 50, showing the details of one apartment and only the outline of the other. Furniture in the drawing room and bed room should be shown.
14. Draw a suitable, dimensioned vertical section for the building planned in Q. 13 to a scale of 1 : 50.
15. Attempt any two of the following :
    (*a*) Draw the detailed dimensioned sketch showing the elevation and sectional details of the windows for the building planned in Q. 13.
    (*b*) Draw the elevation of the building planned in Q. 13.
    (*c*) Show the details of foundations up to plinth of the building selected in Q. 13.
16. Attempt any two of the following :
    (*a*) Briefly discuss the points to be borne in mind while designing the building for residential purpose.
    (*b*) Briefly discuss the various sun-shading devices for a building.
    (*c*) Briefly discuss the various means to reduce the cost of a building.