LECTURE NOTES

ON

BUILDING MATERIALS AND CONSTRUCTION TECHNOLOGY

Compiled by

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Chapter-1

STONES

Introduction:

All the building structures are composed of different types of materials. These materials are either called building materials or materials of construction. It is very essential for a builder, may be an architecture or engineer or contractor, to become conversant thoroughly with these building materials.The knowledge of different types of material, their propertiesand uses for different purposes provides and important tool inthe hands of the builders in achieving economy in material cost. The material cost in a building ranges 30 to 50 percent cost of total cost construction. In addition to material economy, the correct use of material results in better structural strength, functional efficiency and esthetic appearance

Classification of Rocks:

Building stones are obtained from rocks occurring in nature and classified in three ways.
Geological classification
Physical classification
Chemical classification

Geological Classification:

According to this classification, the rocks are of the following types.

Igneous rocks: Rocks that are formed by cooling of Magana(molten or pasty rocky material) are known as igneous rocks.Eg: Granite, Basalt and Dolerite etc.
Sedimentary rocks: these rocks are formed by the deposition of production of weathering on the pre-existing rocks. Examples: gravel, sandstone, limestone, gypsum, lignite etc.
Metamorphic rocks. These rocks are formed by the change in character of the pre-existing rocks. Igneous as well as sedimentary rocks are changed in character when they are subject to great heat and pressure. Known as metamorphism.Examples: Quartzite, Schist, Slate, Marble and Gneisses.

Physical Classification:

This classification based on general structure of rocks.
According to this, the rocks are classified into three types
Stratified Rocks: These rocks posses planes of stratificationor cleavage and such rocks can be easily split along these planes
Ex: sedimentary rocks
An stratified rocks: The structure may be crystalline granular or compact granular. Examples: Igneous rocks and Sedimentary rocks affected by movements of the earth.
Foliated Rocks: These rocks have a tendency to split up in adefinite direction only. Ex: Metamorphic rocks.

Chemical Classification:

According to this classification rocks are classified into threetypes.

Siliceous rocks: In these rocks, silica is predominates. The rocks are hard; durable and not easily effected by weathering agencies. Ex: Granite, Quartzite, etc.
Argillaceous Rocks: In these rocks, clay predominates. The rocks may be dense and compact or may be soft.
Ex: slates, Laterites etc.

Calcareous rocks: In these rocks, calcium carbonatepredominates. The durability to these rocks will depend upon theconstituents present in surrounding atmosphere. Ex: Lime Stone,marble etc.

Uses of stones:
Structure: Stones are used for foundations, walls, columns, lintels, arches, roofs, floors, damp proof course etc.
Face works. Stones are adopted to give massive appearanceto the structure. Wall are of bricks and facing is done in stones of desired shades. This is known as composite masonry.
Paving stones: These are used to cover floor of building ofvarious types such as residential, commercial, industrial etc. They are also adopted to form paving of roads, foot paths etc.
Basic material: Stones are disintegrated and converted toform a basic material for cement concrete, morum of roads,calcareous cements, artificial stones, hallow blocks etc. 5.Misalliances: Stones are also used for (i) ballast for railways (ii) flux in blast furnace (iii) Blocks in the construction of bridges, piers, abutments, retaining walls, light houses, dams etc.

Qualities of a good building stone:

The following are the qualities or requirements of a good building stone.
Crushing strength: For a good building stone, the crushing strength should be greater than l000kg per cm^2.
Appearance: Good building stone should be a uniform colour, and free from clay holes, spots of other colour bands etc capable of preserving the colour for longtime.
Durability: A good building stone should be durable. The factors like heat and cold alternative wet and dry, dissolved gases in rain, high wind velocity etc affect the durability.
Fracture: For good building stone its fracture should be sharp, even and clear.
Hardness: The hardness greater than 17, treated as hard usedin road works. It is between 14 to 17, medium hardness, less 14 said be poor hardness.
Percentage wear: For a good building stone, the percentage wear should be equal to or less then 3 percent.
Resistance to fire: A good building stone be fire proof. Sandstone, Argillaceous stone resists fire quite well
Specific gravity: For a good building stone the specificgravity should be greater then 8.7 or so.
Texture: A good building stone should have compact fine crystalline structure should be free from cavities, cracks or patches of stuff or loose material

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Water absorption: For a good building stone, the percentage absorption by weight after 24 hours should not exceed 0.60.
Seasoning: Stones should be well seasoned before putting into use. A period of about 6 to 12 months is considered to besufficient for proper seasoning.
Toughness Index: Impact test, the value of toughness less than 13 – Not tough, between 13 and 19 – Moderate, greater than 19- high

Characteristics of stones
In order to ensure suitable selection of stone of particular work, one must be conversant with its composition, characteristics, uses and place of availability.

Granite

Igneous rock

Composed of quart, felspar and mica and minerals

Available in grey, green, brown and pink and red

Hard and durable

High resistance to weathering

The texture varies with its quality

Specify gravity 2.7 and compressive strength 700 to 1300 kg/cm^2
Used for ornamental, road metal, railway ballast, aggregate for concrete; for construction of bridges, piers and marine works etc.

Balast
Igneous rock
It is compact, hard and heavy
Available in red, yellow grey, blue and greenish blackcolour
Specific gravity is 3 and compressive strength varies 1530to 1890 kg/cm2.
Used for ornamental, rail road ballast, aggregates forconcrete etc.

Sand Stone:
Sedimentary rock
It is available in variety of formations fine grained, coarsegrained compact or porous
Available in white, green, blue, black, red and yellow.
Specific gravity 2.65 to 2.95
Compressive strength is 650kgs / cm2
Used for ashlar works

Lime Stone:
Sedimentary rock: It is available in a variety of forms which differ from one another in colour Compaction, texture,hardness and durable
Compact lime stone
Granular lime stone
Magnesia lime stone
Kanker lime stone
f. Used for paving, road metal, etc

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Marble
Metamorphic rock
Available in white, blue, green, yellow black and red colour
High compactness,
Suitable for decorative works, wall lining columns, pile,table slabs, hearths, tiled floors, steps of stair case etc.

Slate:
Metamorphic rock
Non absorbent, compact fine grained and produce metallicringing sound when struck
Available in black, dark blue, grey, reddish brown etc.
Used for providing damp proof course, paving dados etc

Aggregates - Grading: Aggregates is derived from igneous,sedimentary and metamorphic rocks or is manufacture from clays, slag etc. The properties of concrete are directly relatedto those of its constituents and should be hard, strong,

durable, and free from clay, loam, vegetables and other such foreign matters. The presence of clay or dirt coating preventsthe adhesion of cement on the surface of aggregates and ultimately retards the setting and hardening of cement and reduces the strength, durability and soundness of concrete.

Depending upon their size, the aggregates are classified as (i)Fine Aggregative (ii) coarse aggregates.

Fine Aggregates: The material, most of when passes through4.75mm I.S. sieve size, is termed as fine aggregates. It shouldnot contain more than 1 to 8% of fine particles, which may beobtained from sea, river, lake or pit may be used as fine aggregates but care should be taken all its impurities must beremoved

Coarse Aggregates: The material whose particles are of such size as are retained on 4.75mm, I.S sieve are called coarse aggregates. The size of the coarse aggregates used depends upon the nature of work. The maximum size may be 23mm for mass concrete such as dams etc. and 63mm for plain concrete. Crushed hard stone and gravel is the common materials used as coarse aggregates for structural concretes. Coarse aggregates usually obtained by crashing granite, gneiss, crystalline lime stone and good variety of sandstone etc.

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SHORT ANSWER QUESTIONS

Name the classification of stones.
Name the types of rocks according to geological classification.
Define igneous rocks.
Define sedimentary rocks.
Define metamorphic rocks.
Name any four building stones.
Name any four good qualities of stones.
Name any two uses of stones.

ESSAY TYPE QUESTIONS

Explain the classification of stones.
Explain in detail about the geological classification of stones.
Explain the qualities of good building stone.
Explain the uses of stones as building materials.
Explain physical and chemical classification of stones.
Explain the uses of the following building materials.
Marble b) Granite c) Basalt d) Sandstone
Explain the grading of aggregates.

* * *

Chapter-2
BRICKS

Bricks are obtained by moulding clay in rectangular blocks of uniform sizeand then by drying and burning these blocks. As bricks are ofuniform size,they can be properly arranged, light in weight and hence bricks replace stones.

Composition - Manufacture Process.

Composition – Following are the constituents of good brick earth.

Alumina: - It is the chief constituent of every kind of clay. A good brick earth should contain 20 to 30 percent of alumina. This constituent impartsplasticity to earth so that it can be moulded. If alumina is present in excess,raw bricks shrink and warp during drying and burning.

Silica-A good brick earth should contain about 50 to 60 percent of silica. Silica exists in clay either as free or combined form. As free sand, it is mechanically mixed with clay and in combined form; it exists in chemical composition with alumina. Presence of silica prevents crackers shrinking and warping of raw bricks. It thus imparts uniform shape to thebricks. Durability of bricks depends on the proper proportion of silica in brick earth. Excess of silica destroys the cohesion between particles and bricks become brittle.

Lime – A small quantity of lime is desirable in finely powdered state to prevents shrinkage of raw bricks. Excess of lime causes the brick to melt and hence, its shape is last due to the splitting of bricks.

Oxide of iron- A small quantity of oxide of Iron to the extent of 5 to 6 percent is desirable in good brick to imparts red colour to bricks. Excess of oxide of iron makes the bricks dark blue or blackish.

Magnesia- A small quantity of magnesia in brick earth imparts yellow tintto bricks, and decreases shrinkage. But excess of magnesia decreases shrink leads to the decay of bricks.

The ingredients like, lime, iron pyrites, alkalies, pebbles, organicmatter should not present in good brick earth

Manufacture of bricks:

The manufacturing of brick, the following operations are involved

Preparation of clay

Moulding

Drying

Burning

Preparation of clay :- The preparation of clay involvesfollowing operations

Unsoiling :- Top layer of 20cm depth is removed as it containimpurities.

Digging: - Clay dug out from ground is spread on level groundabout 60cm to 120cm heaps.
Cleaning:-Stones, pebbles, vegetable matter etc removed and converted into powder form.

Weathering:- Clay is exposed to atmosphere from few weeksto full season.

Blending:- Clay is made loose and any ingradient to be addedto it is spread out at top and turning it up and down in verticaldirection.

Tempering:- Clay is brought to a proper degree of hardness, then water is added to clay and whole mass is kneaded or pressed under the feet of men or cattle for large scale, tempering is usually done in pug mill as shown in the fig 2.1

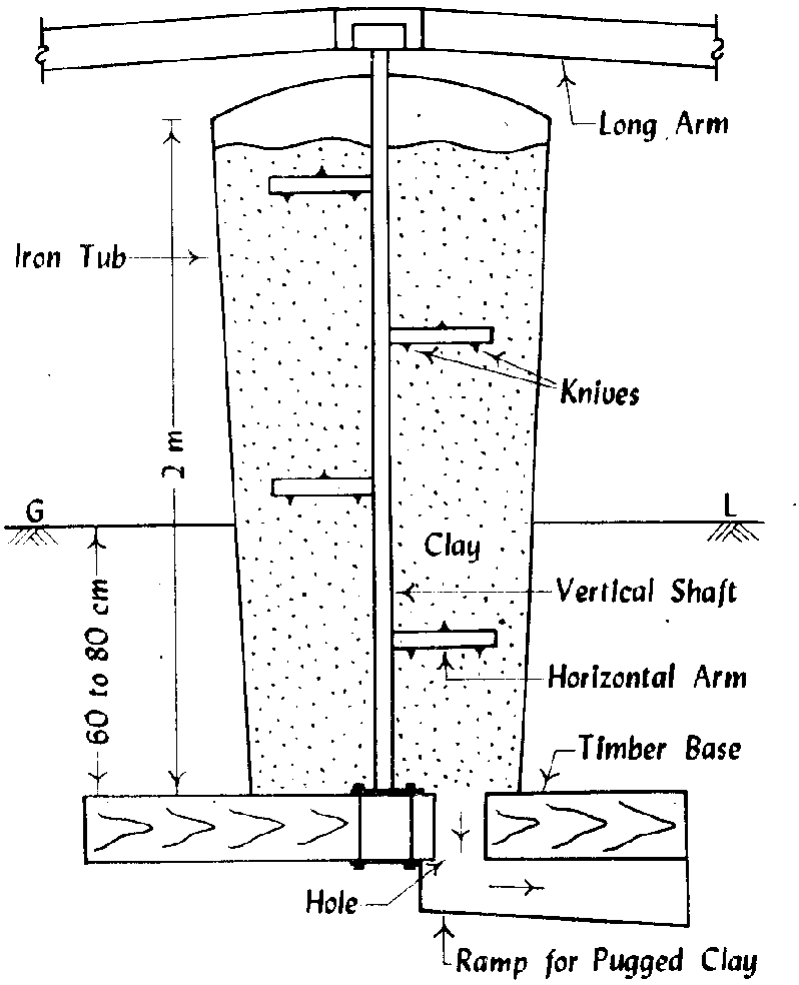


Fig 2.1 Pug Mill

Process:- Clay with water is placed in pug mill from the top. When the vertical staff is rotated by using electric pair, steam or diesel or turned bypair of bullocks. Clay is thoroughly mixed up by the actions of horizontalarms and knives when clay has been sufficiently pugged, hole

at the bottom of tub, is opened cut and the pugged earth is taken out fromramp for the next operation of moulding.

Moulding: Clay, which is prepared form pug mill, is sent for the next operation of moulding. Following are the two ways of moulding.

Hand Moulding: Moulds are rectangular boxes of wood or steel, which are open at top and bottom. Steel moulds are more durable and used for manufacturing bricks on large scale as shown in fig 2.2. Bricks prepared by hand moulding are of two types.

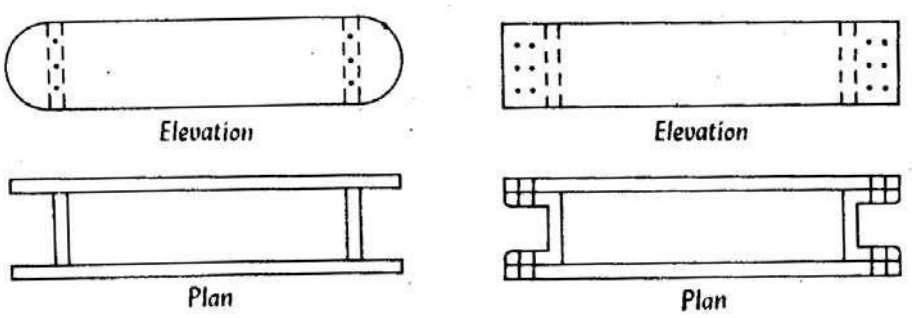


Fig 2.2 Wooden mould & Steel mould

Ground moulded bricks

Table moulded bricks

Ground moulded bricks: ground is first made level and fine sand is sprinkled over it. Mould is dipped in water and placed over thegroundto fill the clay. Extra clay is removed by wooden or metal strike after the mould is filled forced mould is then lifted up and raw

brick is left on the ground. Mould is then dipped in water every time lower faces of ground moulded bricks are rough and it is not possibleto place frog on such bricks.

Ground moulded bricks of better quality and with frogs on their surface are made by using a pair of pallet boards and a wooden block

Table-moulded bricks: Process of moulding these bricks is justsimilar to ground bricks on a table of size about 2m x 1m.

Machine moulding: This method proves to be economical when bricks in huge quantity are to be manufactured at the same spot. It is also helpful for moulding hard and string clay. These machines are broadly classified in two categories

Plastic clay machines

Dry clay machines

Plastic clay machines: This machine containing rectangular openingof size equal to length and width of a brick. Pugged clay is placed in the machine and as it comes out through the opening, it is cut into stripsby wires fixed in frames, so there bricks are called wire cut bricks.

Dry clay machines: In these machines, strong clay is first converted into powder form and then water is added to form a stiff plastic paste.Such paste is placed in mould and pressed by machine to form hard and well shaped bricks. These bricks are behavior than ordinary hand

moulded bricks. They carry distinct frogs and exhibit uniformtexture.

Drying: The damp bricks, if burnt, are likely to be cracked and distored. Hence moulded bricks are dried before thay are taken forthe next operation of burning. Bricks are laid along and across the stock in alternate layers. The drying of brick is by the following means

Artificial drying – drying by tunnels usually 120^0C about 1 to 3days

Circulation of air- Stacks are arranged in such a way that sufficient air space is left between them free circulation of air.

Drying yard- special yards should be prepared slightly higherlevel prevent the accumulation of rain water

Period for frying – usually about 3 to 10 days to bricks tobecome dry

Screens – screens are necessary, may be provided to avoid directexposure to wind or sun.

Burning: This is very important operation in the manufacturing of bricks to impart hardness, strength and makes them dense and durable.Burning of bricks is done either in clamps or in kilns. Clamps are temporary structures and they are adopted to manufacture

bricks on small scale. Kilns are permanent structures and they are adopted to manufacture bricks on a large scale. A typical clamp is as shown in fig 2.3

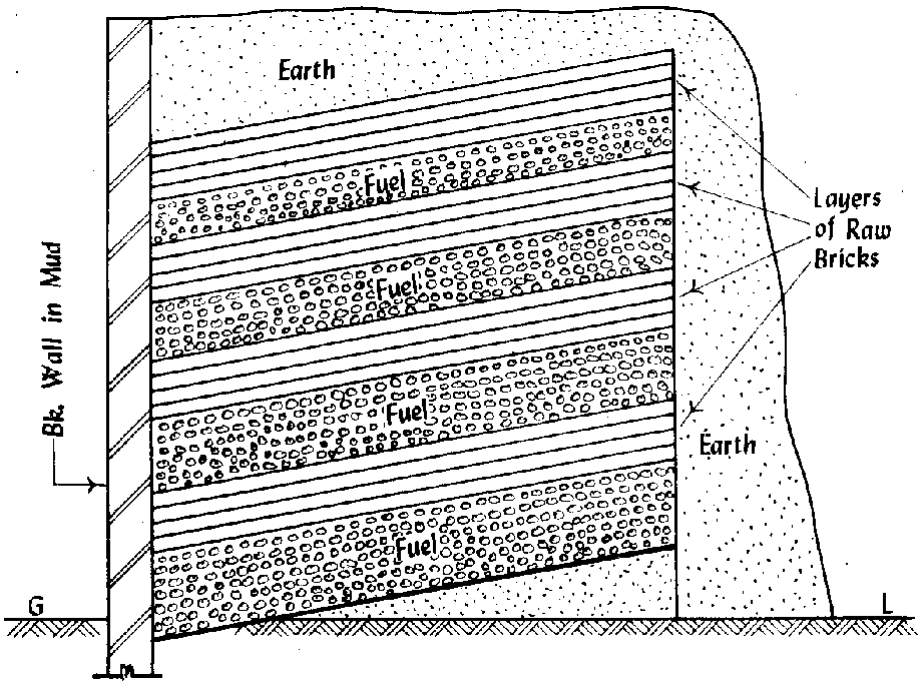


Fig 2.3 Clamp

A trapezoidal shape in plan with shorter is slightly in excavation and wider end raised at an angle of 15^0 from ground level

A brick wall with mud is constructed on the short end and a layer of 70cm to 80cm thick fuel (grass, cow dung, ground nuts, wood or coal) laid on the floor.

A layer consists of 4 or 5 courses of raw bricks laid on edges with smallspaces between them for circulation of air

A second layer of fuel is then placed, and over it another layer of raw bricks is putap. The total height of clamp in alternate layers of brickis about 3 to 4 m

When clamp is completely constructed, it is plastered with mud on sides andtop and filled with earth to prevent the escape of heat

The period of burning is about one to two months and allow the sametime for coding

Burnt bricks are taken out from the clamp

Advantages:

The bricks produced are tough and strong because burning andcooling are gradual

Burning in clamps proves to be cheap and economical

No skilled labour and supervision are required for theconstruction of clamps

There is considerable saving of clamps fuel

Disadvantages:

Bricks are not of required shape

It is very slow process

It is not possible to regulate fire in a clamp

Quality of brick is not uniform

Kilns: A kiln is a large oven, which is used to burnt bricks by

Intermittent kilns

Continuous kilns

COMPARISON BETWEEN CLAMP-BURNING AND KILN-BURNING

No.	Item	Clamp-burning	Kiln-burning
1.	Capacity	About 20000 to 100000 bricks can be preparedat a time.	Average 25000 bricks can be prepared per day.
2.	Cost of fuel	Low as grass, cow dung, litter, etc. may be used.	Generally high as coaldust is to be used.
3.	Initial cost	Very low as no structures are to be built.	More as permanent structures are to be constructed.
4.	Quality of bricks	Percentage of good quality bricks is small about 60% or so.	Percentage ofgoodquality bricks is more about 90% or so.
5.	Regulation of fire	It is not possible to control or regulate fire during the process of burning	Fire is under control throughout the process of burning.
6.	Skilled supervision	Not necessary through-out the process of burn-ing.	Continuous skilled super vision is necessary.
7.	Structure	Temporary structure.	Permanent structure.
8.	Suitability	Suitable when bricks are to be manufactured ona small scale and when the demand of bricks is not continuous.	Suitable when bricks are to be manufactured ona large scale and when there is continuous demand of bricks.
9.	Time of burn-ing and cool-ing.	It requires about 2 to6 months for burning and cooling of bricks.	Actual time for burning of one chamber is about 24 hours and only about 12 days are required for cooling of bricks.
10.	Wastage of heat.	There is considerable wastage of heat from top and sides and hot flue gas is not properly utilised.	Hot flue gas is used to dry and pre-heat raw bricks. Hence wastage of heat is the least.

Classification:

Bricks can broadly be divided into two categories.

Unburnt or sundried bricks

Burnt bricks

Un burnt or Sun dried bricks- UN burn or sun dried with the help of heat received from sun after the process of moulding. Thesebricks can only be used in the constructions of temporary and cheap structures. Such bricks should not be used at places exposedto heavy rains.
Burnt Bricks: The bricks used in construction works are burnt bricks and they are classified into the following four categories.
First Class bricks: These bricks are table moulded and ofstandard shape. The surface and edges of the bricks are sharp, square, smooth and straight. The comply all the qualities of good bricks and used for superior work of permanent nature.
Second class bricks: These bricks are ground moulded andthey are burnt in kilns. The surface of bricks is some whatrough and shape is also slightly irregular. Thesebricks are commonly used at places where brick work is to be provided with a coat of plaster.
Third class bricks: These bricks are ground moulded andthey burnt in clamps. These bricks are not hard and they have rough surfaces with irregular and distorted edges.

These bricks give dull sound when struck together. They are used for unimportant and temporary structures and at places where rainfall is not heavy.
Fourth class bricks: These are over burnt bricks with irregular shape and dark colour. These bricks are used as aggregate for concrete in foundation, floors, roads, etc because of the fact that the over burnt bricks have compacted structure and hence, they are some times foundstronger than even first class bricks.

Qualities of Good Brick:

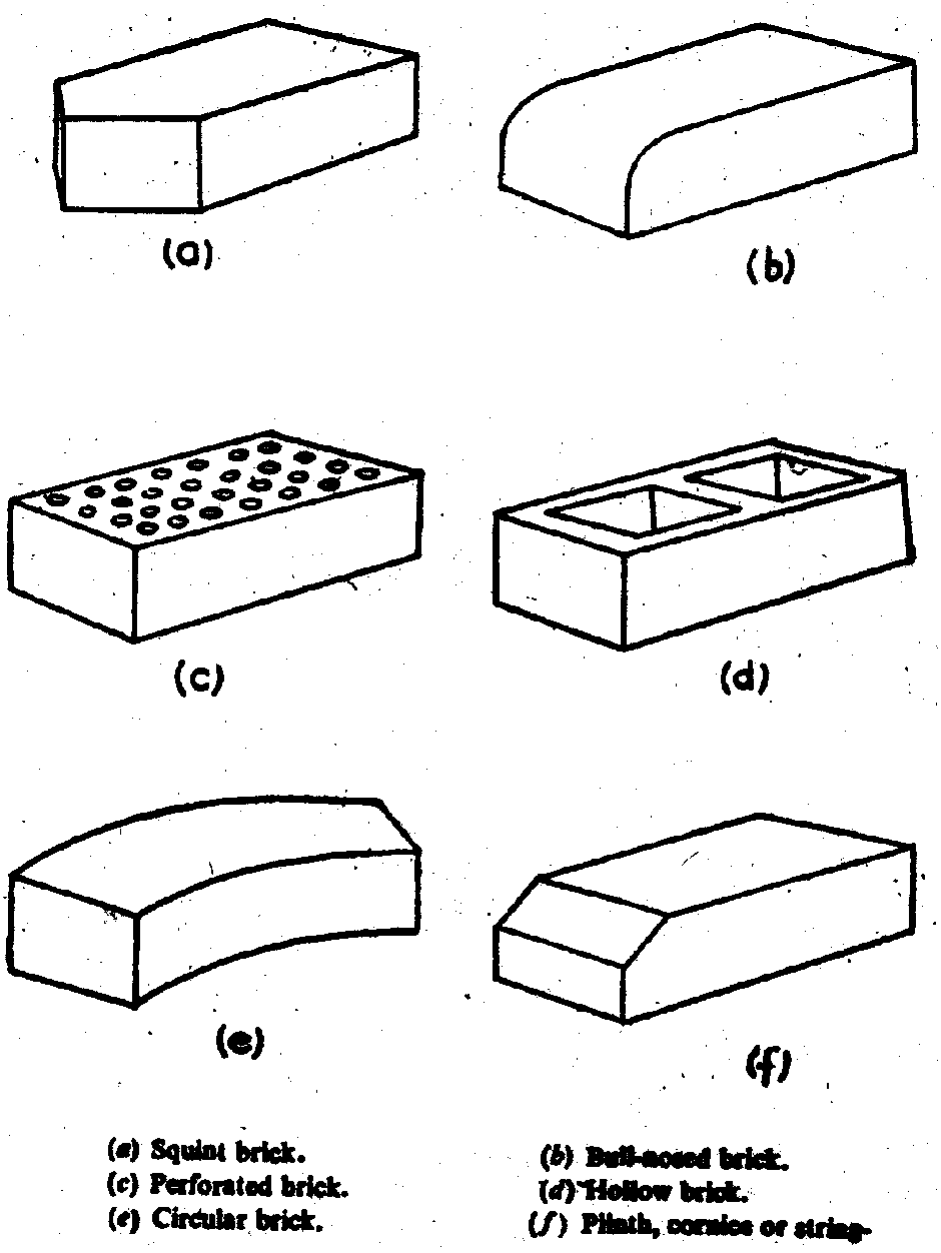
Bricks should be table moulded, well burnt in kilns, copper coloured, free from cracks and with sharp and square edges.
Bricks should be uniform shape and should be of standard size.

Bricks should give clear ringing sound when struck each other.

Bricks when broken should show a bright homogeneous and compact structure free from voids.
Bricks should not absorb water more than 20 percent by weightfor first class bricks and 22 percent by weight for second classbricks, when soaked in coldwater for a period of 24 hours.

Bricks should be sufficiently hard no impression, should beleft on brick surface, when it is scratched with finger nail.
Bricks should be low thermal conductivity and they should besound proof.
Bricks should not break when dropped flat on hard groundfrom a height of about one meter.
Bricks, when soaked in water for 24hours, should not showdeposits of white salts when allowed to dry in shade.
No brick should have crushing strength below 55kg/cm2

Special Types: Bricks are made in a wide range of shapes and to suit the requirements of the location where they are to be used. Special form of bricks may be needed due to structuralconsideration or for ornamental decoration as defined by the architect. Specially moulded bricks avoid the cumbersome processof cutting and rounding the rectangular bricks to thedesired shape.Some of the special types of bricks commonlyused are given below.
Squint Bricks: These bricks are made in a variety of shapes and are used to the construction of a cute and obtuse squint quoins as shown in the fig2.7.



(a) Squint brick. (b) Bull-nosed brick.
(c) Perforated brick. (d) Hollow brick.
(e) Circular brick. (f) Plinth, cornice or string-

Fig 2.7 Types of Special Bricks

Bull Nosed Bricks: These bricks are used to form roundedquoins.

Bricks

Perforated Bricks: These bricks may be standard size bricks produced with perforations running through their thickness. Perforated bricks are easy to burn and their light weight makes it possible to cut down the weight of the structure and effect in foundations. The aperture of the perforations is such that it gives maximum amount of ventilation. But does not permit the entry ofrats or mice. These bricks are used for constructing load bearing walls of low buildings, panel walls for multistoried buildings and for providing partition walls.

Hallow Bricks: These bricks are made of clay and are provided with one or more cavities. Hallow bricks are light in weight and are used to increase insulation against heat and dampness. They are used for the construction of load bearing walls, partition wallsor panel walls to multistoried buildings.

Circular Bricks: These bricks have internal and external faces curved to meet the requirement of the particular curve and radius of the wall. These bricks are used for wells, towers etc

Plinth cornice and String Course Brick: These bricks are moulded in several patterns with the object of adding architecturalbeauty to the structure and at the same time to helping to throw therack water off the face of the walls.

Coping Bricks: These bricks are manufactured in a variety of shapes to set the thickness of the wall and are throated on the underside to throw off rain water as shown in the fig2.7

Paving Bricks: These bricks are specially made for paving the surface of streets and highways. These bricks are usually made from shale, fire clay on a mixture of the two. They are unaffected by weather and ordinary traffic wear. They are loaded on the bed of sand which in term rests on foundation of stone or concrete. Thebricks are laid by grouting with cement mortar or asphalt. They aremachine moulded and are burnt in a continuous kiln to ensure highdegree of vitrification.
Tests for bricks :

A brick is generally subjected to following tests to find out itssuitability of the construction work.
Absorption

Crushing strength or compression strength

Hardness

Presence soluble salts

Shape and size

Soundness

Structure

Absorption: A good should not absorb not more than 20 percent of weight of dry brick
Compressive strength: crushing or compressive strength of brickis found out by placing it in compression testing machine. It is pressed till it breaks. Minimum crushing strength of brick is

35kg/cm^2 and for superior bricks, it may vary from 70 to 140kg/cm^2.
Hardness: No impression is left on the surface the brick istreated to be sufficiently hard
Presence of soluble salts: The bricks should not show any greyor white deposits after immerted in water for 24 hours
Shape and size: It should be standard size and shape with sharpedges
Soundness: The brick should give clear ringing sound struckeach other
Structure: The structure should be homogeneous, compact andfree from any defects

SHORT ANSWER QUESTIONS

What are the constituents of good brick earth?
What are the harmful ingradients in brick earth?
Name the operations involved in the manufacture of brick.
What are the types of bricks?
Name the types of special bricks.
Name any four uses of bricks.
What are the important qualities of brick?
What is the use of frog?
What are the uses of fire bricks?
What are the uses of hallow bricks?
What is the size and weight of standard brick?
What is meant by blending?
What is tempering?

ESSAY TYPE QUESTIONS

Explain the manufacturing process of bricks in detail.
Explain the classification of bricks.
Explain the qualities of bricks.
Explain the special types of bricks.
Explain the composition of good brick in detail (function of eachconstituent).
Explain the tests to be conducted to a brick.
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Chapter-3
CEMENT,MORTAR AND CONCRETE

Cement in its broadest term means any substance which acts as a binding agent for materials natural cement (Roman Cement) is obtained by burning and crushing the stones containing clay, carbonates of lime andsome amount of carbonate of magnesia. The clay content in such stones isabout 20 to 40 percent. Natural cement resembles very closely eminent hydraulic lime. It is not strong as artificial cement, so it has limited use in practice.

Artificial cement is obtained by burning at very high temperature a mixture of calcareous and argillaceous materials in correct proportion. Calcined product is known as clinker. A small quantity of gypsum is addedto clinker and it is then pulverized into very fine powder is known as cement. Cement was invented by a mason Joseph Aspdin of leeds in England in 1824. The common variety of artificial cement is known as normal setting cement or ordinary cement or Portland cement.

Ingradeints – Functions
Ordinary Portland cement contains two basic ingredients, namely argillaceous and calcareous. In argillaceous materials,claypredominates and in calcareous materials, calcium carbonate predominates. Good ordinary cement contains followingingradients.
1. Lime (cao)……. 62%

2. silica (Sio2)	…….	22%
3. Aluminca(Al2 u3)	…….	5%
4. Calcium sulphate (CaSo4)	…….	4%
5. Iron Oxide (Fe2 O3)	…….	3%
6. Magnescia (Mgo)	…….	2%
Sulphur	…….	1%
Alkalies	…….	1%

Functions of Ingradients:
Lime: Lime is the important ingredient of cement and its proportion isto be maintained carefully. Lime in excess makes the cement unsound andcauses the cement to expand and disintegrate. On the other hand, if lime is in deficiency the strength of the cement is decreased and it causescementto set quickly

Silica: This also an important ingredient of cement and it gives or imparts quick setting property to imparts strength to cement.

Alumina: This ingredient imparts quick setting properly to cement. Express alumina weakens the cement.

Calcium Sulphate: This ingredient is in the form of gypsum and its function is to increase the initial setting time of cement.

Magnesia: The small amount of this ingredient imparts hardness and colour to cement.

Sulphur: A very small amount of sulphur is useful in making sound cement. If it is in excess, it causes the cement to become unsound.

Alkalies: Most of the alkalies present in raw material are carried awayby the flue gases during heating and only small quantity will be left. If they are in excess in cement, efflorescence is caused.

Types of Cement

In addition to ordinary cement, the following are the other varietiesof cement.

Acid Resistance Cement: This is consists of acid resistance aggregates such as quartz, quartzite's, etc, additive such as sodium fluro silicate (Na_2SiO_6) and aqueous solution of sodium silicate. This is used for acid- resistant and heat resistant coating of installations of chemical Industry. By adding 0.5 percent of unseed oil or 2 percent of ceresil, its resistance to water is increased andknown as acid water resistant cement.

Blast Furnace Cement: For this cement slag as obtained from blast furnace in the manufacture of pig iron and it contains basic elements of cement, namely alumina, lime and silica. The properties of this cement are more or less the same as those of ordinary cement and prove to be economical as the slag, which is waste product, is used in its manufacture.

Coloured Cement: Cement of desired colour may beobtained by intimately mixing mineral pigments with

ordinary cement. The amount of colouring may vary from 5 to 10 percent and strength of cement if it is exceeds 10 percent. Chromium oxide gives brown, red or yellow for different proportions. Coloured cements are used for finishing of floors, external surfaces, artificial marble, windows

Expanding Cement : This type of cement is produced byadding an expanding medium like sulpho – aluminate and a stabilizing agent to ordinary cement. Hence this cement expands where as other cement shrinks. Expanding cementis used for the construction of water retainingstructures andalso for repairing the damaged concretesurfaces.

High alumina Cement: This cement is produced by grinding clinkers formed by calcining bauxite and lime. The total content should not be less than 32 percent and theratio by weight of alumina to lime should be between 0.85 and 1.30.

Advantages

Initial setting time is about 31/2 hours therefore, allows more timefor mixing and placing operations.

It can stand high temperatures.

It evolves great heat during setting therefore not affected by frost.

It resists the action of acids in a better way.

It lets quickly and attains higher ultimate strength.

Disadvantages:
It is costly
It cannot be used in mass construction as it evolves great heat and asit sets soon.
Extreme care is to taken to see that it does not come in contact witheven traces of lime or ordinary cement.

Hydrophobic Cement: This type of cement contains admixtures,which decreases the wetting ability of cement grains. The usual hydrophobic admixtures are acidol napthene soap, oxidized petrolatum etc when hydrophobic cement is used, the fire pores in concrete are uniformly distributed and thus the frost resistance and the water resistance of such concrete are considerably increased.

Low Heat Cement: Considerable heat is produced during the setting action of cement. In order to reduce the amount of heat, thistype of cement is used. It contains lower percentage of tri calcium aluminates C_3A and higher percentage of dicalcium silicate C_2s. This type of cement is used for mass concrete works because it processes less compressor strength.

Pozzuolona Cement: Pozzuolona is a volcanic powder and thepercentage should be between 10 to 30.
Advantages
It attains compressive strength with age.
It can resist action of sulphates.

It evolves less heat during setting.
It imparts higher degree of water tightness.
It imparts plasticity and workability to mortar and concreteprepared from it.
It offers great resistance to expansion
It possesses higher tensile strength

Disadvantages:
Compressive strength in early days is less.
It possesses less resistance to erosion and weathering action.

Quick Setting Cement: This cement is prepared by adding a smallpercentage aluminum sulphate which reduce the percentage of gypsum or retarded for setting action and accelerating the setting action of cement. As this cement hardnessless than 30 minutes, mixing and placing operations should be completed. This cement is used to lay concrete under static water or running water.

Rapid Hardening cement: This cement has same initial andfinalsetting times as that of ordinary cement. But it attains high strengthin early days due to
Burning at high temperature.
Increased lime content in cement composition.
Very fine grinding.
Advantages:
Construction work may be carried out speedily.

Formwork of concrete can be removed earlier.
It is light in weight.
It is not damaged easily.
This cement requires short period of curing.
Use of this cement also higher permissible stresses in thedesign.
Structural member constructed with this cement may beloaded earlier.

Sulphate Resisting Cement: In this cement percentage of tricalcium aluminates is kept below 5 to 6 percent and it results inthe increase in resisting power against sulphate. This cement is used for structure which are likely to be damaged by sever alkalinecondition such as canal linings, culverts, siphons etc.

White Cement: This is a variety of ordinary cement and it is prepared form such raw materials which are practically free from colouring oxides of Iron, manganese or chromium. For burningof this cement, oil fuel is used instead of coal. It is used for floor finish; plaster work, ornamental works etc.

Uses of Cement:
Cement mortar for masonry work, plaster, pointing etc
Concreter for laying floors, roofs and constructing lintels,beams, weather sheds, stairs, pillars etc.

Construction of important engineering structure such as bridges, culverts, dams, tunnels storage reservoirs, light houses, deckles etc.
Construction of water tanks, wells, tennis courts, septic tanks,lampposts, roads, telephone cabins etc.
Making joints for drains, pipes etc.
Manufacture of pre cast pipes, piles, garden seats, artificially designed urns, flowerpots, etc dustbins, fencing posts etc.
Preparation of foundations, watertight floors, footpaths etc.

Admixtures – Uses.
These are the ingredients or substance, which are added to concreteto improve its properties like strength, hardness, water resisting power,workability etc. Many admixtures like alum etc are commonly used for this purpose.

* * *

SHORT ANSWER QUESTIONS

Name the important ingradients of cement
Name any four uses of cement
What are the important types of cement
What are the uses acid-resistant cement?
What is use of rapid hardening cement?
Explain the following
Quick setting cement b) white cement
What is the use of sulphate resisting cement?
What is meant by blast furnace cement?

ESSAY TYPE QUESTIONS

Name and explain the ingradients functions in the cement
Explain the qualities of cement
Explain the varieties of cement
Explain the following
Rapid hardening cement
High alumina cement
Explain in detail the uses of cement

* * *

* * *

MORTAR

The term mortar is used to indicate a paste prepared by adding required quantity of water to a mixture of binding material like cement orLime and fine aggregates like sand. The two components of mortarnamelythe binding material and fine aggregates are some times referred to as matrix the durability, quality and strength of mortar will mainly depends on quantity and quality of the matrix. The combined effect ofthe two components of mortar is that the mass is able to bind the bricksor stones firmly

Properties – Uses:

The important properties of a good mortar mix are mobility, placeability and water retention. The mobility is used toindicate the consistency of mortar mix, which may range from stiffto fluid
The mobility of mortar depends upon composition of mortar and mortar mixes to be used for masonry work, finishing works, etc are made sufficiently mobile.
The placeability or the ease with which the mortar mix can be placed with minimum cost in a thin and uniform layer overthe surface depends on the mobility of mortar. The placeablity of mortar mix should be such that a strong bond is developed with thesurface of the bed.

A good mortar mix should posses the ability if retaining adequate humidity during the transportation and laying over the porous bed.
If water retention power of mortar mix is low it separates into layers during transportation and when it comes contact with the porous bed like brick, wood, etc, it gives away its water tothat surface. Thus the mortar becomes poor in a amount of water and remaining water proves to be insufficient for its hardening. Hence required strength of mortar will not be achieved with such a mortar mix will.

Properties of good mortar
It should be capable of developing good adhesion with thebuilding units such as bricks, stones etc.
It should be capable of developing the designed stresses.
It should be capable of resisting penetration of rainwater.
It should be cheap.
It should be durable.
It should be easily workable.
It should not affect the durability of materials with which itcomes into contact.

Uses:

To bind the building units such as bricks, stones etc.
To carry out painting and plaster works on exposed surfacesof masonry
To form an even bedding layer for building units

To form joints of pipes
To improve the appearance of structure.

Types of Mortar
The mortar are classified on the bases of the following
Bulk density
Kinds of binding material
Nature of application
Special mortars

Bulk density:
According to bulk density of mortar in dry state, the mortars aretwo types
Heavy mortars bulk density is more than 1500kg/m3 andprepared from heavy quartz
Lightweight mortars – bulk density is less than 1500/mg3and prepared from light porous sands.
Kinds of binding Material
According to the kinds of
binding material, several factorssuch as expected working conditions, hardening temperature, moisture conditions, etc shouldbe considered. The mortars are classified into four categories.
Lime Mortar - in this motor, lime is used as binding material. Lime may be fate lime or Hydraulic lime. Fat lime mortar 1:2 to 1:3 and hydraulic lime mortarmay be1:2 by VOLUME.

Cement mortar: In this mortar, cement is used as binding material. Depending upon the strength required and importance of work, the proportion of cement to sand varies from 1:2 to 1:6 or more.
Gauged Mortar or composite mortar:

The process of adding cement to lime mortar to improve the qualityof lime mortar is known as gauging. It makes lime mortar economical, strong and dense. The usual proportion of cement to lime by volume is about 1:6 to 1:8
Gypsum mortar:

These mortars are prepared from gypsum binding material suchas building gypsum and anhydrite binding materials.

Nature of Application:
According to the nature of application, the mortars areclassified into two categories.

Brick laying mortars: Mortars for brick laying are intended tobe used for brick works and walls. Depending up on the working conditions and type of construction, the composition of masonry mortars with respect to the kind of binding materials is decided.

Finishing Mortars: these mortars include common plasteringwork and mortars for developing architectural or ornamental effects. Generally cement or lime is used as binding material.

SHORT ANSWER QUESTIONS

Define mortar.

What are the important properties of mortar?

Write any four important uses of mortar.

Name the types of mortar.

What are the precautions to be taken while preparing a cementmortar?

ESSAY TYPE QUESTIONS

Explain the properties of mortar.

Explain the procedure for preparation of mortar.

Write all the uses of mortar.

* * *

CONCRETE

Cement concrete is a mixture of cement, sand, pebbles or crushed rock andwater. When placed in the skeleton of forms and allowed to cure, becomeshard like a stone. Cement concrete is important building material becauseof the following reasons.
It can be moulded into any size and shape of durable structural member.
It is possible to control the properties of cement concrete.

It is possible to mechanise completely its preparation and placing processes.
It possesses adequate plasticity for mechanical working.

The cement concrete has the following properties

It has high compressive strength

It is free from corrosion

It hardens with age and continues for a long time after concrete hasattained sufficient strength
It is proved to be economical than steel

It binds rapidly with steel and it is weak in tension, steel reinforcement is placed in cement concrete at suitable places to take up tensile concrete or simply R.C.C.
It forms a hard surface, capable of resisting abrasion stresses. This is called reinforced cement.

It has tendency to be porous to avoid this proper grading &consolidation of the aggregates, minimum water-cement ratio should be adopted.
Constituents - Requirements.

The main constituents of concrete are

Cement / Lime: Before introduction of ordinary Portland cement, lime was used as cementing material. At present most ofthe cement concrete works in the building construction is done with ordinary Portland cement. But other special varieties of cement such as rapid hardening cement, high alumina cement are used under certain circumstances. The cement should complywith all standard specifications
Fine Aggregates: The material, which is passed through 4.7625mm B.S.test sieve, is termed as fine aggregates. Usually natural river sand is used as fine aggregates. But places where natural sand is not available economically, finely crushed stone may be used as fine aggregates.
Coarse Aggregates: The material retained on 4.7625mm size B.S.test sieve is termed as coarse aggregates. Broken stone is generally used as coarse aggregates. For thin slabs, and walls, the maximum size of coarse aggregates should be limited to one third the thickness of the concrete section
Water: Water to be used in the concrete work should have the following properties.
It should be free from oils

It should be free from acids or alkalies

It should be free from Iron, Vegetables matter or othersubstance, which is likely to have adverse effect on concrete.
It should be fit for drinking purpose

Function of Water

It acts as lubricant for fine and coarse aggregates.

It acts chemically with cement to form binding paste with coarseaggregates and reinforcement.
It is necessary to flux the cementing material over the surface ofthe aggregates.
It is employed to damp the concrete in order to prevent themabsorbing water vitally necessary for chemical action
It enables the concrete mix to blow into moulds.

6.2. Uses and typesUses of Concrete:
1:2:2 - For heavy loaded R.C.C columns and R.C.C arches of longspans
1:2:2 - For small pre cast members of concrete like fencing poles,telegraph poles etc. watertight construction.
1:2:3 - For water tanks, bridges, sewers etc.1:2½:3½ - For foot path, concrete roads

1:2:4 - For general work of RCC such as stairs, beams, columns,slabs, etc
1:4:8 /

1:5:10 For mass concrete for heavy walls, foundation footingsetc.

Preparation of concrete mix:

There are two types of concrete mixing

Hand mixing

Machine mixing

Curing of concrete:

Curing of concrete is one of the essential requirement of process of concreting. Curing is process of keep the set concrete damp forsome days in order to enable the concrete gain more strength
Purposes:

Curing protects concrete surfaces from sun and wind

Presence of water is essential to cause the chemical actionwhich a companies the setting of concrete

* * *

SHORT ANSWER QUESTIONS

What are the ingradients of concrete?

What are requirements of materials in concrete

Cement b) Sand c) C.A. d) Water

Write any four important uses of concrete

What are the types of concrete?

What is meant by compaction?

What is the importance of compaction?

What is meant by curing?

What is use of curing of concrete?

ESSAY TYPE QUESTIONS

Explain the requirements of constituents of concrete

Write the uses of concrete

Explain the preparation of concrete by

Hand mixing 2. Machine mixing

What is meant by curing of concrete? Explain importance ofcuring.

What is compaction of concrete? Explain the importance ofcompact

Chapter-4

Other construction materials

TIMBER

Timber denotes wood, which is suitable for building or carpentry or various other engineering purposes like for construction of doors, windows, roofs, partitions, beams, posts, cupboards, shelves etc

Uses of timber:

Used in the form of piles, posts, beams, lintels, door/windowframes and leaves, roof members etc

Used for flooring, ceiling, paneling and construction ofpartition walls

Used for form work for concrete, for the timbering of trenches,centring for arch work, scaffolding, transmission poles andfencing

Used in wagon and coach building, marine installations and bridges

Used in making furniture of agriculture implements, sports goods, musical instruments, well curbs, mortar bodies, carts and carriages, railway sleeps, packing cases etc

Classification of trees

Depending upon their mode of growth trees may be divided inthe following two categories

Endogeneous trees – These trees grow inwards and fibrousmass is seen in their longitudinal sections. Timber from

these trees has very limited engineering applications Ex:bamboo, cane , palm etc
Exogeneous trees: These increases in bulk by growingoutwards and used for engineering purposes.
Exogeneous trees are further sub divided into two groups
conifers b) deciduous

Conifers or evergreen trees: These trees having pointed, needle like or scale like leaves and yield soft wood
Deciduous trees: The trees having flat broad leaves and leaves of those trees fall in autumn and new ones appear in spring season. Timber for engineering purpose is mostly derived from deciduous trees. These trees yield hard wood.
Ex: ash, beach, oak, sal, teak, shishum and wallnutComparison of softwood and hard wood

S.No.	Item	Soft wood	Hard wood
	Annual rings	Distinct	Indistinct
	colour	light	dark
	fire resistance	poor	more
	modullary rays	Indistinct	distinct
	Structure	resinous and	non-resinoussplit easily & close grained
	weight	light	heavy
	strength	strong for direct	equally strongPull & weak for for resisting
	Resisting	thrustor shear	tension,compr -ession & shear

Structure of tree: From the visibility aspect, the structure of a tree canbe divided into two categories
Macro structure

Micro structure

Macro structure: The structure of wood visible to the nakedeye or at a small magnification is called macro structure. Fig
shows the macro structure of exogenous tree.

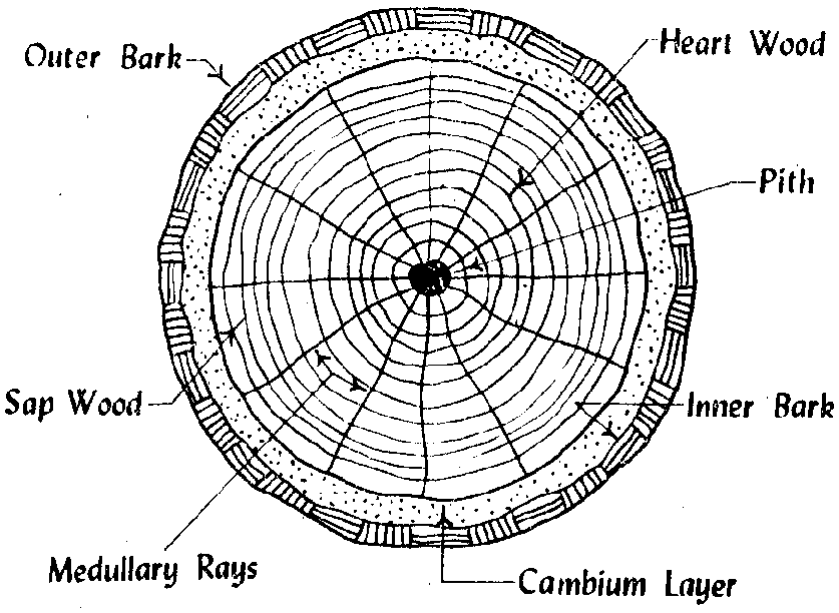


Fig 7.1 Micro structure of exogenous tree

Pith: The innermost central portion or core of the treeis called pith or medulla
Heart wood: The inner annual rings surrounding thepith is known as heart wood. It imparts rigidity to tree

Sap wood: The cuter annual rings between heart woodand cambium layer is known as sap wood
Cambium layer: Thin layer of sap between sap woodand inner bark is known as cambium layer
Inner bark: The inner skin or layer covering thecambium layer is known as inner bark
Outer Bark: The outer skin or cover of the tree isknown as outer bark
Medullary rays: The thin radial fibres extending frompith to cambium layer are known as medullary rays
Micro structure: The structure of wood apparent only atgreatmagnifications is called micro structure under microscope,it becomes evident that the wood consists of living andlead cells of various sizes and shapes.
Defects in Timber:

Defects occurring in timber are grouped into the followingdivisions.
Defects due to conversion: During the process of convertingtimber to commercial form, the following defects may occur.
Chip mark: mark or sign placed by chip on finishedsurface of timber
Diagonal grain: Due to improper sawing of timber

Torn grain: Due to falling of tool small impression isformed
Wane: Presence of original rounded surface on the manufactured piece of timber
Defects due to fungi: The attack of timber by fungi when moisturecontent of timber is above 20% and presence of air and warmth forthe growth of fungi the following defects are caused
Blue stain: Sap of wood is stained to bluesh colour

Brown rot: Decay or disease of timber by removal of cellulose compounds from wood and wood assumes the brown colour
Dry rot: Convert the wood into dry powder form

Heart rot: This is formed when branch has come out of a tree and the tree becomes weak and gives out hallowsoundwhen struck with a hammer
Sap stain: The sap wood looses its colour because of feedon cell contents of sap wood.
Wet rot: Caused chemical decomposition of wood of the timber and timber converts to grayish brown powder known as wet rot.
White rot: Attack lignin of wood and wood assumes the appearance of white mass

Defects due to insects:

Beetles: Small insects form holes of size about 2mm diameter and attack sap wood of all spacies of hard woods. Tunnels are formed in all directions in sapwood by the larvae of these beetles and converted into fine flour like powder. They do not disturb outercover and looks sound.
Marine borers: These make holes or bore tunnels in woodfor taking shelter. The wood attacked by marine borers loses colourand strength
(ii) Termites: White ants are very fast in eating away the wood fromthe core of the cross section. They make tunnels insideindifferent directions and usually donot disturb the outershellor cover
Defects due to natural forces:

The main natural forces responsible for causing defects in timberare abnormal growth and rapture of tissues
Burls: Irregular projections appear on the body of timberbecause of shock at younger age
Callus: Soft tissue or skin which covers the wound oftree.
Chemical stain: Discoloured due to the chemical actioncaused
Coarse grain: Annual rings are widened, tree growsrapidly hence timber possesses less strength

Dead wood: Timber obtained from dead standing tree

Druxiness: White decayed spots by fungi

Foxiness: Due to poor ventilation during storage or by commencement of decay due to over maturity indicatedby red or yellow tinge in wood
Knots: Bases of branches or limbs which are broken or cutoff from the tree as shown in the fig 7.2.

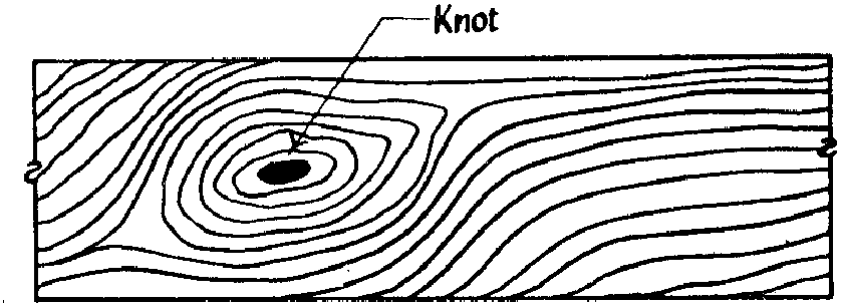


Fig 7.2 Knot

Rind galls: Rind means bark and gall indicates abnormal growth and pecullar curved swellings found on the body of a tree.
Shakes: These are cracks which partly or completely separate the fibres of wood as shown in fig. 7.3.

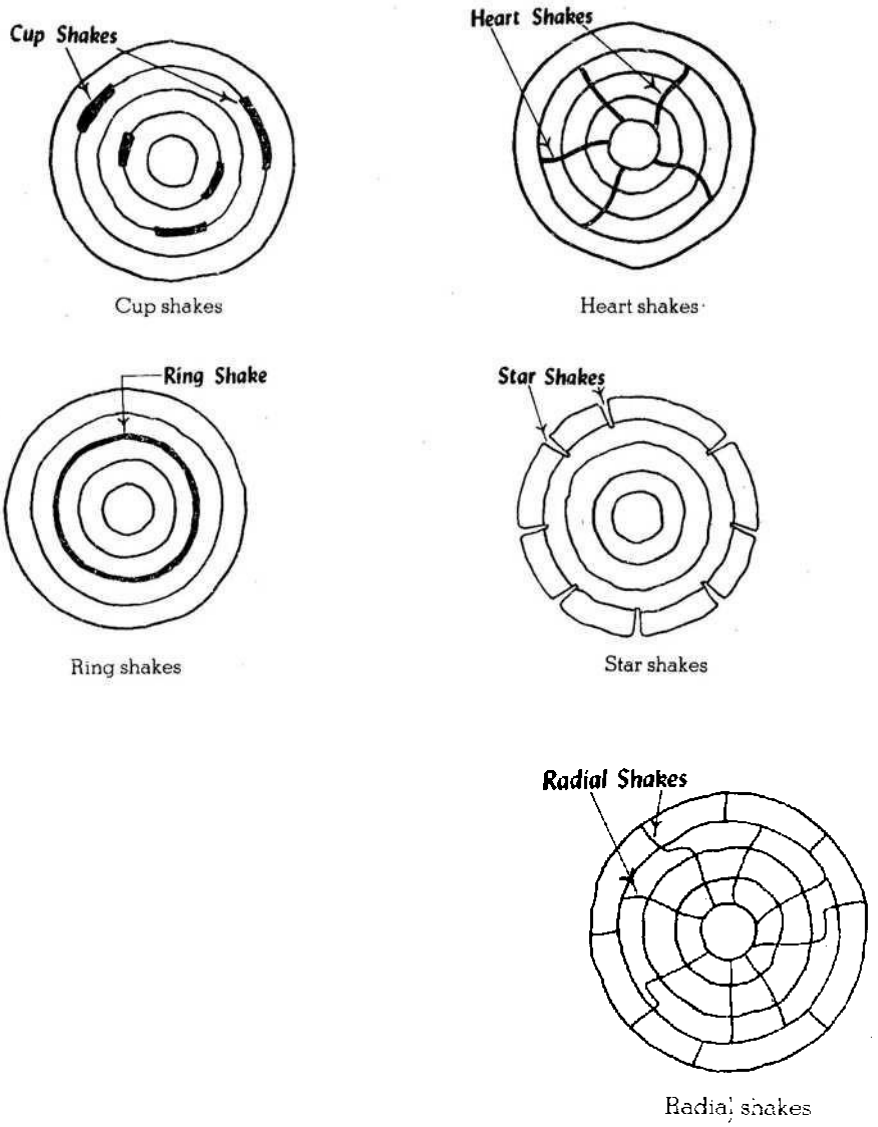
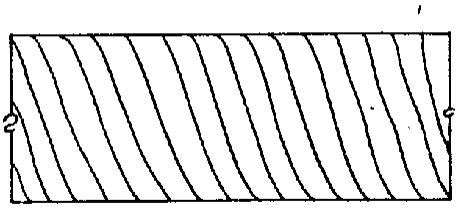


Fig 7.3 Different types of shakes

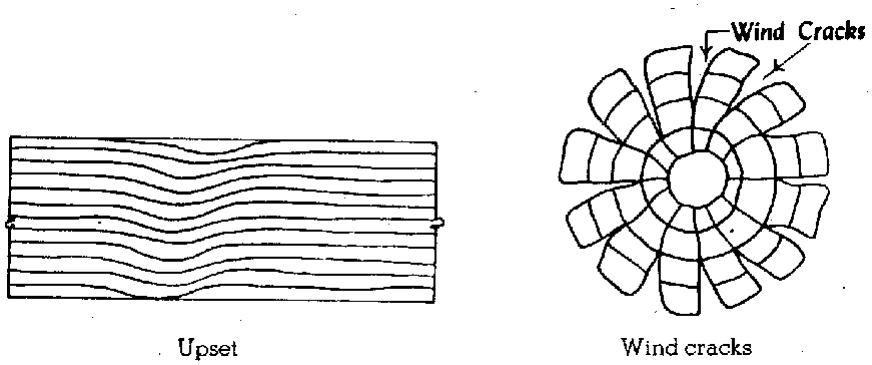
Twisted fibres: or Wandering hearts: caused by twistingof young trees by fast blowing wind as shown in fig 7.4.



Twisted fibres

Fig 7.4

Upsets or ruptures: Indicate wood fibres which are injured by crushing or compression as shown in fig 7.5.



Upset

Wind cracks

Fig 7.5

Characteristics of good timbers:

Appearance: A freshly cut surface of timber should exhibit hard and of shining appearance.
Colour: A colour should preferably be dark

Defects: A good timber should be free from series defects suchas knots, flaws, shakes etc
Durability: A good timber should be durable and capable of resisting the action of fungi, insects, chemicals, physical agencies, and mechanical agencies.
Elasticity: The timber returns to its original shape when load causing its deformation is removed

Fibres: The timber should have straight fibres

Fire resistance: A dense wood offers good resistance to fire

Hardness: A good timber should be hard

Mechanical wear: A good timber should not deteriorateeasily due to mechanical wear or abrasion
Shape: A good timber should be capable of retaining itsshape during conversion or seasoning
Smell: A good timber should have sweet smell. Unpleasantsmell indicates decayed timber
Sound : A good timber should give a clear ringing soundwhen struck
Strength: A good timber should be sufficiently strong forworking as structural member such as joist, beam, rafter etc.
Structure: The structure should be uniform

Toughness: A good timber should be tough (i.e.) capable of offering resistance to shocks due to vibration
Water permeability: A good timber should have low water permeability, which is measured by the quantity of waterfiltered through unit surface area of specimen of wood.
Weathering effects: A good timber should be able to stand reasonably the weathering effects (dry & wet)
Weight: The timber with heavy weight is considered to be sound and strong.
Working conditions: Timber should be easily workable. It should not clog the teeth of saw.

SHORT ANSWER QUESTIONS

1.Give the examples to the exogenous trees 2.Give the examples to the endogeneous tress3.Define the following a) pith b) heart wood 4.Name any four defects in timber
5.What are the important qualities of timber?6.Name any four wood based products 7.What is plywood?
8.What is meant by seasoning?

ESSAY TYPE QUESTIONS

Explain the classification of trees.
Explain different defects in timber
What are the important qualities of timber and explain.
Explain the wood based products
What are the advantages of plywoods?

* * *

SAND

Sand is an important building material used in the preparation of mortar, concrete, etc.
Sources of Sand: Sand particles consist of small grains of silica (Si02). It is formed by the decomposition of sand stones due to various effects of weather. The following are the natural sources of sand.

Pit Sand: This sand is found as deposits in soil and it is obtained by forming pits to a depth of about 1m to 2m from ground level. Pit sand consists of sharp angular grains, which are free from saltsfor making mortar, clean pit sand free from organic and clayshouldonly be used.

Rive Sand: This sand is obtained from beds of rivers. River sand consists of fine rounded grains. Colour of river sand is almost white. As the river sand is usually available in clean condition, it is widely used for all purposes.

Sea Sand: This sand is obtained from sea shores. Sea sand consistsof rounded grains in light brown colour. Sea sand consists of saltswhich attract the moisture from the atmosphere and causes dampness, efflorescence and disintegration of work. Due to all such reasons, sea sand is not recommendable for

engineering works. However be used as a local material afterbeing thoroughly washed to remove the salts.

Characteristics of sand:

It should be chemically inert

It should be clean and coarse. It should be free fromorganic matter.
It should contain sharp, angular and durable grains.

It should not contain salts, which attract the moisture fromatmosphere.
It should be well graded (i.e.) should contain particles ofvarious sizes in suitable proportions.

4.3. Grading of Sand:

According to the site of grains, sand is classified as fine, coarse and gravelly
Sand passing through a screen with clear opening of 1.5875mm is known as fine sand. It is generally used for masonryworks.
Sand passing through a screen with clear openings of7.62mm is known as gravely sand. It is generally used for plastering.

Sand passing through a screen with clear opening of 3.175mm is known as coarse sand. It is generally used for masonary work..

Bulking of Sand:

The presence of moisture in sand increases the volume of sand. This is due to fact that moisture causes film of water aroundthe sand particles which result in the increase of volume of sand. For a moisture content of 5 to 8 percent, the increase in volume may be about 5 to 8 percent, depending upon the grading of sand.The finer the material, the more will be the increase in volume fora given moisture content. This phenomenon is known asbulking ofsand.

When moisture content is increased by adding more water,sand particles pack near each other and the amount of bulking of sand is decreased. Thus the dry sand and the sand completely flooded with water have practically the same volume.

For finding the bulking of sand, a test is carried out with following procedure as in the fig 4.1.

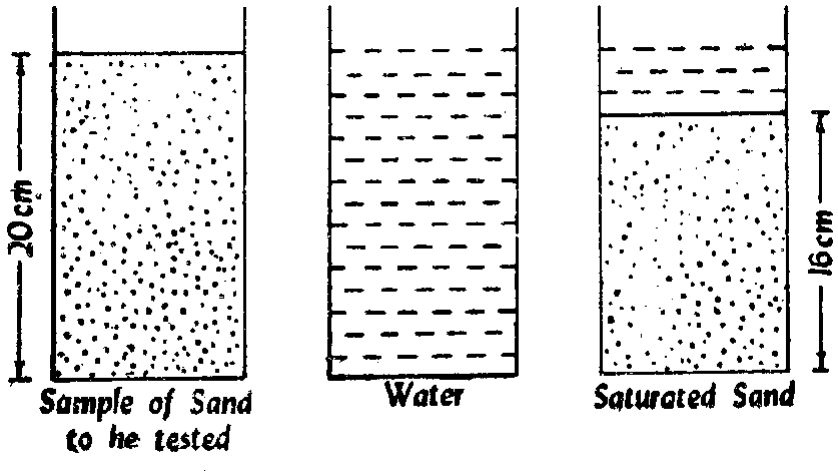


Fig 4.1. Bulking of Sand

A container is taken and it is filled two third with the sample ofsand to be tested.

The height is measured, say 20cm.

Sand is taken out of container

The container is filled with water

Sand is then slowly dropped in the container and it is thoroughlystirred by means of a rod.

The height of sand is measured say 16cm, then bulking of sand =

$$= \frac{20 - 16}{16} = \frac{4}{16} = \text{or } 25\%$$

* * *

sand.

SHORT ANSWER QUESTIONS

What are the main types of sand according to the natural source?
What is meant by bulking of sand?
What are the important characteristics of sand?

ESSAY TYPE QUESTIONS

Explain the sources of sand.
Explain the characteristics of sand.
Explain how bulking of sand is found using the experiment.
Explain the grading of sand.
Explain the bulking of sand.

* * *

Metals: Metals are employed for various engineering purposes such as structural members, roofing materials, damp proof courses,pipes, tanks, doors, windows etc out of all the metals, iron is the most popular metal and it has been used in construction activity since pre-historic times. For the purpose of study metals are grouped in the following two categories
Ferrous metals: Ferrous metals contain iron as their mainconstituent
Ex: Cast iron, wrought iron, steel

Non-ferrous metal: Non ferrous metal does not contain iron as their main constituent
Ex: Aluminium, copper etc

Important varieties of iron ores:

The following are the important commercial varieties of ironores, which are commonly used, in the manufacturing process
Haematite – Red oxide of iron (Fe_2O_3) 65 to 70% of iron

Limonite – $2Fe_2O_3, 3H_2O$ (60% of iron)

Magnetite – Fe_3O_4 (70 to 73% of iron)

Pyrite – FeS_2 (45 to 47% of iron)

Siderite – $FeCO_3$ (40% of iron)

Pig Iron: The crude impure iron, which is extracted from iron ores,is known as pig-iron and it forms the basic material for themanufacture of cast-iron, wrought iron and steel.
The pig iron is manufactured by the following operations

Dressing: Crushed into pieces 25mm, impurities of clay, loam and other earthy matter removed by washing, magnetic separators are used for magnetic impurities
Calcination and roasting: Water and carbon dioxide are removing from ores by calcinations. By roasting, making the ares hot and very dry after removal of sulphur
Smelting: smelting is carried out in a special type furnace known as blast furnace. The raw material consists of iron ores, the fluxing materials like limestone and fuel like coal,charcoal is allowed to through throat portion of the furnace.By the reduction, the pig iron collects in the hearth of furnace. The slag formed is removed and hot gases dust escapes through outlet, which is provided inthe throat portion of furnace as shown in fig 8.1.

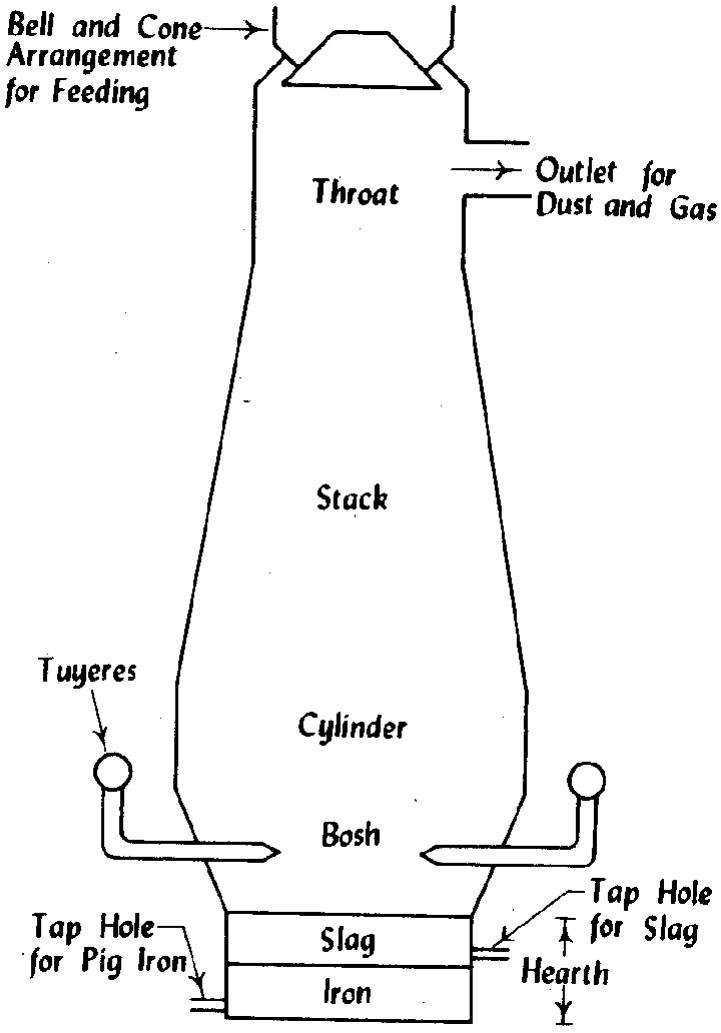


Fig 8.1 Blast Furnace

Cast iron:

Cast iron is manufactured by remelting pig iron with coke and limestone. This remelting is done in a furnace known as cupola furnace, which is more or less same as blast furnace. Its shape is cylindrical with diameter about 1m and height of about 5m as

shown in fig 8.2. The raw materials are led from the top and the furnace is fired. The impurities of pig iron are removed to some extent by oxidation. The molten cast iron is led into moulds of required shapes to form what are known as cast iron castings and slag is removed from the top of cast iron at regular intervals.

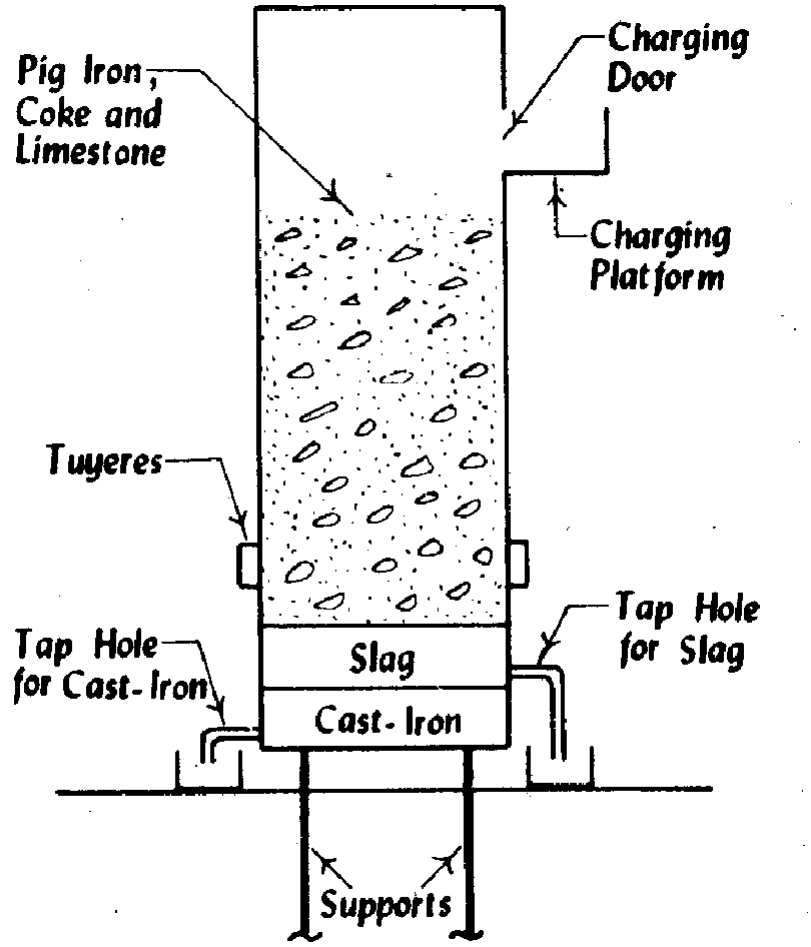


Fig 8.2 Cupola Furnace

Composition of cast iron:

Cast iron contains about 2 to 4 percent of carbon.

Manganese makes cast iron-brittle and hard, so it may be keptbelow 0.75 percent.
Phosphorous makes brittle and percentage may be 1 to 1.5percent.
Silicon decreases shrinkage and ensures softer and bettercastings and it may be less than 2.5 percent.
Sulphur makes cast iron brittle and hard and should be keptbelow 0.10 percent.

Properties of casi-iron:

If placed in salt water, it becomes soft.

It can be hardened by heating and sudden cooling.

It cannot be magnetized.

It does not be rust easily.

It is fusible.

It is hard, but brittle also.

It is not ductile and cannot be adopted to absorb shocks andimpacts.
Melting temperature is about 1250^0 C.

It shrinks on cooking.

Its structure is granular and crystalline with whitish or grayish tinge.
Its specific gravity is 7.5.

It lacks plasticity and hence it is unsuitable for forging work.

It is weak in tension (1500kg/cm^2) and strong in compression (6000kg/cm^2).
Two pieces of C.I. cannot be connected by the process of rivetingor welding (They are to be connected by nuts and bolts).

Uses cast iron:

For making cisterns, water pipes, gas pipes and sewers, manholecovers and sanitary fittings.
For making ornamental castings like brackets, gates, lamppostsetc.
For making parts of machinery which are not subjected to shockloads.
For manufacture of compression members.

For preparing rail chairs, carriage wheels etc.

Wrought Iron: Wrought iron is almost pure and it hardly containscarbon more than 0.15 percent. But the process of its manufactureis laborious and tedious. Wrought iron is manufactured by four operations

Refining

Pudding

Shinging

Rolling

Properties of wrought iron:

It can be easily forged and welded

It can be used to form temporary magnets

It is ductile, melleable and tough

It is moderately elastic

It is unaffected by saline water

It resists corrosion in a better way

Its melting point is about 1500^0C

Its specific gravity is about 7.8

Its ultimate compressive strength is about 2000 kg/cm^2

Its ultimate tensile strength is about 4000kg/cm^2.

Uses of wrought iron:

It is used for rivets, chains, ornamental iron work, railway couplings, water and steam pipes, bolts and nuts, horse shoe bars, hand rails, straps for timber roof trusses, boiler tubes, roofing sheets etc.

Steel : As per as carbon content is concerned, steel forms an intermediate stage between cast iron and wrought iron. Cast iron containscarbon from 2 to 4 percent and wrought iron contains 0.15 percent. In steelthe carbon content varies from 0.25 to 1.5 percent. The steel is manufactured by the following processes.
Bessemen process

Cementation process

Crucible steel process

Duplex process

Electric process

L.D. Process

Open-hearth process

Physical properties of steel:

Carbon content: Variation in carbon percentage produces steel of different grades. Carbon always assists in increasing the hardness and strength of steel and decreases the ductility of steel.
Presence of impurities:

Silicon content is about 0.30 to 0.40 percent, elasticity andstrength of steel are considerably increased.

Sulphur content between 0.02 to 0.10 percent, no appreciable effect on ductility or strength however mealleability and weldability decreases.
Phosphorous content below 0.12 percent reduces shock resistance, ductility and strength of steel.
Manganese content 0.3 to 1.00 percent, the steel becomes very brittle and hence, it loses its structural value
Heat treatment processes: It is possible to alter the properties ofsteel by heating and cooling under controlled conditions. The following are the purposes of heat treatment
To alter magnetic properties of steel
To change the structure of steel
To increase resistance to heat and corrosion
To increase surface hardness
To make steel easily workable

To vary strength and hardness

The principal processes involved in the heat treatment of steel

Annealing- To make steel soft

Case hardening-The core of specimen remains tough andductile
Cementing- The skin of the steel is saturated with carbon(880 to 950^0C)
Hardening- It is reverse process of annealing to make hard

Normalising-To restore steel to normal condition and it is adopted when structure of steel is seriously disturbed for any reason
Tempering-This process is applied to steel, which are treatedwith hardening process
Magnetic properties of steel: Steel widely used in electricalmachinery, generates, transformers etc. For making steel suitable for such use, its magnetic properties are given supreme importanceand these properties are obtained by carefullyadjusting its chemical composition.
Carbon – carbon content as low as possible and should not exceed 0.10 percent.
Silicon-presence of silicon results in considerable increase of electrical losses and hence it highly undesirable.
Sulphur and phosphorous: Combines content of sulphur and phosphorous exceeds 0.3 percent, magnetic properties of steel are greatly affected.
Manganese: If manganese content exceeds 0.3 percent, it proves to be injurious to the magnetic properties of steel.

Uses of steel:

1.	Mild steel	0.10% carbon	Motar body, sheet metal, tin plates etc
2.	Medium carbon steel	0.25%	Boiler plates, structural steel,
		0.45%	rails, tyres etc
		0.60%	Hammers, large stampaing dies etc
3.	High carbon steel	0.75%	Sledge hammers, springs, stamping dies etc
		0.95%	Minor drills, smith & tools, Masons tools
		1.00%	Chisels, hammers, saws, wood, working tools
		1.10%	Axes, cutlery, drills, knives, picks, punches etc.

* * *

paint.

SHORT ANSWER QUESTIONS

1.Name important metals used in building construction 2.Name important non-metals used in the building construction3.What are the uses of cast iron?

4.What are the uses of wrought iron?5.What the properties of steel?

6.Name any four uses of steel. 7.What are the properties of plastics?8.Name any four uses of plastics.

What are the uses of glass?

What are the uses of adhesives?

Name any four uses of asbestos.

What is the use of thermocole?

What is the importance of plaster of paris in the buildingconstruction industry?

Name the uses of linoleum

What are the uses of wall paper?

Write the uses of bitumen & tar

What are the uses of plasticrete?

ESSAY TYPE QUESTIONS

Explain the properties and uses of steel2.Explain the following

a. Plastics b. asbestos

Explain the properties and uses of cast iron4.Explain the following

a. Plaster of paris b. Linoleum

* * *

Chapter-5

Surface protective materials

Paint Application

General

Contrasting colours shall be used for each coat of paint.

The coating manufacturer shall provide a Coating System Data Sheet (CSDS) for each coating system to be used, containing at least the following information for each product:

• Surface pre-treatment requirements.

• Wet film thickness/dry film thickness (max, min. and specified).

• Maximum and minimum recoating intervals at 5 °C, 10 °C and 23 °C.

• Information on thinners to be used (quantities and type).

• Mixing, handling and application requirements/recommendations.

• Hiding power of top coat for specified colours according to ISO 2814. Contrast ratio shall not be less than 94% at the specified top coat thickness.

Application equipment

The method of application shall be governed by the coating manufacturer's recommendation for the particular coating being applied.

Roller application of the first primer coat is not acceptable. When paints are applied by brush, the brush shall be of a style and quality acceptable to the coating manufacturer.

Surface Preparation and Protective Coating

Brush application shall be done so that a smooth coat, as uniform in thickness as possible is obtained.

Application

Prior to the application of each coat, a stripe coat shall be applied by brush to all welds, corners, behind angles, sharp edges of beams etc. and areas not fully reachable by spray in order to obtain the specified coverage and thickness.

Edges of existing coating shall be feathered towards the substrate prior to overcoating.

Each coat shall be applied uniformly over the entire surface. Skips, runs, sags and drips shall be avoided. Each coat shall be free from pinholes, blisters and holidays.

Contamination of painted surfaces between coats shall be avoided. Any contamination shall be removed.

Repairs

All repair of coating shall be conducted in accordance with the original surface preparation and coating application requirements.

PART:(CONSTRUCTION TECHNOLOGY)

Chapter-1

Introduction

Classification:

According National Building code of India, 1970 the buildings on the basis of occupancy are classified into following groups

GROUP A: Residential buildings:

All those buildings in which sleeping accommodation is provided forresiding permanently or temporary with or without looking or dinningor both facilities are termed as residential building

Ex: Apartments, Flats, Bungalows, Dormitories, private houses, Hotels, Hostels, Cottages, Hole day camps, clubs, hotels, Inns etcThese buildings are further subdivided into 5 groups

A1 - Lodging Houses

A2 - Family Private DwellingsA3 - Dormitories

A4 - Flats

A5 - Hotels

GROUP B: Educational buildings:

All those buildings which are meant for education from nursery touniversity are included in this group

Ex: schools, colleges, universities, training institutes etc

GROUP C: Institutional Buildings:

This group includes any building or part thereof, which is used forthe purposes such as medical, health, recovering health after illness,

physical or mental diseases, care of infants or aged persons, panel detention etc. These buildings normally provide sleeping accommodation for the occupants.

GROUP D: Assembly Buildings:

This group includes any building or part or a building where groups ofpeople assemble or gather for amusement; recreation, social, religious,patriotic or similar purpose for example theatres, cinema halls, museums, gymnasiums, restaurants, places of worship, dance halls, club rooms, passenger stations, public transportation services, open airtheatres, swimming pools etc.

GROUP E- Business Buildings:

This group includes any building or part or a building which is used for purposes such as transaction of business, keeping of accounts andrecords etc; dispensaries and clinics, banks, city halls, court halls, libraries etc.

GROUP F – Mercantile Buildings:

This group includes any building or part of a building which is used for shops, stores, market, for safe and display of products or waves either whole sale or retail.

GROUP G – Industrial Buildings:

This group includes any building or part of a building or structure in which product of different kinds and properties are fabricated, assembled or processed. For example, laboratories, assembly plants, laundries, gas plants, power plants, refineries, diaries etc.

GROUP H – Storage Building:

This group includes those building structures which are primarily usedfor the storage structures which are primarily used for the

storage or sheltering of goods, waves or merchandise vehicles or animals, for example warehouses, cold storages, freight depots, store houses, transit sheds, truck terminals, garages etc.

GROUP J – Hazardous Building:

This group includes those building structures which are used for the storage, handling, manufacture or processing of materials which are liable to burn with extreme rapidity and prove hazards to health; building or building contents. Hazards may be due to fire; poisonous fumes or gases, explosions, ignitions etc from materials subjected to various operations. Buildings used for storage of gases under high pressure or for storage and handling of highly flammable liquids or explosives, fireworks etc are included in this group.

Component parts of building

The building basically consists of three parts namely,

Foundation

Plinth and

Super structure as shown in the fig 9.1

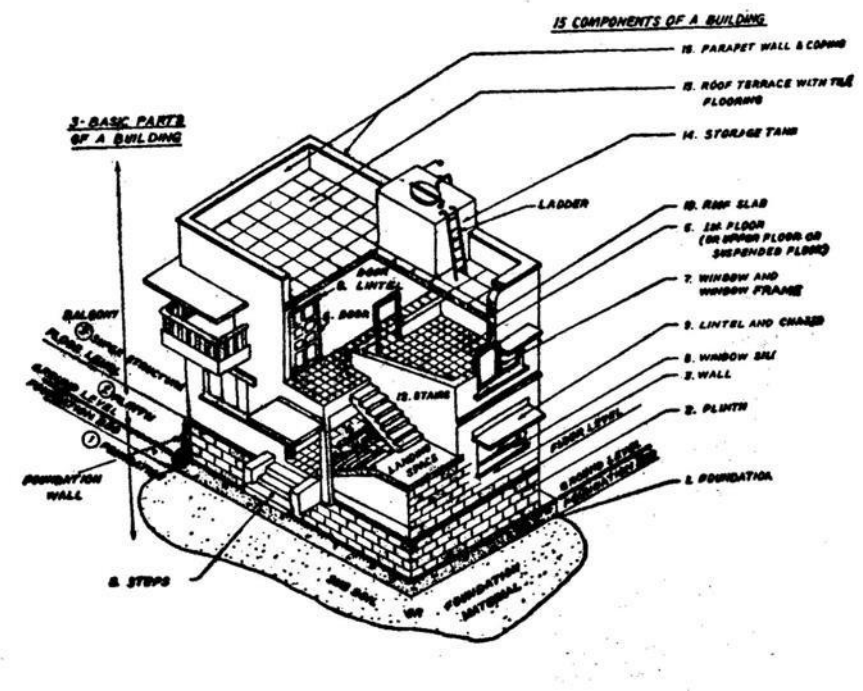


Fig 9.1 Component parts of building

Foundation: It is the lowest artificially prepared part below the surface of the surrounding ground which is indirect contact with sub-strata and transmits all the loads to the ground (or sub-soil)
Plinth: It is the middle part of the structure, above the surface of the surrounding ground up to the surface of the floor immediately above the ground. Its function in the building is same as of sub-structure in the case of the bridge.
Super structure: It is that part of the structure which is constructed above the plinth level (i.e.,) ground level

A building in general made of the following structural components
Foundation
Plinth
Walls and piers in super structure
Ground, basement and upper floors
Doors and windows
Sills, Lintels and weather shades
Roofs
Steps and stairs
Finishes for walls10.Utility fixtures
Each of these components is an essential part of a building and requires due consideration in design and construction for their functional performance. The basic functional requirements of these componentsdiscusses in the following paragraphs.
1. Foundations:
The foundation is the most critical part of any structure and most of the failure is probably due to faulty foundations rather than any other cause. The purpose of foundation is to transmit the anticipated loads safetyto the soil
Basic requirements:
To distribute the total load coming on the structure over a largebearing area so as to prevent it from any movement.
To load the bearing surface or area at a uniform rate so as toprevent any unequal or relative settlement.
To prevent the lateral movement of the structure

To secure a level or firm natural bed, upon which to lay the coursesof masonary and also support the structure.
To increase the suitability of the structure as a whole, so as to prevent it from overturning or sliding against such as wind, rain, frost etc.
Plinth: This is the portion of structure between the surface of the surrounding ground and surface of the floor, immediately above theground. As per Byelaws, the plinth should not be less than 45cm. The basicrequirements of plinth area
To transmit the load of the super-structure to thefoundation
To act as a retaining wall so as to keep the filling portionbelow the raised floor or the building
To protect the building from damp or moisturepenetration into it
It enhances the architectural appearance of the building
Walls and piers in super structure: The primary function of walls is to enclose or liquid space. A load-bearing wall in the super structure should satisfy the following requirements.
Strengths, stability, weather resistance, fire resistance, heat insulation, sound insulation, privacy and security.
Ground basement and upper floors: The main function of a floor is to provide support of occupants, furniture and equipment of a building andthe function of providing different floors is to devoid the building into different levels for the purpose of creating more accommodation within the limited space. The floor should satisfy the following functionalrequirements.

Strength and stability
Durability and dampness
Heal insulation
Sound insulation and fire resistance 5.Doors and windows: The main function of doors in a building is to serve us a connecting link between internal parts and also to allow thefree movement outside the building. Windows are generally provided forthe proper ventilation and lighting of a building.
The following are the functional requirements
Weather resistance
Sound and thermal insulation
Damp prevention and terminate-proofing
Fire resistance and durability
Privacy and security
Sills. Lintels and weather shades:
Windowsills are provided between the bottom of window frame and wall below, to protect the top of wall from wear and tear. The actual frame of door or window is not strong enough to support the weight of the wall above the strong enough to supportthe weight of the wall above the openings and a separate structuralelement has, therefore to be introduced. This is known as lintel andis similar to a beam. Weather shades on ehhajjas are generally combined with lintels of windows to protect from the weather elements such as sun, rain, frost etc.
Roofs:
A roof is the uppermost part of the building whose main function is to enclose the space and to protect the same from the effects of

weather elements such as rain, sun, wind, heat, snow etc. A good roof is just as essential as a safe foundation. The functional requirements of the roof are as follows.

SHORT ANSWER QUESTIONS

1.Define substructure. 2.Define superstructure.
3.What are the structural components of a building?4.Define plinth.
5.Name any four types classification based on N.B.C.

ESSAY TYPE QUESTIONS

1.Explain the structural components of building.2.Explain the classification of buildings.

* * *

Chapter-2

FOUNDATIONS

Every structure consists of two parts. (1) Foundation and (2) Superstructure. The lowest artificially prepared parts of the structure which arein direct contact with the ground and which transmit the loads of the structure to the ground are known as Foundation or Substructure. The solidground on which the foundation rest is called the "foundation bed" or foundation soil and it ultimately bears the load and interacts with the foundations of buildings.

Objects of foundations:

Foundations are provided for the following purposes

To distribute the total load coming on the structure on largearea.

To support the structure

To give enough stability to the structures against variousdistributing forces such as wind, rain etc.

To prepare a level surface for concreting and masonry work. The general inspection of site of work serves as a good for determine the type of foundation, to be adopted for the proposedwork and in addition, it helps in getting the data w.r.to the following items.

Behavior of ground due to variations in depth of watertable

Disposal of storm water at site

Nature of soil by visual examination

Movement of ground due to any reason etc.

Bearing capacity: The ability of the foundation material,weather soil or rock to carry loads safely.

S.No.	Type of Soil	Max. safe bearingcapacity t/m^2
Soft, wet clay or muddy clay		5
Black cotton soil		15
Soft clay		10
Moist clay, and sand clay Mixture		15
5.	Medium clay	25
6.	Compact clay	45
7.	Fine, loose and dry sand	10
8.	Medium, compact and dry sand	25
9.	Compact sand	45
10.	Loose gravel	25

Compact gravel	45
Soft rocks	45
Laminated rock such as sand stone & Lime stone	165
Hard rocks such as granite, diorite, trap	330

Table 10.1

Types of foundations:

Depending upon their nature and depth, foundations have beencategorized as follows

Open foundations or shallow foundations

Deep foundations

Open foundations or shallow foundations: This is most common type of foundation and can be laid using open excavation by allowing natural slopes on all sides. This type of foundation is practicable for a depth of about 5m and is normally convenient abovethe water table. The base of the structure is enlarged or spread to provide individual support. Since the spread foundations are constructed in open excavations, therefore they are termed as open foundations. This type of foundation is provided for structure of moderate height built on sufficiently firm dry ground. The various types of spread footings are:

Wall footing

Isolated footing

Combined footing

Inverted arch footing

Continuous footing
Cantilever footing
Grillage footing

Wall Footing: These footings can be either simple or stepped. The base course of these footings can be concrete or entirely of one material simple footing are used for light structures. They have only one projection beyond the width of the wall. The base width of the concrete base course should be equal to twice the width of wall. The depth of concrete bed is atleast twice the projection as shown in fig 10.3. The depth of concrete bed is calculated by

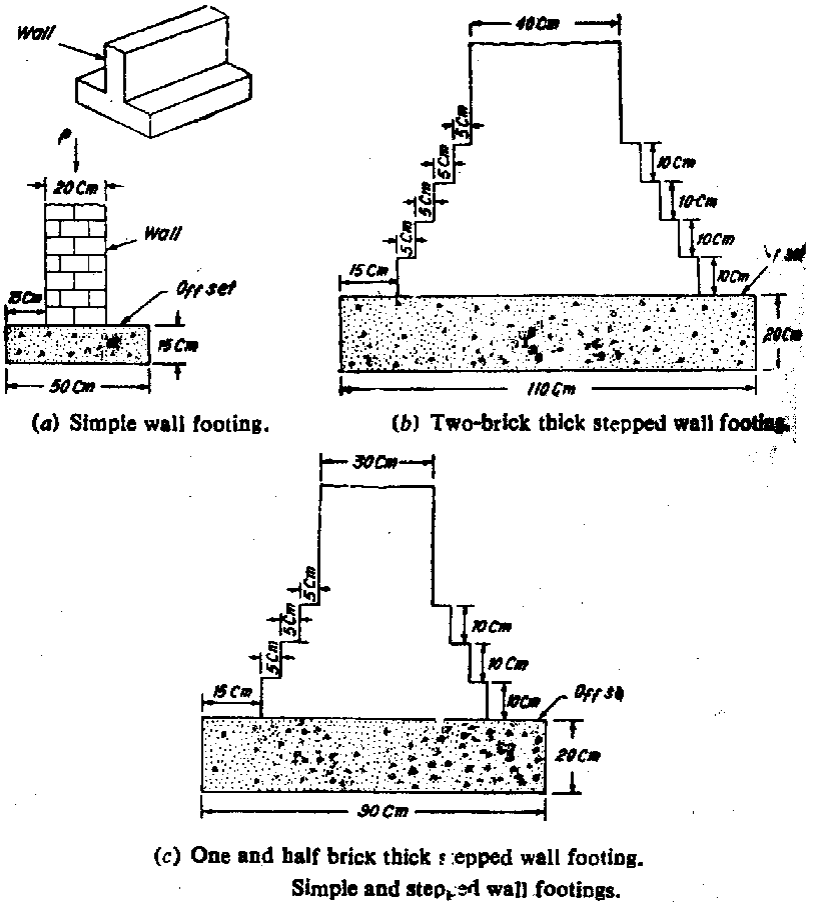
T = mwhere t – depth of concrete bed

m – offset of concrete bed in cmp – Load coming on soil kg/cm^2
f – 0.03 x ultimate crushing strength of concrete in 28 days
The depth of the footing is calculated by the following formula

$$H = \sqrt{\frac{p}{f}} \left| \frac{p\left(1-\sin\phi\right)^2}{w\left(1+\sin\phi\right)} \right| \quad \text{where}$$

H - Minimum depth of footing in metre p - Safe bearing capacity of soil in kg/m^2w - Unit wt. Of soil in kg/m^3
ϕ - Angle of repose of the soil

the depth of footing is generally limited to 0.9m the width offootingshould be calculated by divided the total load in kg/m run by the allowable bearing capacity of soil in kg/m2.



(a) Simple wall footing. (b) Two-brick thick stepped wall footing.

(c) One and half brick thick stepped wall footing.

Simple and stepped wall footings.

Fig 10.3

Isolated Footings: These are used to support individedcolumns.They can be of stepped type or have projections in theconcrete base. In case of heavy loaded columns steel reinforcement is provided in both directions in concrete with 15cm offsets as shown in the fig10.4.

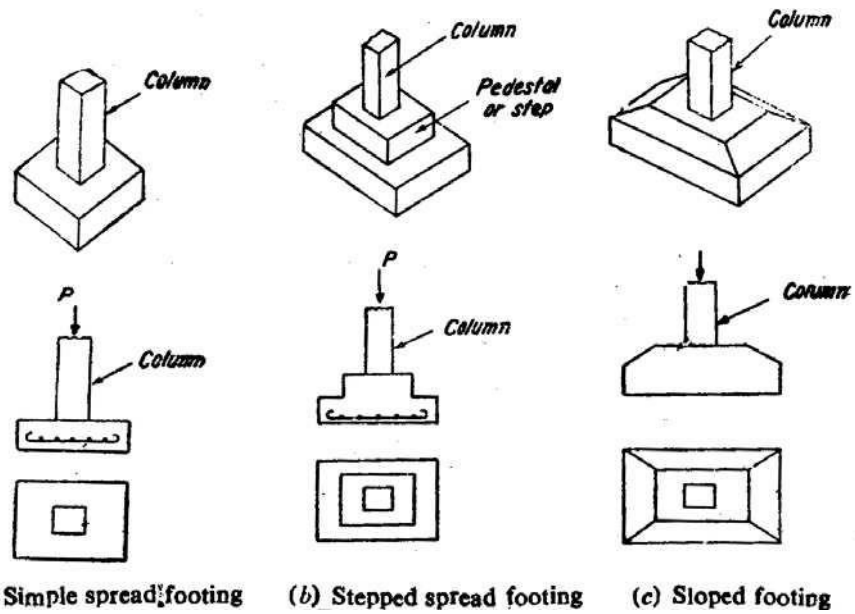
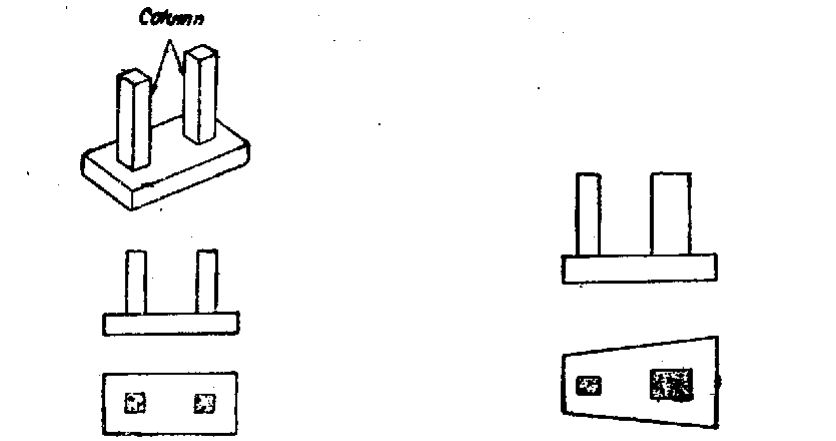


Fig 10.4 Types of Isolated Footings

Combined Footing: A combined footing supports two or more columns in a row A Combined footing may be rectangular or trapezoidal constructed with reinforced concrete. The location ofcentre of gravity of column loads and centroid of the footing should coincide. The combined footing is as shown in fig10.5.



(a) Rectangular combined footing. (b) Trapezoidal combined footing.

Fig 10.5 Combined Footings

Inverted Arch Footing: This type of construction is used on softsoils to reduce the depth of foundation loads above an opening are transmitted from supporting walls through inverted arches tothe soil. In this type the end columns must be stable enough to resist the outward pressure caused by arch actions. The invertedarch footing is as shown in fig10.6.

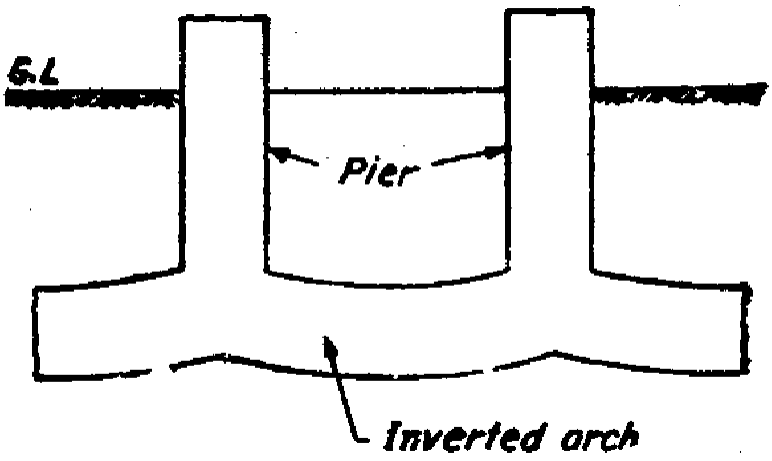


Fig 10.6 Inverted Footing

Continuous Footing: In this type of footing a single continuous
R.C slab is produced as foundation of two or threeor more columns in a row. This type of footing is suitable at locations liable to earthquake activities. This also prevents differential settlement in the structure. In order to have better stability a deeper beam is constructed in between the columnsas shown in fig10.7.

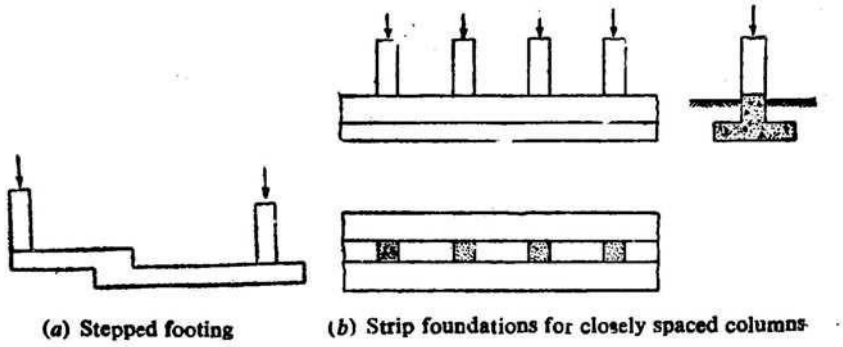
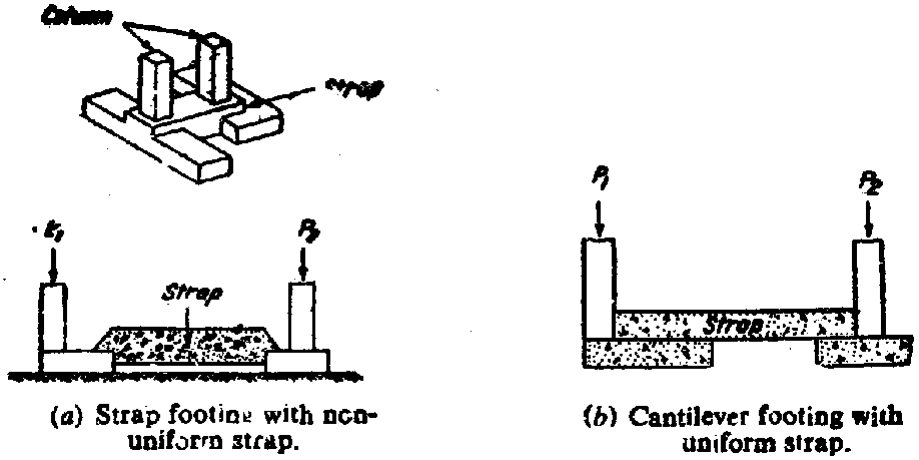


Fig 10.7 Continuous Footing

Strap or cantilever footing: Strap footing consists of two or more individual footings connected by a beam called strap or cantilever footing or pump handle foundation. This type offoundation may be used where the distance between the columnsis so great that combined trapezoidal footing becomes quite narrow with high bending moments strap or cantiliver footing isas shown in fig 10.8.



(a) Strap footing with non-uniform strap.

(b) Cantilever footing with uniform strap.

Fig 10.8 Strap or cantilever footing

Grillage footing : This type of footing is used to transmitheavyloads from steel columns to foundation soils having low bearingpower. This type of foundation avoids deep excavation andprovides necessary area at the base to reduce the intensityof pressure of the foundation soil is not stiff and there is a plenty of water with spring, the sides are protected by sharing. The grillage footing is a s shown in fig 10.9.

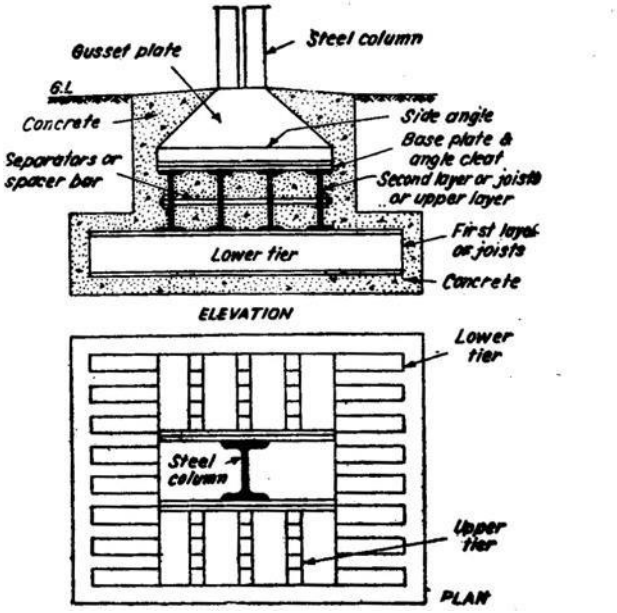


Fig 10.9 Grillage Footing

Raft Foundation: A raft or mat is a combined footing that covers the entire area beneath a structure and supports all the columns. When the allowable soil pressure is low or the structureloads are heavy the use of spread footings wouldcover more thanone half of the area and it may be prove more economical to useraft foundation. There are also used wherethe soil mass containscompressible lenses so that the differential settlement would be difficult to control usually when the hard soil is not available within 1.5 to 2.5m, a raft foundation is adopted. The raft is composed of reinforced. Concrete beam with relatively thin slabunderneath fig 10.10 shows different types of raft.

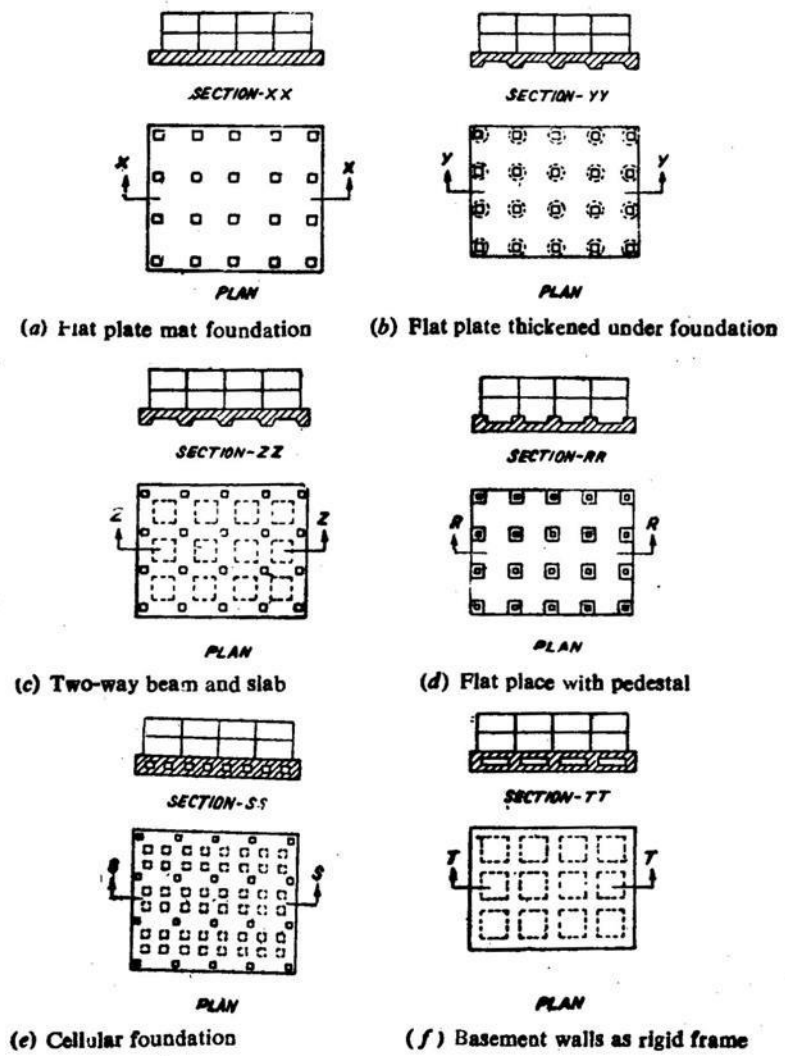


Fig 10.10 Different types of Raft Foundations II Deep foundations:

These foundations carry loads from a structure through weakcompressible soil or fills onto the stronger and less compressible soils or rocks at depth. These foundations are in general used as basements, buoyancy rofts, eaissions, cylinders, shaft and piles.

Basements: There are constructed in place in an open excavation.They are hallow slab structure designed to provide working or storage space below ground level. The structural design is governed by their functional requirements.

Buoyancy rafts: They are hallow substructures designed to provide a buoyant substructure beneath with the net loading onthe soil reduce to the desired low intensity.

Coissions: They are hallow substructures designed to be constructed on or near the surface and then sunk as single units totheir required level.

Cylinders: They are small single cell coissions

Shaft foundations: They are constructed within deep excavation supported by lining constructed in place subsequently filled with concrete.

Pile foundations: Pile foundation is a construction for the foundation supported on piles. A pile is an element of constructioncomposed of timber, concrete, or steel or acombination of them. Pile foundation may be defined as a column support type of a foundation, which may be cast in-situ orPre-cast. This type of construction is adopted when the loose soilextends to a great depth.The load of the structure is transmitted by the piles to hard stratumbelow or it is resisted by the friction developed on the sides of pipes.

Classification based on the function

Bearing piles- Penetrate through soft soil and theirbottom rest on a hard stratum

Friction piles- The frictional resistance is equal to loadcoming on the piles as shown in the fig 10.11.

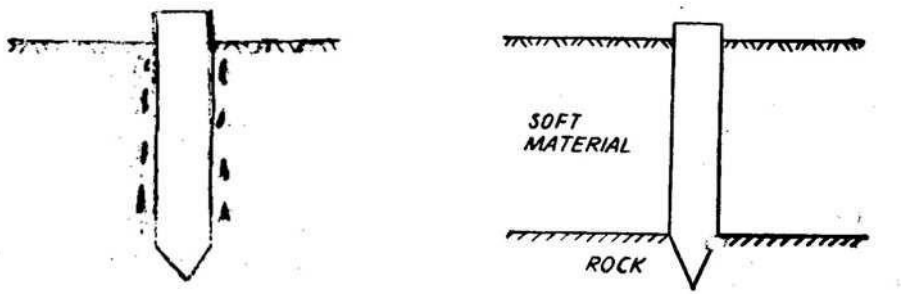


Fig 10.11 Friction file & Bearing Pile

Screw piles-Used for gravely ground sand, mixed gravelground etc as shown in fig 10.12.

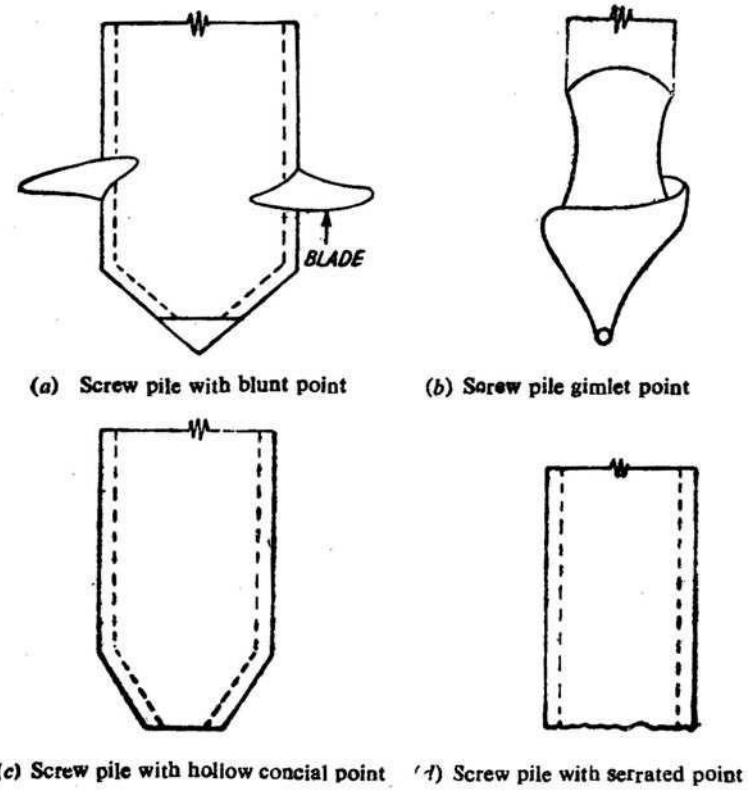


Fig 10.12 Different types of screw piles
Uplift piles- when the structure subjected to upliftpressure.
Butter pile – To resist large horizontal or inclined forces
Sheet pile-used as bulk heads or a impervious cutoff
Classification based on materials and composition
Cement concrete piles-Posses excellent compressivestrength
Precast
Cast-in-site
Under reamed piles
Bored compaction piles as shown in fig 10.13.

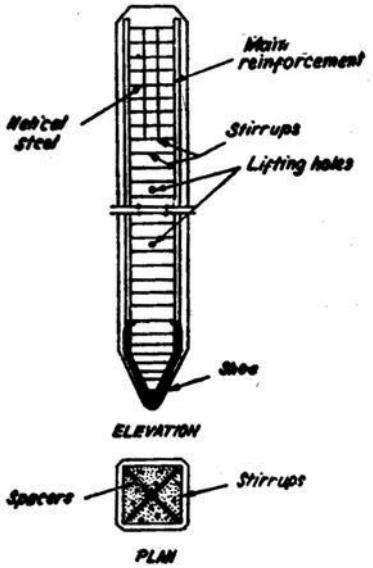


Fig 10.13. Pre-cast concrete Pile

Timber piles-Small bearing capacity, not suitable for hardsoil and economical

Steel piles-With stand impact stresses and resist lateral forces

Sand piles-Not suitable for loose or wet soils or where isa danger of scour. Easy to construct and irrespective of water table.

Composite piles- combination of two different materials are used to form composite file and suitable where the upper part of pile to project above the water table. Economical and easy to construct as shown in fig 10.14.

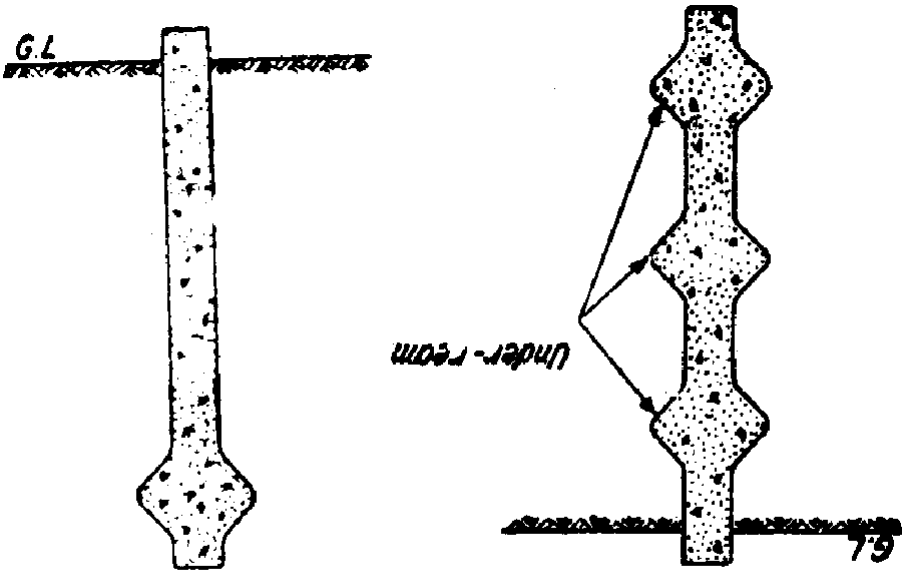


Fig 10.14 Under-reamed Piles

Requirements of a good foundation:
Following are the three basic requirements to be fulfilled by a foundation to be satisfactory
Location : The foundation should be located that it is ableto resist any unexpected future influence which may adversely affect its performance. This aspect requires carefulengineering judgement.
Stability: The foundation structure should be stable or safe against any possible failure
Settlement: The foundation structure should not settle or deflect to such an extent so as to impair its usefulness.

Causes of failure of good foundation:

The different causes for foundation failure are given below

Non uniform settlement of sub soil and masonry

Horizontal movement of the soil adjacent to structure

Alternate swelling and shrinkage in wet and dry cycles ofthe season

Lateral pressure due to lateral movement of earth tendingto over turn the structure

Action of weathering agencies like sun, wind or rain

Lateral escape of the soil beneath the foundation of thestructure

Roots trees and shrubs which penetrate the foundation

* * *

SHORT ANSWER QUESTIONS

What are the main types of foundations?
What is the purpose of foundation?
What is meant by bearing capacity of soil?
Name the methods of determining the bearing capacity of soil?
Define safe bearing capacity.
Name any two causes of failure of foundations.
Name any two requirements of a good foundation
What is shallow foundation?
What is meant by deep foundation?
Name any four types of shallow foundations.
What is the purpose of raft foundation?
What is the grillage footing?

ESSAY TYPE QUESTIONS

Explain the requirements of good foundation.
What is bearing capacity and explain any one method to find thebearing capacity of soil?
Explain the causes for the foundation failures.
Explain the types of shallow foundations in brief.
What are deep foundations? Name the types.
Explain the functions of foundation.

* * *

Chapter-3

WALLS AND MASONRY WORKS

Types of Walls

Following are various types of walls used in building construction:

1. Load Bearing Wall

It carries loads imposed on it from beams and slabs above including its own weight and transfer it to the foundation. These walls supports structural members such as beams, slabs and walls on above floors above. It can be exterior wall or interior wall. It braces from the roof to the floor.

Types of Load Bearing Wall

- Precast Concrete Wall
- Retaining Wall
- Masonry Wall
- Pre Panelized Load Bearing Metal Stud Walls
- Engineering Brick Wall (115mm, 225mm)
- Stone Wall

As the height of the building increased, the required thickness of wall and resulting stress on foundation will also increase and cause it to be uneconomical.

MASONRY WORKS

Masonry is defined as the art of construction in which building units,such as clay bricks, sand-lime, bricks, stones, Pre-cast hallowconcrete blocks, concrete slabs, glass bricks, combination of some of these buildingunits etc are arranged systematically and bonded together to form ahomogeneous mass in such a manner that they can with stand point to other loads and transmit then through the mass without fail or disintegration.

Masonry can be classified into the following categories.

Stone masonry

Brick masonry

Hallow block concrete masonry

Reinforced masonry

Composite masonry

These can be further sub-divided into varies types depending uponworkmanship and type of materials used.

Definitions of terms:

Course: A course is a horizontal layer of bricks stones

Bed: the surface of a stone perpendicular to the line of pressure of (lower surface of bricks or stones in each course)

Back: The inner surface of wall not exposed is called back. Thematerial forming back is known as backing

Face: The exterior of the wall exposed to weather is knownas face. The material used in the facing of wall is known as facing'

Hearting: It is the interior portion of a wall between facing andbacking

Head: It is a brick or stone, which lies with its greatest lengthat right angles to the face of the work.

Stretcher: It is a brick or a stone which lies with its congest side parallel to the face of the work

Bond: The method of arranging bricks so that the individual units are tied together

Spalls: The chips of stones used for filling the interstics in stone masonry

Quoins: The stones used for the corners of walls of structure

Bat: It is a portion of a brick cut across the width.

Closer: It is the portion of a brickcut in such a manner that itsone long face remains uncut

Queen closer: it is the portion of a brick obtained by cutting abrick length-wise into two portions

King closer: It is the portion of brick obtained by cutting off the triangular piece between the centre of one end and the centre of one side.

Bevelled closer: It is the portion of a brick in which the whole length of the brick is bevelled for maintaining half widthat one end and full width at the other

Frog: It is an indentation or depression on the top face of a brick made with the object of forming a key for the mortar.

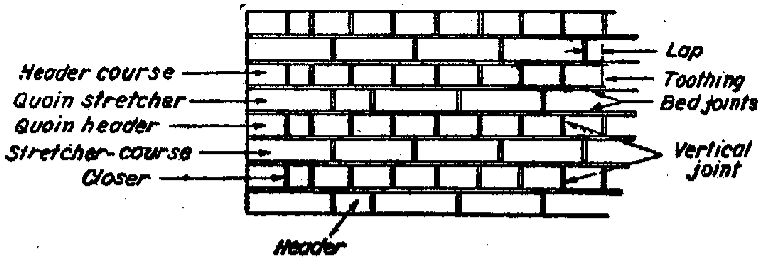
Sill: It is a horizontal stone, concrete or wood, employed for the purpose of shedding off rain water from the face of wall immediately below the window opening

Corbel: It is the extension of one or more course of stone or brick from the face of a wall to serve as a support for wall plates

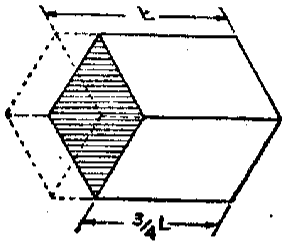
Templates: Pieces of stones placed under the end of a beamto distribute load over a greater area.

Coping: It is the course placed upon the exposed top of an external wall to prevent the seepage of water

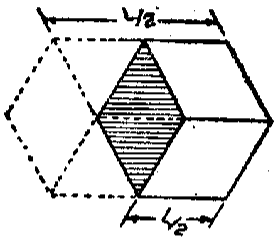
Buttress: It is a sloping or stepped masonry projection from atall wall intended to strengthen the wall against the thrust of aroof as shown in fig 11.1



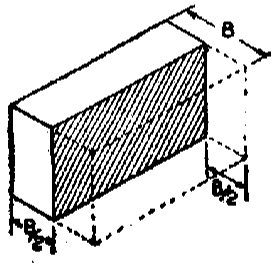
Masonry wall



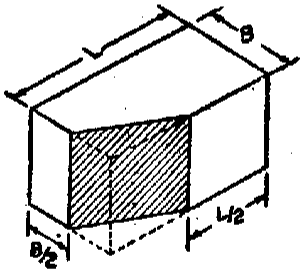
Three quarter Bat



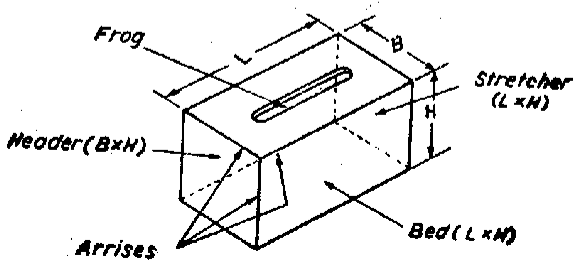
Half bat



Queen closer



King closer



Full brick

Fig 11.1 Definitions of terms

Stone masonry: The construction of stones bonded together withmortar is termed as stone masonry where the stones are available in a abundance in nature, on cutting and dressing to the proper shape, they provide an economical material for the construction of various building components such as walls, columns, footings, arches, lintels, beams etc.

Uses of stone masonry:
Stone masonry construction is used in
Building foundations, dams, monumentalstructures
Building walls, piers, columns, pillars, lighthouses and architectural works.
Arches, domes, lintels and beams
Roofs, flems, paving jobs
Railway, bullest, black boards and electricalswitch boards
Selection of stone for stone masonry:
The selection of stones for stone masonry depends upon

Availability

Ease of working

Appearance

Strength and stability

Polishing characteristics

Economy

Durability

The table 11.1 given broadly outlines the different types of stonesused for different purposes

S.No.	Purpose	Stones used
1.	Heavy engineering works Ex: stocks, break waters, light houses, bridges, piers	Granite, gneiss
2.	Buildings situated in industrial towns	Granite and compact Sandstone
3.	Pavements, railway ballast, doorsits and steps	Granite slabs And slate
4.	Electrical switch board	Marble slabs And slate
5.	Fire resistance works	Compact sandstone
6.	Carving and ornamental works	Marble and laterite
7.	Face work and architectural purposes	Marble, granite closer gained sand stone

Tools required for stone masonry construction:

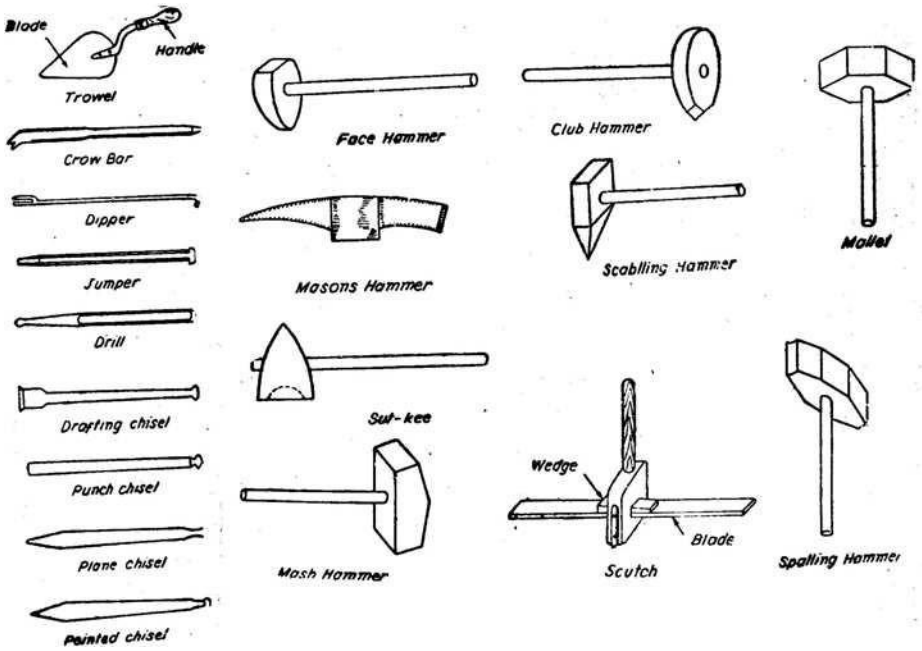


Fig 11.2 Tools for Stone Masonry
Trowel : This is used to lift and spread mortar
Square: This is made of flat steel having each arm about0.5m long
Plumb rule and bob: This is used to check the vertically ofwalls
Spirit level: this is used to chick the horizontality of walls
Line and pin: This is used to maintain the alignment of thework in progress
Bevel: The instrument used to set right angles
Pick axe: This is employed for dressing of rough stone andsplit the stones in the quarry
Crowbar: This is used to make stones in query
Chisels: They are used to dress stones

Spall hammer: This is heavy hammer used for roughdressing of stones
Mallet: The wooden hammer used for driving of woodedheaded chisels
Iron hammer: This is used for carving of stones
Scabbling hammer: This is used to break small projectionsof stones
Pitching tool: This is used to make the stones of required size
Gauge: this is employed to dress stones for spring course,comice, coping etc
Claw tool: This is employed for dressing the surface ofstones
Nicker: This is employed to draw fine chisel lines on thestone surface
Jumper: They are used for boring holes
Wedge and feathers: They are employed for cutting thestones after they have been bored with jumper.
Gad: A small steel wedge used for splitting of stones
Drag: This is employed to level a stone surface
Punch: This is employed to dress roughly the stones
Handsaw: This is used to cut soft stones
Cross-cut saw: This is used to cut hard stones
Frame saw: This is used to cut large blocks of stones.
Types of Stone Masonry:
Based on the arrangement of the stone in the construction and degree of refinement in the surface finish, the stone masonry can be classified broadly in the following two categories

Rubble masonry
Ashlar masonry

General principles in the stone masonry construction
The stones to be used for stone masonry should be hard, toughand durable.
The pressure acting on stones should be vertical
The stones should be perfectly dressed as per the requirements
The heads and bond stones should not be of a dumb bell shape.
In order to obtain uniform distribution of load, under the ends ofgriders, roof trusses etc large flat stones should be used
The beds of the stones and plan of the course should be at rightangles to the slope in the case of sloping retaining wall
Wood boxing should be filled into walls having fine dressedstone work to protect it during further construction
The mortar to be used should be good quality and in the specifiedfaces.
The instruction work of stone masonry should be raiseduniformly.
The plumb bob should be used to check the vertically of erectedwall
The stone masonry section should always be designed to takecompression and not the tensile stresses
The masonry work should be properly cured after the completionof work for a period of 2 to 3 weeks
As per as possible broken stones or small stones chips should notused

Double scaffolding should be used for working at higher level
The masonry hearting should be properly packed with mortar andchips if necessary to avoid hallows
The properly wetted stones should be used to avoid mortarmoisture being sucked

1)

11.5 Types of brick bonds:

Bonding is a process of arranging bricks and mortars to tie them together in a mass of brickwork. It should have a minimum of vertical joints in any part of the work.
Characteristics of brick bond or rules for bonding:

The brick masonry should have bricks of uniform shape and size

For satisfactory bondage the lap should be one-fourth of the brickalong the length of the wall and half brick across thickness of the wall
The brick bats use should be discouraged

The vertical joints in the alternate courses should coincides withthe centre line of the stretcher
The alternate courses the centre line of header should coincidewith the centre line of stretcher, in course below or above it.
The stretcher should be used only in the facing while heartingshould be done in the headers only

Classifications of bonds: The bonds can be classified as follows:

Stretcher bond

Header bond

English bond

Double Flemish bond

Single Flemish bond

Garden wall bond

Facing bond

Dutch bond

Raking bond

Zigzag bond

English cross bond

Bonds in columns

Brick on edge bond or soldier course

Bonds at junction and squint junction

Stretcher bond: In this type of bond all the bricks are laid with their lengths in the direction of the wall. This pattern is used only for wall having thickness of 9cm only as shown in fig 11.14.

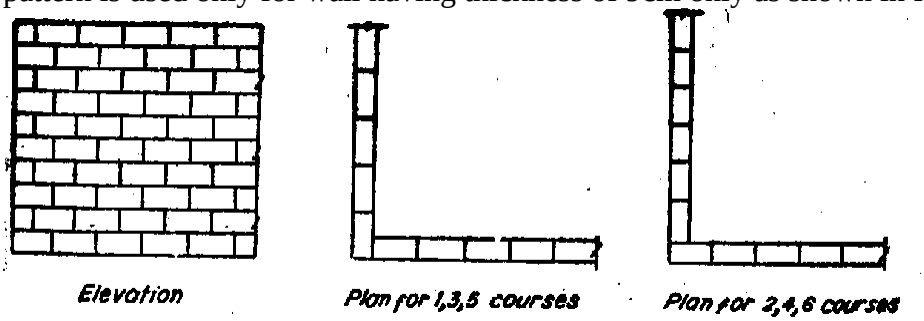
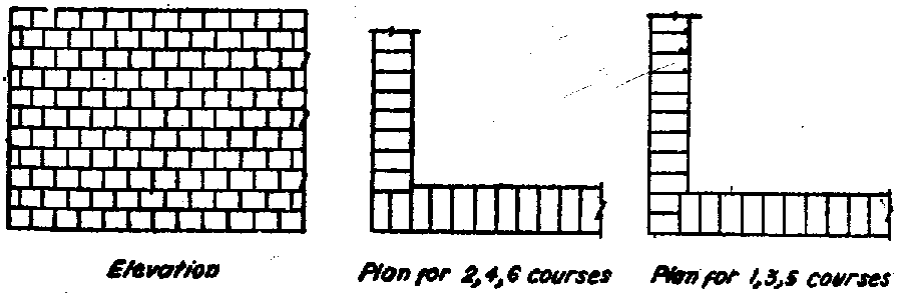


Fig 11.14 Stretcher Bond

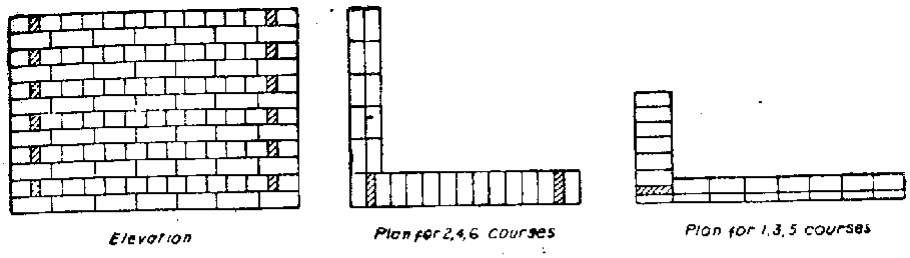
Header bond: In this type of bond all the bricks are laid with their ends towards the face of the wall. This arrangement is suitable for one brickwallof curved wall and footings for better load distribution asshown in fig 11.15.

Fig 11.15 Header Bond

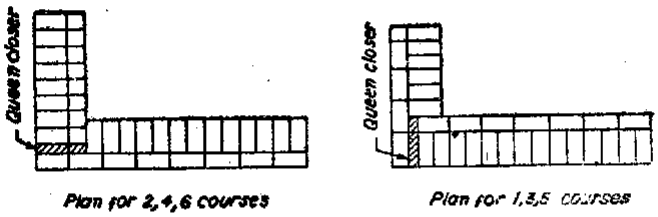


English bond: In this type of bond alternate course of headers andstretchers are laid. It is necessary to place queen closer in the heading course for breaking the joints vertically. The different english bonds are as shown in fig 11.16 and 11.17.

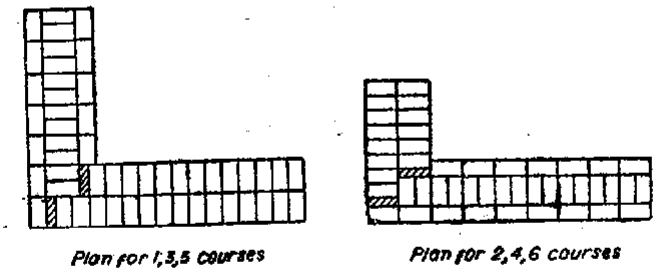
Fig 11.16 English Bond



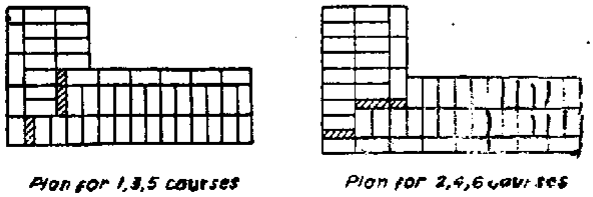
One-brick wall English bond



One-and-a-half-bricks wall English bond.



Two-bricks wall English bond.



Two-and-a-half-bricks wall English bond.

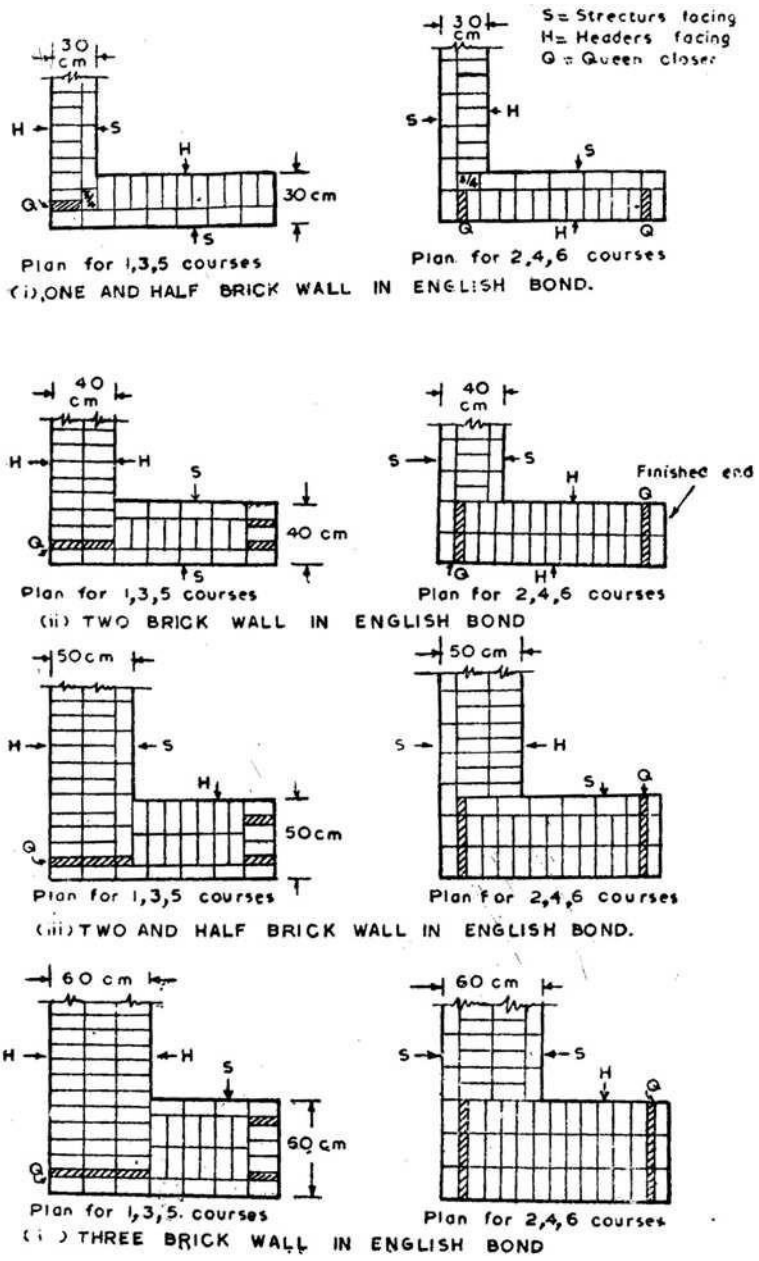


Fig 11.17 Alternate arrangements for variouswall thicknessess in English Bond

Double Flemish bond: In this type, alternate heads and stretchersare laid in each course. The facing and backing are of the same

appearance brickbats and queen closers are used. The double Flemish bond is as shown in fig 11.18.

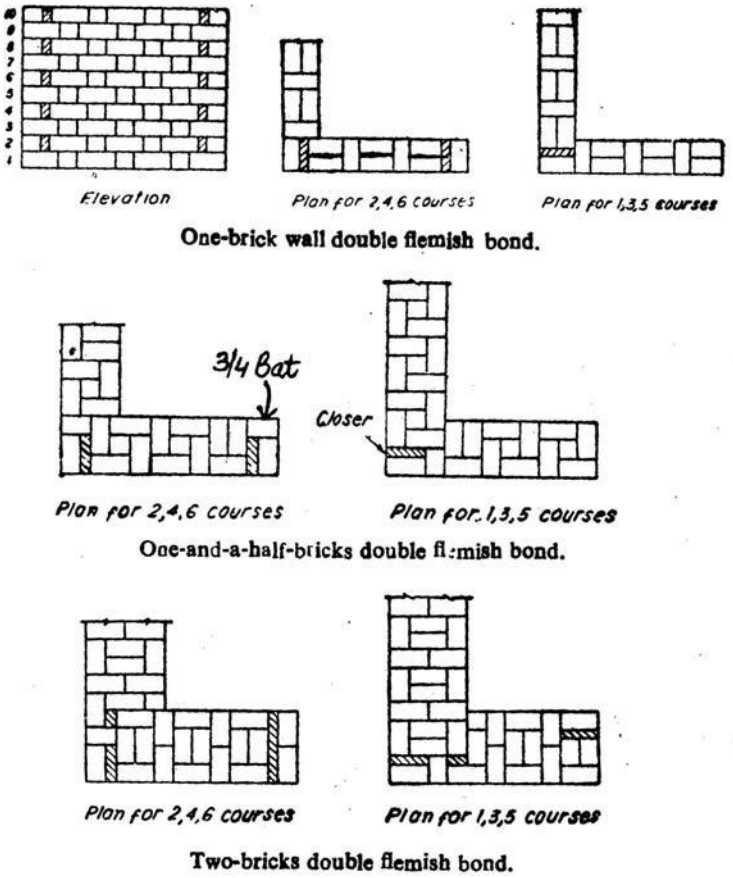


Fig 11.18 Double Flemish Bond

Single Flemish bond: This type of bond is comprised of double Flemish bond facing and English bond backing in each course. Thistype of construction partially possesses the strength of Englishbond,and appearance of Flemish bond. As this type of bond requires minimum thickness of 1 ½ bricks so it cannot be used for

walls having thickness less than 1½ bricks. The fig 11.19 shows the single Flemish bond.

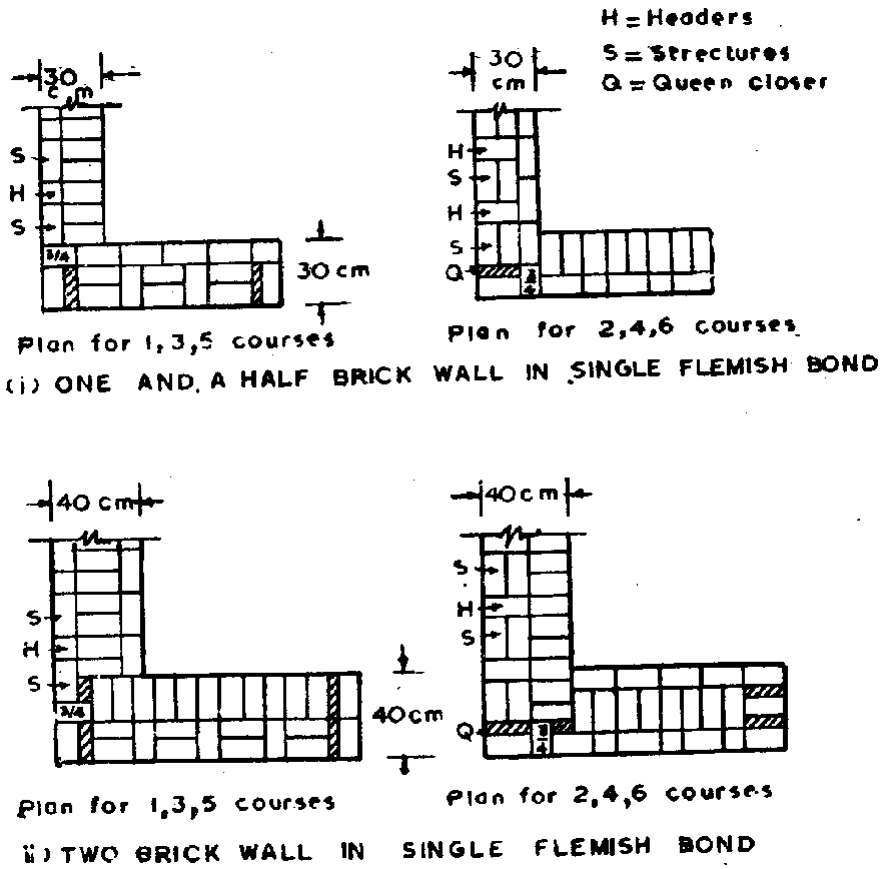


Fig 11.19 Single Flemish Bond

Garden wall bond: This type of bond is employed for the construction of garden walls, compound walls, boundary walls etc. This wall bond can be both English as well as Flemish as shown in the fig 11.20 & 11.21.

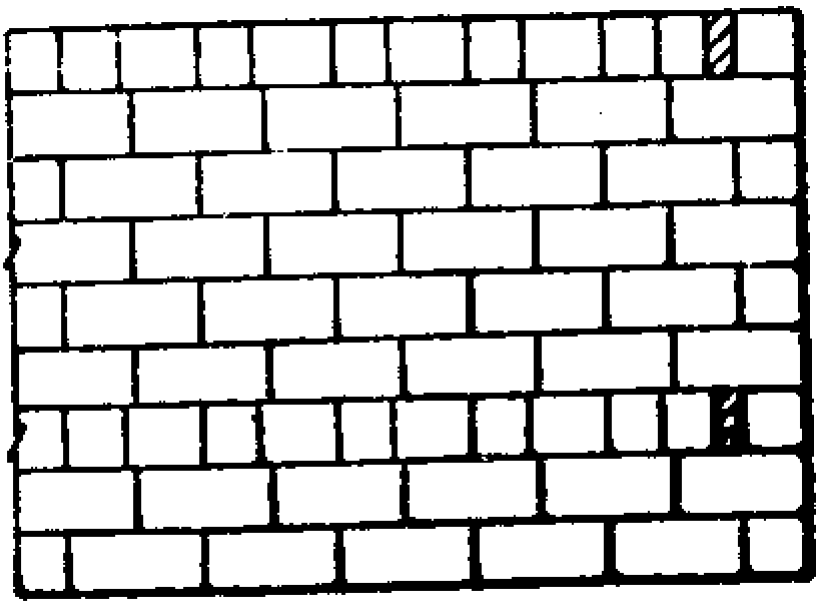


Fig 11.20 English Garden Wall Bond

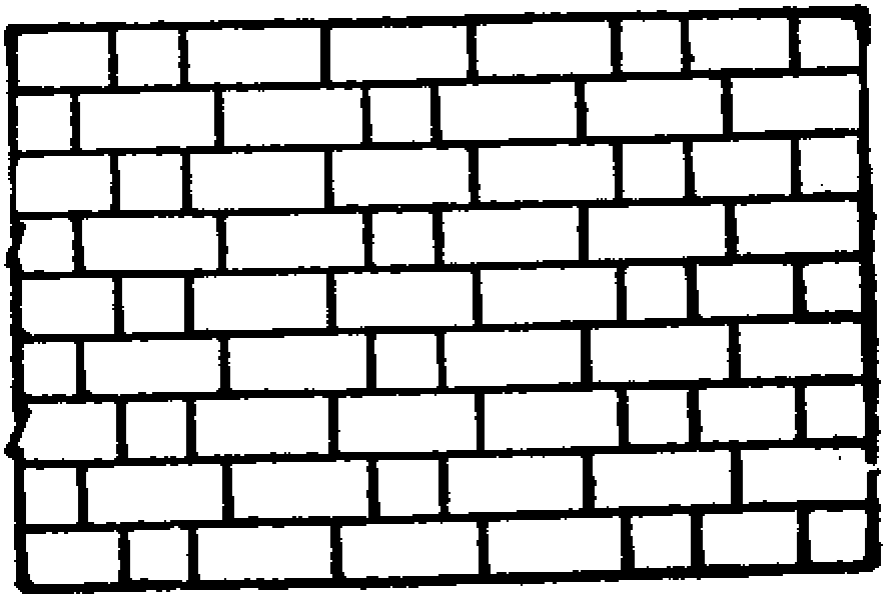


Fig 11.21 Flemish Garden Wall Bond

Facing bond: In this type of bond bricks of different thickness are used in the facing and backing of the wall. In this case, a header course is placed after several stretcher courses. In this type of bond,the distance between the successive heading courses is equal to common multiple of thickness of backing and facing bricks.
Dutch bond: This is the modified form of English bond. Thecornersof the wall provided with dutch bond are quite strong. The alternatecourses in this type of bond are headers and stretchers. In stretcher course ¾ bat is used as quoin. A header is placed next to the ¾ bat in every alternate stretcher course as shown in the fig 11.22.

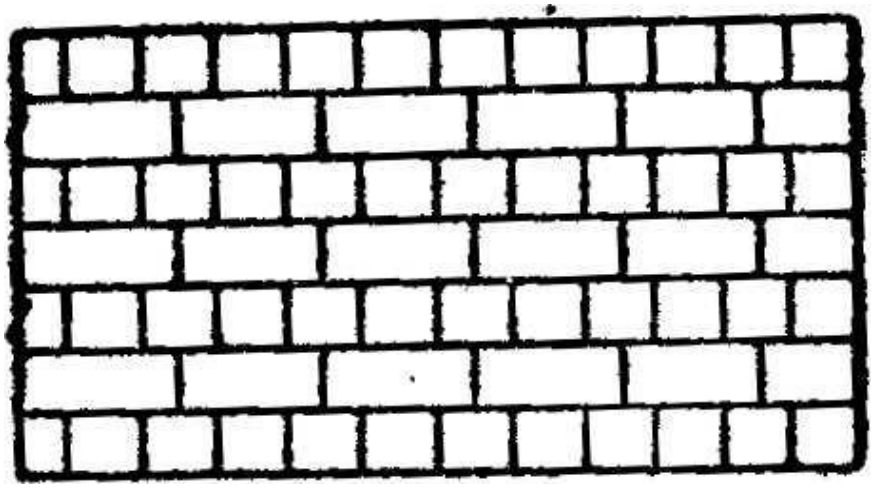


Fig 11.22 Dutch Bond
Raking bond: In this type of bond alternate courses are placed in different directions to get maximum strength in the wall. The rackingcourses are laid to certain interval along the height of the wall in verythick wall having number of headers more than the no.

of stretchers between the facing and backing. Thus the raking courserectifies the defect of low longitudinal, stiffness in thick wall. This is of two types a. Herring bone bond (placed at 45^0 in both direction)
b. Diagonal bond as shown in fig 11.23.

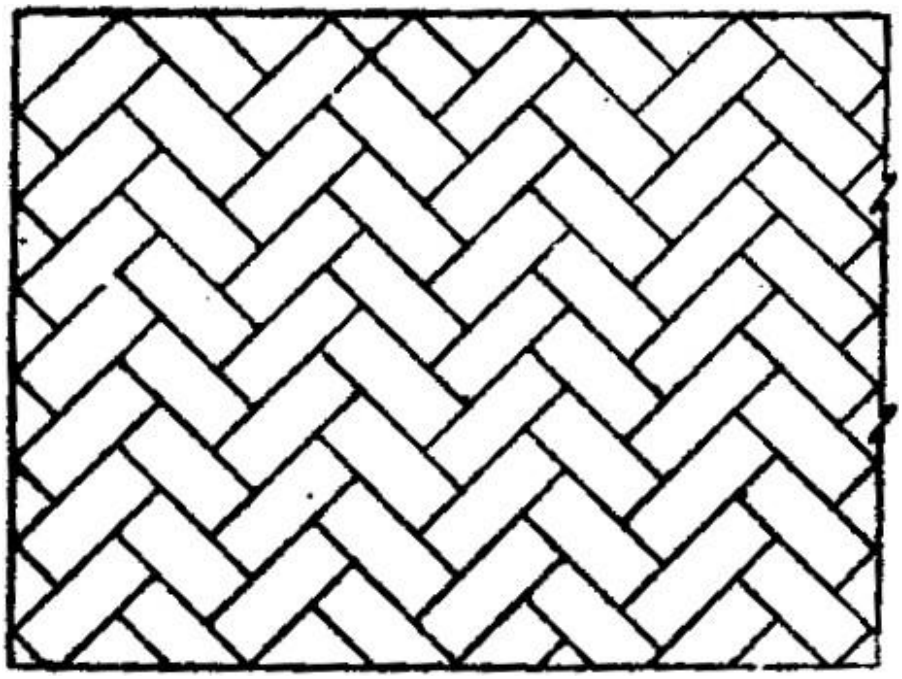


Fig 11.23 Herring Bone Bond
Zigzag bond: This type of bond very much similar to herring bone bond. The only difference is that bricks are laid in zigzag way and used for paving the brick floor as shown in fig 11.24

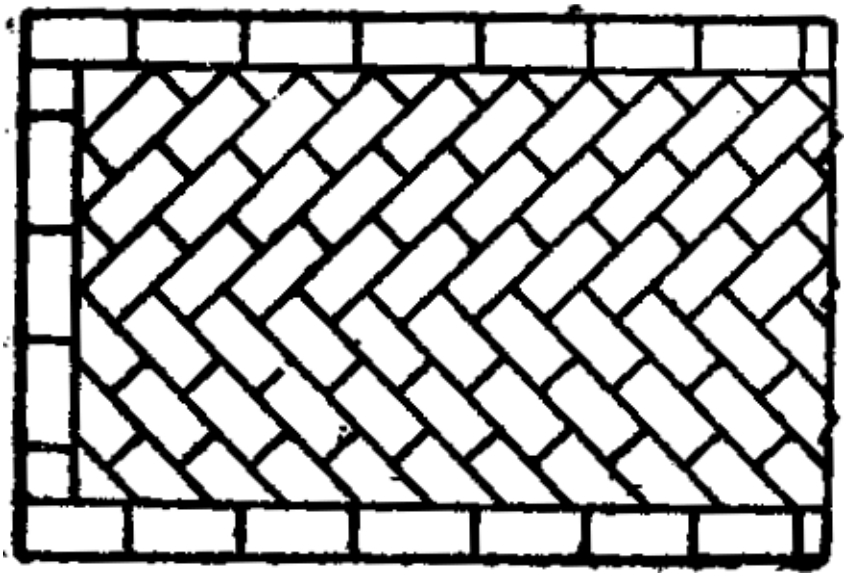


Fig 11.24 Zigzag Bond

English cross bond: This type of bond is aesthetically more sound and posses greater strength than English bond. In this bond every alternate stretcher course has a header placed next to the quolin stretcher and rest of the details are similar to English bond asshownin fig 11.25

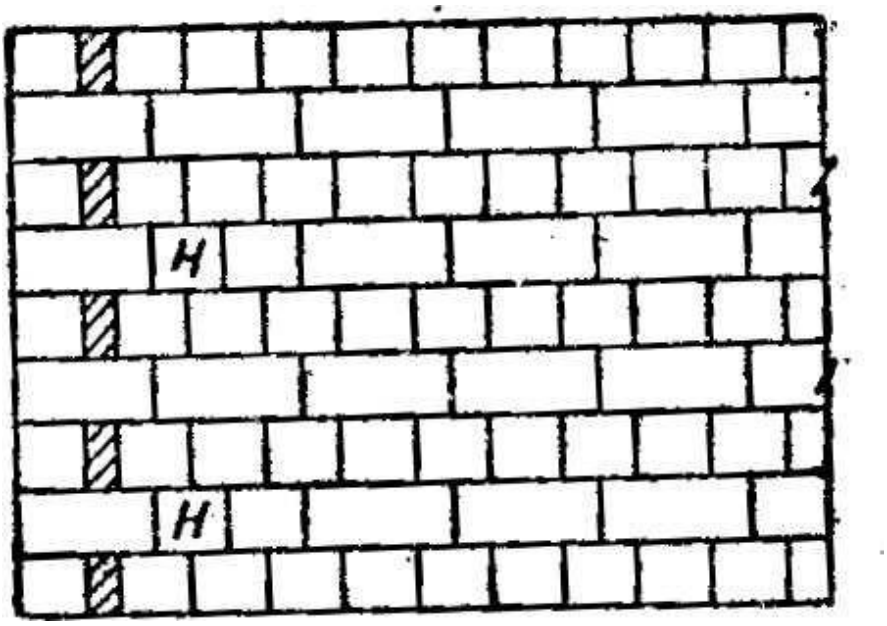


Fig 11.25 English Cross Bond

Brick on edge bond or soldier course: In this type of bond, the bricks are laid on edge. The bricks are placed as headers andstretchers in alternate courses in such a manner that headers are placed on bed and the stretchers are placed an edge forming a continuous cavity. This bond is weak in strength but economical.

Bonds in columns: Generally English bond or double Flemish bondare used for column construction. In case of circular or octagonal construction moulded bricks are used. The various arrangements of bricks in different columns shapes are as shown in fig 11.26.

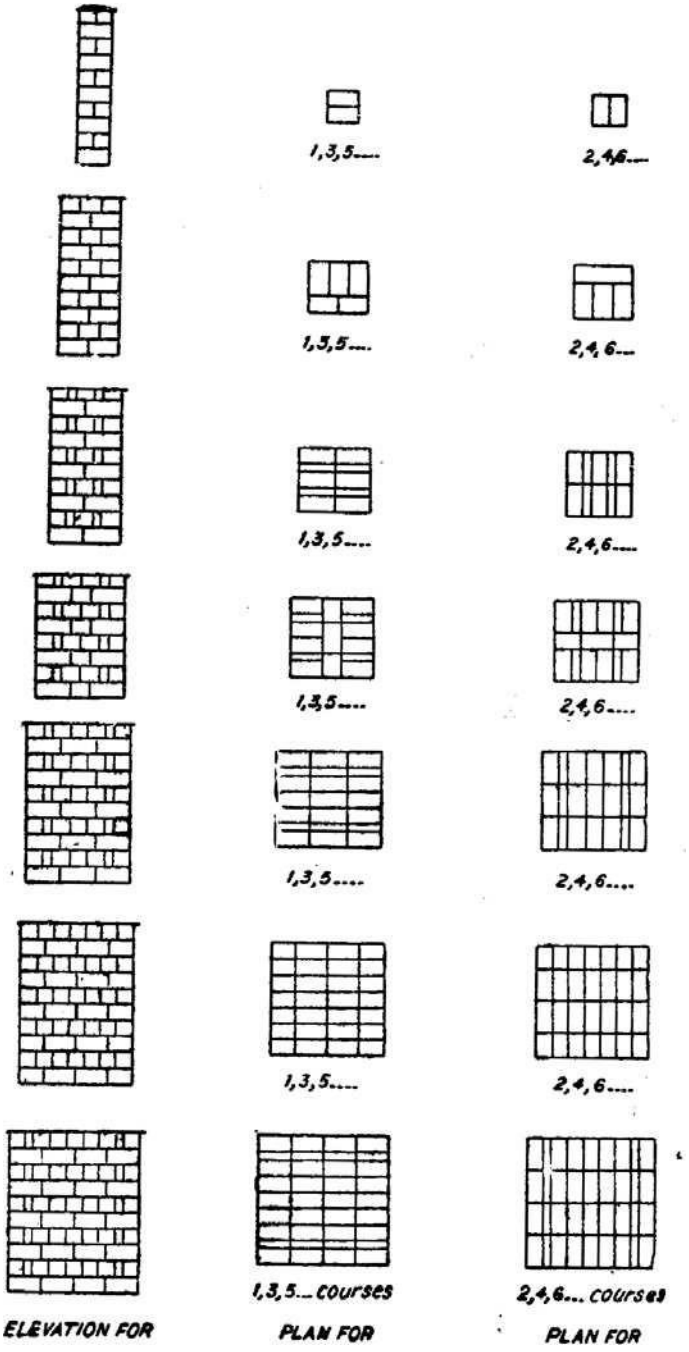


fig 11.26 Bonds in columns

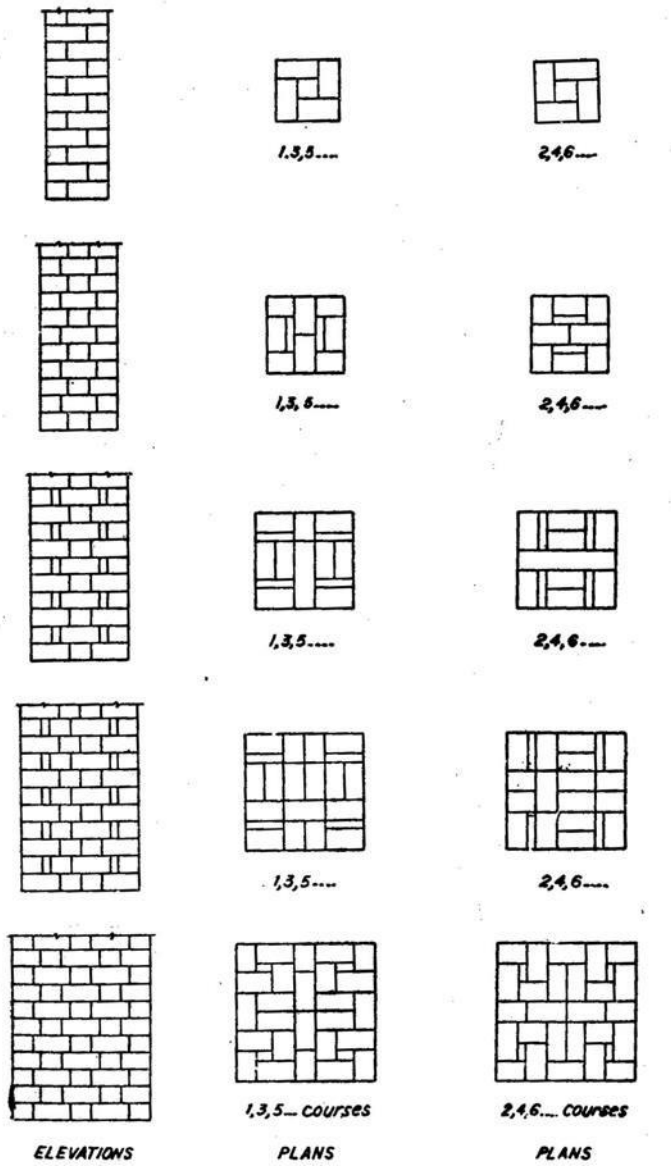
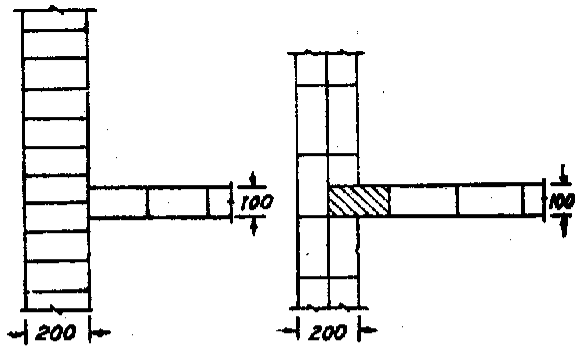
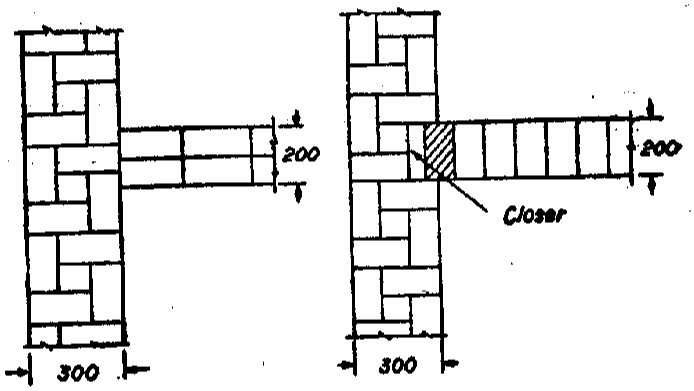


Fig 11.27 Columns in Double Flemish bond

Bonds at junction: When two walls meet or intersect each other,the meeting point is known as junction For tee junction- English or double Flemish is usedas shown in fig 11.28.



Plans for one-brick Tee-Junction.



Plans for one-and-a-half brick Tee-Junction.

Fig. 8·39. Tee-Junction in English Bond.

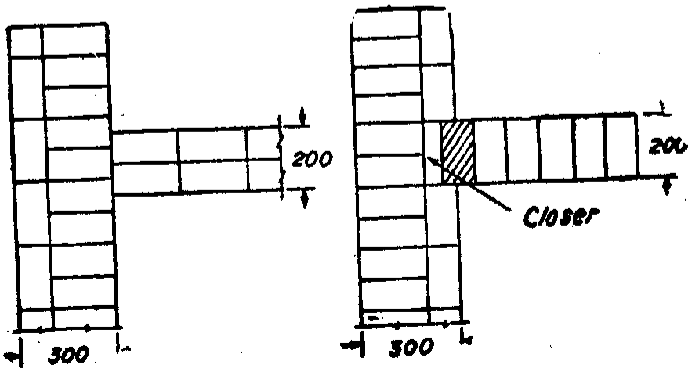


Fig 11.28 Bonds in Tee-Junction

For cross junctions – English bond is used as shown in fig. 11.29

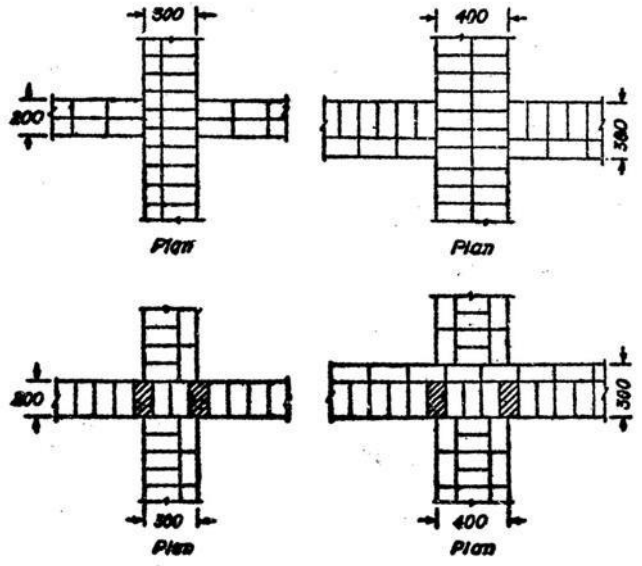


Fig 11.29 Cross Junctions in english bond

* * *

SHORT ANSWER QUESTIONS
What is masonry?
Name the types of masonry3.Define the following
Strecher
Quoins
Queen closer
King closer
Frog
Sill
Define stone masonry
What are the uses of stone masonry?
Name the import stones used in the construction of stone masonry7.What is the use of following tools in the construction of stone
masonry
Plumb rule
Spirit level
Line and pin
Bevel
Mallet
Chisel
Scabbling hammer
Jumper
Gauge
Define brick masonry
What are the uses of brick masonry
Name the important types of stone masonry

ESSAY TYPE QUESTIONS

What is stone masonry? Explain the uses of stone masonry

Explain the following with neat sketch a) king closer b) queencloser.

What are factors to be considered for the selection of stone forstone masoanry?

Explain different types of stones used for various purposes

Explain the types of tools and their uses for stone masonryconstruction

What are the general principles adopted in the stone masonryconstruction

Explain the types of stone masonry

Explain the types of brick masonry

What are principles adopted in brick masonry construction?

Compare the merits and demerits of stone masonry and brickmasonry.

* * *

Chapter-4

Floors,roofs and staircase

FLOORS

In order to sub-divide the portion between the plinth level or basement level and roof level, solid constructions are Carrie out. These constructionsare known as floors and exposed top surface of floors are termed as floorings. Ground floors or basement floors, which directlyrest on the ground, do not require the provision of a floor. But they are provided withsuitable type of flooring.

Types of Floors:
Floors are classified into two categories
Timber Floors
Composite Floors

Timber Floors: In this floor, only timber is used as a material.Timber floors are further divided into four types.
Basement or Ground floor of timber
Single Joist timber beam
Double Joist timber beam
Framed triple joist timber floor.

Features of Timber Floors:
Floor Boards: These boards are provided at the top of bridging joists and they form the wearing surface of the floor. The width varies from 100mm to 200mm and thickness varies from 20mm to 40mm. the

thickness may be changes when a floor subject to heavy traffic from 60 to 80mm. The floor boards are joined and widened by any suitable joint asshown in the figure.12.1

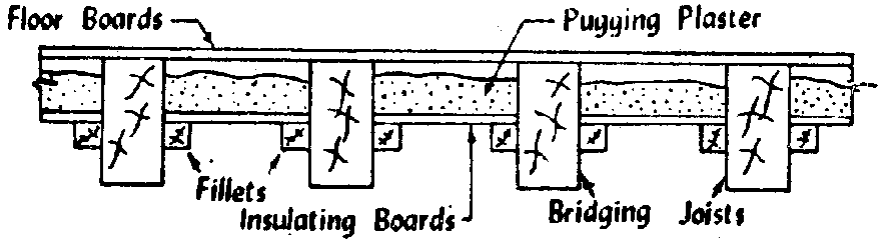


Fig 12.1 Pugging

Floor Ceilings: To make the underside of the floor flat and toimprovethe appearance as a whole, ceilings may be provided rest on bridging joistsor binders. The ceilings may consists of plaster boards or sheets ofasbestors cement or some suitable material. In order to make ceilings strong and durable, ceiling joists may be provided at right anglesto the bridging joists or the binders.

Pugging: In order to make the timber floor sound proof,pugging may be resorted. Pugging plaster is a mixture ofchopped straw and mortar. Insulating boards supporting on fillets are provided and hallows space between the floorboardsand the insulating boards is filled up with the pugging plaster.

Trimming: When openings are to be provided in woodenfloors, it is clear that bridging joists will not rest on the walls. In such cases, the process of trimming is required. Trimming joists support one or two trimmer joists to which trimmed joistsare fixed. The trimming joists and trimmer joists have

slightly greater section than bridging joists Fig. 12.2 shows a wooden floor with stair well.

Use of stell sections: Binders and girders of wooden floor canbe replaced by mild rolled steel joists. The only precaution to be taken in this case would be to encase the R.S.J. by concreteso as to prevent rusting of R.S.J. The use of steel section makesthe floor light and economical.

Basement or ground floor of timber:

In auditorium, to carry out dances or dramas timber floors are constructed on ground floor. Sleeper walls, which may be of one-half brick or one brick thickness, are constructed at centreto centre distance of 1.20m to 1.80m. Wall-plates are providedalong the wall as well as along the sleeper walls andthey reducethe spans of the building joists and serve as end supports for the bridging joists. On wall-plates rest the endsof bridging joists, which are usually provided at a centre to centre distanceof about 30 cm. Finally, floor boards are provided to finish upthe floor. The details are as shown in fig12.2.

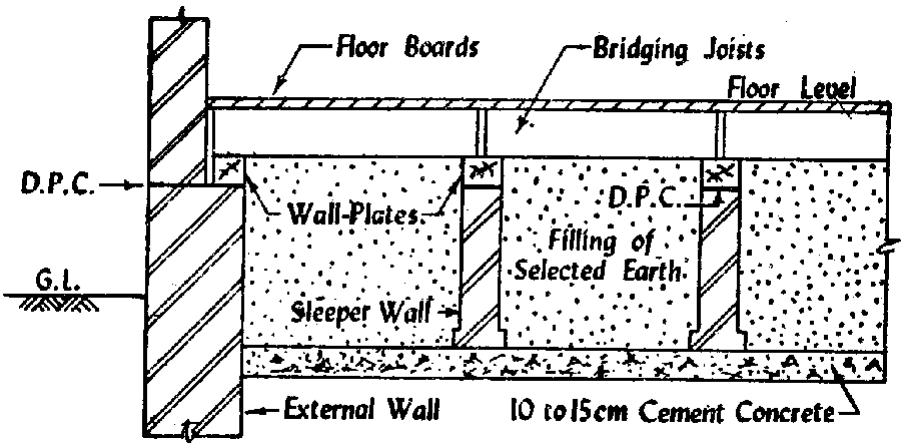


Fig 12.2. Basement or ground floor of timber

Single Joist timber floor:

These floors consist of single joist, which are placed belowthe floorboards. The joists are usually placed at a centre to centre distance of 30cm to 45cm. The joists are supported on wall-plates at their ends. A space of about 50mm is kept for thecirculation of air as shown in fig 12.3. Single joist timber floorcan be adopted for a maximum span of about 3.6m. When the span of joist exceeds 2.4m, it becomes necessary to strengthenthe joist by providing bearing bone strutting. In this arrangement, inclined timber pieces are firmly fixed between the joists and the ends of these struts are nailed to thejoist. At the end, wedges are provided between the wall and the joists.

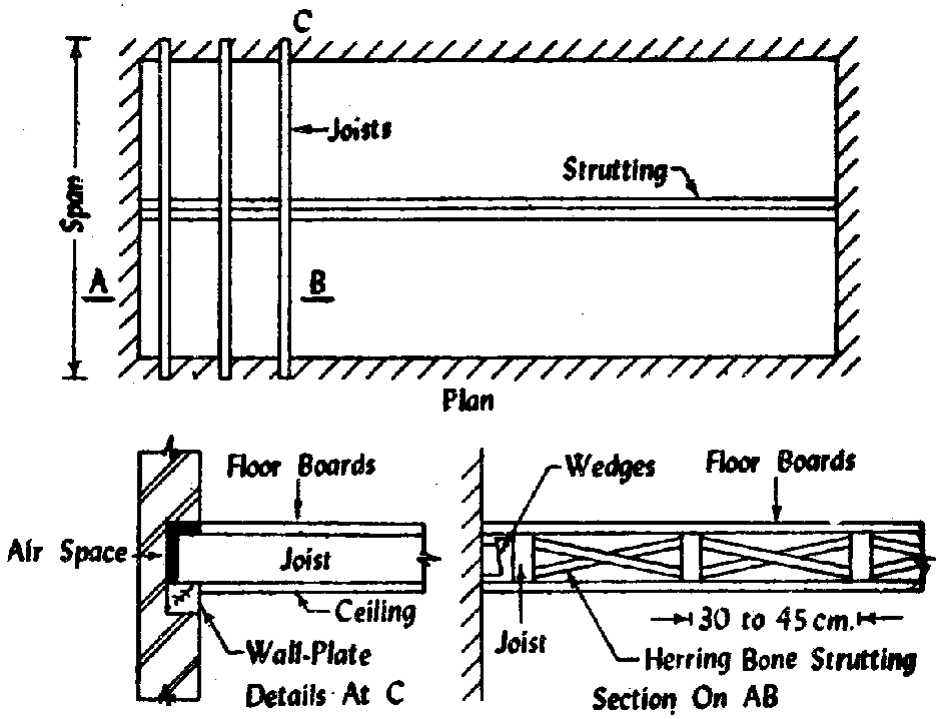


Fig 12.3 Details of single joist timber floor

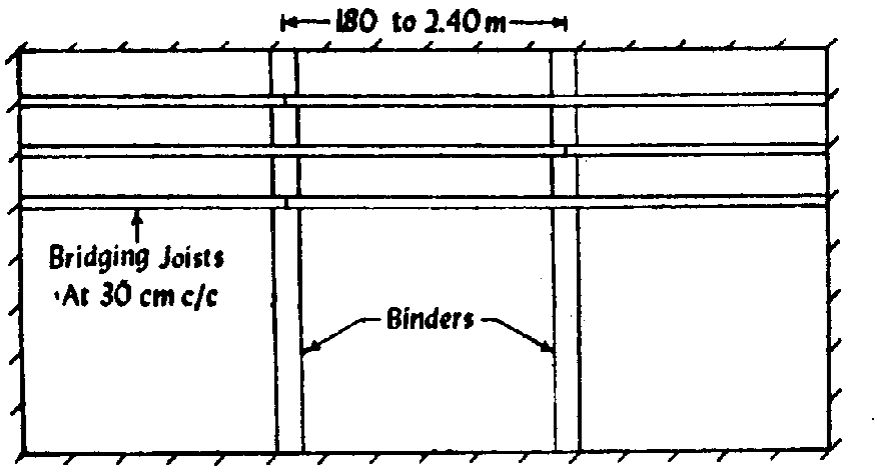
Double joist timber floors:

In this type of floors, intermediate supports known as binders,are provided for bridging joists. Binders are generally placed at a centre to centre distance of 1.80m to 2.40m as shown in fig

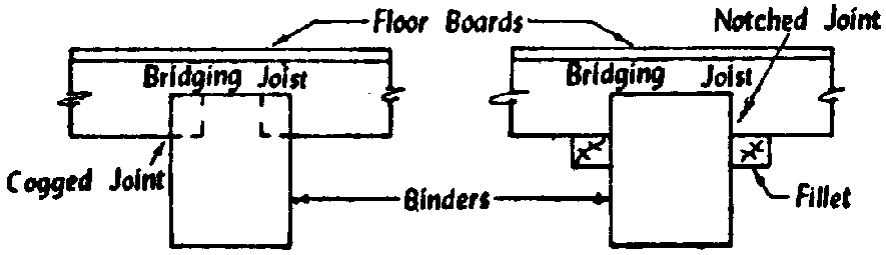
12.4. The ends of binders rest on wooden or stone blocks. Double joist timber floors are stronger than the single joist timber floors. They prevent the passage of sound in better way and they are suitable for spans of 3.60 to 7.50m. This typeof floors has following disadvantages.

The weight of floor is thrown on few points in a wall.

Depth of floor is increased by the use of binders and accordingly height of the room is decreased.



Plan of double joist timber floor



Methods of fixing binders with joists

Fig 12.4

Framed or triple joist timber floor:

In this type of floors, intermediate supports, known as girders,are provided for the binders. Thus, this type of floor consists of girders, binders, bridging joists and floor boards as shown in fig 12.5. Girders are generally placed at a centre to centre distance of 3 metres. Binders are staggered and connected to girders by tusk and tenon joints. Alternatively, the ends of binders are supported on the iron stirrups, which are fixed to

the girders. The ends of girders rest on walls on stone or concrete templates. This type of timber floor is suitable for spans greater than 7.50.

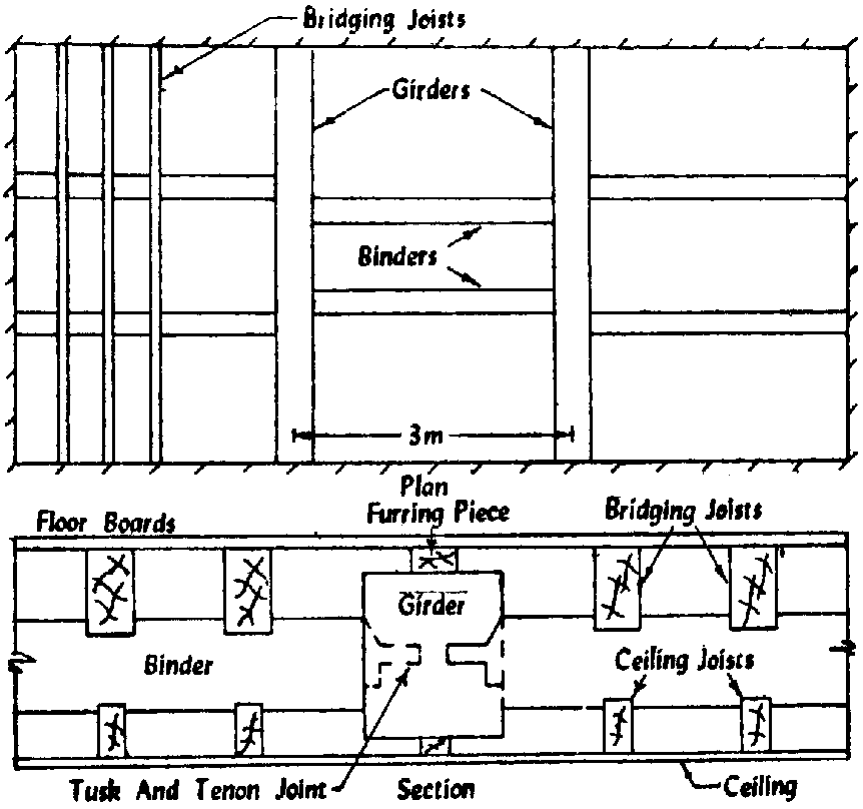


Fig 12.5 Details of framed timber floorsII Composite Floors:
Floors composed of more than one material are known as composite floors and they found to possess the following advantages.
Resist fire and sound in better way than timber floors
Better hygienic because can be easily cleaned
Adopted for greater spans.

The following are the types of composite floors
Double flag stone floors
Filler Joists floors
Jack arch floor
R.C.C. floors
Hallow block and rib floors
Double flagstone floors:
In this type of floors, flagstones are used in two layers as shownin fig 12.6. If span is about 4m, only rolled steel joists are provided and span exceeds 4m, a framework consists of rolledsteel beams and joists is formed. Steel beams are placed at a distance of about 3m centre to centre and joists areplaced at right angles to beams. Flagstones of about 40mm thickness andof suitable width are fixed on the lower flanges and upper flanges. The joints of top layer of flagstones are finished in a better way to give a nice appearance. Filling of selected earth or concrete is done in the space between thetwo layers ofthe flagstones.

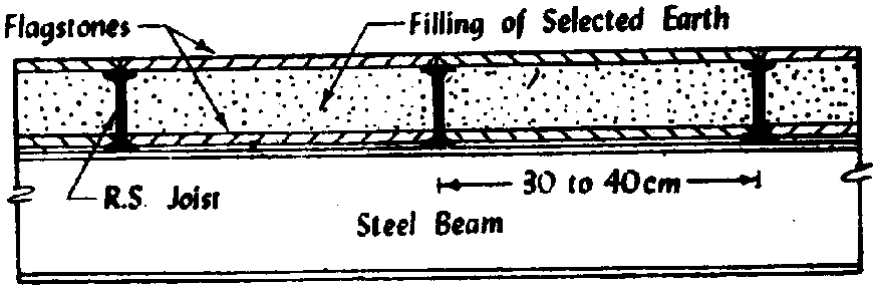


Fig 12.6 Double Flagstone floor

Filler Joist floors:
In this type of floors, small sections of rolled steel joists are placed in concrete, this joists may either rest on wall or on steelbeam as shown fig 12.7. The joists act as a reinforced and are spaced at a centre to centre distance of 60cm to 90cm.Concreteshould completely surround the rolled steel / joists and beams.

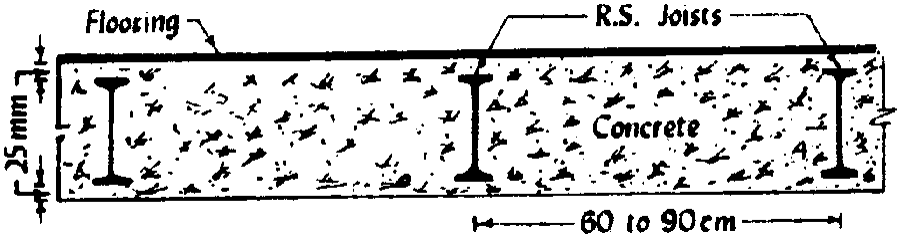


Fig 12.7 Filler Joist Floor
Jack arch floors:
In this type of floor, brick arches or cement concrete arches areconstructed and these arches rest on the lower flanges of mild steel joists. The joists in turn rest either on wall or on beam. The joists are placed at a distance of about 80cm to 120cm center to center. The rise of arch should be 10cm to 20cm. andthe minimum depth of concrete at the crown should be 15cm.The only disadvantage of this floor is that it does not give plainceiling surface as shown in the fig 12.8. (a& b)

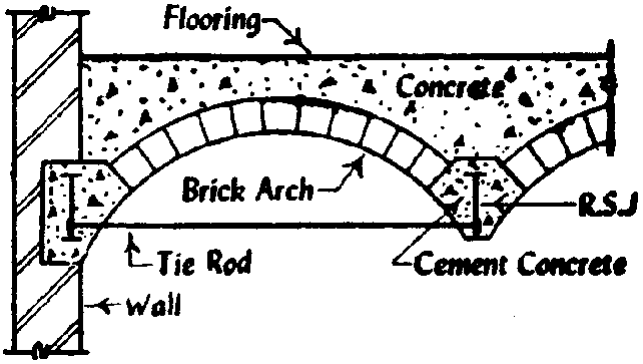
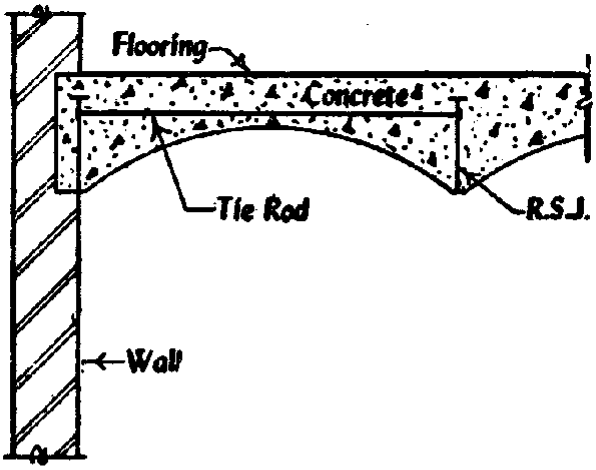


Fig 12.8 (a) Brick Jack arch floor



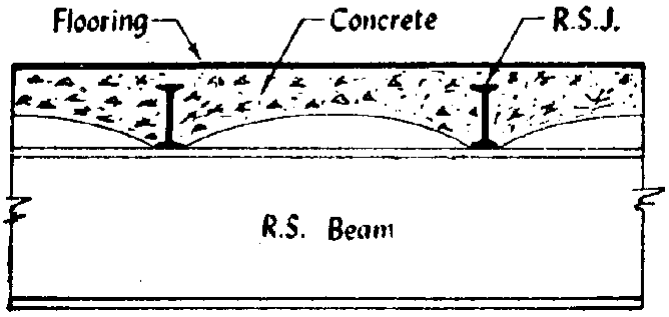


Fig 12.8 (b) Concrete jack floor

R.C.C Floor: In this type of floors steel bars and concrete areused to form a floor. This type of floor is widely used in modern construction. The slab and beam are designed as per loading coming on the floor and proper reinforcement is placedat a suitable place. In case of R.C.C. slab thickness varies from80mm to 150mm and the main reinforcement is generally in the form of mild steel bars of diameter varying from 9mm to 12mm as shown in the fig. 12.9.

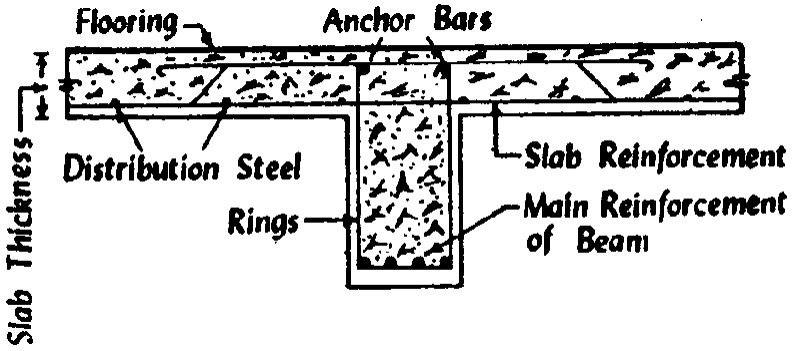


Fig 12.9 R.C.C. Floor

The reinforced concrete may be cast-in-situ or pre-cast, the former being very common. R.C.C. floors are less costly, durable, easy to construct and fire-proof. However, they are likely to transmit sound. In any case R.C.C. floors are fast replacing other types of floors.

Hallow Block and Rib Floors: In this type of floors, hallow blocks of clay or concrete are used to reduce the total weight of the floor. In one form, the blocks are placed 10cm apart and in this space, mild steel bars are placed as shown in the

fig 12.10.A minimum cover of 80mm is kept at the top.Suitableflooring at the top and sealing finish are provided. The blocksare provided with rough or grooved surface sothat they can develop enough bond with the concrete. This type of floor is economical, fire proof, sound proof and light in weight. If properly designed, this type of floor can even be used to carryheavy loads.

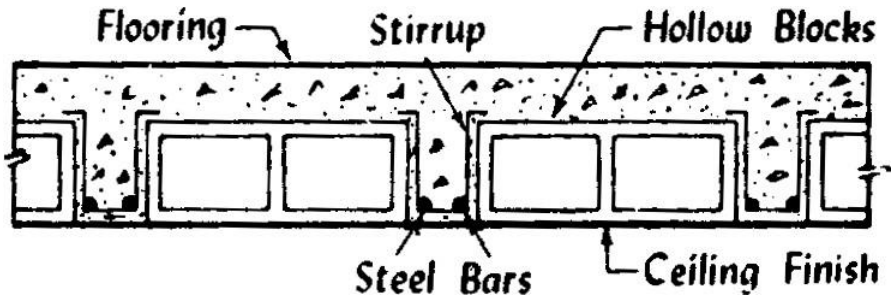


Fig 12.10 Hallow Block and Rib floor

* * *

SHORT ANSWER QUESTIONS
Define floor
What are the types of floors?
Name the types of timber floors
What are the advantages of composite floors?
Name the types of composite floors.

ESSAY TYPE QUESTIONS
Explain different types of timber floors briefly
Explain the following
double flag stone floors
jack arch floors
Explain the construction of composite floors briefly
Explain the following
R.C.C. floor
Hollow block and rab floors

* * *

ROOFS

A roof is defined as the uppermost part of a building which is constructedin the form of a frame work to given protection to thebuilding against rain,heat, snow, wind etc. A roof basically consists of structural elements provided at the top of building for the support of roof coverings.
Following are the requirements of well planned roof:
It should be durable against the adverse effects of various agenciessuch as wind, rain, sun etc.
It should grant the desirable insulation against sound and heat.
It should be structurally stable and sound, it should be capable oftaking the loads likely to come over it.
It should be well-drained
It should have efficient water-proofing arrangement.

Types of roofs-Methods of construction:
The roofs classified into the following three categories;
Pitched roofs
Flat roofs
Curved roofs
Pitched roofs: A sloping roof is known as pitched roof as shown in the fig 13.1. The technical terms in connection with the pitched roof are given below

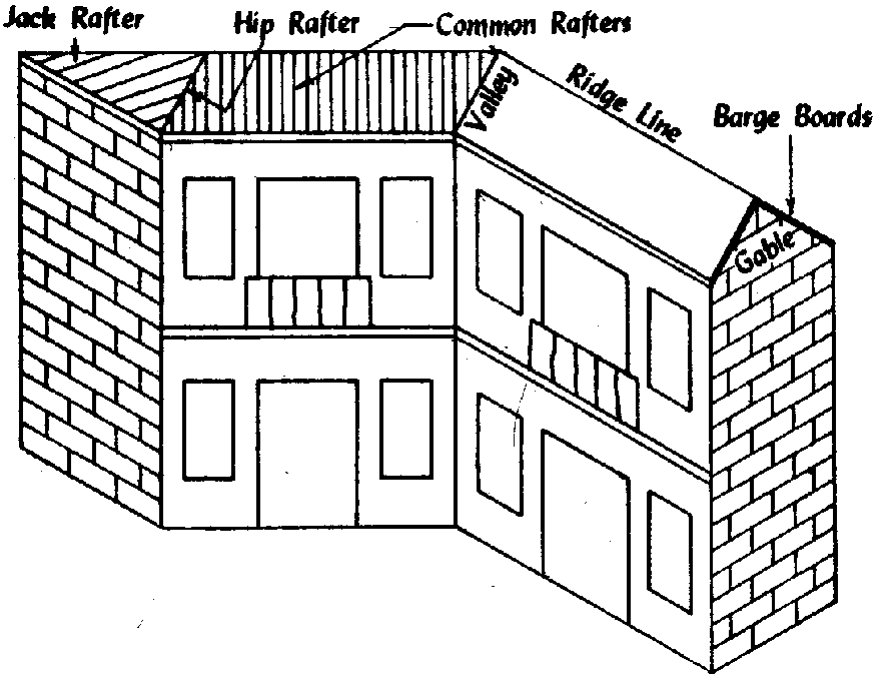
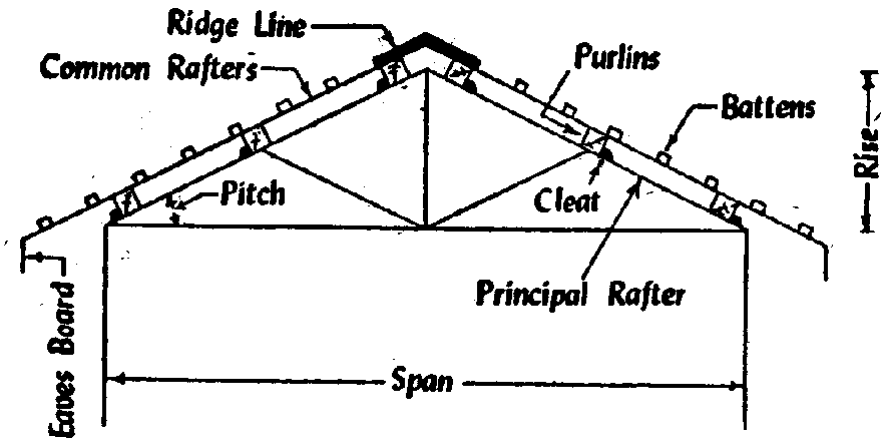


Fig 13.1 Building with pitched roof

Barge Boards: Wooden planks or boards which arefixed on the gable end of the roof
Battens: Thin strips of wood which are fixed onrafters or ceiling to support the roof ceiling.
Cleats: Small blocks of wood which are fixed on trussto prevent the sliding of purlins.
Dragon beam: The diagonal piece of wood which islaid across the corner of the wall.

Eaves: The lower edge of a roof which are resting uponor projecting beyond the supporting walls are known as eave as shown in the fig 13.2
Gable: The triangular upper part of a wall formed at the end of a pitched roof is known as gable.
Hip: The angle formed at the intersection of two roof slopes is known as hip.
Pitch: The inclination of sides of a roof to the horizontal plane is known as pitch, expressed in degrees or as a ratio of rise to span.
Purlins: The wooden pieces which are placed horizontally on principal rafters to carry the common rafters are known as purlins.
Rafters: There are the pieces of timber which extend from the caves to the ridge
Common rafters: These are the intermediaterafters, which give support to the roof coverings a shown in the fig 13.2.
Hip rafters: Which provided at the junction of two roof slopes
Jack rafters: Any rafters, which is shorter than common rafters is known as Jack Rafters.
Principal rafters: These are the inclined members of a truss

Ridge: A wooden piece provided at the ridge line of a sloping roof is known as ridge or ridge board or ridge piece
Span: The horizontal distance between the internalfaces of walls or supports is known as span or clear span.
Template: A bidding block generally provided at the end of a truss. This block is known as template and it helps in spreading load over a large area. A template may be of wood or stone or R.C.C.
Verge: The edge of a gable, running between the cavesand ridge is known as a verge
Valley: When two roof surfaces meet together and form an internal angle, a valley is formed
Wall-plate: These are long wooden members which are embedded on top of walls to receive the common rafters
Fig 13.2 Truss



Types of pitched roofs:

Single roof

Double or purlin roof

Trussed roofs

Single roof: In this type of roofs, common rafters are provided toeach slope without any intermediate support. The following are thevarieties of single roof.

Lean to roof

Couple roof

Couple close roof

Collar beam roof

Lean to roof: It is the simplest form of a pitched roof and it is knownas pent roof or Aisle roof. In this type of roof, one wall is carried upsufficiently higher than the other to give necessary slope to the roof.A lean-to roof is generally used for sheds, out-houses attached to main buildings verandah etc. This is suitable for amaximum span of2.40m as shown in fig 13.3.

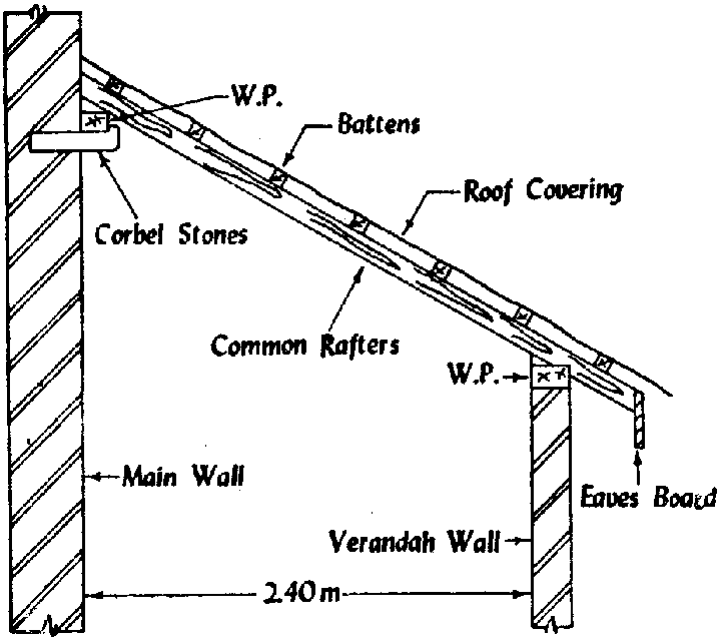


Fig 13.3 Lean-to roof

Couple roof: In this type of roof the common rafters slope upwardsfrom the opposite walls and they meet on a ridge piece in the middleas shown in the fig 13.4. A couple roof is suitable for spans upto about 3.6m.

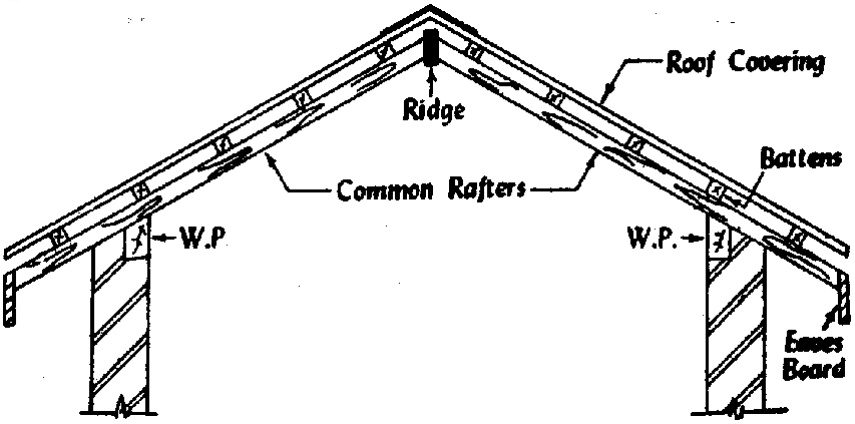
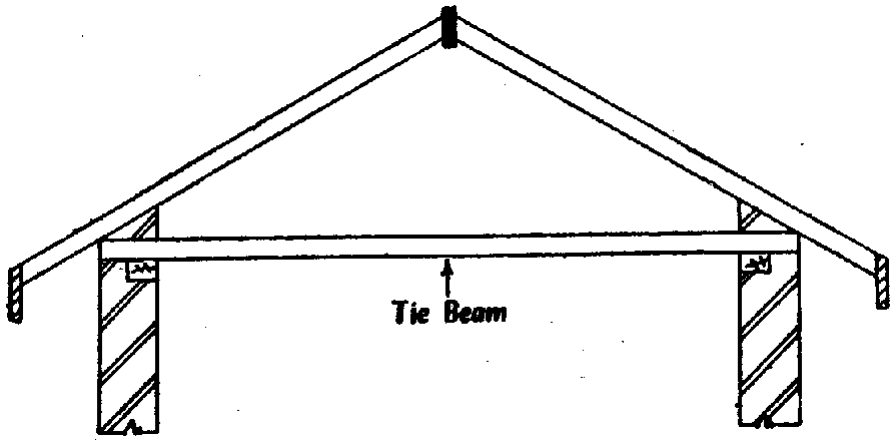


Fig 13.4 Couple roof

Couple close roof: This roof is just similar to couple roof except thatthe legs of the common rafters are connected by a tie beam as shownin the fig 13.5. The tie beam prevents the tendency of raftersto spreadout and thus danger of overturning of the walls is avoided. This roofcan be adopted economically upto the span of 4.2m.
Fig 13.5 Couple close roof

Collar beam roof: The tie beam is raised and placed at a higher levelas shown in fig 13.6 known as collar or collar beam. This beam roofis adopted to economise the space and to increase the height of a room. This roof can be adopted upto a maximum spanof 4.8m.



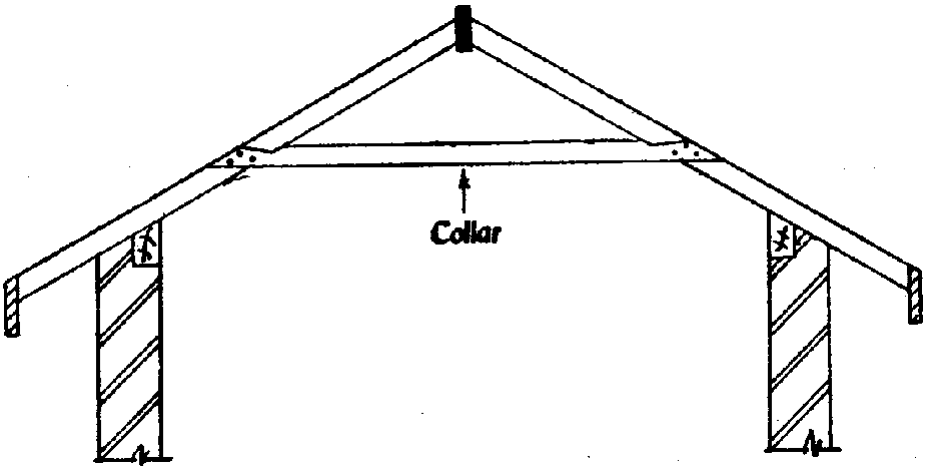


Fig 13.6 Collar beam roof

Double or purlin roofs: When the span exceeds 2.4m, the necessary size for the rafters becomes uneconomical. Hence in order to reduce the size of rafters, intermediate supports called purlins are introduced under the rafters as shown in fig 13.7. Thisroof can be adopted economically upto 4.8m.

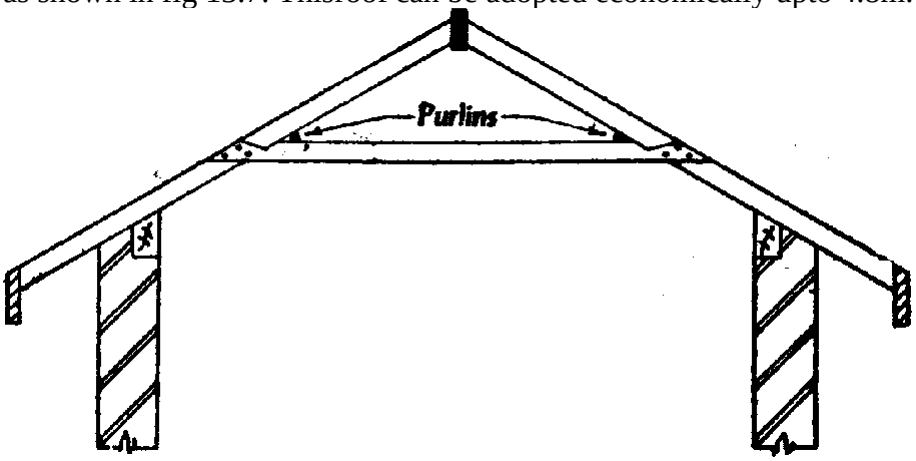


Fig 13.7 Double or Purlin roof

Trussed roofs: When the span exceeds 4.8m and when there are no inside supporting walls or partitions for purlins, framed structure known as trusses are on the roof, position of cross walls,span and material of the truss. The spacing is 3m for wooden trusses. Trusses carry the ridge piece and purlins on which the common rafters rest. Some of the usual forms of roof truss are given below.

King-post truss

Queen post truss

Mansard truss

Truncated truss

Bel-fast truss

Steel trusses

Composite trusses

King post truss: In this type of truss, the central post known as king-post forms support for the tie beam. The inclined members, known as structs, prevents the principal rafters frombending in the middle. A king-post truss suitable for roofs of span varying from 5 to 8 m as shown in fig 13.8.

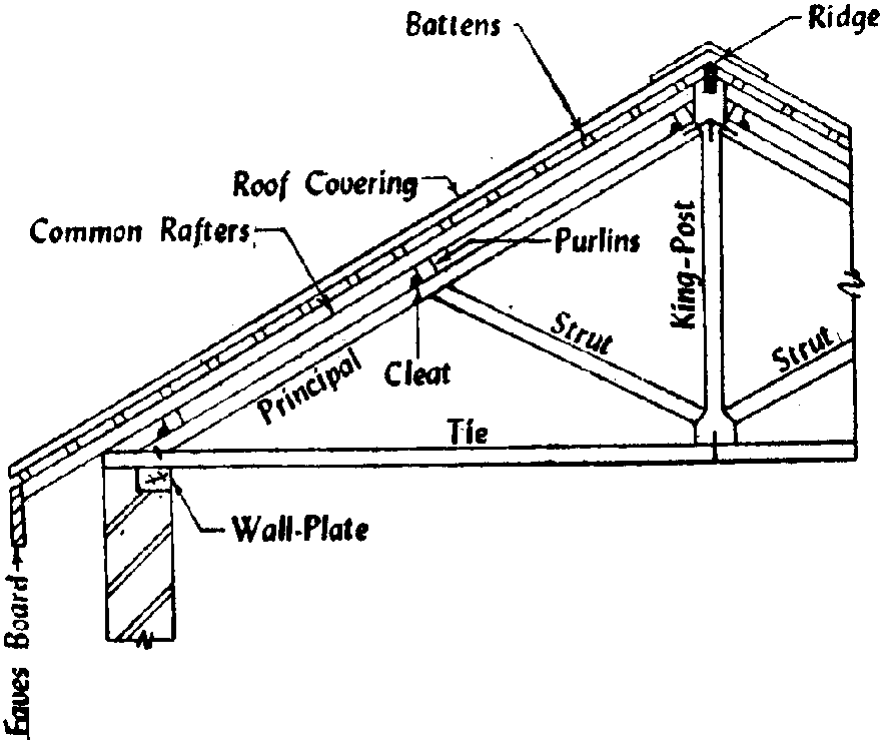


Fig 13.8 King post truss roof

Queen post truss: This truss is differ from a king-post trussin having two vertical members known as queen posts. The upper ends of the queen posts are kept in position by meansof a horizontal member known as straining beam. Additional purlins are supported on the queen posts. A queen post trussis suitable for roof spans varying 8 to 12 m as shown in fig 13.9.

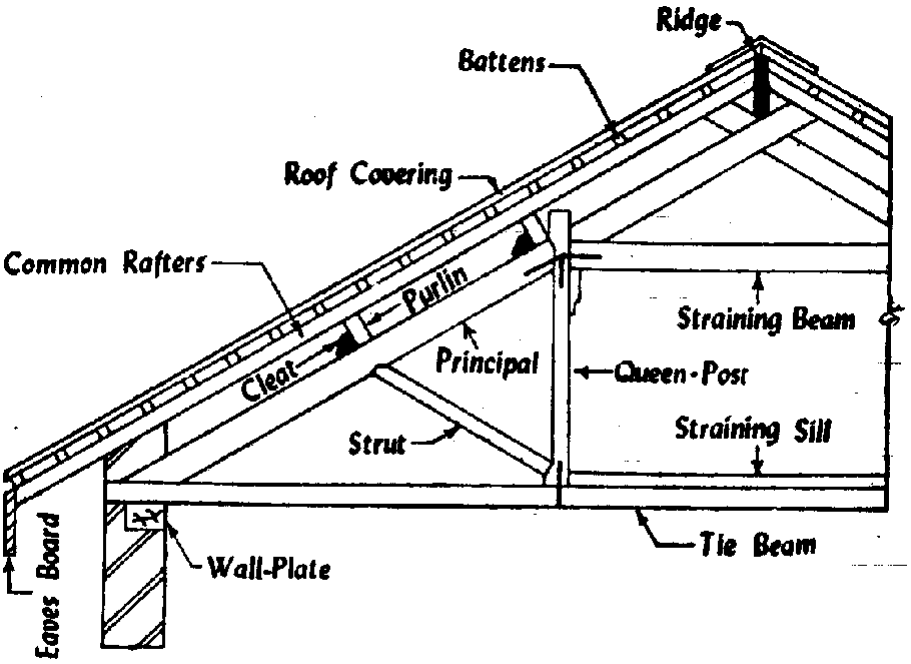


fig 13.9 Queen post truss

Mansard truss: this is a combination of king post and queen post trusses. Lower queen post & upper king post trusses. Useof mansard trusses results in the economy of space and room may be provided in the room as shown in the fig 13.10.

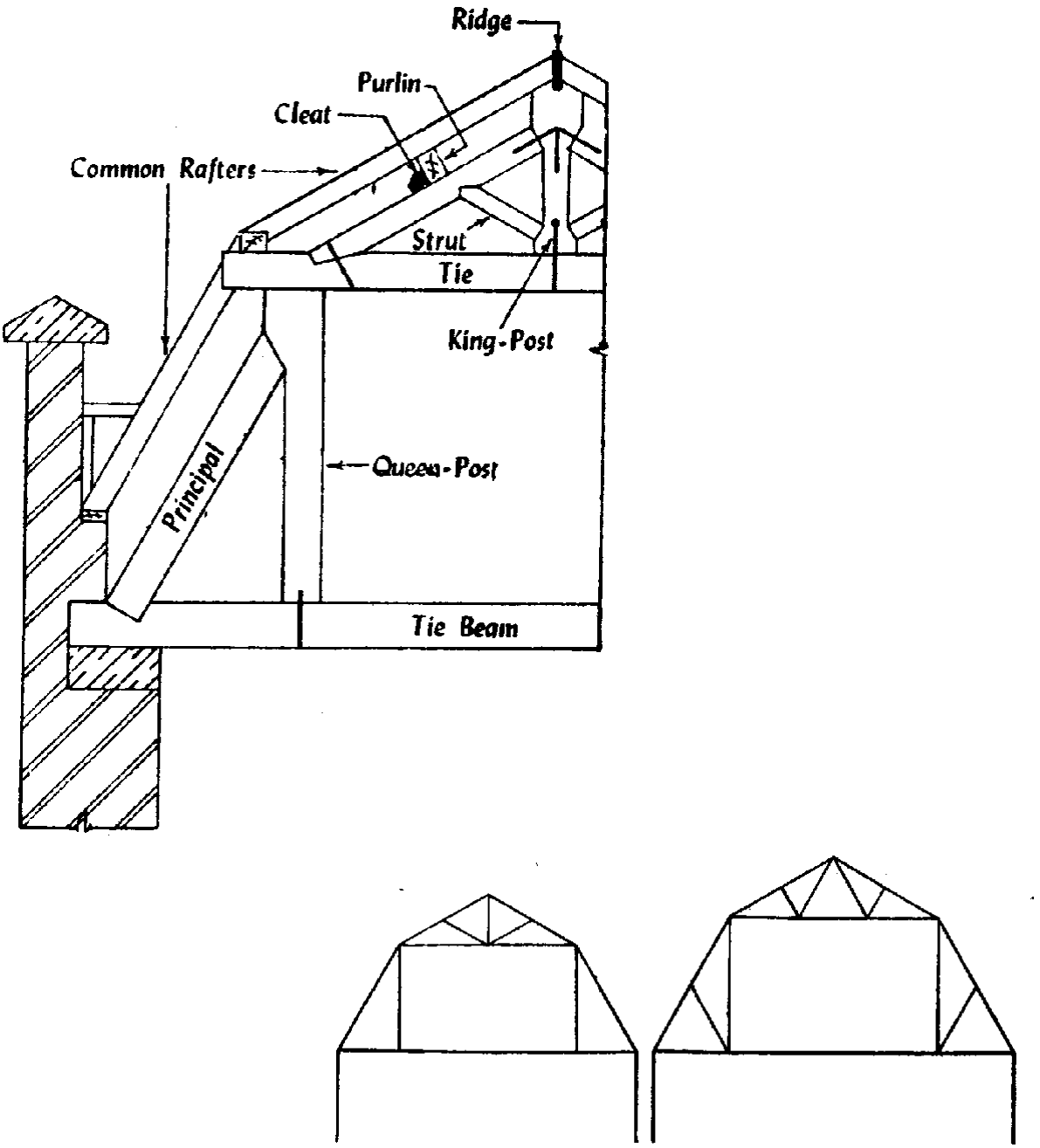
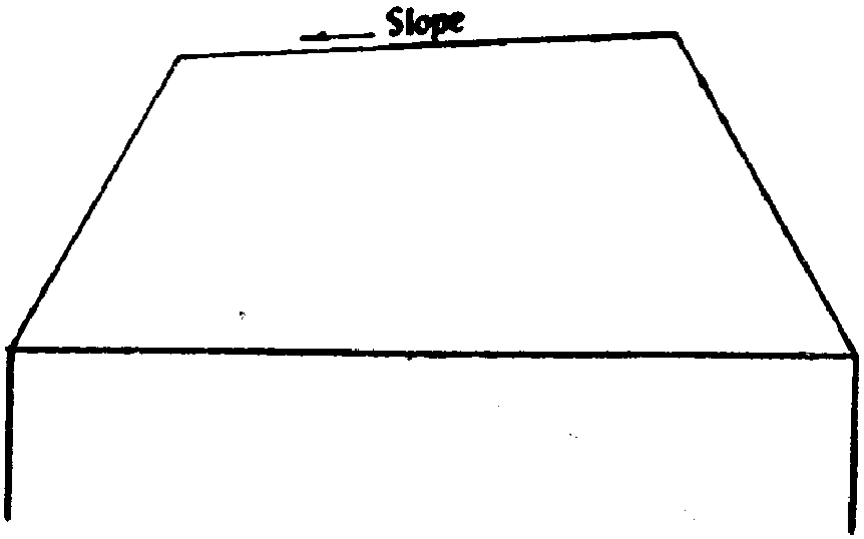
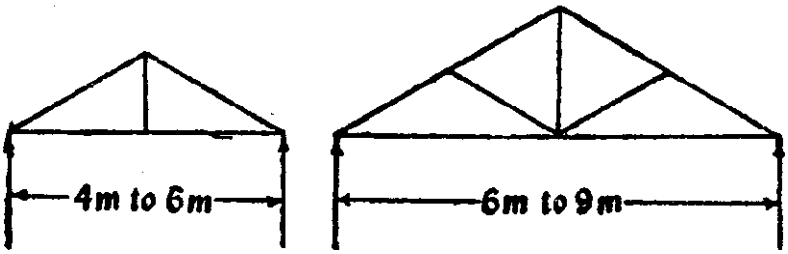


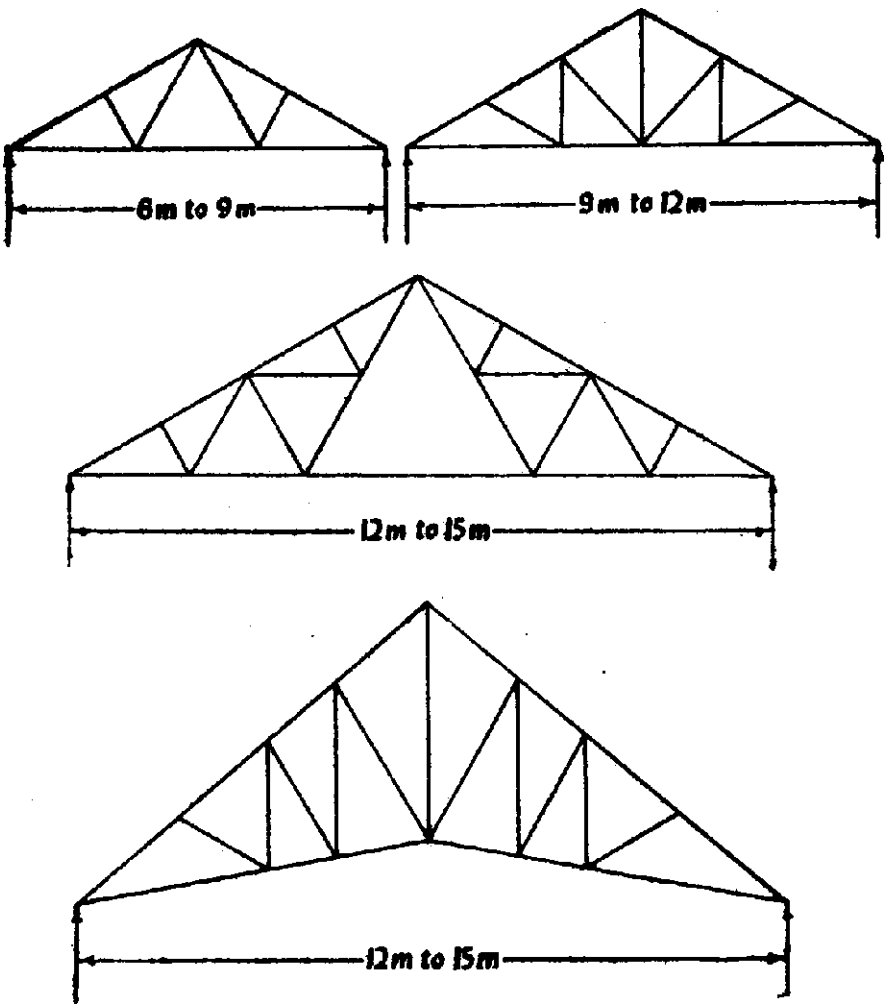
Fig 13.10 Mansard truss

Truncated truss: This is similar to mansard except that the topis finished flat as shown in fig 13.11.
Fig 13.11 Truncated truss
Steel trusses: For spans greater 12m, it becomes economical to use steel trusses. For smaller spans, steel trusses



consists ofangles riveted or welded together through plates known as gusset plates. As steel resists both compression and tension stresses, the design of steel truss is simplified various types ofsteel trusses are shown in fig 13.12.




6m to 9m
9m to 12m
12m to 15m
12m to 15m

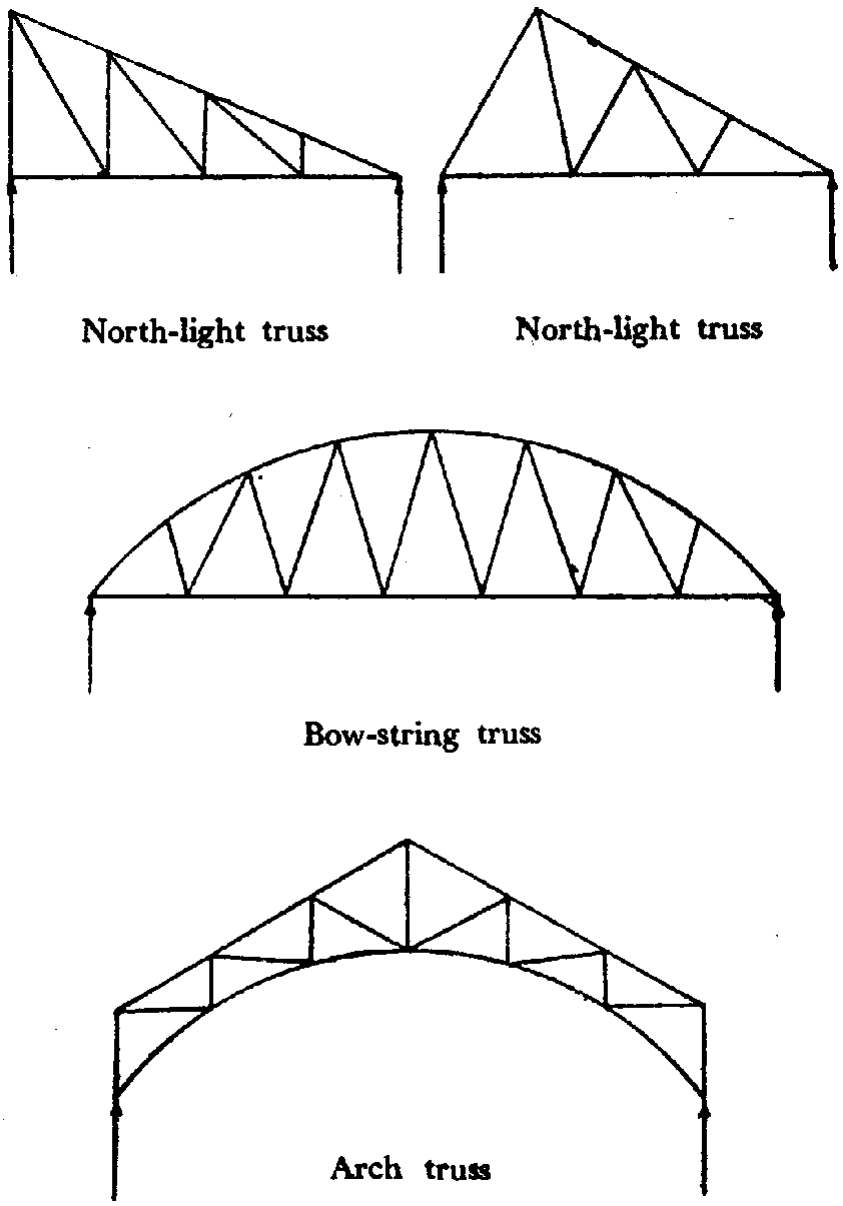


Fig 13.12 Steel trusses

Composite stress: This truss composed of wooden members and steel. Steel members resists tension. A composite truss is light and economical as shown in the fig 13.13.

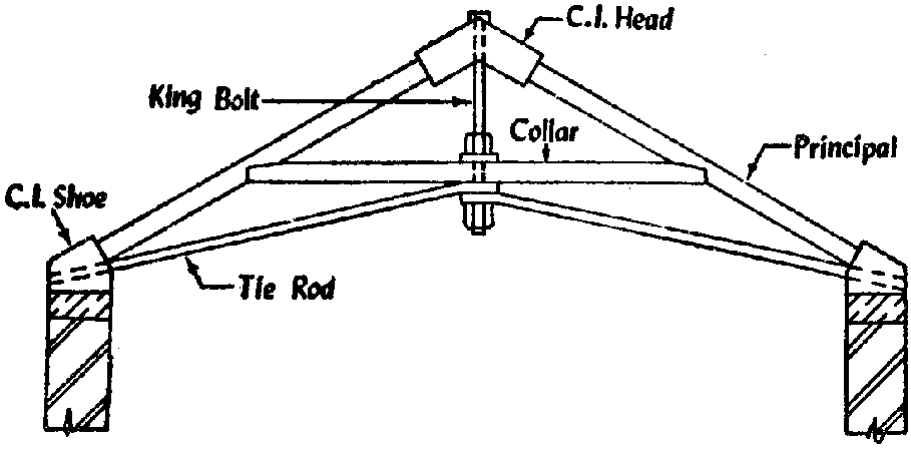


Fig 13.13 Composite stress
The factors should be considered before selecting the type of roofcovering for pitched roof

Climate of the locality

Nature of the building (iii)Initial cost and maintaince cost(iv)Resistance to fire and heat
(v) Special features of the locality.

Flat Roofs: A roof which is nearly flat is known as flat roof. It should be noted that no roof can be laid perfectly level. The roof must slope in one direction or the other to cause rain water toflow off rapidly and easily. The construction of flat roof is same asthat of floors except that the top surface is made slightly.

Sloping in case of flat roofs. The types of flat roofs commonlyused are

Madras terrace roof

Bengal terrace roof

Madras Terrace Roof: Procedure of construction:
Teak wood joists are placed on rolled steel joists with a furring piece between the joists and rolled steel joists.
The furring is placed sloping and gives necessary slope to the flat roof
A course of specially prepared terrace bricks of 150x75x25mm is laid diagonally across the joists with lime mortar
After the brick course, has set, a course of brick bat concrete of 75mm thick with 3 parts of brick bats, one part of gravel and sandand 50 percent of lime mortar by volume is laid.
The concrete is well rammed for three days and allowed to set

Flat tiles are laid over the layer of concrete of thickness 50mm

Finally, the surface of roof is finished with three coats of plastergiven a slope of 1 in 30.
As this type of flat roof is widely used in madras state, it is knownas madras terrace roof as shown in fig 13.14.

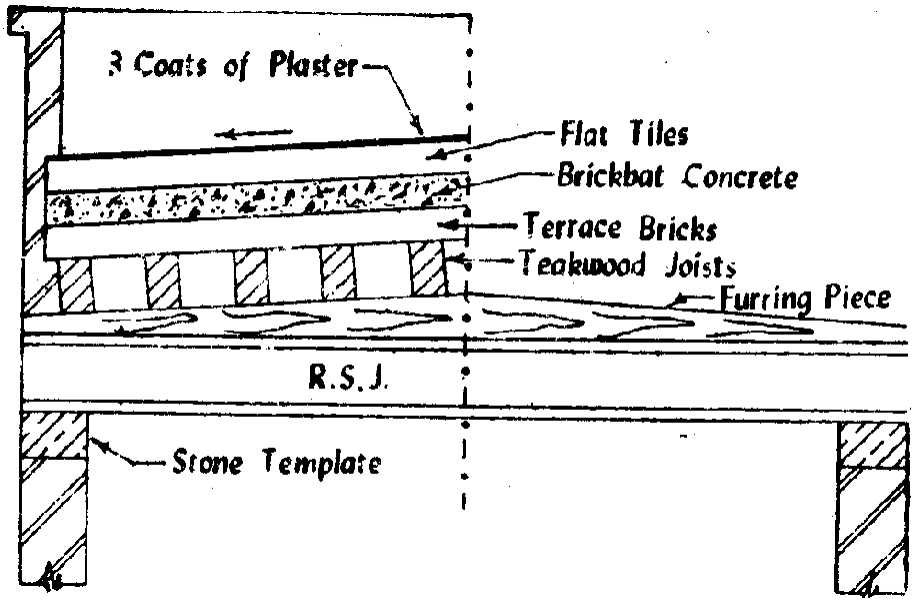


Fig 13.14 Madras Terrace Roof

Bengal terrace roof: Procedure of construction:

Rafters are placed, with a slight inclination, at 30cm to 50cm c/c. one end of the rafters is inserted into the main wall to a depth of 20cm and its other end is supported on a verandah wall.

Battens are placed at right angles to the rafters at a centre to centre distance of about 15cm

A course of flat tiles is then laid in mortar over the battens.

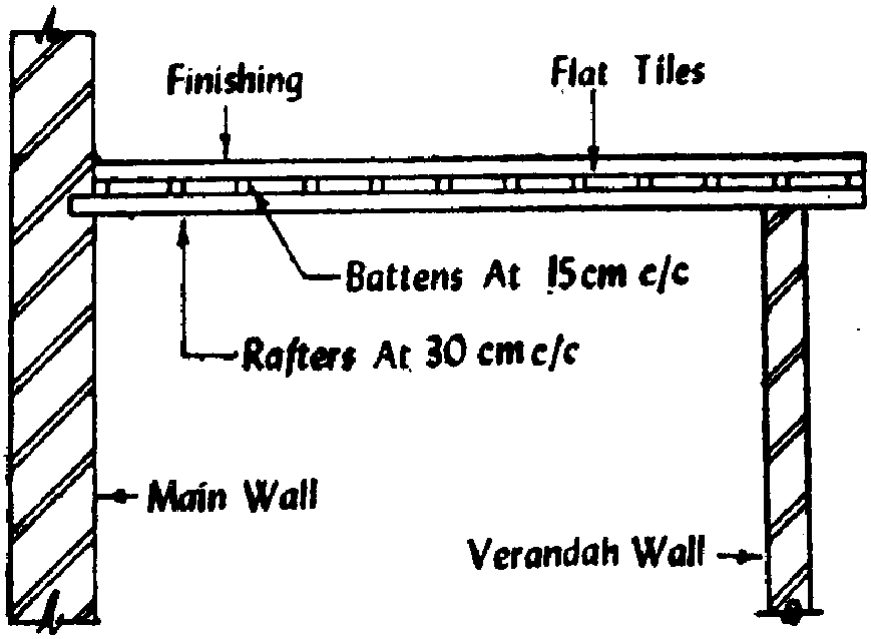
Finally, the surface of the roof is finished in any one of the following methods

Two or more courses of flat tiles may be laid and thesurface of roof is rubbed and polished with two or three coats of plaster

A layer of jelly concrete of 40mm thick may be laid over the first course of files. On this layer of concrete, another course of flat tiles is laid and the surface of roof is rubbed and polished with two or three coats ofplaster As this type of roof is mainly used in Bengal state to cover verandahs, it is known as Bengal Terrace roof as shown in fig13.15.

Fig 13.15 Bengal Terrace roofAdvantages of flat roofs:

The construction of roof is simplified



It is easier to make a flat roof fire-proof than asloping roof

The roof are can be utilized as roof garden, dryling yards and conveniently be used for sleeping in hot season.
The construction of work of upper floors can beeasily started where as pitched roof, the entire roofis to removed and is to be replaced by a new floor under such circumstances
Flat roofs is found to be economical than pitched roof.
Disadvantages
Flat roofs cannot be used for long spans without introduction ofintermediate pillars and beams
Cracks are developed on the surface of the roof due to thevariation in temperature
Pockets of water are formed on the surface of the roof if slope isnot sufficient and leads to leakage of roof
Flat roofs are not suitable, where rainfall is heavy
The dead weight of flat roof is considered and hence it proves tobe more expensive, Initial cost is higher than pitched roof.

Curved roofs: These are the just the modifications of pitched roofs and are frequently employed in modern age to cover large areas shed/roofs and domes are the varieties of curved roofs.They are useful for big structures such as factories, monumental works etc curved roofs may be constructed of timber or R.C.C. the latter material being very common now-a-days. They are two common forms of a shell roof

A north-light shell roof
A barrel vault shell roof are as shown in fig13.16 & 13.17

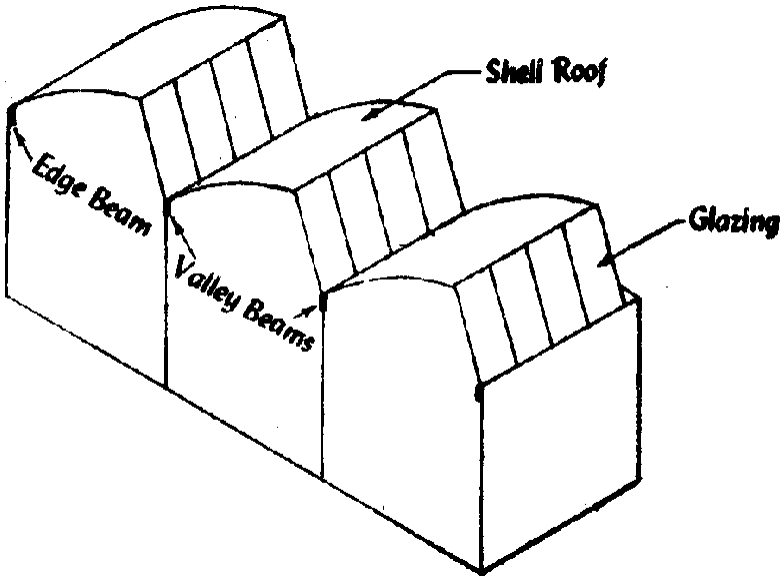


Fig 13.16 North-light shell roof

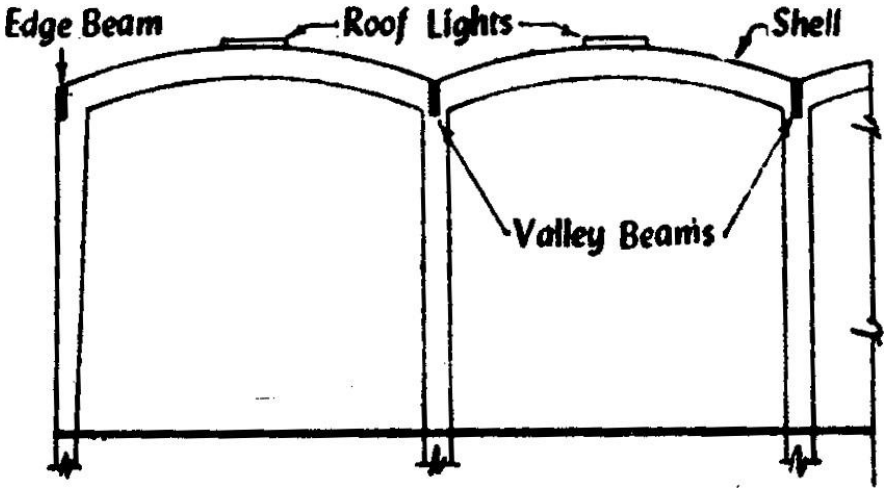


Fig 13.17 Barrel vault shell roof
A dome is a round vault forming a roof. It is useful when roof is tobe provided on circular brick work or regular polygon shaped walls .

Curved roofs afford pleasing appearance and due to arch action, the stresses are considerably reduced which results in thin sections for a curved roof.

Procedure of construction

Pre-cast units of cement concrete tilis of size 70 x 70cm witha uniform minimum thickness of 20mm in the form of domes with a rise of about 50mm are used

Pre-cast units of R.C.C. 1:2:4 beams are prepared as perdesignusually 90mm deep and 130mm wide as per design usually 90mm deep and 130mm wide

The beams are suitably laid across the supporting walls

The tiles are placed in position after spreading some mortar on the edges of beams. The minimum bearing of tiles on beamsshould be 25mm and that on walls should be 50mm to 70mm

The haunches between the humps of tiles are filled up with cement concrete of proportion 1:2:4

Suitable water-proofing treatment to the roof is given at the top. The roof thus exhibits a flat surface at the top and curved surface at bottom.

Advantages

It can be constructed in short time

It does not require skilled supervision

It is cheap in construction

It requires less frame work

* * *

SHORT ANSWER QUESTIONS
Define roof.
What are the categories of roof?
Define common rafter.
What are the types of pitched roofs?
What are the advantages of flat roofs?
What are the advantages of curved roof?
Name the different types of single roofs.
What are the types of trussed roofs?
What is king post and queen post trusses?

ESSAY TYPE QUESTIONS
What are the requirements of a well planned roof?
Explain the classification of roofs briefly.
Explain types of single roofs.
Explain king post and queen post truss.
Explain the construction of flat roof of madras terrace roof
Explain the construction of flat roof of Bengal terrace roof.
Explain the advantages and disadvantages of flat roofs.
Explain briefly about curved roofs.

* * *

STAIRS

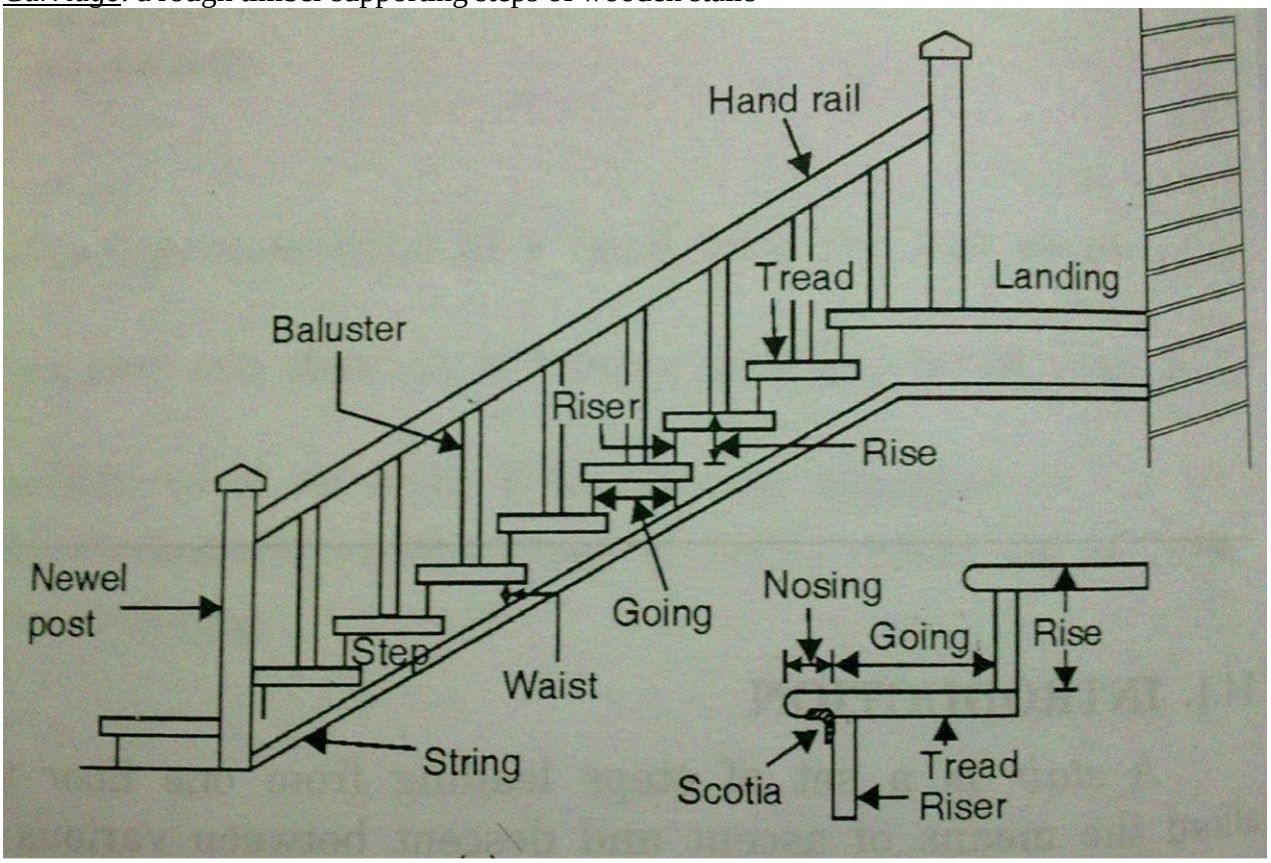
The means of communication between various floors is offered by various structures such asstairs, lifts, ramps, ladders, escalators.
STAIR: A stair is a series of steps arranged in a manner as to connect different floors of abuilding. Stairs are designed to provide an easy and quick access to different floors.
A staircase is an enclosure which contains the complete stairway.
In a residential house stairs may be provided near the entrance.

In a public building, stairs must be from main entrance and located centrally.STAIRCASE: Room of a building where stair is located.
STAIRWAY: Space occupied by the stair.

TECHNICAL TERMS

BALUSTER: Vertical member which is fixed between stairway and horizontal to providesupport to hand rail.
BALUSTRADE: Combined framework of baluster and hand rail.
STRING: Inclined member of a stair which supports ends of steps. They are of two types,
cut/open string, (ii) closed/housed string.
In open string, upper edge is cut away to receive the ends of steps.
In closed string, the ends of steps are layed between straight and parallel edges ofthe string.
FLIGHT : Unbroken series of steps between the landings.
GOING: horizontal distance between faces of two consecutive risers.
HANDRAIL: inclined rail over the string. Generally it is moulded. It serves as a guard rail. It is provided at a convenient height so as to give grasp to hand during ascent and descent.
HEAD ROOM: vertical distance between nosingsof one flight and the bottom of flight immediately above is called head room.
LANDING: horizontal platform between two flights of a stair. A landing facilitates change of direction and provides an opportunity to take rest.
NEWEL POST: vertical member placed at ends of flights to connect ends of string and hand rail.
NOSING: projection part of tread beyond face of riser.
LINE OF NOSING: imaginary line parallel to strings and tangential to nosings. The underface of hand rail should coincide with line of nosing.
PITCH: angle of inclination of stair with floor.
Angle of inclination of line of nosing with horizontal.
RISE: vertical distance between two successive treads.
RISER: vertical member of the step, which is connected to treads.

RUN: length of a stair in a horizontal plane which includes length of landing.
SCOTIA: an additional finish provided to nosing to improve the elevation of the stepwhich also provides strength to nosing.
SOFFIT: under surface of a stair. Generally it is covered with ceiling or finished withplaster.
STEP: combination of trade and riser. Different types are.
Commode steps: it has curved riser and tread
Dancing step: they don't radiate from a common centre
Flier: ordinary step of rectangular shape in plan
Round ended step: similar to bullnose step except that its ends are sem-icircular in plan
Splayed step: it has either one end/both ends splayed in plan
Winder : this is a tapering step and is used to change the direction of aflight. The winders radiate from a common centre.
Tread: horizontal upper portion of a step.
Waist: thickness of structural slab in RCC stair
Carriage: a rough timber supporting steps of wooden stairs



REQUIREMENT OF GOOD STAIRCASE

Stairs should be so located that it is easily accessible from the different rooms of abuilding.
It should have adequate light and proper ventilation.
It should have sufficient stair width to accommodate no. of persons in peakhour/emergency.
Generally for interior stairs, clear width may be
at least 50cm in one/two family dwellings
at least 90cm in hotels, motels, apartment and industrial building
at least 1.1m for other types like hospitals, temples etc.
No. of steps in a flight should be restricted to a maximum of 12, minimum of 3.
Ample head room should be provided for tall people to give feeling of spaciousness. Itshould be minimum of 2.15m.
Risers and treads sizes should be provided from common point view.Tread = 2.5cm – 32.5 cm (wide), excluding nosing.
Tread < 25cm, should have a nosing of about 2.5cm

Comfortable height of riser = 17.5cm-18.5cm.

Riser * tread = (400-410). 426
Riser + tread = (42.5-43.5) 40-45
2(riser) + tread = 60-64 cm 60

Take rise = 14cm, going = 30cm.for each 2cm substracted from going, add1cm to rise.

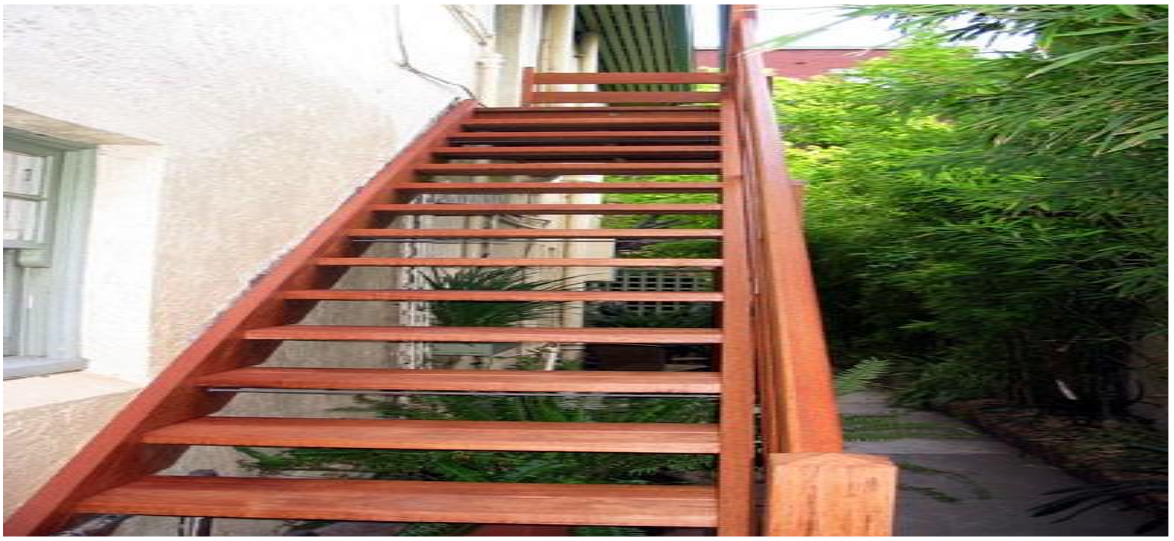
Stair width depends on purpose and importance of building.
No. of stairways required should be controlled by maximum floor area contributory tostairway.
(No. of persons using stairs/floor/55cm stairwidth)should be 15 for hospital and nursing home.
Should be 30 for institutional and residential buildingShould be 45 for storage building
Should be 60 for mercantile, educational, industrial building, theatres, restaurants.Should be 80 for church concert hall, museum
Should be 320 for stadium and amutementstructures.

Minimum width of landing = width of stair
Maximum and minimum pitch should be 40^0 and 25^0.
Winder should be provided at lower end of flight when it is essential. Use of winder should be avoided.
Live load to be considers n stairs have been stipulated by IS 875-1964
Stairs and landings should be designed for live load of 3000kg/m.s2 in building where there are no possibilities of overcrowding in public building and warehouses where overcrowding is likely live load may be taken as 500kg

Railing should be design for horizontal force of 55 and vertical force of 70 applied at top of rail

TYPES OF STAIRS

Straight stair:
Here there is no change in the direction of any flight between two successivefloors.
It can be straight run with a single flight between floors or a series of flightswithout change indirection
Parallel stairsAngle stairs Scissors stair
Straight stair can have a change in direction at any intermediate landing.
In parallel stair, there is complete reversal of direction occurs.
In angle stair, successive flights are at an angle to each other.
Scissor stairs are comprised of a pair of straight runs in opposite direction and areplaced on opposite sides of a fire resistive wall.



Turning stairs:

Quarter turn stair :

Provided where flight direction is to be changed by 90^0

Change in direction can be affected by either introducing a quarterspace landing or by providing winders at junctions.

Half turn stair:

They change their direction through 180^0. They can be dog legged andopen newel.

In doglegged stair, flights are in opposite direction and no space isprovided between the flights.

In open newel stair, there is a well/opening between flights and may beused to accommodate lift.

Open newel stairs are used at places where sufficient space isavailable.

Three quarter turn stair:

They change in the direction through 270^0 or direction is changed withits upper flight crossing the bottom one.

In this type an open well is formed.

Circular stair:

When viewed from above, appear to follow a circle with a single centre ofcurvature and large radius.

Generally they are provided at the rear of a building to the access for servingat various floors.

All the steps radiate from a newel post in the form of winders.

Made up of stone,cast iron/RCC.

Spiral stairs:

Similar to previous one except that the radius of curvature is small and thestair may be supported by a centre post.

Over all diameter range from 1-2.5m

Curved stair:

When view from above appear to follow a curve with 2 or more centre ofcurvature, such as ellipse.

Geometric stair:

They have no newel post are of any geometric shape.

The change in direction is achieved through winders.

They needs more skills for its construction and are weaker than open newelstairs

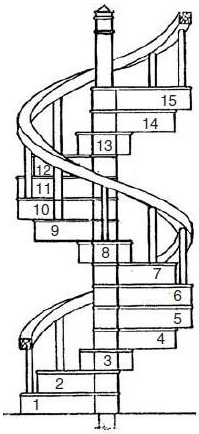
Here the open well between forward and backward flights is curved.

Bifurcated stair:

So arranged that there is a wide at the start and subdivided into narrow flightsat mid landing.

The two narrow flights start from either side of mid landing.

They are suitable for modern public buildings.



Spiral stairs

CLASSIFICATION OF STAIRS BASED ON MATERIALS OF CONSTRUCTION

General materials used in construction of stairs are

Wooden
Stone
Brick
Metals/steel
Plane concrete
RCC

Wooden stair

As they are light in weight, mostly used for residential building.
The main objection to this stair is that it is easily attacked by fire andthus, in fire, the occupants of upper floor can't escape.
If it is made from good timber like Teak, and thickness is about 45mm,it becomes sufficiently fire proof and allows enough time for occupantson upper floor to escape.
Factors to be considered here are,

The string supporting ends of wooden steps may be a cutstring/closed string.
Scotia blocks may be provided to give additional finish towooden steps.
Small triangular wooden blocks called glue blocks may be provided at inner angle formed between a trade and riser, toprovide additional strength.
A metal strip may be provided on nosing of wooden step toincrease its resistance against wear and tear.
The landing may be formed by providing wooden beams ofsuitable sizes.
Sometimes risers are omitted. trades are housed in strings andsoffit is covered with wooden battens/metal sheets.
The timber used should be free from fungal decay, insect attack, or any defect. Edges may be finished smooth and excesslight timber should not be used.

Metal Stair

They are not frequently/commonly used stairs.
The external fireescape stairs are generally made of metal.
Common metals are CI, bronze, and mild steel.
Widely used in factories, workshop, and godowns.Main features are,
Stringers are usually of channel section
Tread and riser of a step may be of one unit or may notbe

RCC Stair

Tread and risers are supported on angles, which areconnected to stringers.
Risers may be totally omitted.
Spirals stairs of CI consists of CI newel fixed in centeraround which the CI stepsare fixed.
For metal stairs metal balusters with pipe handrail areused.

Commonly used in all type of construction.
They resist better fire and wear than any other material andcan be moulded to desiredshape.
The step can be provided with suitable finishing material suchas marble, terrazzo, tilesetc.
They can be easily maintained, strong, durable and pleasing inappearance.
They can be designed for greater widths and layer spans.
The steps may cast in situ/pre cast.
It is possible to pre cast a flight and place it in position byequipm

chapter-5

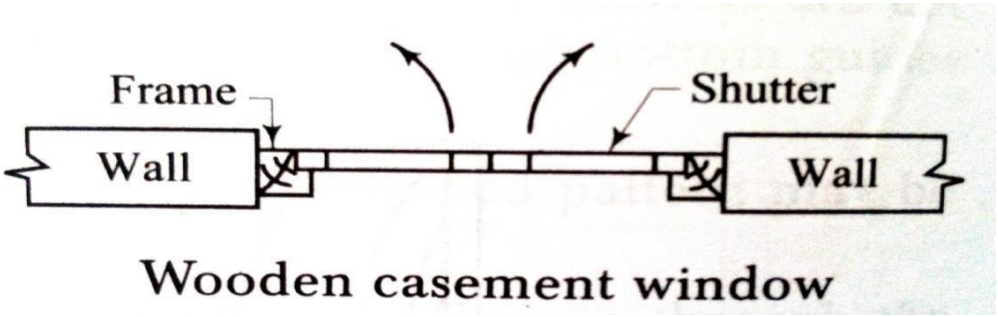
DOORS AND WINDOWS AND LINTELS

TYPES OF WINDOWS

Depending upon the manner of fixing, materials used for construction, nature of the operationalmovements of shutters , etc., the common varieties of windows used in the building can be grouped as follows:
Casement windows
Sliding windows
Metal windows
Corner windows
Gable windows bay windows
Lantern or lantern lights
Skylights

CASEMENT WINDOWS:

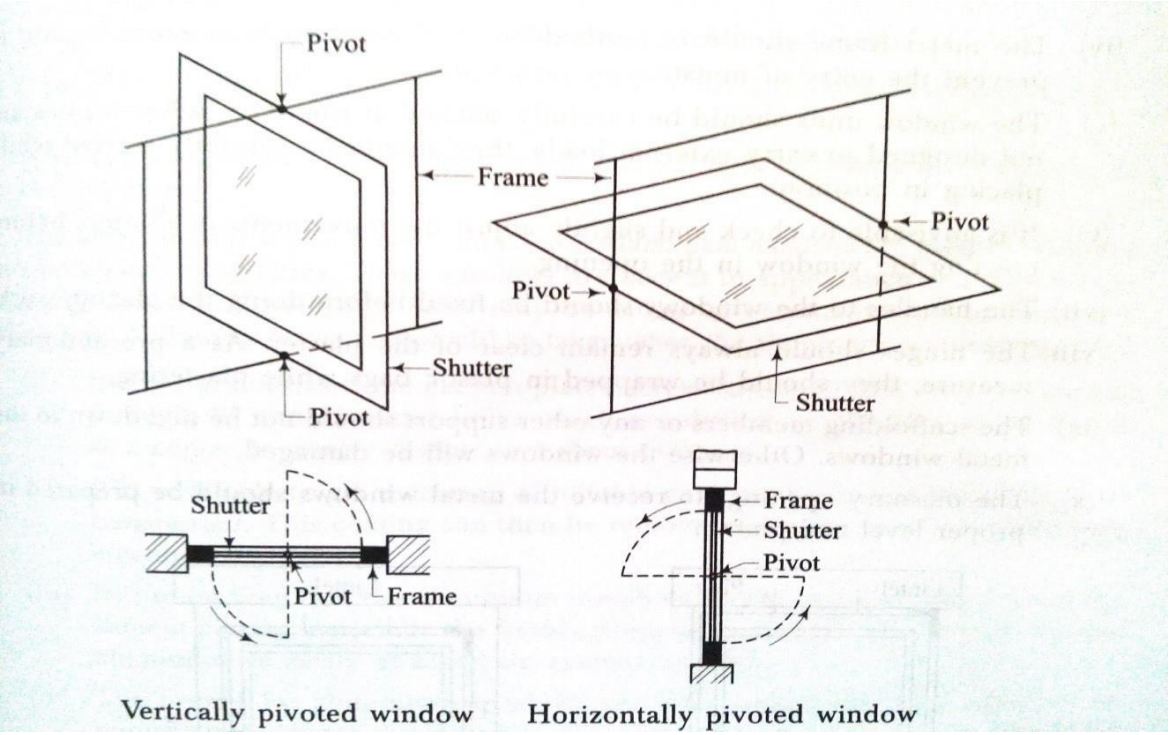
These are the windows, the shutters of which open like doors. The construction of acasement window is similar to the door construction.



Wooden casement window

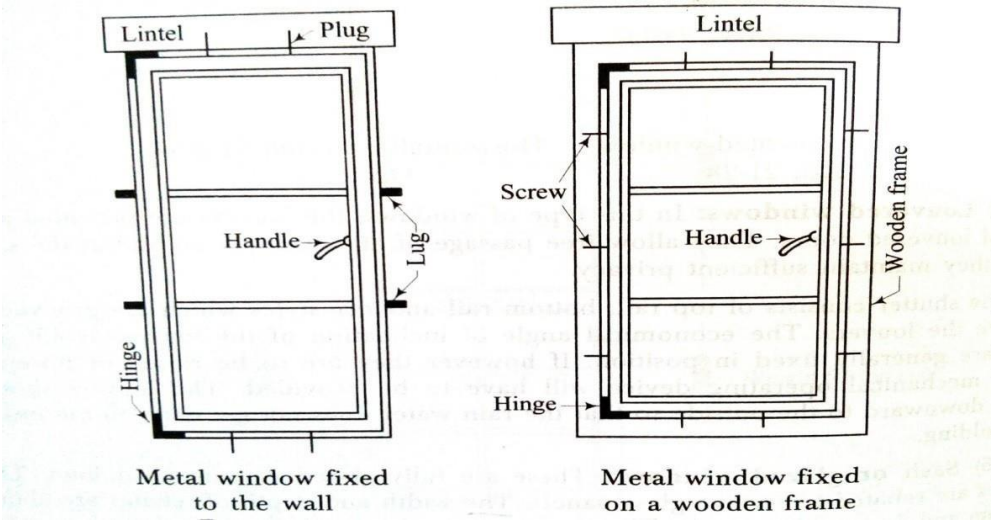
SLIDING WINDOWS:

These windows are similar to the sliding doors and the shutters moves on the roller bearings, either horizontally or vertically. Such windows are provided in trains, buses, bank counter, shopsetc.



METAL WINDOWS:

These are now a days widely used, especially for public building. The metal used in constructionmay be mild steel, bronze, or other alloys. The metal frame may be fixed direct to the wall or it may be fixed on a wooden frame.

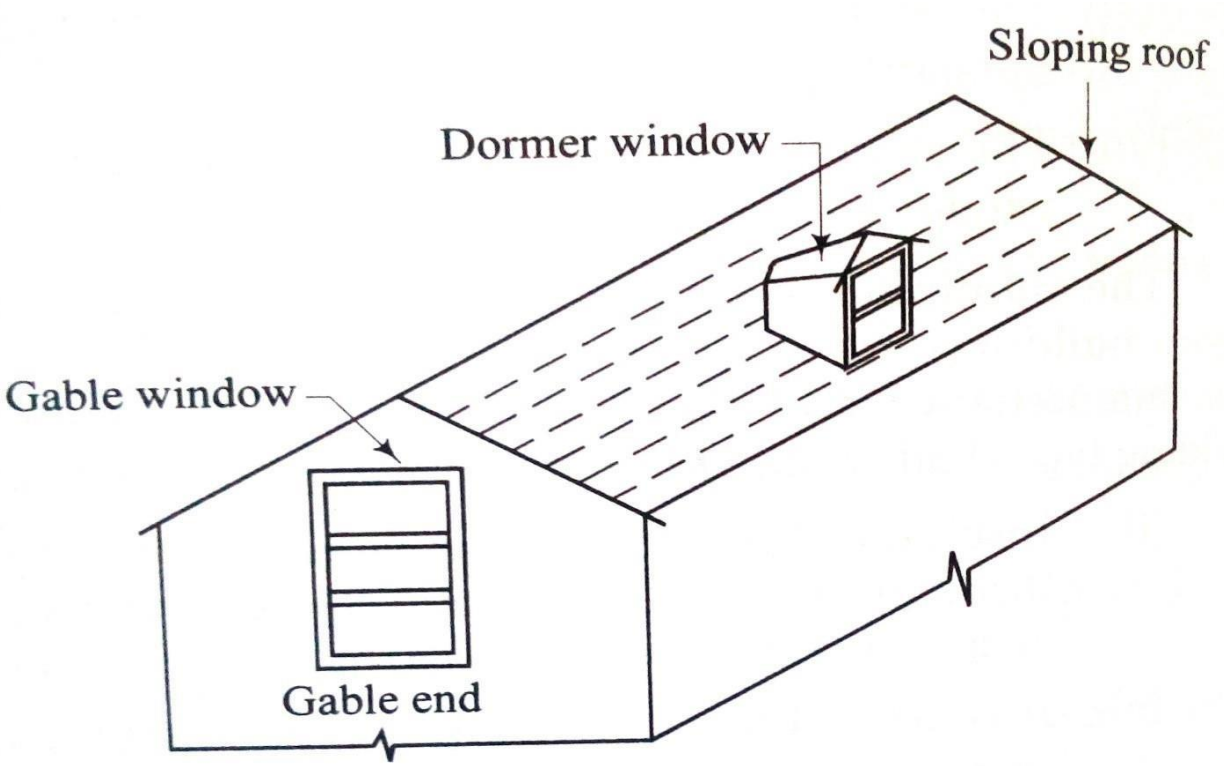


CORNER WINDOWS:

These windows are provided at the corner of a room .They are placed at the corner of the room and thus they have two faces in two perpendicular direction. Due to such situation,there is entry of light and air from two direction and in many cases , the elevation of building is also improved.

GABLE WINDOWS:

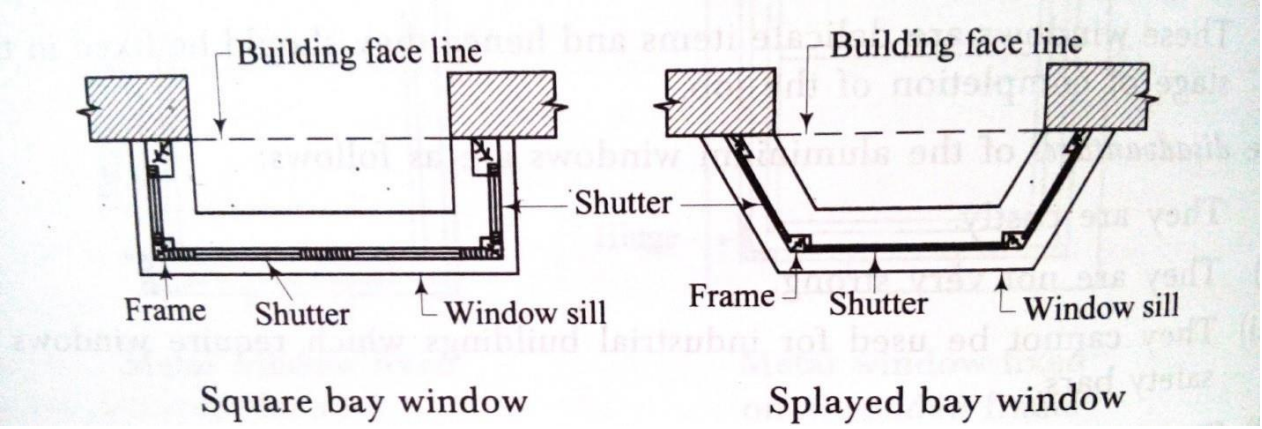
These are the windows which are provided in the gable ends of a roof.



Gable window and dormer window

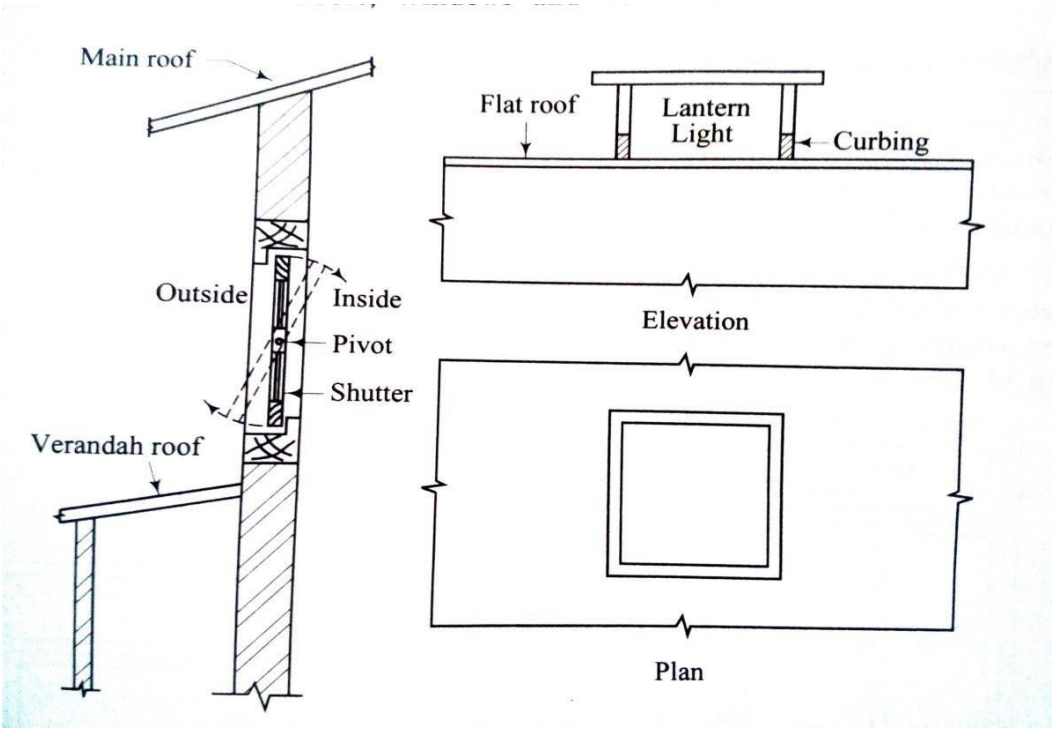
BAY WINDOWS:

These windows project outside the external wall of a room. They maybe square , splayed, circular, polygonal or of any shape. The projection of bay windows may start from floor level orsill level. These windows admit more lights, increase opening area , provide ventilation and improve the appearance of building.



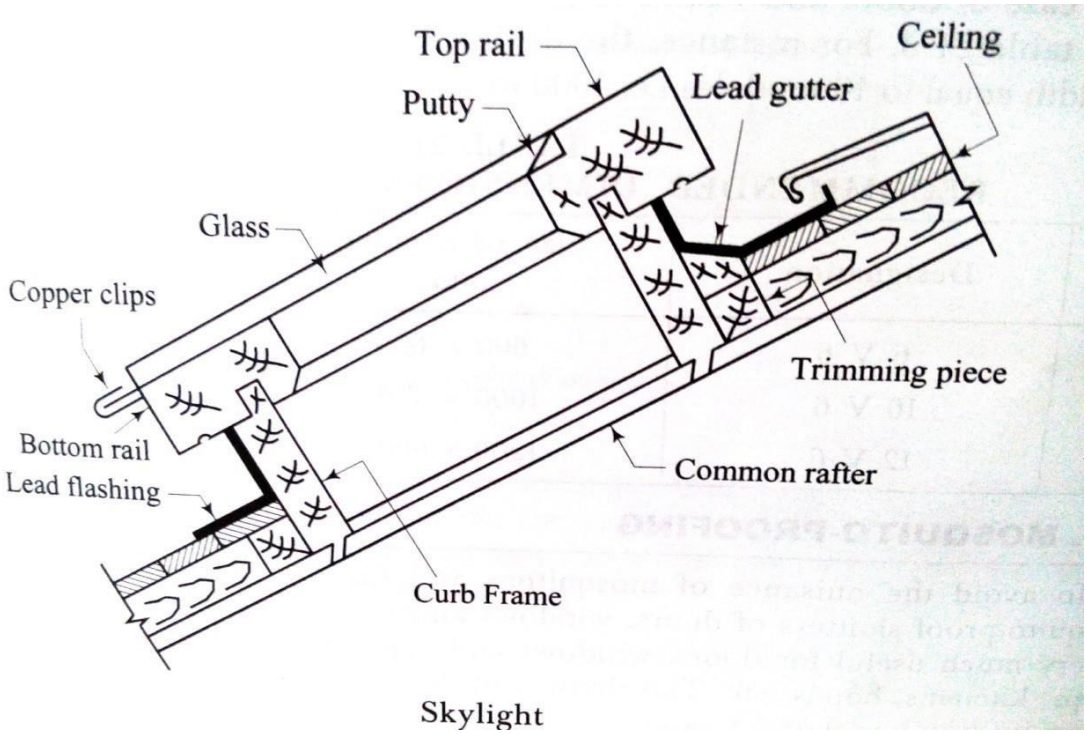
LANTERNS:

These are the windows which are fixed on flat roofs to provide light to the inner portion ofbuilding where light coming from external windows are insufficient. They maybe square orrectangular or curved.



SKYLIGHTS:

these are the windows which are provided on the sloping surface of a pitched roof. The commonrafter are suitably trimmed and the skylight is erected on a curb frame. As skylight are mainly meant for light, they are usually provided with the fixed glass panel.



Skylight

TYPES OF DOORS

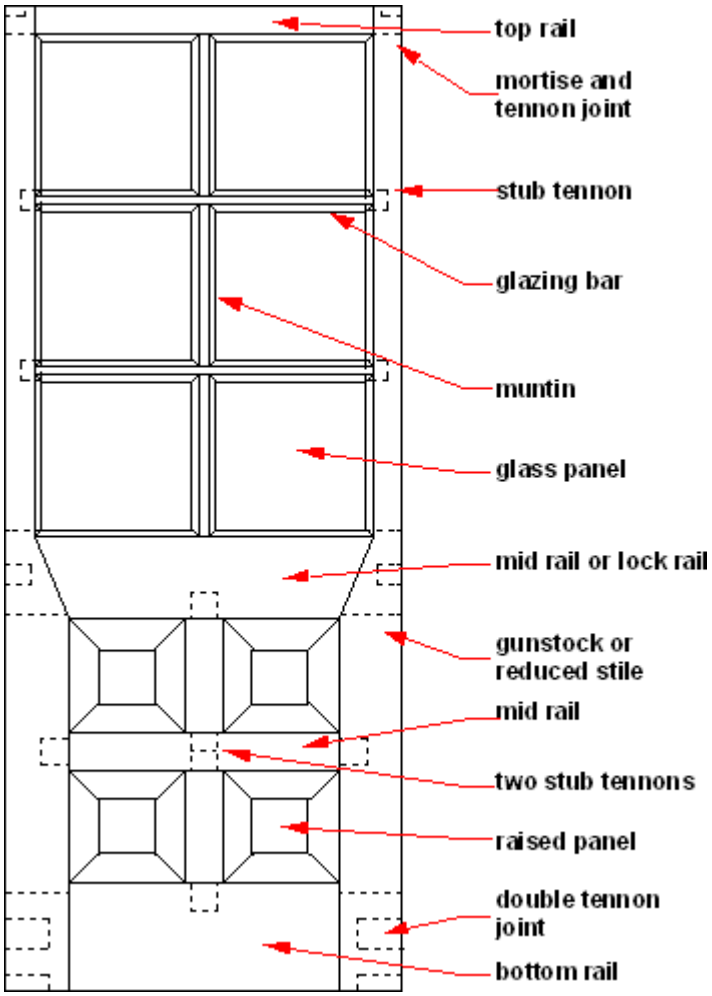
A door is a moving structure used to block off, and allow access to, an entrance to or within anenclosed space, such as a building or vehicle. Similar exterior structures are called gate.
Typically doors have an interior side that faces the inside of a space and an exterior side that faces the outside of that space. While in some cases the interior side of a door may match its exterior side, in other cases there are sharp contrasts between the two sides, such as in the case ofthe vehicle door. Doors normally consist of a panel that swings on hinges or that slides or spins inside of a space.

Panel doors:

Panel doors, also called stile and rail doors, are built withframeand panel construction.
EN 12519 is describing the terms which are officially used in European Member States. Themain parts are listed below:

Stiles - Vertical boards that run the full height of a door and compose its right and left edges. The hinges are mounted to the fixed side (known as the "hanging stile"), and thehandle, lock, bolt, and/or latch are mounted on the swinging side (known as the "latch stile").

Rails- Horizontal boards at the top, bottom, and optionally in the middle of a door that join the two stiles and split the door into two or more rows of panels. The "top rail" and"bottom rail" are named for their positions. The bottom rail is also known as "kick rail".A middle rail at the height of the bolt is known as the "lock rail", other middle rails are commonly known as "cross rails".
Mullions - Smaller optional vertical boards that run between two rails, and split the door into two or more columns of panels, the term is used sometimes for verticals in doors, butmore often (UK and Australia) it refers to verticals in windows.
Muntin - Optional vertical members that divide the door into smaller panels.
Panels - Large, wider boards used to fill the space between the stiles, rails, and mullions.The panels typically fit into grooves in the other pieces, and help to keep the door rigid. Panels may be flat, or in raised panel designs. Can be glued in or stay as a floating panel.
Light or Lite - a piece of glass used in place of a panel, essentially giving the door awindow.



Plank and batten doors:

Plank and batten doors are an older design consisting primarily of vertical slats:

Planks - Vertical boards that extend the full height of the door, and are placed side byside filling the door's width.
Battens - Smaller slats that extend horizontally across the door which the planks are affixed to. The battens hold the planks together. Sometimes a long diagonal slat or two are also implemented to prevent the door from skewing. On some doors, especially antique ones, the battens are replaced with iron bars that are often built into the hinges asextensions of the door-side plates.

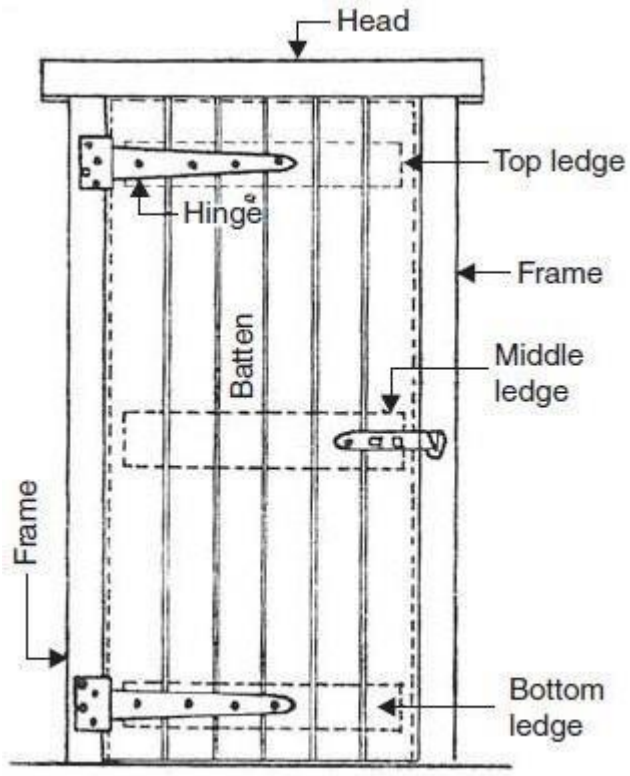
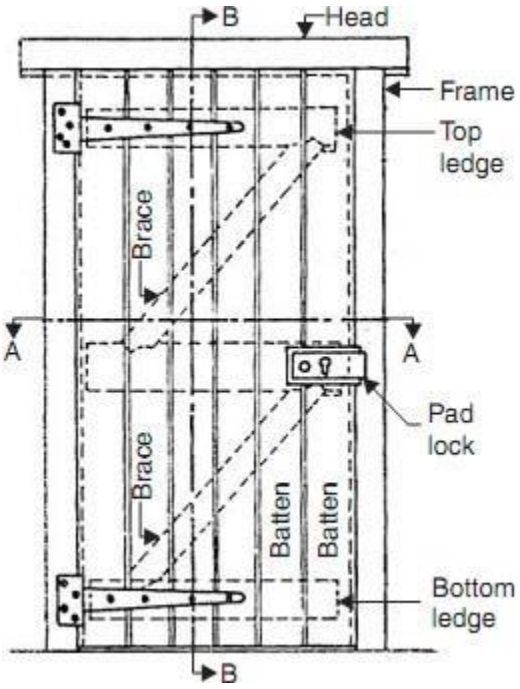


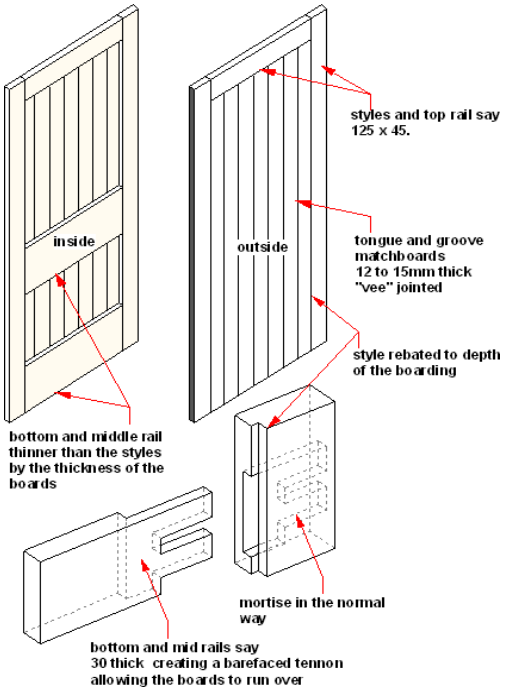
Fig. 8.21. Battened and ledged door

Ledged and braced doors:

This type consists of vertical tongue and grooved boards held together withbattens and diagonal braces.



Frame and filled doors:

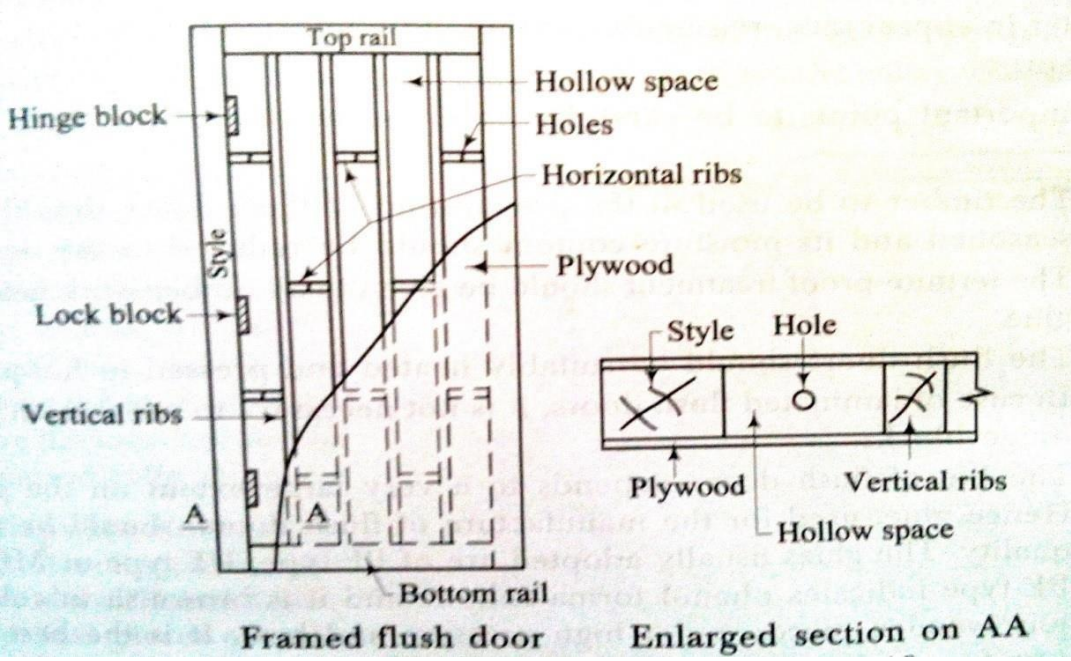


This type consists of a solid timber frame, filled on one face, face with Tongue and Groovedboards. Quite often used externally with the boards on the weather face.

Flush doors:

A flush door consists of a framework of rails and styles and it is covered with plywood. Thereare two varieties of flush doors

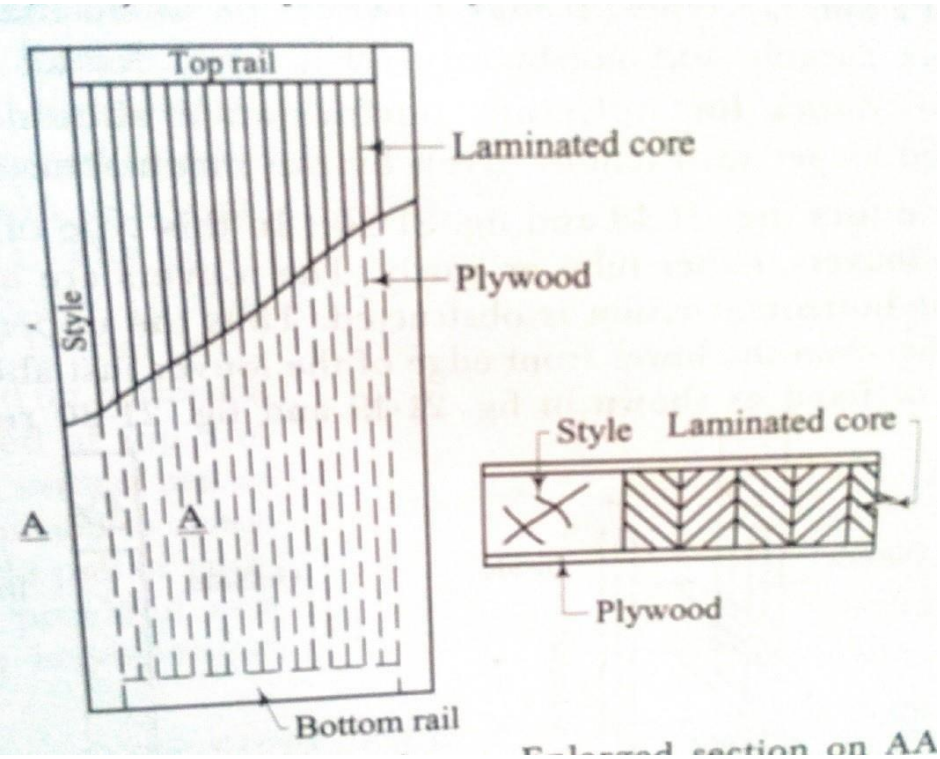
framed flush door :



It consists of styles, rails, horizontal ribs, vertical ribs, and plywood. As shown in fig.

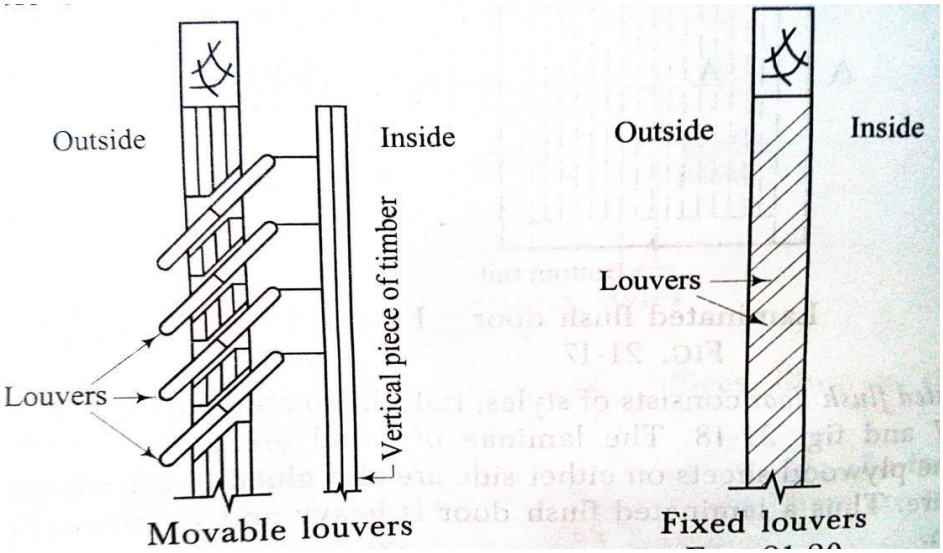
laminated flush door

It consists of styles, rails, laminated core and plywood as shown in fig.



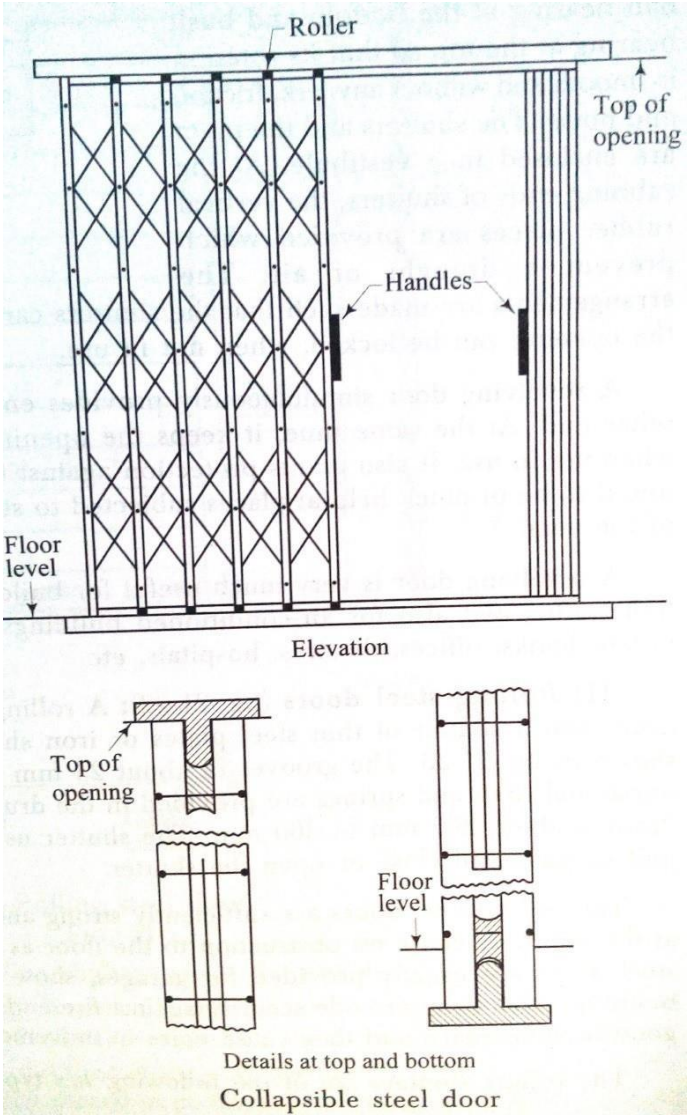
Louvered Doors:

In this type of doors, the shutters are provided with louvers, either fully or partly. The louvers arearranged at such an inclination that horizontal vision is obstructed. The louvers maybe movable or fixed as shown in fig.



Collapsible Steel Doors:

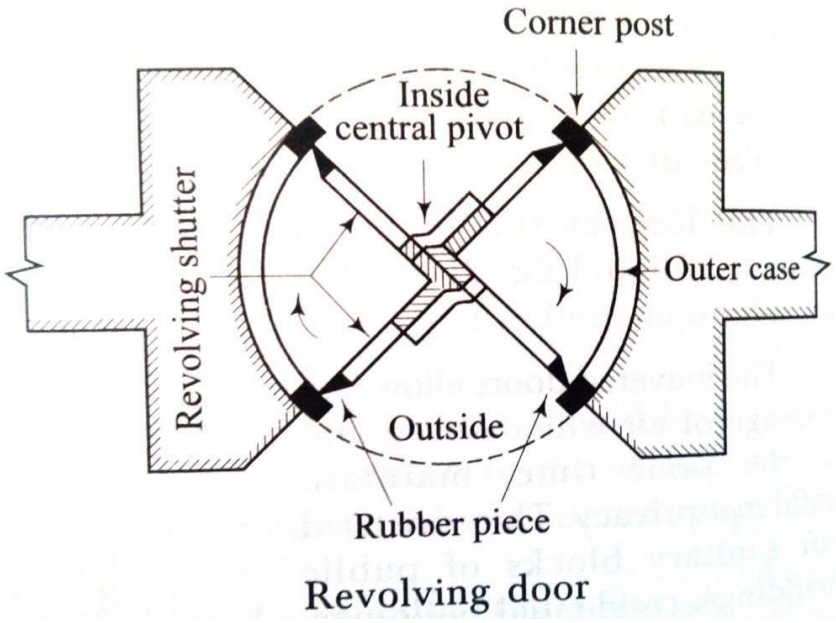
It consists of a mild steel frame. A collapsible steel door works without hinges and it is used for compound gates, residential building , schools, sheds, godowns , workshop, public building , etc.



Collapsible steel door

Revolving Doors:

It essentially consists of a centrally placed mullion in a circular opening revolving shutters whichare 4 in number are radially attached to pivot as shown in fig.



Revolving door

ARCHES

Arches are structural members used in a building to bridge across the opening of doors,windows, or cupboards etc. to support the weight of the superimposed masonry by arch action.
Arch action;-It consist of small wedge shaped units joint together by mortar.

But arches made of steel and Rcc are builtinsingle unit without the use of wedge shaped unitsand are used for bridge constructions.
Terms;-

Intrados:-the inner curve of arches

Soffit- Inner surface of arch

Extrados- Externalcurve of arch

Voussoirs-wedge shaped unit forming courses of an arch

Skewback- inclined surface of abutment.it is prepared to receive the arch

Springer - first voussoirs at springing level on either side of arch which is adjacent toskewback
Crown - highest point of extrados

Key - wedge shaped unit at crown of arch. It is made prominent by making it of larger sectionnad projected above and below the outline of arch.
Abutment - the end support of arch

Piers - intermediate support of an arcade.

Springing point- point from which curve of arch springs

Springing line- imaginary horizontal line joining 2 springing points

Span - clear horizontal distance between supports

Rise - clear vertical distance between highest point on intrados and springing line

Centre- geometrical centre of arch curve

Ring- circular course forming on arch

Depth or height- perpendicular distance between intrados and extrados

Spandril- irregular triangular shape formed between extrados and horizontal line drawntangent to crown
Haunch- the lower half portion of arch between crown and skewback

Arched - row of arches supporting a wall above and supported by piers

Thickness of soffit- horizontal distance measured perpendicular to the front and back face ofan arch
Impost - projecting course at upper part of a pier and abutment to stress the springing line.

The arch may be defined as a mechanical arrangements of wedge shaped blocks of stoneor bricks which mutually support each other and entire arch is supported at ends by piers or abutments. The wedge shaped units are so arranged together along a curve line that they balancetheir own weight by mutual pressure and exert a vertical pressure only which can be sustainedby support below.
Stability consideration

Stability of arches depends on friction between surfaces of voussoirs and cohesion ofmortar.
Stability of arches is endangered by

Crushing of arch material

Sliding of voussoirs

Rotation / overturning about an edge

Differential settlement of supports

To maintain the stability or equilibrium of arches, points to be noted
What is Lintel?
A lintel is a beam placed across the openings like doors, windows etc. in buildings to support the load from the structure above. The width of lintel beam is equal to the width of wall, and the ends of it is built into the wall. Lintels are classified based on their material of construction.
Horizontal lintels are easy to construct as compared to arches.
Bearing of Lintel
The bearing provided should be the minimum of following 3 cases.
10 cm
Height of beam
$1/10^{th}$ to $1/12^{th}$ of span of the lintel.

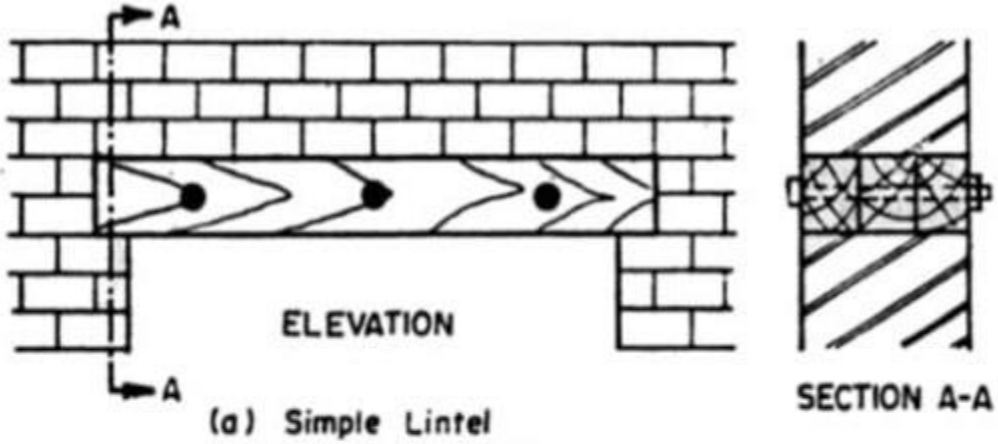
Types of Lintel used in Building Construction

Lintels are classified based on the material of construction as:

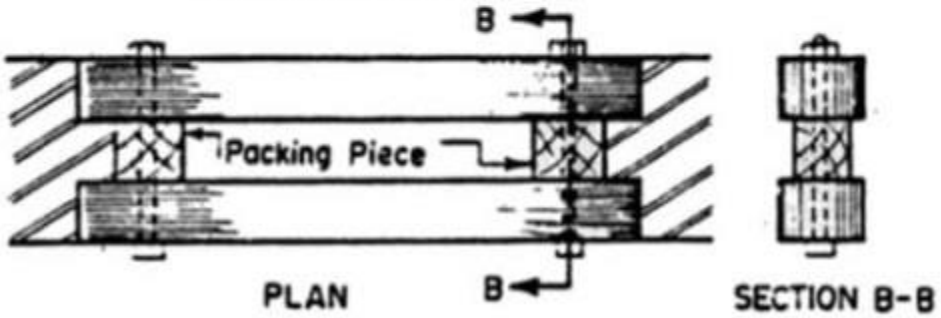
1. Timber Lintel

In olden days of construction, Timber lintels were mostly used. But now a days they are replaced by several modern techniques, however in hilly areas these are using. The main disadvantages with timber are more cost and less durable and vulnerable to fire.

If the length of opening is more, then it is provided by joining multiple number of wooden pieces with the help of steel bolts which was shown in fig (a). In case of wider walls, it is composed of two wooden pieces kept at a distance with the help of packing pieces made of wood. Sometimes, these are strengthened by the provision of mild steel plates at their top and bottom, called as flitched lintels.



(a) Simple Lintel

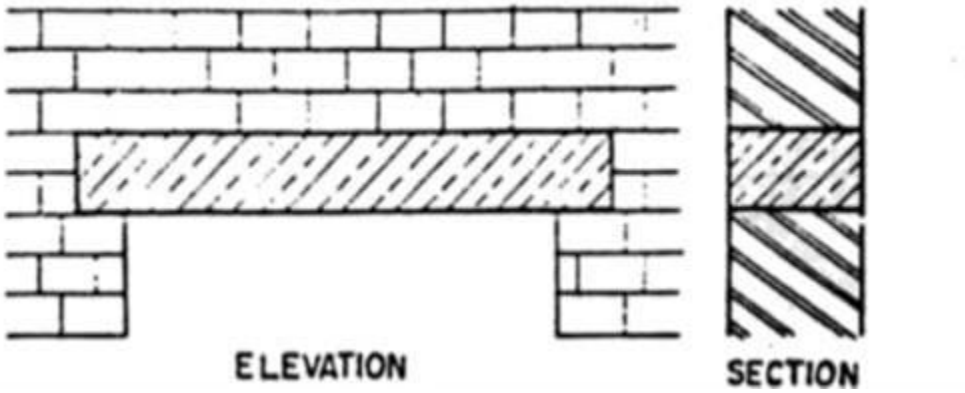


(b) Built-up Lintel

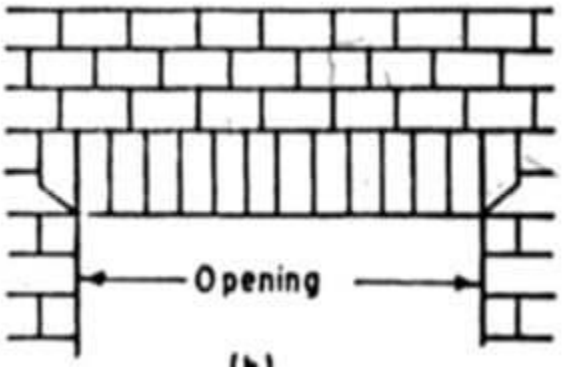
2. Stone Lintel

These are the most common type, especially where stone is abundantly available. The thickness of these

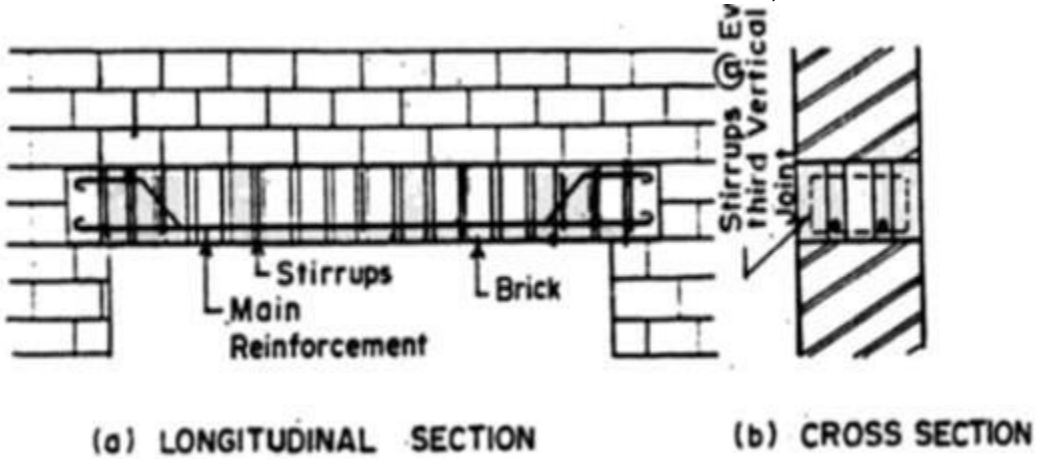
are most important factor of its design. These are also provided over the openings in brick walls. Stone lintel is provided in the form of either one single piece or more than one piece.
The depth of this type is kept equal to 10 cm / meter of span, with a minimum value of 15 cm. They are used up to spans of 2 meters. In the structure is subjected to vibratory loads, cracks are formed in the stone lintel because of its weak tensile nature. Hence caution is needed.



3. Brick Lintel
These are used when the opening is less than 1m and lesser loads are acting. Its depth varies from 10 cm to 20 cm, depending up on the span. Bricks with frogs are more suitable than normal bricks because frogs when filled with mortar gives more shear resistance of end joints which is known as joggled brick lintel.



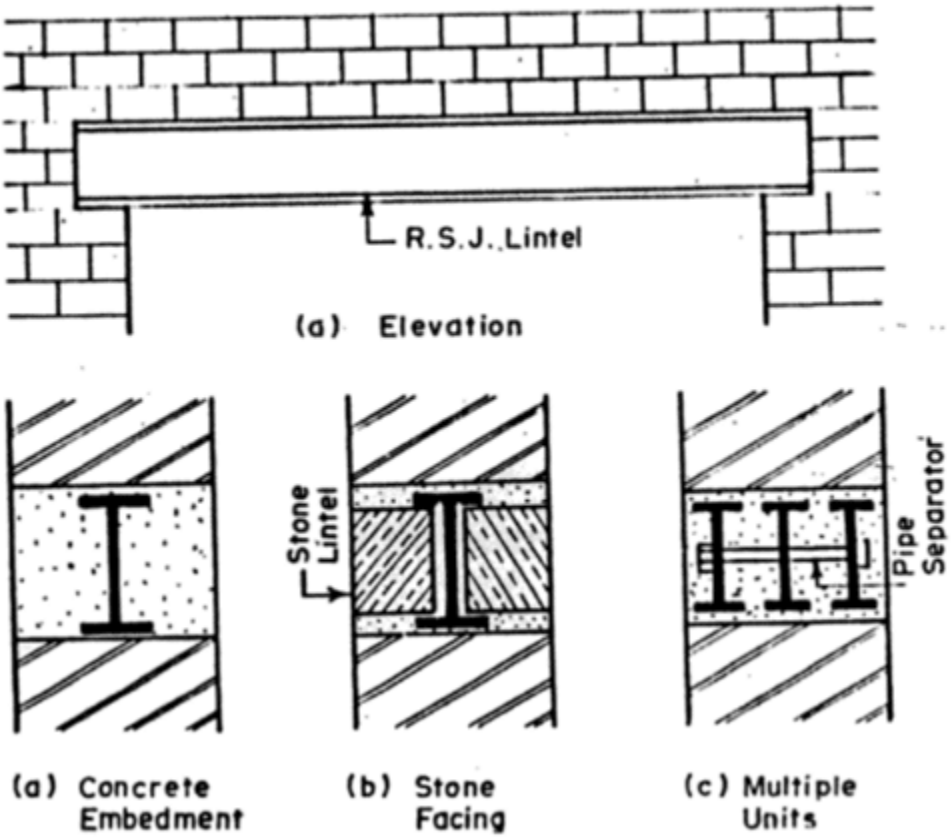
4. Reinforced Brick Lintel
These are used when loads are heavy and span is greater than 1m. The depth of reinforced brick lintel should be equal to 10 cm or 15 cm or multiple of 10 cm. the bricks are so arranged that 2 to 3 cm wide space is left length wise between adjacent bricks for the insertion of mild steel bars as reinforcement. 1:3 cement mortar is used to fill up the gaps.
Vertical stirrups of 6 mm diameter are provided in every 3rd vertical joint. Main reinforcement is provided at the bottom consists 8 to 10 mm diameter bars, which are cranked up at the ends.



5. Steel Lintel

These are used when the superimposed loads are heavy and openings are large. These consist of channel sections or rolled steel joists. We can use one single section or in combinations depending up on the requirement.

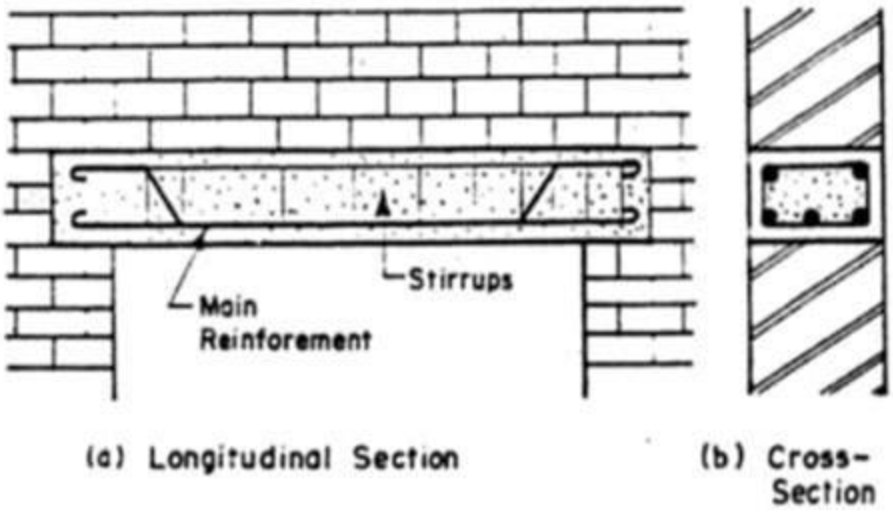
When used singly, the steel joist is either embedded in concrete or cladded with stone facing to keep the width same as width of wall. When more than one units are placed side by side, they are kept in position by tube separators.



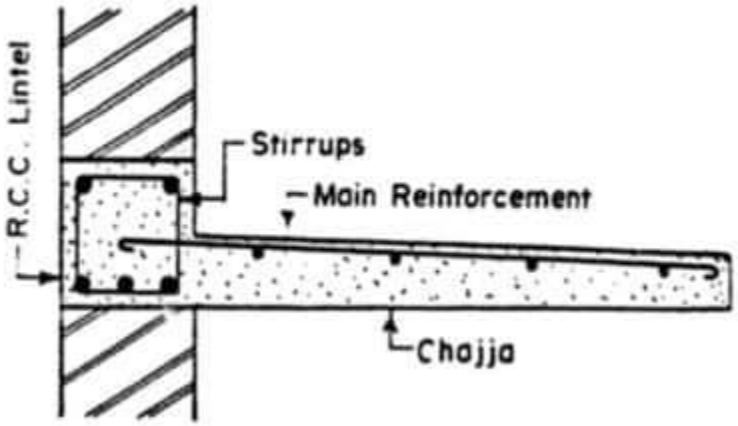
6. Reinforced Cement Concrete Lintel

At present, the lintel made of reinforced concrete are widely used to span the openings for doors, windows, etc. in a structure because of their strength, rigidity, fire resistance, economy and ease in construction. These are suitable for all the loads and for any span. The width is equal to width of wall and depth depends on length of span and magnitude of loading.

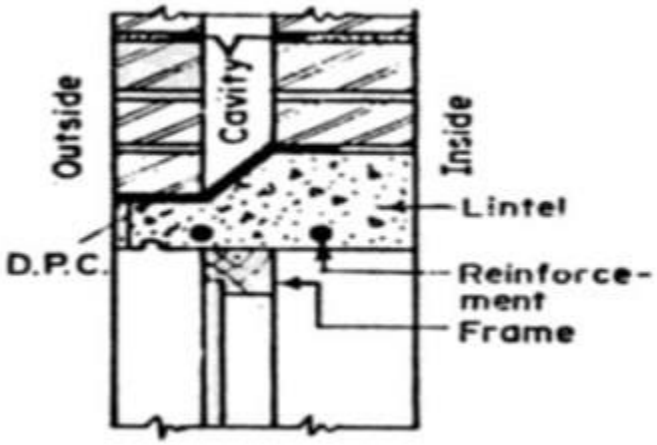
Main reinforcement is provided at the bottom and half of these bars are cranked at the ends. Shear stirrups are provided to resist transverse shear as shown in fig.



R.C.C lintel over a window with projection is displayed in below fig.



R.C.C boot lintels are provided over cavity walls. These will give good appearance and economical. A flexible D.P.C is provided above as shown in fig.



What is a lintel?

A lintel is a beam placed across the openings like doors, windows etc. in buildings to support the load from the structure above. The width of lintel beam is equal to the width of wall, and the ends of it is built into the wall. Lintels are classified based on their material of construction.

What are the types of lintel in construction?

Lintels are classified as:

1. Timber Lintels

2. Stone Lintels
3. Brick Lintels
4. Reinforced Brick Lintel
5. Steel Lintel
6. Reinforced Concrete Lintel

What is a steel lintel?

These are used when the superimposed loads are heavy and openings are large. These consist of channel sections or rolled steel joists. We can use one single section or in combinations depending up on the requirement.

When used singly, the steel joist is either embedded in concrete or cladded with stone facing to keep the width same as width of wall. When more than one units are placed side by side, they are kept in position by tube separators.

PAINTING

Paint is a liquid surface coating. On drying it forms a thin film on the painted surface. Paints are classified as oil paints, water paints, cement paints, bituminous paints and special paints such as fire proof paints, luminous paints, chlorinated rubber paints (for protecting objects against acid fumes), etc. The paintings are the coating of fluid materials
The functions of the paints are:

To protect the coated surface against possible stresses mechanical or chemical;deterioration—physical or environmental;
Decorate the structure by giving smooth and colourful finish; check penetration of waterthrough R.C.C; check the formation of bacteria and fungus, which are unhygienic and give ugly look tothe walls;
check the corrosion of the metal structures;
Check the decay of woodwork and to varnish the surface to display it to better advantage

Defects in Painting:

A painted building with full colour effects gives complete satisfaction. But the appearanceof defects becomes a ready source of complaint. Unfortunately paintingdefects are by no means uncommon. They may arise from a variety of causes but the principal reasons behindthem are incorrect choice of paint in relation to backing materials, application of paint to adamp surface or one to which moisture may have access and; poor workmanship.

Effects of background:
The factors affecting durability are dampness, cleanliness, movements, chemical reactions,etc. The traditional construction in brick, cement, etc. involves the use of wet procedures. If paint is applied on an insufficiently dry background the moisture is trapped and in the process of subsequent drying the adhesion of the paint breaks down. Emulsion paints are somewhat better in this respect.

The painting processes can be delayed for proper results for movements caused byshrinkage and special paints should be used for thermal movements.
Chemical reaction between backing material and paint film may push the paint off the backing material and lead to softening or decolourise the paint. This effect generally occursonly if moisture is present and is noticeable in oil paints over materials containing cement or lime. The breakdown of bond is because of the crystallization of salts belowthe paint film and the discolouration is usually due to action of free lime on the pigments.

Effects of weather:
The paint film is subjected to chemical attack of atmosphere, sunlight and heat, all deterioratingit. Special chemical resistant paints should be applied in industrial areas. Alkali resistant paintsweather well in coastal areas. Blue and green colours tend to fade when exposed to bright light.In addition the fierce heat of sun may breakdown the paint film because of the disintegration of the material itself and also because of the thermal movement. The most common defects noticed after paintings are as follow:
Blistering and peeling are swelling of the paint film and can be defined as localized loss of adhesion between one or more coatings or between primer and parent surface. When swelling is because of oil or grease on the surface it is known as blistering and in case of moisture it is called peeling. It occurs in nonporous coatings such as oil based paints and enamels. A special heat-resisting type of paint should be used for hot surfaces such as radiators.It is brought about by moist air, oily or greasy surface, or imprisoned gases betweenthe paintedsurface and the paint film, which expand under the influence of heat. Emulsion paints providea porous coating and allow the moisture to pass through.
Checking is a mild form of cracking. If hair cracks produced enclose small area it is knownas crazing. In case the enclosed area is large the defects is called crocodiling. It is caused whenthe paint film lacks in tensile strength and occurs when paint is applied during very cold weather or because of insufficient drying of undercoat. When cracks are very small and do notenlarge with time, the top coating is flattened with emery paper and a fresh coat of paint is applied.
Cracking: The cracks extend throughout the entire paint system extending right down to theoriginal surface. Cracks in the plaster or masonry do not let the paint to remain intact.

Paint applied on glossy surface. Premature application of top coat before the previous coat hascompletely dried. Painting improperly seasoned wood.
Flaking: It is detachment of paint film from the surface. The moisture penetrates through thecracks on the coatings and the bond between surface and paint film is lost. The curing methodsare: Use of plastic emulsion paints, Surface should be rubbed with emery paper before applyinga fresh coat and All dirt or dust on surface should be removed prior to painting.
Chalking: Paint film becomes powder due to insufficient oil in primer.

Alligatoring: One layer of paint films sliding over the other one, when a hard paint is appliedover a soft one or vice versa.
Wrinkling: or crawling appears when the paint film is quite thick or the oil in the paint is more than required. The lower portion of the paint does not dry due to greater thickness of thepaint film which shrinks due to drying in course of time.
Running and sagging: Paints applied over smooth and glossy surface do not stick and flow back or towards the unpainted area. This is known as running and sagging. The surface to-be painted should, therefore, be rubbed with an emery paper before painting.
Bloom: is identified as dull patches on the finished, polished or painted surface due to defectin the quality of paint or poor ventilation.
Flashing: is characterized by the appearance of certain glossy patches on the painted surface.The reasons attributed to this defect are weathering actions, use of cheap paint, and poor workmanship.
Grinning: it is due to the imperfect opacity of the paint film even after the final coat. The background and its defects can be clearly visible in such a case.
Failure of Painting: The main causes of failure of painting are:

Bad workmanship	Conditions for painting
Moisture	Salt and alkalies
Unsuitable surfaces	Wrong choice of paint

Painting of various surfaces:

New plastered surface:

The procedures for paining a new plastered surface are:

Surface preparation: Paint cannot take care of construction defects. Before applying the paint, it is ensured that the surface is free from dust, dirt, loose matter, grease etc. and is rubbed with an emery paper, to provide a mechanical key between surface and paint for satisfactory adhesion.
Sequence of Painting: The primer (first coat) is applied with brush or spray on the prepared surface. It should be thinned with water or thinner in the recommended mannerand proportion before application. After drying it is rubbed with emery paper. Dents and cracks, if any, are filled with putty using a knife applicator. Putty shouldnot be applied thick. If the required thickness is large, it should be applied in two coats. Afterthe putty has dried, the whole surface is rubbed down well in order to smoothen the putty andprovide a mechanical key to the finished coats. Two or three finish coats are applied. Each coat is allowed to dry before the application of next coat.
Old plastered surface

The procedure depends on the state of the existing coating. If any of the defects discussed below is very much pronounced it is completely removed and the surface is painted as a new surface.

Painting of new woodwork

Painting of woodwork should be done with great care. Normally 3–4 coats are sufficient for wood work.
Surface preparation: The wood should be well seasoned, dried, cleaned and the surface made smooth with an emery paper. Nails, if any, should be driven down the surface by at least 3 mm.
Knotting: Knots in the wood create lot of problems. These excrete resin which causes defects such as cracking, peeling and brown discolouration. Knotting is done so that resin cannot exude from the knots. Any of the following methods may be used suitably.

Ordinary knotting: This is also known as size knotting. The knot is treated with a coat of hot red lead ground with a strong glue size in water. Then a coat of red lead ground in boiled linseed oil is applied.
Lime knotting: The knot is covered with hot lime for 24 hours after which it is scrappedoff. Thereafter, the process described in ordinary knotting is followed.
Patent knotting: Two coats of varnish or shelac are applied.
Priming coat: The main function of priming coat or primer is to form the base for subsequent ones. After knotting priming coat is applied over the entire surface to fill all thepores. A second priming coat is applied after first has dried. In general the ingredients are same as those of the subsequent coats but with a difference in proportion.
Stopping: After the priming coat putty is applied to fill the pores of the surface. Then it is rubbed smooth. Colouring pigment is also added to it to match the shade of the finishedcoat. On drying, the selected paint is applied with brushes to bring smoothness and uniformity in colour. After painting the surface in one direction, the brush is worked inthe perpendicular direction to eliminate brush marks. This is known as crossing. All the successive coats are applied after drying and slight rubbing of previous coats for proper bond.

Painting of old woodwork:

The old paint is removed with a sharp glass piece, sand paper, paint remover or with a blow lamp. Any smoky or greasy substance should be washed with lime and subsequently rubbed with pumice stone. The surface is then washed with soap and water and dried completely. Thentwo coats of paints are applied in a way similar to that described in painting new surfaces.
Painting metal surfaces:
New ironwork: The surface should be free from scales, rust and grease. Scales and rust arecleaned by hard wire brush. Grease is removed by using petroleum or by hot alkaline solution of Na_2CO_3 or NaOH, benzene, and lime water. A priming coat of red lead with barytes and raw linseed oil is then applied over the prepared surface. After drying of the priming coat, one or more undercoats with desired paint are applied. The second coat is given only after the first coat has dried. The finishing coat is applied carefully to producea smooth fine surface.

Old ironwork: The surface is prepared by scraping properly all the scales and rust with emery paper. The greasy substances are removed with lime water. The old paint may be burned with a blow lamp or by suitable solvents. After this the surface is brushed with hotlinseed oil and painted as for new iron work.
Structural steel: The major problem to overcome in painting iron and steel is corrosion due to electrolysis caused by the presence of air and moisture. Red lead is considered tobe the best priming coat; it produces a tough elastic film, impervious to air and moisture.Pure linseed oil priming coat is detrimental in that it stimulates corrosion. The linseed oilfilm is rendered more impervious by the use of spar varnish. Graphite paint used for blackcolour, is very durable and is not affected by sulphur films, ammonia or chlorine gases. Silica-graphite paints are best; they do not crack and blister in course of time. Aluminiumpaint is also gaining popularity because of its shining and contrast properties and heat andchemical resistance. Bituminous paints may be very well adopted to paint inside of pipes,iron under waters, piles, ships and boats; they are unsatisfactory when exposed to sunlight. Lead or zinc paint should never be applied directly over the iron surface as it encourages galvanic action destroying the paint.
Painting of floor surfaces: The enamels are used for painting of floor surfaces. The selected enamel should be strong enough to resist abrasion, moisture, and alkali actions. Itshould be of shinning nature and quick drying type.
Painting of concrete surfaces: The cement paint is used to paint concrete surfaces. The paint is available in a powder form and it is dissolved in water to workable consistency. The paint thus prepared should be consumed with in 2 to 3 hours. The two coats are applied at an interval to provide curing of painted surface.
DAMP PROOF

Damp prevention and fire protection are the chief requirements toensure the safety of buildings against dampness and fire respectively.The sources, effects, techniques and methods of damp prevention, materials used for damp-proofing (D.P.C) damp-proofing treatments in buildings, treatment of dampness are discussed under damp proof chapter.
Sources of dampness(causes)

Dampness in building in generally due to one or more of the following causes
Faulty design of structure

Faulty construction or poor workmanship

Use of poor materials in construction

These cause give rise to an easy access to moisture to enter the building from different points, such as rising of moisture from ground, rain penetration through walls, roofs and floors etc. The moisture entering the building from foundation and roofs, travels in different directions further under the effects of capillary action and gravity respectively. The entry of water and its movements,in different parts of the building are positively due to the one or more of the causes listed above.

Effects of dampness:

The various effects caused due to dampness in buildings mainly results in poor functional performance, ugly appearance and structural weakness of the buildings.
A damp building creates unhealthy living and working conditionsfor the occupants
Presence of damp condition causes efflorescence on building surfaces which ultimately results in the disintegration of bricks stones, tiles etc and hence reduction of strength
It may result in softening and crumbling of plaster

It may cause bleaching and flaking of the paint which results in theformation of coloured patches on the wall surfaces and ceilings
It may result in the corrosion of metals used in the construction ofbuildings
The materials used as floor coverings such as tiles are damagedbecause they lose adhesion with the floor bases
Timber when in contact with damp condition, gets deteriorated dueto the effect of warping, buckling and rolling of timber
All the electrical fittings gets deteriorated, causing leakage ofelectric current with the potential danger of a short circuit
Dampness promotes the growth of termites and hence createsunhygienic conditions in buildings

Dampness when accompanied by the warmth and darkness, breedsthe germs of tuberculosis, neuralgia, aute and chronisneumatism etc which some times result in fatal diseases
Techniques and methods of damp prevention:

The following are the precautions to be taken to preventdampness in buildings, before applying the various techniques.
The site should be located on high ground and well drainedsoil to safe guard against foundation dampness
All the exposed walls should be of sufficient thickness tosafeguard against rain protection (minimum 30cm)
Bricks of superior quality free from defects should be used

Good quality cement mortar (1:3) should be used to producedefinite pattern and perfect bond in the building
Cornices and string courses should be provided to throughrain water away from the walls
All the exposed surfaces like top of walls, compound wallsetc should be covered with water proofing cement plaster
Cavity walls are more reliable than solid walls in preventingthe dampness
Techniques:

Use of damp proof courses

Water proof or damp proof treatments

Cavity walls or hallow walls

Guniting or shot concrete or shotcrete

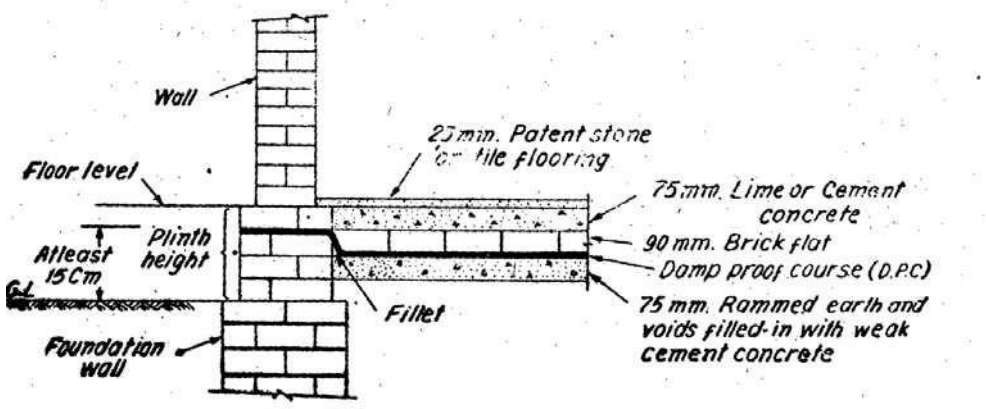
Pressure grouting or cementation

Use of damp-proof courses (D.P.C.)

These are layers or membranes of water repellent materials such as bituminuous felts, mastic asphalt, plastic sheets, cement concrete, mortar, metal sheets, stones etc which are interposed in the building structure at all locations wherever water entry is anticipated or suspected. The best location or position of D.P.C. in the case of building without basement lies at plinth level or structures without any plinth level, it should be laid at least 15cm above ground level. The damp proof course provided horizontallyand vertically in floors, walls etc. In the case of basements, layingof D.P.C. is known as taking Fig 14.1 shows the D.P.C. treatmentabove ground level.

Fig 14.1 D.P.C. above ground level for new buildings

Water proof surface treatments: The surface treatment consistsin filing up the pores of the material exposed to moisture by



providing a thin film of water repellent material over the surface (internal / external) . External treatment is effective in preventingdampness

Many surface treatments, like pointing, plastering, painting, distempering etc are given to the exposed surfaces and also to the internal surface . The most commonly used treatment to protect thewalls against dampness is lime cement plaster (1:6) (1- cement, 6-lime) mix proportion. Generally employed as water proofing agentin surface treatments are sodium or potassium silicate. Aluminiumor zinc sulphate, Barium Hydroxide and magnesium sulphate in alternate applications. Soft soap and alum also in alternate applications, unie and unseed oil; coal tar, bitumen, waxes and fats;resins and gums

Waxes and fats are not suitable in tropics as they melt with risein temperatures

Integral damp-proofing treatments :

The integral treatment consists of adding certain compounds to theconcrete or mortar during the process of mixing, which when usedin construction acts as barriers to moisture penetration underdifferent principles

Compounds like chalk, talc, fallers earth etc have mechanical action principle (i.e.,) they fill the pores present in the concrete or mortar and make them denseand water proof

Compounds like denser and water proof sulphates, calcium chlorides etc work on chemical action principle (i.e.) they react chemically and fill the pores to act as water-resistant
The compounds like soaps, petroleum, oils fatty acidscompounds such as sterates of calcium, sodium ammonium etc work on the repulsion principle i.e., they are used as admixture in concrete to react with it and become water repellent
Cavity walls or hallow walls: A cavity wall consists of two parallel walls or leaves or skins of masonary separated by acontinuous air space or cavity. The provision of continuous cavityin the wall per effectively prevent the transmission orpercolation of dampness from outer walls or leaf to inner wall or leaf. The following are the advantages of cavity wall.
As there is no contact between outer and inner walls of cavity wall, possibility of moisture penetration is reduced to a minimum.
A cavity wall prevents the transmission of heat through wall.
A cavity wall offer good insulation against sound.

The cavity wall tends to reduce the nuisance of efflorescence.
The cavity wall also provides benefits such as economy, better comfort and hygienic conditions in buildings

The cavity wall construction and D.P.C. details for flat roofs isas shown in fig no 14.2

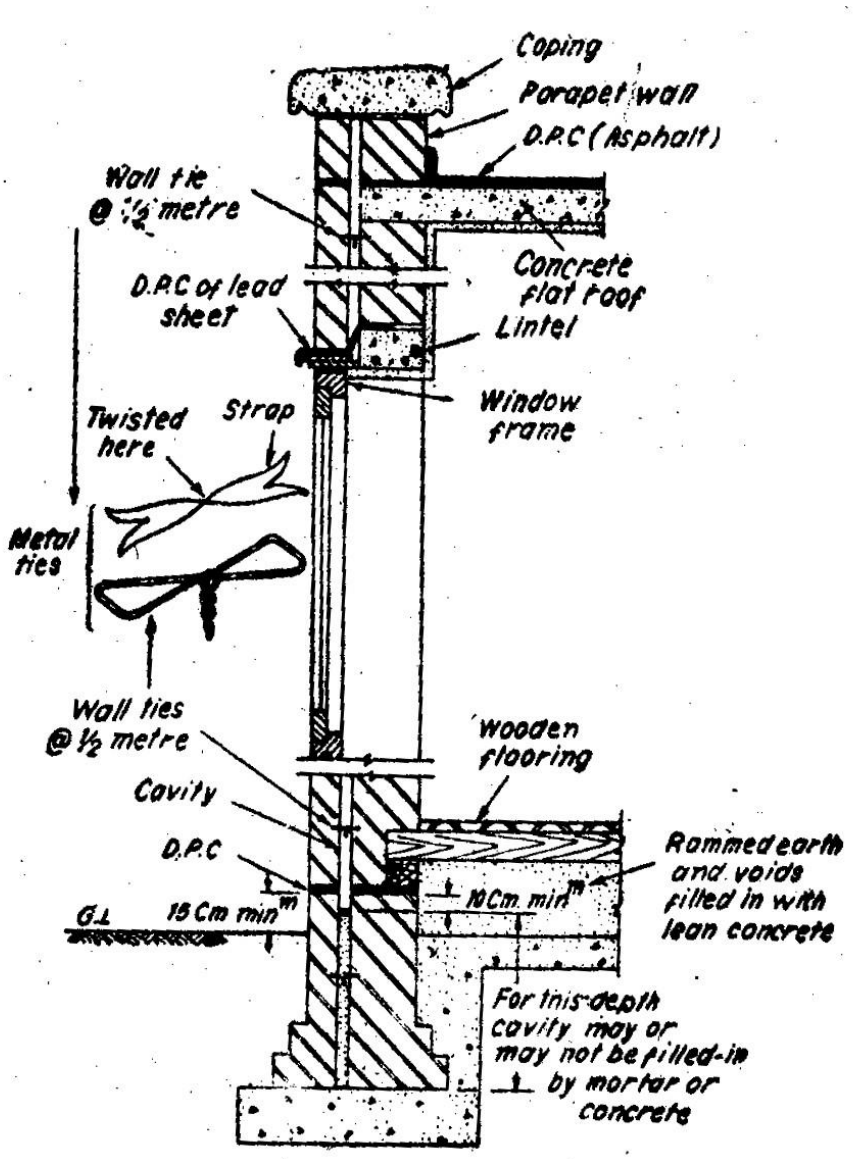


Fig 14.2 Cavity wall construction and D.P.C. details for flat roofs

Guniting: (or shot concrete) : The technique of guniting consistsin forming an imperious layer of rich cement mortar(1:3) or fine aggregate mix for water proofing over the exposed concrete surface or over the pipes, cisterns etc for resisting the waterpressure. By this technique, an impervious layer of highcompressive strength (600 to 700 kg/cm^2) is obtained and hence this is also very useful for reconditioning or repairing old concrete works

Pressure grouting or (cementation). The mixture of cement, sand and water under pressure into the cracks, voids or fissures present in the structural component or the ground. In general, the foundations are given this treatment to avoid the moisture penetration. This technique also used for repairing structures,consolidating ground to improve bearing capacity, forming water cut-offs to prevent seepage etc.

SHORT ANSWER QUESTIONS

Define damp prevention

What is D.P.C. ? Give examples.

What are the important sources of dampness?

Name any four effects of dampness

Name any four methods of preventing dampness

Define fire protection

What are the general methods of fire safety in buildings?

What are the properties of ideal fire resisting material?

ESSAY TYPE QUESTIONS

Explain the sources of dampness.

Explain the effects of dampness.

Explain the methods of preventing dampness

Explain the fire-resisting properties of the following material

Timber

Stone

Bricks

Concrete

Explain fire-resistance construction

Explain the general measures of fire safety in buildings.

TERMITE PROOFING

1 INTRODUCTION

Anti-termite treatment and damp proofing are the essential requirements to ensure safety of buildings against termite and dampness. All possible measures and techniques to achieve these two basic requirements will be discussed in this unit. We shall deal with types of termite, anti-termite treatment, damp proofing, sources or causes of dampness and its effects, methods of damp proofing and damp proof treatments of buildings.

Objectives

After studying this unit, you should be able to

• conceptualise problem of termites and their effects,
• explain different types of anti-termite treatment commonly used to prevent damages due to termites,
• discuss damp proofing and water proofing, their causes and effects in buildings, and
• describe various materials and methods used for damp proofing treatments in the buildings.

ANTI-TERMITE

Insects have been in existence for millions of years and they are capable of survival under most adverse conditions and environments. Termites, also types of

 insects, cause maximum damage to the buildings. Termites, popularly known as white ants, cause considerable damage to wood work, furnishings etc. of buildings. In some countries, the loss caused due to termites is estimated to be as high as 10% of the capital outlay of the buildings. Anti-termite treatment is, therefore, necessary so that damages due to termites are either reduced or stopped all together.

TYPES OF TERMITE

Termites are divided mainly into following two types. These are

(a) dry wood termites, and
(b) subterranean termites.

Dry Wood Termite

Dry wood termites live in wood and do not maintain contact with the ground. They normally build nests within the dry timber members like door window frames, wooden furniture etc. and destroy them gradually. They are, however, not as common as subterranean termites and they cause lesser damage to the buildings.

Subterranean Termites

Subterranean termites on the other hand live in soil and require moisture for their existence. They are mainly responsible for causing damage to the buildings and its contents. They build underground nests or colonies and form mud-wall tunnels or runways (tubes), which serve as safe shelter for their movements. Sometimes they build nests near ground in stumps of dead trees or create colonies in the form of dome shaped mounds on the ground. It is through these mud wall tubes that they maintain direct contact with the soil for meeting their moisture requirements. These mud walls also create conditions of darkness, which is essentially needed for their survival. The termites enter the building through foundations or from ground adjacent to buildings and advance upward through floors destroying everything that comes within their reach. They may also enter the building through cracks in masonry and joints or cracks in floors in contact with ground. Termites eat celluloses materials like wood, grass, etc. and also attack materials like leather, plastics, rubber, furniture, furnishings; clothing, stationery etc.

3.4 ESSENTIALS OF TERMITE-PROOFING

A careful examination of untreated building can show that damage by termites

and evidence of their activity is not difficult to find. Often such damage or termite activity can be found on the upper floors as well. Even if termite damage on the lower floors is not clearly visible, this should not lead to the conclusion that they have not established a colony on the upper floors.

The termite-proofing treatment should invariably be given to all types of buildings during the construction stage. It is because of the fact that during the post-construction period, it is extremely difficult and costly to control the termite growth. Care should be taken to ensure that no bridge is formed between any part of building and untreated soil. In order to reclaim land by utilizing debris or filling material, great care should be exercised to ensure that debris is termitefree. As far as possible metal strain or suitable joint fillers may be used to make

Anti-termite,
Damp Proofing and
Water Proofing

the floor joints free from termite attack. To check termite movements from ground, the foundations should be either made of concrete or any other solid material. Also, care should be taken to ensure that building site is free from dead wood, old tree stumps, etc. The superstructure should be treated with suitable preservatives to make it termite-proof. All the wooden members like door frames, stair-cases, etc. should be set on flooring. They should not be through flooring to prevent ground soil contact.

TYPES OF ANTI-TERMITE TREATMENT

The anti-termite treatment in buildings may be divided into two categories :
Pre-construction treatment and Post-construction treatment

Pre-construction Treatment

Pre-construction treatment is the kind of anti-termite treatment carried out right from the stage of initiating the construction activities for the building. The various stages involved in this treatment are described below.

Site Preparation

This consists in removing stumps, roots, logs, waste-wood etc. from the site where the building is to be constructed. In case the termites mound are discovered within the plinth area of the building they should be destroyed by use of insecticide solution. For this treatment, holes should be made into the mound at several places by use of crow-bar and the insecticides taken in the form of water suspension or emulsion should be poured into the holes. The quantity of insecticides solution to be used depends on the size of mound. For a mound having volume of about 1 cu.m., 4 litres of an emulsion in water of one of the following chemicals may be used :

DDT 5%,
BHC 0.5%,
Aldrin 0.25%
Heptachlor 0.2%
Chlordane 0.5%

(Here, chemical concentration is expressed by weight.)

Soil Treatment

The most reliable method to protect building against termites is to apply a chemical treatment to the soil at the time of construction of the building. This treatment consists in poisoning the soil underneath the building and around the foundations of the buildings with insecticide solution. This should be done in such a way that a complete chemical barrier is created between the ground from where the termites come and damage wood work in the building. An insecticide solution consists of anyone of the following chemicals in water emulsion :

(a) Aldrin 0.5%
(b) Heptachlor 0.5%

(c) Chlordane 1% (whereas chemical concentration is expressed by weight).

Chapter-7

Green Building,Energy management and energy audit of buildings

Introduction

•Green building is the practice of creating structures and processes that are environment friendly and resource-efficient throughout the life span of a building right from site selection to design, construction, operation, maintenance, renovation and deconstruction.

Green Building

Introduction

•Green Buildings are designed to reduce the overall impact on human health and the natural environment by the following ways:

•Using energy, water and other resources efficiently.

•By reducing waste, pollution, and environmental degradation.

Objectives Of Green Building

•The aim of green building design is to minimize resources, maximize the reuse, recycling and utilization of renewable resources.

•It maximizes the reuse, recycling, and utilization of renewable resources.

•It maximizes the use of efficient building material and construction practices, optimizes the use of onsite resources and use of renewable sources of energy, use efficient waste management practices and provide comfortable and hygienic indoor working conditions.

The Difference Between an Energy Audit and Energy Management

Whether you own a small business, a large commercial building, a cold storage facility, or a manufacturing operation, it's important to take advantage of any programs, rebate incentives, and strategies that may help you save money on energy bills. There are short-term strategies that can positively impact your bottom line immediately, as well as long term strategies that can reduce your energy consumption and stabilize your energy consumption in the future.

A good place to start when employing either strategy, is with an energy audit. Energy audits track your energy usage and efficiency to identify key areas for improvement. The information revealed through the energy audit can provide insights that will help you accelerate savings. The power of an energy audits is severely undervalued. While they may sound expensive, complicated, or even unnecessary, they are one of the best ways to understand your unique energy situation, while addressing areas for improvement.

What is an Energy Audit?

An energy audit is an assessment of the energy consumed in a given location which is used to find the inefficiencies. The first step to an energy audit is evaluating how much energy is being used so homeowners can identify the improvements that need to be made in order to increase energy efficiency. Only once the faults in the energy system are recognized, can they be corrected. This leads to saving energy which ends up a decreased energy bill and improved efficiency.

What is Energy Management?

Energy management is the process of monitoring, controlling, and conserving energy in a building or organization. The energy management process starts with an energy audit of a given location. Just as stated above, the goal is to find opportunities to improve efficiency. Essentially, energy management involves taking the energy audit and putting it into action with a number of strategies. For example, installing lights on a timer to turn off automatically at night. After action is taken, tracking the progress of the changes made is the most important part. Eventually this cycle starts over, resulting in another energy audit.

The Difference Between an Energy Audit and Energy Management

The real difference between the two lies in the difference between a systematic, one-time procedure and a long-term strategy dedicated to continuous improvement and energy efficiency.

An energy audit is a timely study. The reason being, that it critically examines the energy bill of the consumer and any improvements that can be immediately done in order for energy consumption reduction. These savings can be as minor as zero investment savings as simple as a change in operation in order to find a more efficient route or as large as capital investments such as purchasing all new equipment.

Energy management is about continuous improvement by monitoring energy over time. It is the long term and committed version of energy audits. Energy management follows the system of “plan-do-act-check”. This system was implemented by the International Standards for Energy Management.

Reference Book :

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