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SUBJECT- BUILDING MATERIAL&BUILDING CONSTRUCTION

(3rd Semester)

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DEPARTMENT OF CIVIL ENGINEERING

MODULE -1

STONES

The engineering structures are composed of materials. The service conditions of a buildings demand wide range of materials and various properties such as water resistance ,strength , durability , temperature resistance ,appearance, permeability ,etc.

- The building materials like stone .,cement concrete ,timber, metals etc.It is most necessary for construction of building .
- Stone is a solid material. It is defined as a sound rock that can be safely used in some situation in the construction as a massive dressed or undressed unit.
- Stone materials are often used for construction because they are strong ,durable and very resistance to weather conditions.

CLASSIFICATION OF ROCKS

The building stones are obtained from the rocks which are classified in the following three ways.

1.Geological classification.

2.Physical classification.

3.Chemical classification.

GEOLOGICAL CLASSIFICATION: According to this classification ,the rocks are of the following three types:-

1.Igneous rocks. 2.sendimentary rocks 3. Metamorphic rocks.

IGNEOUS ROCKS- The inside portion of the earth's surface has high temperature so as to cause fusion by heat at even ordinary pressures. The molten or pasty rocky material is known as the **magma**&this magma occasionally tries to come out to the earth's surface through crack or weak portions.

- The rocks which are formed by the cooling of magma are known as the igneous rocks. Such rocks are formed due to cooling of magma at a considerable depth from earth's surface.
- The igneous rocks commonly used in building industry are of plutonic type. The granite is the leading example of this type of rock.
- In this igneous rocks are recognized in the following three classes;
- **PLUTONIC ROCKS**- suchrocks are formed due to cooling of magma at a considerable depth from earth's surface. The cooling is slow and the rock possess coarsely grain crystalline structure.
- **HYPABYSSAL ROCKS**-such rocks are formed due tocooling of magma at a relatively shallow depth from the earth's surface. The cooling is quick

and hence these rocks possess finely grained crystalline structure. The dolerite is and example of this type of rock.

- VOLCANIC ROCKS–suchrocks are formed due to pouring of magma at earth's surface. The cooling is very rapid as compared to the previous two cases. Hence these rocks are extremely fine grained in structure. They frequently contain some quantity of glass which is a non crystalline material. The basalt is an example of this of type of rock.
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SEDIMENTARY ROCKS–These rocks are formed by the deposition of products of weathering on the pre-existing rocks. All the products of weathering are ultimately carried away from their place of organic by the agents of transport. Such agents are frost , rain, wind, flowing water, etc.

Following are four types of deposition

Residual deposits– some portion of the products weathering remain at the site of origin. Such as a deposit is known as a residual deposits.

Sendimentary deposits–The insoluble products of weathering are carried away in suspension and when such products are deposited ,they give rise to the sedimentary deposits.

Chemical deposits– some material that is carried away in solution may be deposited by some physio-chemical processes such evaporation ,precipitation ,etc.it gives rise to the chemical deposits.

Organic deposits–Some portion of the product of weathering gets deposited through the agency of organisms,such deposits are known as the organic deposits.

METAMORPHIC ROCKS- These rocks are formed by the change in character of the pre-existing rocks.

- The igneous as well as sedimentary rocks are changed in character when they are subject to great heat and pressure. The process of change is known as the metamorphism.
- The mineral composition and texture of a rock represent a system which is in equilibrium with its physio-chemical surroundings .
- The increasing of temperature and pressure upsets this equilibrium and metamorphism results from and efforts to re-establish a new equilibrium.
- In this process the original constituent minerals which are unstable under the change conditions are converted into new ones which are more stable under the change conditions are converted into new ones which are more stable under the change conditions.
- These minerals are arranged in a manner which is more suitable to the new environments.

PHYSICAL CLASSIFICATION

This classification is based on general structure of rocks. According to this classification ,the rocks are of the following three types.

1.stratified rocks.

2.unstratified rocks

3.foliated rocks

- **Stratified rocks**–These rocks possess planes of stratification or cleavage and such rocks can easily be split up along these planes. The sedimentary rocks are distinctly stratified rocks.

- **Unstratified rocks**–These rocks are unstratified.Thestructure may be crystalline granular or compact granular.The igneous rocks of volcanic agency and sedimentary rocks affected by movements of the earth are of this type of rocks.

- **FOLIATED ROCKS**–These rocks have a tendency to be split up in a structure may be crystalline granular or compact granular. The foliated structure is very common in case of metamorphic rocks.

CHEMICAL CLASSIFICATION

This classification is known as the scientific or engineering classification and according to this classification, the rocks are of following three types. :

1.sillicious rocks

2.Argillaceous rocks; &

3.Calcareous rocks

Silicious rocks- In these rocks ,the silica predominates. The rocks are hard and durable. They are not easily affected by the weathering agencies.

- The silica however in combination with weaker minerals may disintegrated easily.

- It is therefore necessary that these rocks should contain maximum amount of free silica for making them hard and durable. The granites,quartzites,etc.are example of silicious rocks.
- **Calcareous rocks-**In these rocks, the calcium carbonate predominates. The durability of these rocks will depend upon the constituents present in the surrounding atmosphere. The limestones,marbles,etc are examples of calcareous rocks.

USES OF STONES

- The stones are used in the construction of buildings from the ancient times and most of the ancient temples and fronts of our country were built with stones.
- The TajMahal at Agra and red fort,Jama Masjid,Parliament House,central secretariat and Rashtrapati Bhawan at Delhi and various other prominent structures spreads throughout the length and breath of our country furnish us the splendid examples of contribution of stones as a building materials.
- STRUCTURE-The stones are uses for foundation ,walls,columns,lintels,arches,roofs,floors,damp-proof courses etc.
- FACE-WORK-The stones are adopted to give massive appearance to the structure. The walls are of bricks and facing is done in stones of desired shades. This is known as the composite masonary.

- **PAVING**–The stones are used to cover floor of building of various types such as residential,commercial,industrial,etc. They are also adopted to from paving of roads, footpaths,etc.
- **BASIC MATERIAL**–The stones are disintegrated and converted to form a basic material for cement concrete, murum of roads,calcareous cements,artificial stones,hollow blocks,etc.
- **MISCELLANEOUS**–In addition to above uses, the stones are also used as:
- 1.ballast for railways.
- 2.flux in blast furnaces,
- 3. Block in the construction of bridges,piers,abutments,retaining walls,light houses,dams,etc.

NATURAL BED OF STONES

DEFINATION–The building stones are obtained from rocks. These rocks have a distinct of division along which stones can easily be split. This plane is known as the natural bed of stone.

- it thus indicates the plane or bed on which the sedimentary stones was originally deposited.
- The natural bed of stones need not necessarily be horizontal .for sedimentary rocks, it is easy to observe and locate the natural bed as it lies along the planes of stratification.

IMPORTANCE–In stone masonary ,the general rule to be observed is that the direction of natural bed of all sedimentary stones should be

perpendicular or nearly so to the direction of pressure. such an arrangement gives maximum strength to the stonework.

- The natural beds of stones can be detected by pouring water and examining the directions of layers. The magnifying glass may also be used for this purpose.
- An experienced worker can easily locate the direction of natural bed of stones from the resistance offered to the chisel.The stones break easily along these natural beds.
- With respect to natural bed, the stones are placed in different situation as follows;
- **ARCHES:**In stones arches the stones are placed with their natural beds .
- The thrust of arch acts normal to beds.
- **CONICES STRING COURSAES ETC.:** The stones are partially unsupported in case of cornices, stings courses, etc. .Hence they should be placed with direction of natural beds as vertical.

TESTS FOR STONES

The building stoned are to be tested for their different properties .following are such tests for the stones.;

1.Acid Test

2. Attrition test

3.Crushing test

4. Crushing test

5. Freezing and thawing test

6. Hardness test

7. Impact test

8. Microscopic test

9. Smith's test

10. Water absorption test.

ACID TEST- In this test,a sample of stone weighing about 0.5 to 1 N is taken .It is placed in a solution of hydrochloric acid having strength of one per cent and it is kept there for seven days. The solution is agitated at intervals .

- A good building stones maintains its sharp edges and keeps its surfaces free from powder at the end of this period.
- If edges are broken and powder is formed on the surface, It indicates the presence of calcium carbonates and such a stones will have poor weathering quality.
- It is natural that this test cannot be applied to the lime stones. The test is usually carried out on the sandstones.
- **ATTRITION TEST-**This test is done to find out the rate of wear of stones which are used in road construction.
- The result of test indicates the resisting power of stones against the grinding action under traffic .Following procedure is adopted:
- The sample of stone is broken into pieces of about 60mm size.
- Such pieces, weighing 50N , are put in both the cylinder are respectively 200mm and 340mm.
- The cylinder are closed. Their axes make an angle of 30 with the horizontal.
- The cylinder are rotated about horizontal axis for 5 hour at the rate of 30 R.P.M.

- After this period, the contents are taken out from the cylinders and they are passed through a sieve of 1.50 mm mesh.
- The percentage wear is worked out follows:
- Percentage wear=loss in weight÷intial weight x100

- **CRUSHING TEST-**The compressive strength of stone is found out with the help of this test.

- The sample of stones is cut in to cube of size 40mmx40mmx40mm .

- The sides of cubes are finely dressed and finished. The minimum number of specimens to be tested is three. Such specimens should be placed in water for bout 72 hour prior to test and thereafter tested in saturated condition.

- The load bearing surface is then covered with plaster of paris or 5mm thick plywood .The load is applied axially on the cube in a crushing test machine. The rate of loading is 13.72N/mm2 per minutes.

- The crushing strength of the stone per unit area is the maximum load at which its sample crushes or fails divided by the area of the bearing face of the specimen.

- ## CRYSTALLISATION TEST;-

In this test, at least four cubes of stones with side as 40mm are taken. They are dried for 72 hours and weighed. They are immersed in 14% solution of Na2SO4 for 2 hours.

They are dried at 100c and weighed. The difference in weight is noted. This procedure of drying ,weighing, immersing and reweighing is repeated at least five times, Each time, the change in weight is noted and it is expressed as a percentage of original weight.

- ## FREEZING AND THAWING TEST-

- The specimen of stone is kept immersed in water for 24 hours.it is then placed in a freezing mixture at-12 c for 24 hours.
- It is then thawed or warmed at atmospheric temperature.
- This should be done in shade to prevent any effect due to wind ,sunrays,rain etc.
- Such a procedure is repeated several times and behavior of stones is carefully observed.
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HARDNESS TESTS-

To determined the hardness of a stones the test is carried out as follows;

1.A cylinder of diameter 25 mm and height 25mm is taken out from the sample of stone.

2. It is weighed.

3. It is placed in Dorry"S testing mechine and pressed with a pressure of 12.50N .

4. Annular steel dis of machine is then rotated at a speed of 28R.P.M.

5.During the rotation of disc,the coarse sand of standards specification is sprinkled on the top of disc.

6. After 1000 revolutions, the specimen is taken out and weighed .

7. The coefficient of hardness is found out from the following equation.

Coefficient of hardness=20-loss in weight in gm/3

IMPACT TEST-

To determine toughness of a stones, the impact test is created out in pages impact machine as follows;

- A cylinder of determind 25mm and height 25mm is taken out from the simple of stones .
- It is placed on caused iron anvil of machine .
- A steel hammer of weight 20N is allow to falt axially in a veritical direction over the specimen.
- The height of first blow is 1cm ; that of second blow is 2cm;that of 3^{rd} blow is 3cm; and so on.
- The blow at which specimen breaks is noted .If it is nth blow n represent the toughness intakes of stones.

MICROSCOPIC TEST-

In this test ,the simple of stones is subjected to the microscope examination. The thin sections of stones are taken and placed under the microscope to study various properties such as;

Avarage grain size.

Existence of pores,fissures, venis and shakes;

Mineral constituents ;

Nature of cementing materieals;

Presence of any harmful substance

Texture of stones'

SMITH'S TEST-

This test is performed to find out present of soluble matter in a sample of stone .the few chips or pieces of stones are taken and they placed they are placed in the glass tube .

This tube is then filled with clear water. After about one hour , the tube is vigorously stirred or shaken .

The presence of earthy matter will conver the clear water in to dirty water.

If water remain clear ,the stone will be durable and free from any soluble matter .

On the other hand ,if the water becomes dirty ,it will indicates that the stones contents too much of soluble earty and mineral matters.

WATER ABSORPTION TEST-

Following procedure is adopted for this test.;

Form the given sample of stone , acube weighing about 0.50N this prepare with actual weight is record .let it be W1 N.

- The cube is then immersed in distilled water for a period of 24 hours .
- The cube is taken out of water and surface water is wiped of with a dampcloth.
- It is weighed again.
- Percentages absorption by weight after 24 hours=W2-W1/W1X100
- Percentages absorption by volume after 24 hours=W2-W1/W2-W3x100

QUALITIES OF A GOOD BUILDING STONE

- **CRUSHING STRENGTH**- For a good structural stone ,The crushing strength should be greater than 100N/mm.
- **APPEARANCE**-the stones are to be used for face work should be decent in appearance and that should be capable of preserving their colour uniformly for a long time.
- The colour of the stones as compared to dark coloured stones because there are chances of the latter variety to be attacked easily by weathering agents.
- **DURABILITY**-A good building stones should be durable .the various factor contributing to durability of a stone are its chemical composition ,texture, resistance to atmoshpheric and other influences location in structure ,etc.

- **FACILITIES OF DRESSING** ;-The stones should be such that they can be easily carved,moulded,cut and dressed .
- It is an important consideration from the economic point of view.
- However this property of stones is opposed to its strength,deurability and hard ness.
- **FRACTURE**-for a good building stone ,its fracture should be sharp ,even,bright and clear with grains well cemented together. A Dull chalky and earthly fracture of a stone indicates signs of earely future decay.
- **HARDNESS**-The coefficient of hardness as worked out in hardness test ,should be greater than17 for astone to be used in road work.
- If it is between 14 and ,17 the stone is said to be medium hardness.
- **RESISTANCE TO FIRE**-The minerals composing stone should be such that shape of stone is preserved when a fire occurs.
- **SEASONING**-the stones should be well seasoned before putting into use. The stones obtained fresh from a quarry contain some moisture which is known as the quarry sap.
- The presence of this moisture makes the stones soft .Hence the stones quarried freshly are easy to work.
- **SPECIFICGRAVITY;-for** a good building stone its specific gravity should be greater than 2.7 or so. The heavy stones are more compact and less porous and they can be used for various engineering application such as dams,weirs,retaining walls ,docks, harbours, etc.

- **TEXTURE**–In impact test, if the value of toughness index comes below 13the stones is not tough. If it comes between 13 and 19 the stone is said to be moderately tough.if it exceed 19 the toughness of stones is said to be high.

• DRESSING OF STONES–

- The stones after beings quarried , are to be cut into suitable sizes and with suitable surface.

- This process is known as the dressing of stones and it is carried out for the following purposes

- To get the desired appearance from stone work.

- To make the transport from quarry easy and economical.

- To suit to the requirements of stone masonary.

- To take advantages of local men near quarry who are trained for such type of work etc.

- ADVANTAGES;- At quarry site ,it is possible to get cheap labour for the process of dressing of stones.

- It is possible to sort out stones for different works,if quarry dressing is practiced.

- The irregular and rough portions of the stones are removed which decrease the weight of stones and it also facilities easy transportation of the stones.

- The stones when quarried freshly contain quarry sap and hence they are comparatively soft and can be easily dressed.

- AXED FINISH;

- The surface of hard stones such as granite are dressed by means of an axe such a finish is termed as an axed finish.

- BOALTED OR DROVED FINISH

- In this type of finish ,the boaster is used to make non continuous parallel marks on the stone surface.

- These mark may be horizontal ,inclined or vertical. A boaster is a chisel having an edge of width about 60mm.

- CHISEL– DRAUGHTED MARGINS;

- In order to obtain uniform joints in stones work, the margins are placed which may be either squared or pitched or chamfered.

- CIRCULAR FINISH

- In this type of finish, the surface of stone is made round or circular as in case of a column.

- DRAGGED OR COMBED FINISH

- In this type of finish a drag or a comb which is a piece of steel with a number of tech, is rubber on the surface In all direction and surface .

- This finish is suitable for soft stones only.

- **FURROWED FINISH–**

- In this type of finish a margin of about 20mm width is sunk on all the edges of stoned and the central portion is made to project about 15mm.

- A number of vertical or horizontal grooves about 10 mm wide are formed in this projected portion .

- This finish is generally adopted to makes the quoins prominent.

- **MOULDED FINISH**

- This surface of stone can be mould in any desirerd shape so as improved the appearance of the work . The moulding can be made either by hand or machine.

QUESTIONS

- **What is stones?5x2**

  Stones is solid materials .Its obtained from rocks which are used in building constructions and designing of any type of engineering structure.

- **How many type of classification of rocks ?**

There are three type of classification.

1.Geological classification.

2. Chemical classification.

3. Physical classification.

3. What is igneous rocks ?

The inside person of the earth's surface has high temperature so as to cause fusion by heat at even ordinary pressure.

- The molten or pasty rocky materieal is known as magma and these magma occaisanally tries to come out to the earth's surface through cracks or weak portions.
- The rocks which are formed by cooling of magma is known as igneous.

4.what are the tests of stones?

1.Acid test. 3. Crushing test 5. crystallization test

2.Attrition test 4.freezing and thawing test 6. Impact test

7.Microscopic test. 9. Hardness test

8. smith's test 10. waterabsorption test

5.Write two advantages of dressing of stones?

- At quarry ,it is possible to get cheap labour for the process of dressing of stones.
- It is possible to sort out stones for differentworks,if quarry dressing is practiced.

LONG QUESTIONS;-

1.Explain the geological classification of rocks. 5x6

2. How are rocks physically and chemically classified?

3. Define nature bed of a stone and discuss its importance.

4. What are the various uses and properties of stones?

4.What are good characterstics of a stones?

- Explain about the testing of stones ? 10x2
- Explain briefly the dressing of stones ?

CHAPTER-2

BRICK–A brick is a type of block used to build walls, pavements and other elements in masonry construction.

Properly, the term brick denotes a block composed of dried clay, but is now also used informally to denote other chemically cured construction blocks.

Bricks can be joined using mortar, adhesives or by interlocking them.

In India, standard brick size is 190 mm x 90 mm x 90 mm as per the recommendation of BIS. With mortar thickness, the dimension of the brick becomes 200 mm x 100 mm x 100 mm which is also known as the nominal size of the modular brick.

BRICK is a similar term referring to a rectangular building unit composed of similar materials, but is usually larger than a brick.

Lightweight bricks (also called lightweight blocks) are made from expanded clay aggregate. In India, most commonly used, rectangular, standard size of solid concrete block is 4″(100 mm), 6″(150 mm) and 8″ (200 mm) thick CMU.

Types of Bricks:

- **Classification of Bricks Based on Quality:**
  - **First Class Brick:** The size is standard.
  - The color of these bricks is uniform yellow or red.
  - It is well burnt, regular texture, uniform shape.
  - The absorption capacity is less than 10%, crushing strength is, 280 kg/cm2 (mean) where it is 245 kg/cm2 (minimum).
  - It doesn't have efflorescence.

- It emits a metallic sound when struck by another similar brick or struck by a hammer.
- It is hard enough to resist any fingernail expression on the brick surface if one tries to do with a thumbnail.
- It is free from pebbles, gravels or organic matters.
- It is generally used–

  in a building of long durability, say 100 years

  for building exposes to a corrosive environment;

Second Class Brick:

The size is standard, color is uniform yellow or red.

It is well burnt, slightly over burnt is acceptable.

It has a regular shape; efflorescence is not appreciable.

The absorption capacity is more than 10% but less than 15%. Crushing strength is 175kg/cm2 (mean) where the minimum is 154 kg/cm2 .

It emits a metallic sound when struck by another similar brick or struck by a hammer. It is hard enough to resist any fingernail expression on the brick surface if one tries to do with a thumbnail.

It is used for the construction of one-storied buildings, temporary shed when intended durability is not more than 15 years.

Third Class Brick:

- The shape and size are not regular.
- The color is soft and light red colored.

- It is under burnt, slightly over burnt is acceptable.
- It has extensive efflorescence. The texture is non-uniform.The absorption capacity is more than 15% but less than 20%.
- The crushing strength is 140kg/cm2 (mean) where the minimum crushing strength is 105kg/cm2 .
- It emits a dull or blunt sound when struck by another similar brick or struck by a hammer. It leaves fingernail expression when one tries to do with the thumbnail.

- **b) Classification of Bricks Based on Building Process:**
- **1. Unburnt Bricks:**
- These are half burnt bricks. The color is yellow. The strength is low.
- They are used as surki in lime terracing.
- They are used as soiling under RCC footing or basement.
- Such bricks should not be exposed to rainwater.
- **Burnt Bricks:**
- Burnt bricks are made by burning them in the kiln. First class, Second-Class, Third-Class bricks are burnt bricks.
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- **Over Burnt or Jhama Brick:**

- It is often known as the vitrified brick as it is fired at high temperature and for a longer period of time than conventional bricks.
- As a result, the shape is distorted. The absorption capacity is high.
- The strength is higher or equivalent to first class bricks.
- It is used as lime concrete for the foundation.
- It is also used as coarse aggregate in the concrete of slab and beam which will not come in contact with water.
- **c) Classification of Bricks Based on Manufacturing Method:**
- 1. **Extruded Brick:** It is created by forcing clay and water into a steel die, with a very regular shape and size, then cutting the resulting column into shorter units with wires before firing.
- It is used in constructions with limited budgets.
- It has three or four holes constituting up to 25% volume of the brick.
- **Molded Brick:**
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It is shaped in molds by hand rather being in the machine

. Molded bricks between 50-65mm are available instantly. Other size and shapes are available in 6-8 weeks after the order.

Dry pressed Brick:

It is the traditional types of bricks which are made by compressing clay into molds. It has a deep frog in one bedding surface and shallow frog in another.

d) Classification of Bricks Based on Raw Materials:

1. Burnt Clay Brick:

It is obtained by pressing the clay in molds and fried and dried in kilns. It is the most used bricks. It requires plastering when used in construction works.

2. Fly ash clay Brick

: It is manufactured when fly ash and clay are molded in 1000 degree Celsius. It contains a high volume of calcium oxide in fly ash.

That is why usually described as self-cementing. It usually expands when coming into contact with moisture. It is less porous than clay bricks. It proved a smooth surface so it doesn't need plastering.

3.Concrete Brick: It is made of concrete. It is the least used bricks. It has low compression strength and is of low quality. These bricks are used above and below the damp proof course.

These bricks are used can be used for facades, fences and internal brickworks because of their sound reductions and heat resistance qualities. It is also called mortar brick.

It can be of different colors if the pigment is added during manufacturing. It should not be used below ground.

- **Sand-lime Brick:** Sand, fly ash and lime are mixed and molded under pressure. During wet mixing, a chemical reaction takes place to bond

the mixtures. Then they are placed in the molds. The color is greyish as it offers something of an aesthetic view.

It offers a smoother finish and uniform appearance than the clay bricks. As a result, it also doesn't require plastering. It is used as a load bearing members as it is immensely strong.

5. Firebrick: It is also known as refractory bricks. It is manufactured from a specially designed earth. After burning, it can withstand very high temperature without affecting its shape,size, and strength. It is used for the lining of chimney and furnaces where the usual temperature is expected to be very high.

Properties of Brick:

The essential properties of bricks may be conveniently discussed under the following four headings: physical, mechanical, thermal and durability properties.

- **Physical Properties of Bricks:**
- These properties of bricks include shape, size, color, and density of a brick.

Shape:

The standard shape of an ideal brick is truly rectangular. It has Well defined and sharp edges.

The surface of the bricks is regular and even.

(ii) Size: The size of brick used in construction varies from country to country and from place to place in the same country. In India, the recommended standard size of an ideal brick is **19 x 9 x 9 cm** which with mortar joint gives net dimensions of **20 x 10 x 10 cm.**

These dimensions have been found very convenient in handling and making quantity estimates.

Five hundred such bricks will be required for completing 1 m3 brick masonry.

(iii) Color.

The most common color of building bricks falls under the class RED. It may vary from deep red to light red to buff and purple.

Very dark shades of red indicate over burnt bricks whereas yellow color is often indicative of under-burning.

(iv) Density.

The density of bricks or weight per unit volume depends mostly on the type of clay used and the method of brick molding (soft-mud, Stiff-mud, hard-pressed etc.).

In the case of standard bricks, density varies **from 1600 kg/m3 to 1900 kg/m3** . A **single brick (19 x 9 x 9 cm)** will weigh **between 3.2 to 3.5 kg. depending** upon its density.

(2) Mechanical Brick Properties.

(i) Compressive Strength of Bricks:

- It is the most important property of bricks especially when they are used in load-bearing walls.
- The compressive strength of a brick depends on the composition of the clay and degree of burning.
- It may vary from 3.5 N/mm2 to more than 20 N/mm2 in India.

- It is specified under the I.S. codes that an ordinary type building brick must possess a minimum compressive strength of 3.5 N/mm2 .
- The first and 2nd class bricks shall have a compressive strength not less than 7 N/mm2 and 14 N/mm2 respectively.

Thermal Properties of Building Bricks:

Besides being hard and strong, ideal bricks should also provide an adequate insulation against heat, cold and noise

. The heat and sound conductivity of bricks vary greatly with their density and porosity.

Very dense and heavy bricks conduct heat and sound at a greater rate. They have, therefore, poor thermal and acoustic (sound) insulation qualities.

For this reason, bricks should be so designed that they are light and strong and give adequate insulation.

Durability:

By durability of bricks, it is understood that the maximum time for which they remain unaltered and strong when used in construction.

Experience has shown that properly manufactured bricks are among the most durable of man-made materials of construction.

Their life can be counted in hundreds of years. The durability of bricks depends on some factors such as: absorption value, frost resistance, and efflorescence.

(i) Absorption Value.

This property is related to the porosity of the brick.

True Porosity is defined as the ratio of the volume of pores to the gross volume of the sample of the substance.

Apparent porosity, more often called Absorption value or simply absorption, is the quantity of water absorbed by the (brick) sample.

This is expressed in percentage terms of the dry weight of the sample: Absorption=W2 – W1 / W1 x 100. Where W2 is weight after 24 hours of immersion in water and W1 is the oven dry weight of the sample.

The absorption values of bricks vary greatly.It is, however, recommended that for first class bricks, they shall not be greater than 20 percent and for ordinary building bricks, not greater than 25 percent.

The absorption characteristic of bricks effects their quality in many ways:

Firstly:

higher porosity means fewer solid materials; hence, strength is reduced. **Secondly:**

higher absorption will lead to other water-related defects such as frost-action and efflorescence.

Thirdly: higher absorption results in deeper penetration of water which becomes a source of dampness.

There are four different operations are involved in the process of manufacturing of bricks:

- Preparation of clay.
- Moulding
- Drying.
- Burning.

1. Preparation of clay for brick manufacturing:

Preparation of clay for bricks manufacturing is done in six steps:

Unsoilingof clay We need pure clay for the preparation of bricks. The top layer of soil may contains impurities, so the clay in top layer of soil about 200mm depth is thrown away. This is called unsoiling.

Digging After the removal of top layer, the clay is dug out from the ground and spread on the plain ground.

Cleaning In this stage, the clay is cleaned of stones, vegetable matter etc. if large quantity of particulate matter is present, then the clay is washed and screened. The lumps of clay are converted into powder with earth crushing rollers.

Weathering The cleaned clay is exposed to atmosphere for softening. The period of weathering may be 3 to 4 weeks or a full rainy season. Generally, the clay is dug out just before the rainy season for larger projects.

Blending If we want to add any ingredient to the clay, it is to be added in this stage by making the clay loose and spread the ingredient over it. Then take small portion of clay into the hands and tuning it up and down in vertical direction. This process is called blending of clay.

Tempering In this stage, water is added to clay and pressed or mixed. The pressing will be done by cattle or with feet of men for small scale projects, pug mill is used as grinder for large scale projects. So, the clay obtains the plastic nature and now it is suitable for molding.

2. Molding of clay for brick manufacturing

In the molding process, prepared clay is mold into brick shape (generally rectangular). This process can be done in two ways according to scale of project.

- Hand molding (for small scale)

- Machine molding (for large scale)

Hand molding of bricks

If manufacturing of bricks is on a small scale and manpower is also cheap then we can go for hand molding. The molds are in rectangular shape made of wood or steel which are opened at the top and bottom.
The longer sides of molds are projected out of the box to serve it as handles. If we take durability in consideration steel molds are better than wooden molds. In hand molding again there are two types and they are

- Ground molded bricks
- Table-molded bricks

Ground molded bricks

- In this process of ground molding, first level the ground and sand or ash is sprinkled over it.
- Now place the wet mold in the ground and filled it with tempered clay and press hard to fill all corners of the mold. Extra clay is removed with metal strike or wood strike or with wire.
- The mold is then lifted up and we have raw brick in the ground. And again wet the mold by dipping it in water and repeat the same process. The process of dipping mold every time to make bricks is called slop molding.
- Sometimes, the inside surface of mold is sprinkled with sand or ash instead of dipping in water this is called sand molding
- Frog mark of bricks are made by using a pair of pallet boards. Frog mark means the mark of depth which is placed on raw brick while molding. The depth may be 10mm to 20mm.
- Frog mark stats the trademark of manufacturing company and also it is useful to store mortar in it when the bricks is placed over it.

Table molded bricks

- This process is similar to ground molding process, but here the bricks on molded on the table of size 2m x 1m.

- Ground molding is economical when compared to table molding.

Machine molding of bricks

we are having two types The bricks required are in large quantity, then machine molding is economical and also saves more time. Here also of machines,

- Plastic clay machines
- Dry clay machines

Plastic clay machines

This machines contain an opening in rectangular shape and when we place the tempered clay in to this machine it will come out through this opening.

Now, the rectangular strips coming out the opening are cut by wires to get required thickness of brick. So, these are also called wire cut bricks. Now these raw bricks are ready for the drying process.

Dry clay machines Dry clay machines are more time saving machines. We can put the blended clay into these machines directly without tempering.

Means tempering is also done in this machine by adding some water.

When the required stiffness is obtained the clay is placed in mold and pressed hard and well-shaped bricks are delivered. These are called pressed

bricks and these do not require drying they may directly sent to burning process. 

3. Drying of raw bricks

- After molding process the bricks contain some amount of moisture in it. So, drying is to be done otherwise they may cracked while burning. The drying of raw bricks is done by natural process.
- The bricks are laid in stacks. A stack consists 8 to 10 stairs. The bricks in these stacks should be arranged in such a way that circulation of air in between the bricks is free.
- The period of drying may be 3 to 10 days. It also depends upon the weather conditions.
- The drying yards are also prepared on higher level than the normal ground for the prevention of bricks from rain water.
- In Some situations artificial drying is adopted under special dryers or hot gases.

4. Burning of bricks

- In the process of burning, the dried bricks are burned either in clamps (small scale) or kilns (large scale) up to certain degree temperature. In this stage, the bricks will gain hardness and strength so it is important stage in manufacturing of bricks.
- The temperature required for burning is about 1100°C. If they burnt beyond this limit they will be brittle and easy to break. If they burnt under this limit, they will not gain full strength and there is a chance to absorb moisture from the atmosphere.
- Hence burning should be done properly to meet the requirements of good brick.

The good bricks which are used to be used for the construction of important structures should posses the following qualities:

- The bricks should be table-moulded. well burnt in kilns, Copper-coloured, free from cracks and with sharp and square edged. The colour should be uniform and bright.

- The brick should be uniform in shape and should be of standard size.

Standard	Imperial (in)	Metric (mm)
Australia	9 × 4⅓ × 3	230 × 110 × 76
Denmark	9 × 4¼ × 2¼	228 × 108 × 54
Germany	9 × 4¼ × 2¾	240 × 115 × 71
India	9 × 4¼ × 2¾	228 × 107 × 69
Romania	9 × 4¼ × 2½	240 × 115 × 63
Russia	10 × 4¾ × 2½	250 × 120 × 65
South Africa	8¾ × 4 × 3	222 × 106 × 73
Sweden	10 × 4¾ × 2½	250 × 120 × 62

Standard size of bricks

- The brick should give clear **metallic ringing sound** when struck with each other.

Striking of bricks with each other

- the bricks when broken or fractured should show a bright homogeneous and uniform compact structure free from voids.
- The brick should not absorb water more than **20%** by weight for first class bricks and **22%** by weight for second class bricks, when soaked in cold water

for a period of 24 hours. Bricks soaked in water

- No brick should have crushing strength below than **5.50 N/mm²**
- The brick when soaked in water for 24 hours, should not show deposits of white salts when allowed to dry in shade.
- It **should not break into pieces** when dropped flat on hard ground from a height of about one meter.
- It should be sufficiently hard. No impression should be left on brick surface, when it is scratched.
- It should have **low thermal conductivity** and it should be sound proof.

Composition of Good Brick Earth:

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 about 20% to 30% of alumina.
- This constituent imparts plasticity to the earth so that it can be moulded. If alumina is present in excess, with inadequate quantity of sand, the raw bricks shrink and warp during drying and burning and become too hard when burnt.

(2) Silica:

It exists in clay either as free or combined. As free sand, it is mechanically mixed with clay and in combined form, it exists in chemical composition with alumina. A good brick earth should contain about 50 per cent to 60 per cent of silica.

The presence of this constituent prevents cracking, shrinking and warping of raw bricks. It thus imparts uniform shape to the bricks. The durability of bricks depends on the proper proportion of silica in brick earth.

The excess of silica destroys the cohesion between particles and the bricks become brittle.

(3) Lime: A small quantity of lime not exceeding 5 per cent is desirable in good brick earth. It should be present in a very finely powdered state because even small particles of the size of a pin-head cause flaking of the bricks. The lime prevents shrinkage of raw bricks. The sand alone is infusible. But it slightly fuses at kiln temperature in presence of lime.

Such fused sand works as a hard cementing material for brick particles. The excess of lime causes the brick to melt and hence its shape is lost. The lumps of lime are converted into quick lime after burning and this quick lime slakes and expands in presence of moisture. Such an action results in splitting of bricks into pieces.

(4) Oxide of Iron:

A small quantity of oxide of iron to the extent of about 5 to 6 per cent is desirable in good brick earth.

It helps as lime to fuse sand. It also imparts red colour to the bricks. The excess of oxide of iron makes the bricks dark blue or blackish.

If, on the other hand, the quantity of iron oxide is comparatively less, the bricks will be yellowish in colour.

(5) Magnesia:

A small quantity of magnesia in brick earth imparts yellow tint to the bricks and decreases shrinkage. But excess of magnesia leads to the decay of bricks

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Types of Tests on Brick

-
  - 1. Absorption Test on Brick
  - 2. Crushing Strength or Compressive Strength Test on Brick
  - 3. Soundness Test of Brick
  - 4. Hardness Test on Brick
  - 5. Shape and Size Test on Brick
  - 6. Colour Test of Brick
  - 7. Structure Test of Brick
  - 8. Efflorescence Test on Brick

1. Absorption Test on Brick

The absorption test is the type of test conducted on bricks to determine the moisture absorbed by the bricks when subjected to extreme conditions.

The absorption test can be used as an indicator of the durability properties of bricks such as quality, degree of burning and behaviour of bricks in weathering.

The test can be briefly explained as follows:

Apparatus Required

1. A ventilated oven

2. A weighing balance with a sensitivity of less than 0.1%

3. Sample of whole bricks

Procedure

The procedure for the absorption test on bricks includes the following series of steps:

i. The brick specimen is first dried in the ventilated oven at a temperature ranging from 105 degrees Celsius to 115 degrees Celsius until the specimen attains a constant mass.

- ii. The heated specimen is then allowed to cool at room temperature.
- iii. The specimen is weighed and its mass is recorded (M1).
- iv. Then, the specimen is immersed in water at a temperature of about 27 degrees Celsius for 24 hours.
- v. The brick specimen is taken out from the water and wiped with a clean cloth to remove the traces of water that may be present.
- vi. The specimen thus obtained is then weighed (M2).
-
- Calculation of Water Absorption of Bricks
- Water absorption by the brick specimen is given by the formula,

- $$W = \frac{M_2 - M_1}{M_1} X\ 100$$
- The average result shall be reported.
- where,
- M2 = Wet Weight of brick after immersion of brick in water for 24 hours
  M1 = Dry Weight after oven drying of brick at 105-110 deg. C
-

2. Crushing Strength or Compressive Strength Test on Brick

Bricks that are used for masonry construction are generally subjected to compressive loads thus it is necessary to determine the compressive strength of bricks.
The compressive strength test is also known as the crushing strength test which is an important type of laboratory test conducted on bricks to determine the load-carrying capacity of bricks when subjected to a compressive load.

This test is performed utilizing a compression testing machine.

The test can be briefly explained as follows:

Apparatus & Materials Required

1. Compression Testing Machine

2. Sample of whole bricks

3. Cement, sand, aggregate for specimen preparation

Specimen Preparation

The samples of whole bricks are first taken and the unevenness is removed.

The dimensions are duly measured.

The samples are then immersed in water for 24 hours at room temperature. After 24 hours, the specimen is removed and dried.

If traces of water are still present, it is wiped out with a clean cloth.

Then, cement mortar is prepared and the frog of the specimen is filled with the prepared cement mortar.

Any voids present are also filled with cement mortar.

The mortar filled bricks specimen is then stored in damp jute bags for 24 hours.

Keep the bricks in water for 3 to 7 days. This is to permit the mortar to harden.

Procedure

The procedure for the crushing strength test on bricks involves the following series of steps:

1. The specimen with the mortar filled face upwards is placed in the plates of the compression testing machine.

2. The load is then applied axially at a uniform rate of 14N/ mm^2 per minute until failure occurs. The maximum load at failure is recorded.

3. The compressive strength is then calculated using the following formula:

Compressive Strength= Maximum load at failure / Average Area of Bed Face

3. Soundness Test of Brick

A soundness test on bricks is carried out to determine the nature of bricks when subjected to sudden impact.

It is a simple test in which two bricks are taken randomly from the stack of bricks.

The bricks are then struck against each other.

If it emits a clear metallic ringing sound; the brick is of good quality.

. Hardness Test on Brick

The hardness of bricks generally implies the resistance of bricks to scratch.

For this test, the brick is scratched with a sharp tool or fingernail.

If the scratching does not leave behind any impression on the brick, it is considered as a hard brick.

5. Shape and Size Test on Brick

To maintain uniformity in the construction, the bricks must be of proper shape and uniform size.

A good brick must have a proper rectangular shape with sharp edges.

For this test, about 20 bricks from the stacked bricks are taken.

The samples taken are then stacked along the length, breadth and height and duly compared.

If all the bricks are of similar size, then they can be used in construction works.

6. Colour Test of Brick

The Colour test of bricks simply involves the visual examination of bricks for acceptable bright uniform colour throughout the body of the brick.

7. Structure Test of Brick

Structure test of bricks includes the process of breaking the brick followed by the observation of the inner portion of brick clearly to check the homogeneity and presence of lumps.

8. Efflorescence Test on Brick

A good brick should be free from soluble salts.

The presence of soluble salts in the bricks leads to efflorescence on the bricks thereby decreasing the quality of bricks.

To carry out the efflorescence test on bricks, the sample bricks are taken and immersed in water for 24 hours.

Then, the specimen is allowed to dry in shade.

After complete drying, the specimen is thoroughly observed.

If any white or grey patches are seen on the brick surface, it indicates the presence of soluble salts and is not suitable for construction.

QUESTION

1.What is brick?

- Brick is a type of block used to build walls, pavements and other elements in masonry construction.
- Property ,the term brick denotes a block composed of dried clay, but is now also used informally to denote other chemically cured construction blocks.

2.How many type of bricks are based on quality?

There are three types of bricks are based on quality.

1^{st} class brick

2^{nd} class brick

3^{rd} class brick

3.write two advantages of brick?

- The bricks are obtained by moulding clay in rectangular blocks of uniform size and the then by drying and burning these blocks.
- As bricks are of uniform size, they can be properly arranged.
- They are light in weight no lifting appliance is required for them.

4.Write two physical properties of brick?

1. Colour.

The most common color of building bricks falls under the class RED. It may vary from deep red to light red to buff and purple.

Very dark shades of red indicate over burnt bricks whereas yellow color is often indicative of under-burning.

2. Density.

The density of bricks or weight per unit volume depends mostly on the type of clay used and the method of brick molding (soft-mud, Stiff-mud, hard-pressed etc.).

In the case of standard bricks, density varies **from 1600 kg/m3 to 1900 kg/m3** . A **single brick (19 x 9 x 9 cm)** will weigh **between 3.2 to 3.5 kg. depending** upon its density.

5.what is moulding?

In the molding process, prepared clay is mold into brick shape (generally rectangular). This process can be done in two ways according to scale of project.

- Hand molding (for small scale)
- Machine molding (for large scale)

- **What is nominal size of bricks?**

  Nominal size

  19cmx9cmx9cm

  Standard size.20cmx10cmx10cm

LONG QUESTIONS

1.Define classification of brick which are based on quality?

2.Explain the process of manufacturing of bricks ?

3.Explain the test on bricks ?

4.Explain qualities of good building ?

5. Explain compostion of good bricks?

Chapter -3 CEMENT,MORTAR,CONCRETE

CEMENT

- A **cement** is a binder, a substance used for construction that sets,hardens, and adheres to other materials to bind them together.

- Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete.
- Concrete is the most widely used material in existence and is behind only water as the planet's most-consumed resource.

4 Properties of Cement :

Physical & Chemical Properties

- Properties of Cement
  - A. Physical Properties of Cement
    - 1. Fineness
    - 2. Soundness
    - 3. Consistency
    - 4. Setting Time
    - 5. Heat of hydration
    - 6. Strength of Cement
    - 7. Compressibility
  - B. Chemical Properties of Cement
    - a. Lime
    - b. Alumina
    - c. Sulfur Trioxide
    - d. Iron oxide
    - e. Silica
    - f. Alkaline

- g. Magnesia

Ingredient	Percentage in cement
Lime	60-65
Silica	17-25
Alumina	3-8
Magnesia	1-3
Iron oxide	0.5-6
Calcium Sulfate	0.1-0.5
Sulfur Trioxide	1-3
Alkaline	0-1

A. Physical Properties of Cement

1. Fineness

1.It is the biggest factor in the strength of cement. Higher fineness leads to higher strength.

2.Higher fineness denotes more area for cement-water reaction increasing strength.

3.Fineness in cement is achieved by grinding the clinker during the process of production.

2. Soundness

1.The capacity of not changing of properties of the material, like volume change; when water is added to it, is soundness.

2.Material with high soundness has a higher strength. So cement should also have high soundness.

3.Cement should be the cause of high soundness in mortar and concrete.

A few reasons for unsoundness are :

1. Excessive use of Gypsum in cement.

2. Excess of Lime

3. Burned Less

4. Excessive magnesia content

Some of the tests carried out to ensure the soundness are:

a. Le Chatelier Test

b. Autoclave Test

3. Consistency

Uniformity in the nature of the material leads to higher consistency. So, cement should have high consistency.

In other words, the flowing ability of cement paste is called consistency.

4.. Setting Time

When water is added to the cement, it hardens and sets.

Setting time may depend upon uniformity of cement, water-cement ratio, presence of admixtures, etc.

The initial setting time of the cement should not be less, and the final setting time should not be high.

The best initial and final setting time for cement is given as:

Initial Setting Time: 30-45 Minutes

Final Setting Time: Below 10 Hours

Types of Cement and their Uses

- Ordinary Portland Cement (OPC)
- Portland Pozzolana Cement (PPC)
- Rapid Hardening Cement
- Quick setting cement
- Low Heat Cement
- White Cement
- Colored cement
- Air Entraining Cement
- Expansive cement
- Hydrographic cement

1. Ordinary Portland Cement (OPC)

Ordinary Portland cement is the most widely used type of cement, which is suitable for all general concrete construction. It is the most commonly produced and used type of cement around the world, with annual global production of around 3.8 million cubic meters per year. This cement is suitable for all kinds of concrete construction.

2. Portland Pozzolana Cement (PPC)

Portland pozzolana cement is prepared by grinding pozzolanic clinker with Portland cement. It is also produced by adding pozzolana with the addition of gypsum or calcium sulfate or by intimately and uniformly blending Portland cement and fine pozzolana.

This cement has a high resistance to various chemical attacks on concrete compared with ordinary portland cement, and thus, it is widely used. It is used in marine structures, sewage works, sewage works, and for laying concrete underwater, such as bridges, piers, dams, and mass concrete works, etc.

3. Rapid Hardening Cement

Rapid hardening cement attains high strength in the early days; it is used in concrete where formworks are removed at an early stage and are similar to ordinary portland cement (OPC). This cement has increased lime content and contains higher c3s content and finer grinding, which gives higher strength development than OPC at an early stage.

The strength of rapid hardening cement at the three days is similar to 7 days strength of OPC with the same water-cement ratio. Thus, the advantage of this

cement is that formwork can be removed earlier, which increases the rate of construction and decreases the cost of construction by saving formwork cost.

Rapid hardening cement is used in prefabricated concrete construction, road works, etc.

4. Quick setting cement

The difference between the quick setting cement and rapid hardening cement is that quick-setting cement sets earlier. At the same time, the rate of gain of strength is similar to Ordinary Portland Cement, while quick hardening cement gains strength quickly. Formworks in both cases can be removed earlier.

Quick setting cement is used where works is to be completed in very short period and for concreting in static or running water.

5. Low Heat Cement

Low heat cement is produced by maintaining the percentage of tricalcium aluminate below 6% by increasing the proportion of C2S. A small quantity of tricalcium aluminate makes the concrete to produce low heat of hydration. Low

heat cement suitable for mass concrete construction like gravity dams, as the low heat of hydration, prevents the cracking of concrete due to heat.

This cement has increased power against sulphates and is less reactive and initial setting time is greater than OPC.

9. White Cement

It is prepared from raw materials free from Iron oxide and is a type of ordinary portland cement, which is white. It is costlier and is used for architectural purposes such as precast curtain wall and facing panels, terrazzo surface, etc. and for interior and exterior decorative work like external renderings of buildings, facing slabs, floorings, ornamental concrete products, paths of gardens, swimming pools, etc.

10. Colored cement

It is produced by mixing 5- 10% mineral pigments with ordinary cement. They are widely used for decorative works on floors.

11. Air Entraining Cement

Air entraining cement is produced by adding indigenous air-entraining agents such as resins, glues, sodium salts of sulfates, etc. during the grinding of clinker.

This type of cement is especially suited to improve the workability with a smaller water-cement ratio and to improve frost resistance of concrete.

12. Expansive Cement

Expansive cement expands slightly with time and does not shrink during and after the time of hardening. This cement is mainly used for grouting anchor bolts and prestressed concrete ducts.

13. Hydrographic cement

Hydrographic cement is prepared by mixing water-repelling chemicals and has high workability and strength. It has the property of repelling water and is unaffected during monsoon or rains.

Hydrophobic cement is mainly used for the construction of water structures such as dams, water tanks, spillways, water retaining structures, etc.

5. Heat of hydration

The chemical reaction between cement and water is called the heat of hydration.

When water is added to cement, heat is generated. This can affect cement quality because excessive hydration leads to undesired strength.

Hydration depends upon the water-cement ratio, uniformness, temperature of curing, etc.

The heat of hydration is mainly affected by C_3S and C_3A.

6. Strength of Cement

Compressive, tensile, and flexural strength play a vital role in the durability and quality of cement.

Factors affecting the strength of cement are:

a. Water-cement ratio of a mix.

b. Cement-fine aggregate ratio

c. Curing conditions

d. Size and shape of a specimen

e. The manner of moulding and mixing

f. Loading conditions

g. Age of cement

7. Compressibility

Cement has high compressive strength. Thus, it provides stability and durability to the structure.

B. Chemical Properties of Cement

a. Lime

If the lime is used more than 65 %, it may result in the problem of expansion.

b. Alumina

Excess use of alumina quickens the setting time but weakens the cement bonding.

c. Sulfur Trioxide

If more Sulfur Trioxide is used, the cement becomes unsound.

d. Iron oxide

It is also called Ferric Oxide. It is responsible for the colour of the cement.

e. Silica

Silica provides high compressive strength, abrasion resistance, and bond strength to cement.

f. Alkaline

The high amount of alkali use leads to difficulty in the regulation of setting time, and the low amount leads to discolouration of cement.

g. Magnesia

If the magnesia is used in high amounts, it results in unsoundness and uneconomical.

Cement Manufacture

There are six main stages of cement manufacturing process.

Stage 1

Raw Material Extraction/Quarry

The raw cement ingredients needed for cement production are limestone (calcium), sand and clay (silicon, aluminum, iron), shale, fly ash, mill scale and bauxite. The ore rocks are quarried and crushed to smaller pieces of about 6 inches.

Secondary crushers or hammer mills then reduce them to even smaller size of 3 inches. After that, the ingredients are prepared for pyroprocessing.

Stage 2

Grinding, Proportioning and Blending

The crushed raw ingredients are made ready for the cement making process in the kiln by combining them with additives and grinding them to ensure a fine homogenous mixture.

The composition of cement is proportioned here depending on the desired properties of the cement. Generally, limestone is 80% and remaining 20% is the clay. In the cement plant, the raw mix is dried (moisture content reduced to less than 1%); heavy wheel type rollers and rotating tables blend the raw mix and then the roller crushes it to a fine powder to be stored in silos and fed to the kiln.

Stage 3

Pre-Heating Raw Material

A pre-heating chamber consists of a series of cyclones that utilizes the hot gases produced from the kiln in order to reduce energy consumption and make the cement making process more environment-friendly.

The raw materials are passed through here and turned into oxides to be burned in the kiln.

Stage 4

Kiln Phase

The kiln phase is the principal stage of the cement production process. Here, clinker is produced from the raw mix through a series of chemical reactions between calcium and silicon dioxide compounds. Though the process is complex, the events of the clinker production can be written in the following sequence:

- Evaporation of free water
- Evolution of combined water in the argillaceous components
- Calcination of the calcium carbonate ($CaCO_3$) to calcium oxide (CaO)
- Reaction of CaO with silica to form dicalcium silicate

- Reaction of CaO with the aluminum and iron-bearing constituents to form the liquid phase
- Formation of the clinker nodules
- Evaporation of volatile constituents (e. g., sodium, potassium, chlorides, and sulfates)
- Reaction of excess CaO with dicalcium silicate to form tricalcium silicate

The above events can be condensed into four major stages based on the change of temperature inside the kiln:

- 100°C (212°F): Evaporation of free water
- 100°C (212°F)-430°C (800°F): Dehydration and formation of oxides of silicon, aluminum, and iron
- 900°C (1650°F)-982°C (1800°F): CO2 is evolved and CaO
- is produced through calcination
- 1510°C (2750°F): Cement clinker is formed

The kiln is angled by 3 degrees to the horizontal to allow the material to pass through it, over a period of 20 to 30 minutes. By the time the raw-mix reaches the lower part of the kiln, clinker forms and comes out of the kiln in marble-sized nodules.

Stage 5

Cooling and final grinding

After exiting the kiln, the clinker is rapidly cooled down from 2000°C to 100°C-200°C by passing air over it. At this stage, different additives are combined with the clinker to be ground in order to produce the final product, cement.

Gypsum, added to and ground with clinker, regulates the setting time and gives the most important property of cement, compressive strength.

It also prevents agglomeration and coating of the powder at the surface of balls and mill wall.

Some organic substances, such as Triethanolamine (used at 0.1 wt.%), are added as grinding aids to avoid powder agglomeration.

Other additives sometimes used are ethylene glycol, oleic acid and dodecyl-benzene sulphonate.

The heat produced by the clinker is circulated back to the kiln to save energy. The last stage of making cement is the final grinding process.

In the cement plant, there are rotating drums fitted with steel balls. Clinker, after being cooled, is transferred to these rotating drums and ground into such a fine powder that each pound of it contains 150 billion grains. This powder is the final product, cement.

Stage 6

Packing and Shipping

Cement is conveyed from grinding mills to silos (large storage tanks) where it is packed in 20-40 kg bags. Most of the product is shipped in bulk quantities by trucks, trains or ships, and only a small amount is packed for customers who need small quantities.

MORTAR

The term mortar is used to indicates a paste prepared by adding required quantity of water to a mixture of binding material like cement or lime and fine aggregate like sand .

Types of mortar

- Cement Mortar
- Lime Mortar
- Surki Mortar
- Gauged Mortar
- Mud Mortar

Cement Mortar

Cement mortar is a type of mortar where cement is used as binding material and sand is used as fine aggregate. Depending upon the desired strength, the cement to the sand proportion of cement mortar varies from 1:2 to 1:6.

Lime Mortar

Lime mortar is a type of mortar where lime (fat lime or hydraulic lime) is used as binding material and sand is used as fine aggregate. The lime to the sand proportion of cement mortar is kept 1:2. The pyramids at Giza are plastered with lime mortar.

Gauged Mortar

Gauged mortar is a type of mortar where cement and lime both are used as binding material and sand is used as fine aggregate. Basically, it is a lime mortar where cement is added to gain higher strength. The process is known as gauging. The cement to the lime proportion varies from 1:6 to 1:9. Gauged mortar is

economical than cement concrete and also possess higher strength than lime mortar.

Surki Mortar

Surki mortar is a type of mortar where lime is used as binding material and surki is used as fine aggregate. Surki mortar is economic.

Surkhi Mortar

Mud Mortar

Mud mortar is a type of mortar where mud is used as binding material and sawdust, rice husk or cow-dung is used as fine aggregate. Mud mortar is useful where lime or cement is not available.

SAND

Sand is **used for making concrete, mortars, and plasters and also for filling under floor, basements**. To avoid transport expenses as it plays a major part of the cost of sand, as far as possible local sand is preferred to maintain the economy in construction.

Natural Sources of Sand:

1) Pit sand

(2) River sand

(3) Sea sand.

1) Pit Sand: T

his sand is found as deposits in soil and it is obtained by forming pits into soils. It is excavated from a depth of about 1 m to 2 m from ground level. The pit sand consists of sharp angular grains which are free from salts and it proves to be excellent material for mortar or concrete work. For making mortar, the clean pit sand free from organic matter and clay should only be used.

When rubbed between the fingers, the fine pit sand should not leave any stain on the fingers. If there is any stain, it indicates the coating of oxide of iron over the sand grains.

(2) River Sand:

This sand is obtained from banks or beds of rivers. The river sand consists of fine rounded grains probably due to mutual attrition under the action of water current. The colour of river sand is almost white. As river sand is usually available in clean condition, it is widely used for all purposes.

3) Sea Sand:

This sand is obtained from sea shores. The sea sand, like river sand, consists of fine rounded grains. The colour of sea sand is light brown. The sea sand contains salts. These salts attract moisture from the atmosphere. Such absorption causes dampness, efflorescence and disintegration of work. The sea sand also retards the setting action of cement.

Due to all such reasons, it is the general rule to avoid the use of sea sand for engineering purposes except for filling of basement, etc. It can however be used as a local material after being thoroughly washed to remove the salt.

Classification of Sand:

According to the size of grains, the sand is classified as fine, coarse and gravelly.

The sand passing through a screen with clear openings of 1.5875 mm is known as the fine sand. It is mainly used for plastering.

The sand passing through a screen with clear openings of 3.175 mm is known as the coarse sand. It is generally used for masonry work.

The sand passing through a screen with clear openings of 7.62 mm is known as the gravelly sand. It is generally used for concrete work.

Bulking Of Sand:

The presence of moisture in sand increases the volume of sand. This is due to the fact that moisture causes film of water around sand particles which results in the increase of volume of sand. For a moisture content of about 5 to 8 per cent, this increase of volume may be as much as 20 to 40 per cent, depending upon the grading of sand.

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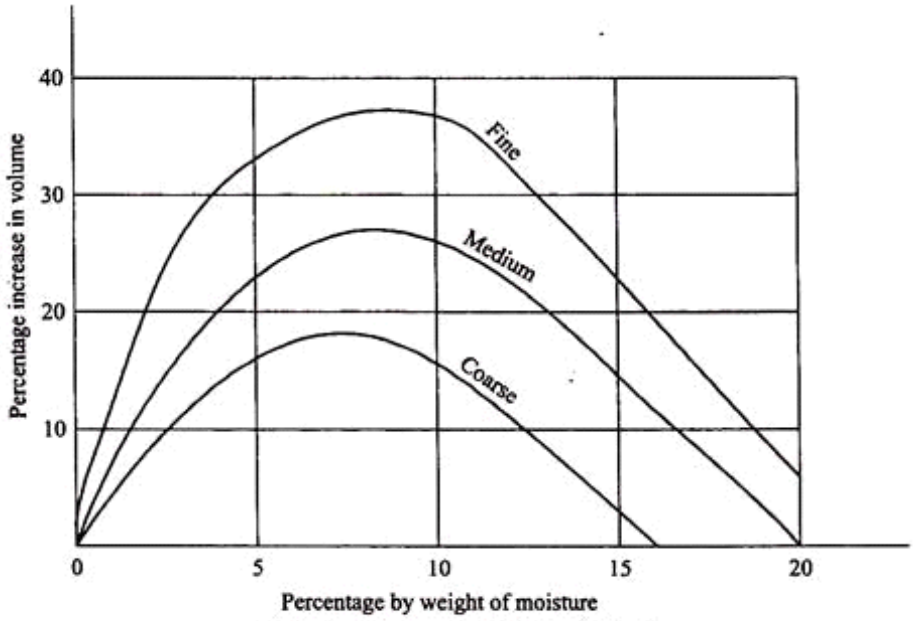


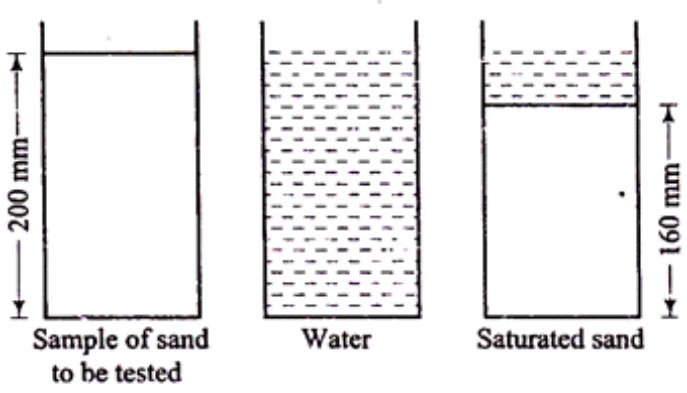
Chart showing bulking of sand
FIG. 7-1

When moisture content is increased by adding more water, the 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.

The bulking of sand affects the volumetric proportioning of sand to a large extent. It is more with fine sand and less with coarse sand. If proper allowance is not made for the bulking of sand, the cost of concrete and mortar increases and it results into under-sanded mixes which are harsh and difficult for working and placing.

A very simple test, as shown in fig.

may be carried out to decide the percentage of bulking of sand.



Bulking of sand
FIG. 7-2

Following procedure is adopted:

(i) A container is taken and it is filled two-third with the sample of sand to be tested.

(ii) The height is measured, say it is 200 mm.

(iii) The sand is taken out of container. Care should be taken to see that there is no loss of sand during this transaction.

(iv) The container is filled with water.

(v) The sand is then slowly dropped in the container and it is thoroughly stirred by means of a rod.

(vi) The height of sand is measured, say it is 160 mm.

$$\text{Then, Bulking of sand} = \frac{(200-160)}{160} = \frac{40}{160} = \frac{1}{4} \text{ or } 25\%.$$

Properties of Good Sand:

Following are the properties of good sand:

(i) It should be chemically inert.

(ii) It should be clean and coarse. It should be free from any organic or vegetable matter. Usually 3 to 4% clay is permitted.

(iii) It should contain sharp, angular, coarse and durable grains.

(iv) It should not contain salts which attract moisture from the atmosphere.

GRAVEL

GRAVEL loose aggregation of small, variously sized fragments of rock. It has a wide range of applications in the construction industry.

The weathering and erosion of rocks is the natural process by which gravel deposits are formed. Gravel can also be produced in quarries known as gravel pits, where rocks such as sandstone, limestone and basalt are crushed down to size. Gravel particle sizes range from 2 mm to over 60 mm, and are available in a range of colours, textures and stone types.

Gravel, along with sand, is used for the manufacture of concrete, as well as for mixing with asphalt as part of road construction. It can be used as the base layer for roads before being covered with tarmac, and is also commonly used

to surface roadways, especially those in rural areas and in icy conditions. It can also be used to as part of roof coverings.

Gravel can be used along with pebbles as a form of render known as pebbledash which is used for the external walls of a building in which the top coat is textured to create a rough finish. For more information, see Pebbledash.

Gravel can be used in the filtration of water, where it acts as a natural filter holding back precipitates which may contain impurities as well as other sand-sized particles. The angularity and hardness of gravel makes it resistant to water erosion.

Gravel is commonly used for landscaping applications, such as on driveways, walkways, or as a decorative filler over soil instead of grass.

MORRUM

Moorum(or murum) is the word derived from the Tamil language, which means powdered rock.

Moorum is also a type of soil, mostly used for construction purposes. Generally, it is deep brown or red in color. Moorum is used in plinth filling, road pavements, backfilling in trenches, footing pits, etc. It is a suitable type of soil in the construction field, since it does not contain any organic matter and can be compacted easily forming hard surfaces.

Soil: The soil is defined as a complex mixture of minerals, gravels, organic matter, rock particles, etc. In other words, the soil is the upper crust of the earth, supporting animals and plant growth with countless organisms within it.

FLY ASH

Fly ash is a coal combustion product that is composed of the fine particles of burned fuel that are driven out of coal-fired boilers together with the flue gases.

Fly ash is a multifunctional material and can be used for different purposes, its utilization depends on local conditions and it can be used in different ways for different products.

The government of India has issued guidelines to use at least 25% ash in the manufacture of clay bricks, blocks, or tiles within a radius of 50 km from coal or lignite based thermal power plants.

Uses of Fly Ash

Portland Pozzolana Cement

Fly Ash is blended with Portland cement to manufacture Portland Pozzolana Cement. The minimum and maximum percentages of fly ash in Portland Pozzolana Cement (PPC), specified by IS – 456, have risen from 10% to 15% and from 25% to 35% respectively.

Fly Ash Concrete

Fly ash is used as a replacement for Portland cement in concrete, it replaces up to 30% by mass of Portland cement, but can be used in higher percentage in certain applications. In some cases, fly ash increases concrete's final strength and its chemical resistance and durability.

In concrete, fly ash can be used as partial replacement of cement and sand to enhance the workability of fresh concrete, to reduce the heat of hydration and to improve concrete impermeability and resistance to sulphate attack. Fly ash in concrete can be used when its properties lie in certain limits as of concrete but classification by particle size and control of the unburned coal greatly enhances the beneficial effects of the fly ash.

Fly Ash Bricks

One method by which fly ash bricks are manufactured by mixing it with an equal amount of clay and then firing in a kiln at about 1000 °C. This method reduces the amount of clay required. Another type of fly ash brick is made by mixing soil, Plaster of Paris (POP), fly ash and water, and allowing the mixture to dry. This method reduces air pollution as no heat is required.

Roller Compacted Concrete (RCC)

Fly ash is also used in roller compacted concrete dams. It lowers the heat of hydration allowing thicker placements to occur.

Soil Stabilization

Soil stabilization is the permanent physical and chemical change of soils to increase their physical properties. It can be achieved with a variety of chemical additives which includes fly ash for which proper design and testing is done.

Embankments

Fly ash is also used for embankment construction, it has a large uniformity coefficient and it consists of clay-sized particles. Grain size distribution, compaction characteristics, shear strength, compressibility, permeability, and frost susceptibility, these properties affect the use of fly ash in embankments.

Other Uses:

- Fly ash is also used in the production of flowable fill.
- Fly ash is used as a component in geopolymers.
- When fly ash is treated with silicon hydroxide, it acts as a catalyst.
-

CONCRETE

Concrete, an artificial stone-like mass, is the composite material that is created by mixing binding material (cement or lime) along with the aggregate (sand, gravel, stone, brick chips, etc.), water, admixtures, etc in specific proportions. The strength and quality are dependent on the mixing proportions.

$$\text{Concrete} = \underline{\text{Binding Material}} + \underline{\text{Fine \& Coarse Aggregate}} + \underline{\text{Water}} + \underline{\text{Admixture (optional)}}$$

Concrete is a very necessary and useful material for construction work. Once all the ingredients -cement, aggregate, and water unit of measurement mixed inside the required proportions, the cement and water begin a reaction with one another to bind themselves into a hardened mass. This hardens the rock-like mass in the concrete.

Concrete is powerful, easy to create, and can be formed into varied shapes and sizes. Besides that, it is reasonable, low cost, and instantly mixed. It is designed to allow reliable and high-quality fast-track construction.

Composition of Basic Concrete Mix

If we evaluate the concrete composition to see what concrete is made of, we can see there are four basic ingredients within the concrete material mix:

- Binding materials like cement or lime
- Aggregates or Inert Materials
    - Fine aggregate (sand)
    - Coarse aggregate (stone chips, brick chips)
- Water
- Admixture (e.g. Pozzolana)

Binding Materials

Binding material is the main element of a concrete material mix. Cement is the most commonly used binding material. Lime could also be used. When water is mixed with the cement, a paste is created that coats the aggregates within the mix. The paste hardens, binds the aggregates, and forms a stone-like substance.

Aggregates

Sand is a fine mixture. Gravel or crushed stone is the coarse mixture in most mixes.

Water

Water is required to with chemicals react with the cement (hydration) and to supply workability with the concrete. The number of water combined in pounds compared with the number of cement is named the water/cement quantitative relation. The lower the w/c quantitative relation, the stronger the concrete. (Higher strength, less permeability)

Types of Concrete Mix

Concrete is employed for various projects starting from little homemade comes to large subject field buildings and structures. It is used for sidewalks, basements, floors, walls, and pillars at the side of several alternative uses. Many sorts of concrete are utilized in the development works.

Based on the variations in concrete materials and purposes, concrete can be classified into three basic categories–

- Lime Concrete
- Cement Concrete
- Reinforced Cement Concretes

Lime Concrete

Lime concrete uses Lime as the binding material. Lime is usually mixed with surki and khoa or stones in the proportion 1:2:5 unless otherwise specified. The khoa or stones are soaked in water before mixing. Lime concrete is used mainly in foundation and terrace roofing.

Advantages of Lime Concrete

- Lime concrete is cheaper than cement concrete.
- Lime concrete is more workable than cement concrete.
- Lime concrete has a lower heat of hydration, which makes it suitable for mass concrete works.

- Lime concrete has good resistance to fire.
- Lime concrete has good resistance to sulfate attack.

Disadvantages of Lime Concrete

- Lime concrete has a lower strength than cement concrete.
- Lime concrete is not as durable as cement concrete.
- Lime concrete is susceptible to attack by frost.

Cement Concrete

Most engineering construction uses cement concrete composites as the main building material. It consists of cement, sand, brick chips, or stone chips of the required size. The usual proportion is 1:2:4 or 1:3:6. After mixing the required amounts of concrete materials, the mix is cured with water for 28 days for proper strength building.

Cement concrete is a versatile construction material with a wide range of applications. It can be used in structural applications such as beams, columns, slabs, and foundations. It can also be used in non-structural applications such as paving, curbing, and landscaping. Cement concrete is also a popular choice for precast applications such as pipes, paving stones, and sewer systems.

The main advantages of cement concrete are its strength, durability, and fire resistance. It is also relatively low maintenance and can be easily repaired if damaged. However, cement concrete is a relatively heavy material and can be difficult to work with. It is also susceptible to cracking and can be damaged by extreme weather conditions.

Reinforced Cement Concretes

For enhancing the tensile strength of concrete, steel reinforcements are added. Sometimes, RCC is prestressed under compression to eliminate or reduce tensile stresses. The resulting concrete is known as Prestressed Concrete.

The word 'Reinforced' means 'strengthened' or 'supported'. Reinforced Cement Concrete, therefore, is a composite material consisting of concrete and steel reinforcements.

The steel reinforcements used in RCC can be in the form of rods, bars, wires, meshes, etc. The concrete is cast around these steel reinforcement bars or rods to form the desired shape. The steel reinforcement bars are placed in such a way that they provide enough support to the concrete against the expected loads.

The steel reinforcement bars are placed in such a way that they provide enough support to the concrete against the expected loads.

Workability

It means the ability of concrete to handle, transport and placing without any segregation. The concrete said to be workable if it can be easily handled, placed and transported without any segregation while placing it in site.

Water cement ratio–

The amount of water to the amount of cement by weight is termed the water cement ratio.

The strength and quality of concrete depends on the ratio.

The steps involved in the process of **concreting** are:

Placing of Concrete

- The concreting shall be commenced only after the inspection of centering, shuttering, and reinforcement is completed.
- The shuttering shall be clean and free from shavings, sawdust, pieces of wood, or other foreign material.
- In case of concreting of slabs and beams, wooden plank or catwalks of chequered MS plates supported directly on the centering with the use of

wooden blocks or lugs should be provided to convey the concrete to the desired location without disturbing the reinforcement.

- The workers shall not be allowed to walk over the reinforcement.
- In the case of columns and walls, it is desirable to place concrete without construction joints.
- The progress of concreting in the vertical direction shall be restricted to one meter per hour.
- The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients.
- In deep trenches and footings, concrete shall be placed through chutes.
- In the case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 meters at a time.
- During cold weather, concreting shall not be done when the temperature falls below 4.5°C.
- The concrete shall be protected against frost action by suitable methods. The concrete, if damaged by frost, shall be removed and placed again.
- During hot conditions, precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C.
- The time taken between mixing and placing of concrete shall not exceed 30 minutes of the initial setting process, else retarders must be used in the concrete to keep it green for the desired period.

Compaction of Concrete

- The concrete shall be compacted into dense mass immediately after placing it by means of mechanical vibrators designed for continuous operations.
- Hand compaction shall be carried out with the help of tamping rods to thoroughly compact the concrete around the reinforcement, embedded fixtures, and into corners of the form.

- The concrete layers shall be placed so that the bottom layer is not completely set before the top layer of the concrete is laid.
- The vibration shall keep the concrete in an agitated state until the concrete is entirely de-aerated and compacted.
- The concrete shall be compacted adequately until the mortar fills the spaces between the coarse aggregates and starts to cream up to form an even and finished surface.
- When this condition is achieved, the vibrator shall be stopped and removed from the concrete.
- The needle vibrators shall be withdrawn so as to prevent the action of loose pockets in case of internal vibrators.
- In case both external and internal vibrators are being employed for compaction, the internal vibrator shall be withdrawn first, after which the external vibrators shall be removed so that no loose pocket or air gaps are left in the concrete.
- Shaking of reinforcement for the purpose of compaction should be avoided.
- The whole process of compaction shall be completed before the initial setting begins, i.e., within 30 minutes of mixing of water into the dry mix of concrete.

Curing of Concrete

- Once the concrete has begun to harden, i.e., about 1 to 2 hours after it is laid, it shall be protected from quick-drying by covering with moist gunny bags, sand, canvass Hessian, or any other material.
- The surface of concrete shall be cured after 24 hours of laying of concrete by ponding method for a minimum period of seven days from the date of placing of concrete.

GRADES OF CONCRETE

It defined by the **concrete mix proportion** and the **minimum** strength of **concrete** at end of **28 days curing** period.

There are different **types of concrete mix** which are based on concrete **classification** according to its **compressive strength.**

The number of grades of nominal concrete mixes, is 7: M5, M10, M15, M20, M25,

M5= 1:5:10 M10=1:3:6 M15=1:2:4 M20=1:1.5:3 ,M25=1:1:2

For making concrete we use cement, sand, aggregate, and water which are mixed with a certain ratio, and concrete is cast and put in a cube of 150 mm size and put in a water bath for 28 days and afterward, it is tested in a compression testing machine. The compressive stress result is known as the "grade of concrete". It is expressed in N/mm^2.

The "M" refers to Mix and Number after M (M10, M20) Indicating the compressive strength of concrete after 28 days of curing and testing.

M indicates the proportion of materials like Cement: Sand: Aggregate (1:2:4) or Cement: Fine Aggregate: Coarse Aggregate.

If we mention M10 concrete, it means that the concrete has 10 N/mm2 characteristic compressive strength at 28 days.

Questions

1.What is cement ?

A **cement** is a binder, a substance used for construction that sets,hardens, and adheres to other materials to bind them together.

Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete.

2.what are the properties of cement ?

Lime

Alumina

,Silica

,Sulfur trioxide,

magnesia ,

Alkalis.

- **What is intial and final setting time of cement ?**
- Setting time may depend upon uniformity of cement, water-cement ratio, presence of admixtures, etc. The initial setting time of the cement should not be less, and the final setting time should not be high.
- The best initial and final setting time for cement is given as:
- **Initial Setting Time:** 30-45 Minutes
- **Final Setting Time:** Below 10 Hours
-

4.what is heat of hydration?

The chemical reaction between cement and water is called the heat of hydration.

When water is added to cement, heat is generated. This can affect cement quality because excessive hydration leads to undesired strength.Hydration depends upon the water-cement ratio, uniformness, temperature of curing, etc.

The heat of hydration is mainly affected by C_3S and C_3A.

5.what is water cement ratio ?

The amount of water to the amount of cement by weight is termed the water cement ratio.

The strength and quality of concrete depends on the ratio.

6.what is mortar ?

The term mortar is used to indicates a paste prepared by adding required quantity of water to a mixture of binding material like cement or lime and fine aggregate like sand.

7.What are the type of mortar ?

- Cement Mortar
- Lime Mortar
- Surki Mortar
- Gauged Mortar
- Mud Mortar

8.what is sand ?

Sand is **used for making concrete, mortars, and plasters and also for filling under floor, basements**. To avoid transport expenses as it plays a major part of the cost of sand, as far as possible local sand is preferred to maintain the economy in construction.

9.what is gravel ?

GRAVEL loose aggregation of small, variously sized fragments of rock. It has a wide range of applications in the construction industry.

Gravel particle sizes range from 2 mm to over 60 mm, and are available in a range of colours, textures and stone types.

10.what is morrum ?

Morrum(or murum) is the word derived from the Tamil language, which means powdered rock.Morrum is also a type of soil, mostly used for construction purposes. Generally, it is deep brown or red in color. Morrrum is used in plinth filling, road pavements, backfilling in trenches, footing pits, etc.

11.What is concrete ?

Concrete, an artificial stone-like mass, is the composite material that is created by mixing binding material (cement or lime) along with the aggregate (sand, gravel, stone, brick chips, etc.), water, admixtures, etc in specific proportions. The strength and quality are dependent on the mixing proportions.

12.what is curing of concrete ?

Curing is the process of maintaining satisfactory temperature and moisture conditions in concrete long enough for hydration to develop the desired concrete properties.

LONG QUESTIONS

1.what is cement &type of cement ?explain it.

2.what are physical & chemical properties of cement ?

3.what are the process of manufacturing of cement ?

4. what is mortar & type of mortar ? explain it.

5.what is sand & what are the natural sources ?

6.Explain about bulking of sand .

7.what is concrete & types of concrete mix ?

8.what are process of concreting ?

OTHER CONSTRUCTION MATERIALS

CHAPTER–4

TIMBER–

The word timber is derived from an old English word *timbrian* which means to build.

The timber thus denotes wood which is suitable for building or carpentry or various other engineering purposes and it is applied to the trees measuring not less than 600mm in girth or circumference of the trunk.

1.converted timber; This indicates timber which is sawn and cut into suitable commericial sizes.

2.rough timber ;This indicates timber which is obtained after felling a tree.

3.standing timber; this indicates timber contained in a living tree.

Advantages :

Timber is strong than any other material. Timber can be easily worked to any size & shape. It can be jointed to required form.

Timber can used for furniture & decoration fittings. Structural connections can be easily made in timber. Timer are light in weight, quite durable.

Its resale value is good. Its non conductors of heat & sound.

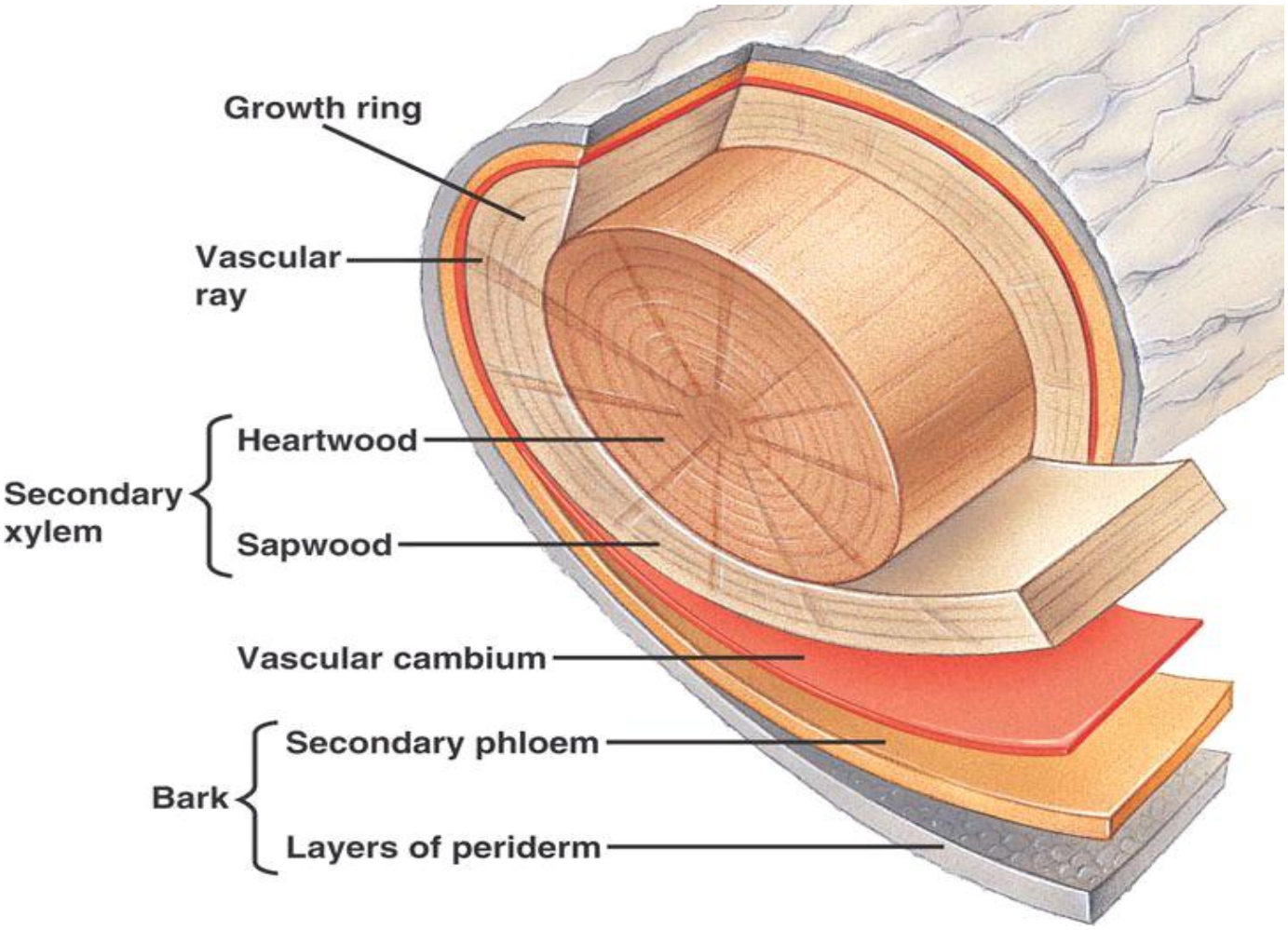
Classifications of Timber :

1)**Exogenous Trees**

2)**Endogenous Trees**

Exogenous Tress :

Trees which grow outwards and increase in bulk by the formation of successive annual rings are known as exogenous trees.



Timber which is used for building engineering works,Is Mostly obtained from exogenous trees. Examples : Deodar, Kail, Sal, Teak, Shishum, Chir etc .

Exogenous trees are further divided into following two types:-

1)**Conifers or Evergreen Trees**

2)**Deciduous or Broad – Leaf Trees**

Conifers or Evergreen Trees : Soft Wood

Trees which remain evergreen & bear fruits.These trees usually yield soft wood & show distinct annual rings. They are light in color & weight.

Deciduous or Broad Leaf Trees : Hard Wood

Trees which shed their leaves in the autumn &put on new leaves in the spring season are known as deciduous or broad leaf trees.

These trees usually yield hard wood & dark in color, Hard, close grained and strong.They are useful for important engineering works. Example :Sal, Teak, Shishum, Babul, Ash, Mahogany etc.

Endogenous Trees :

Endogenous trees which grow end wards in a longitudinal fibrous mass are known as endogenous trees.

These trees are too flexible & aren't suitable for engineering works.Example : Canes, Bamboos , palms etc

STRUCTURE OF A TREE

A tree basically consist of three parts ,namely ,trunk,crown and roots.

The function of the trunk is to support the crown and to supply water and nutrients from the roots to the leaves through branches and from the leaves back to the rots. The roots are meant to implant the trees in the soil,to absorb moisture and the mineral substances it contains and to supply them to the trunk.

1.Macrostructure

2.Microstructure

MACROSTRUCTURE

The structure of wood visible to the naked eye or at a small magnification is called the macrostructure.

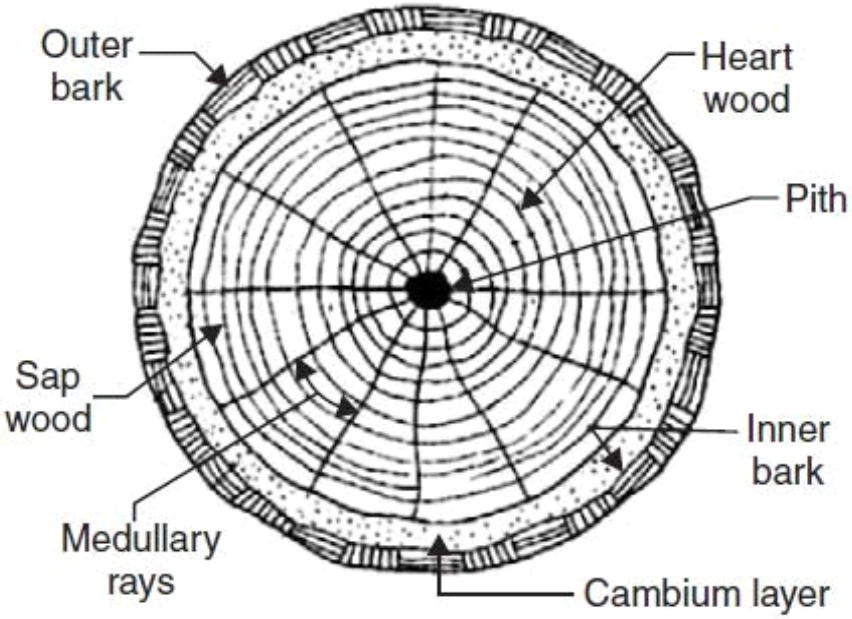


Fig. 1.7. Cross-section of exogeneous tree

Pith–

The inner most central protion or core of the tree is called the pith.

It varies in size and shape for different types of trees.it nourishes the plant in its young age.

When the plant beomes old,the pith dies up and decays and the sap is then transmitted by the woody fibers deposited round the pith.

Heart wood–

The inner annual rings surrounding the pith constitute the heart wood. It is usually dark in colour.as a matter of fact, it indicates dead portion of tree and as such,It does not take active part in the growth of tree.It provide strong and durable timber for various engineering purposed.

Sap wood–

The outer annual rings between heart wood and cambium layer is known as the sap wood .it is usually light in colour and weight .It indicates recent growth and it contains sap .the annual rings of sap wood are less sharply defined than those of heart wood.

Cambium layer–

The thin layer of sap between sap wood and inner bark is known as the cambium layer.

It indicates sap which has yet not been converted into sap wood. If the bark is removed for any reason,the cambium layer gets exposed and the cells cease to be active resulting in the death of tree.

Inner bark–

The inner skin or layer covering the cambium layer is known as the inner bark. It gives protection to the cambium layer from any injury.

Outer bark–

The outer skin or cover of the tree is known as outer bark .it is the outmost protetive layer and it sometimes contains cracks and fissures.

Medullary rays–

The thin radial fibers extending from pith to cambium layer are known as the medullary rays.

The function of these rays is to hold together the annual rings of heart wood and sap wood. These rays are sometimes broken and in some verities of trees,they are not very prominent.

MICROSTRUCTURE

The structure of wood apparent only at great magnification is called microstructure. When studied under a microscope, it become evident that wood consists of living and dead cells of various sizes and shapes.

A living cells consists of four parts,namely,membrane,protoplasm,sap and core.

The cell membrane consists mainly of cellular tissue and cellulose.

The cells, according to the functions they perform,are classified into the following three categories.

1.conductive cells

2.mechanical cells

3. storage cells

Conductive cells–These cells serve mainly to transmit nutrients from roots to the branches and leaves.

Mechanical cells–These cells are elongated,thick–walled and have tightly interconnected narrow interior cavities.

These cells impart strength to the wood.

Storage cells–These cells serve to store and transmit nutrients to the living cells in the horizontal direction and they are usually loacated in the medullary rays.

Meaning of seasoning–

When a tree is newly felled, it contains about 50 percent or more of its own dry weight as water.This water is in the form of sap and moisture.

The water is to be removed before the timber can be used for any engineering purpose.In other words, the timber is to be dried.

This process of drying of timber is known as the seasoning of timber and the moisture should be extracted during seasoning under controlled conditions as nearly as possible at a uniform rate from all parts of the timber.

Reasons for Seasoning

Seasoning of timber is done to fulfill some specific requirement. Followings are the reasons to perform timber seasoning.

- To change and improve the properties of wood.
- To make a correct percentage of shrinking of woods.
- To make a confident use of woods.

- To reduce the adverse behavior of woods.

Methods of Seasoning of Timber

There are mainly two methods of seasoning of timber. These are:

- Natural Seasoning
- Artificial Seasoning

Following tree diagram can be used to illustrate all the methods of timber seasoning.

Natural Seasoning

Seasoning of woods or timbers using natural elements is called *natural seasoning*. eg. water and air seasoning.

a. Water seasoning

Removal of wood sap immersing logs into water flow is called *water seasoning*. It is carried out on the banks of the river while thicker ends are kept towards upstream. After that, the logs are allowed to dry. Disadvantage: It is time consuming such as 2 to 4 weeks generally.

b. Air seasoning

Exposing the woods to air for seasoning. At first, a platform is required that is built on the ground at 300mm height above the ground.

Secondly, the arrangement of woods in layers. Air circulation is maintained between logs because it helps to reduce the moisture which is important for seasoning. The environment for this need to maintain some conditions. A clean, shady, dry, cool place is preferred. Sometimes logs are coated by the impermeable substance to reduce extreme moisture. To improve the quality oil coating, thick paint coating is maintained. To prevent fungal infection logs are treated with petrol or gasoline.

Advantage:

- Good quality of seasoned wood.
- A large amount is convenient in this process.
- Well-seasoned timber is formed.

Disadvantage:

- It's a slow process.

Artificial Seasoning

a. Seasoning by Boiling

Seasoning by boiling wood logs in hot water is called seasoning by boiling. Drying is done after proper boiling. For a large amount of wood, it is done in an enclosed place where hot steam is passed.

Advantages

- It takes a short amount of time. Generally, 3-4 hours is good enough.
- Develops the strength and elasticity.

Disadvantages

- It is serviceable basically for a small quantity of wood, not convenient for a large amount.
- The cost is high.

b. Chemical seasoning

Reduction of moisture using salt solution is called chemical seasoning. After the absorption of water by the solution logs are let to dry.

Advantage

- It increases the strength of the timber.
- It is less time-consuming.

Disadvantage

- Chemical reagents can sometimes reduce strength.
- It can cause a problem in gluing or finishing or corrosion while using.

c. Kiln seasoning

Seasoning of wood by using a large chamber or oven where there is a good process for the circulation of hot air.

Advantage

- Most effective and economic seasoning.

Kiln seasoning can be done by 2 processes such as:-

- **Progressive kiln Seasoning:** Wood log is entered through the kiln ant the temperature and humidity differentials are maintained through the length of the kiln to maintain proper drying.
- **Compartmental Seasoning:** Its maintained by enclosed container or buildings. Advantage: It accelerates the process because external energy is used.

d. Electrical seasoning

Dry wood is non-conductor of electricity while green timber is a conductor, so, can pass alternating current. Thus in this method alternating current is used for drying the cells of wood by creating heat. As electricity is used, it's called electrical seasoning.

Advantage:

- Using this method quick drying is obtained. a French electrical seasoning method is used to season overnight.

Disadvantages:

- The equipment required is very costly.
- It is an uneconomic process as a high rate of electricity is consumed.
- During heating the cells of wood or timber they lose their strength and become weak.

Qualities Improved by Seasoning

By seasoning, some common known qualities are improved which are mentioned below:

- Strength
- Hardness
- Durability
- Weight
- Painting and finishing
- Gluing
- Resistance to insect attack
- Electrical resistance
- Heat content

Precautions

Following precautions must be taken during seasoning of timber.

- During seasoning, the moisture should be removed under an environment maintaining conditions.
- Moisture should be extracted almost at an equal rate from all logs because differentiated dryness causes irregular shape.
- Seasoned timber should be protected from exposure to the rain and excessively high humidity during air seasoning
- During seasoning, a proper gap between logs should be maintained for easy and uniform air or water or hot air passing.
- Tiles
- They are **manufactured furnishing materials commonly used to cover internal walls, ceilings and floors**. They can be simple and functional or decorative and elaborate (such as mosaics). Tiles can be manufactured from

a wide range of substances, both hard (e.g. ceramic, porcelain, stone, marble, clay, slate, glass, etc.)

Terracotta

Terracotta used in architecture is **made from natural clay and fired in a kiln**. Intrinsically, it's an environmentally friendly building material and can be easily recycled. Bricks and façade panels can be repurposed or they can be reduced to debris for use in the construction of roads.

CAST IRON

IT is created when iron ore, or pig iron, is placed in a blast furnace and heated until the impurities are cooked out. At that point, the ore becomes a molten liquid that is subsequently poured into a mold and cast into a specific size and shape. The process for creating cast iron has mostly remained the same since it was invented by the Chinese more than two millennia ago. That being said, modern technology now allows for cast iron to be adapted or custom created to fit the needs of the builder or buyer. By changing the levels of the cast iron material properties–like carbon, silicon, chromium, copper, manganese, titanium, and other elements–the outward appearance, strength and the structure of the cast iron can vary dramatically.

WROUGHT IRON

Wrought iron is a very low carbon metal made by intensive hand work using small scale production methods. Predominantly, it was manufactured prior to the Patent for the Bessemer process in 1856.

There were numerous methods for producing wrought iron; early iron is often referred to as Charcoal iron, or Bloomery iron, because it was produced in small

blooms. In the late 18th century more efficient Puddling furnaces were used to produce Puddled wrought iron. Many other types of production methods were used across the world, all of which produced varying qualities and quantities of iron.

Confusingly, the term 'wrought iron' can also be applied to decorative hand made steel artefacts because wrought means to make by hand (to wrought). However, a more generally accepted description for these hand made steel items is decorative ironwork.

MILD STEEL

Mild steel is widely used in **machinery and automobile manufacturing**. It is cheap, suitable for different cutting and coating methods and has good weld ability while providing good enough physical properties. These attributes make it useful for producing frames, panels, etc.

Mild steel is used in most of the construction fields. This type of steel is immensely strong. This strength is a great advantage in constructing buildings. Good flexibility in steel framing is another important feature of this mild steel.

This one can bend without cracking, as a steel building can flex when it is pushed to one side by say, wind, or an earthquake.

The third characteristic of steel is its plasticity or ductility. This means that when subjected to great force, it will not suddenly crack like glass, but slowly bend out of shape.

This property allows steel buildings to bend out of shape, or deform, thus giving warning to inhabitants to escape. Failure in steel frames is not sudden — a steel structure rarely collapses.

Steel in most cases performs far better in earthquake than most other materials because of these properties. Following are some types of steel construction. It is also called steel fabrication.

PAINTS

The paints are coatings of fluid materieals and they are applied over the surfaces of timber and metals.

The final finishing of all surface such as walls,ceilings,woodwork,metalwork,etc.the surface should be coated with paint or vanish or distemper.

CHARACTERISTICS OF AN IDEAL PAINT

It should possess a good spreading power is maximum area of the surface should be covered by minimum quantity of the paint.

The paint should be fairly cheap and economical.

The paint should be such that it can be easily fresly applied on the surface.

The paint should be such that it dries in reasonable time and not too rapidly.

The pain should be such that its color is maintained for a long time.

The pain should form a hard and durable surface.

The pain should not affected by weathering action of the atmosphere.

OBJECT-

It protects the surface from weathering effects of the atmosphere and actions by other liquids, fumes and gases.

It is used to give good appearance to the surface. The decorative effects may be created by painting and the surface becomes hygienically good,cleans,colourful and attractive.

It provides a smooth surface for easy cleaning.

TYPES OF PAINTING

Aluminium Paint:

The very finely ground aluminium is suspended in either quick-drying spirit varnish or slow-drying oil varnish as per requirement. The spirit or oil evaporates and a thin metallic film of aluminium is formed on the surface.

The advantages of aluminium paint are as follows:

(i) It is visible in darkness.

(ii) It resists heat to a certain degree.

(iii) The surfaces of iron and steel are better protected from corrosion by this paint than any other paint.

Anticorrosive Paint:

This paint essentially consists of oil and a strong drier. A pigment such as chromium oxide or lead or red lead or zinc chrome is taken and after mixing it with some quantity of very fine sand, it is added to the paint.

Asbestos Paint:

This is a peculiar type of paint and it is applied on the surfaces which are exposed to the acidic gases and steam.

4. Bituminous Paint:

This paint is prepared by dissolving asphalt or mineral pitches or vegetable bitumen in any type of oil or petroleum. A variety of bituminous paints is available. The paint presents a black appearance and it is used for painting ironwork under water.

Cellulose Paint:

This paint is prepared from nitro-cotton, celluloid sheets, photographic films, etc. An ordinary paint hardens by oxidation. A cellulose paint hardens by evaporation of thinning agent. It thus hardens quickly. It is a little more costly, but it presents a flexible, hard and smooth surface. Also, the surface painted with cellulose paint can be washed and easily cleaned. The cellulose paint is not affected by contact with hot water and the surface can stand extreme degrees of cold and heat.

Cement Paint:

This paint consists of white cement, pigment, accelerator and other additives. It is available in dry powder form. The cement paint is available in variety of shades and it exhibits excellent decorative appearance. It is waterproof and durable. It proves to be useful for surfaces which are damp at the time of painting or are likely to become damp after painting.

For external finish, on cement-plastered walls, it is mixed with water immediately before its application. It is desirable to provide cement paint on rough surface rather than on smooth surface because its adhesion power is poor on smoothly finished surface.

For painting surfaces like corrugated iron sheets, etc., the cement paint is mixed with boiled linseed oil. The mixture is constantly stirred during use.

The cement paint is applied in two coats. Before the first coat is applied, the surfaces are wetted to even and control suction and to assist the hardening process of the cement paint. It should however be seen that there is no presence of

liquid water on the surface when the paint is applied. The application of paint over a surface exposed directly to hot sunlight should be avoided. Otherwise the coating will dry before it is cured and will become chalky.

Following are the advantages of cement paints:

(i) It requires less skill and time for applying cement water paints and the applying implements can be cleaned with water only.

(ii) The preparation of surfaces is easier in a cement paint system as it is not necessary to remove the previous coats of cement paints.

(iii) They are suitable for painting fresh plasters having high alkalinity because cement paints are not likely to be attacked by the alkalinity of masonry surfaces.

(iv) They become an integral part of the substrata and add to its strength.

Following precautions should be taken to avoid defects or complaints of the cement paints:

(i) The defect of cracking occurs when the film of paint has not adequate flexibility to move with thermal or moisture movements in the surface.

The cement paints however become integral part of the surface, if they are suitably cured and hence they do not move independently of the surface.

(ii) The efflorescence or crystalline deposits are sometimes seen on the finished surfaces. Such defects are mainly due to the nature of surface before application of paint or due to some external factor like highly saline atmosphere.

(iii) The flaking or lifting of the paint film due to loss of adhesion can be prevented by properly curing the surface after the application of paint.

Colloidal Paint:

No inert material is mixed in this type of paint. It requires more time to settle and in the process of settlement, it penetrates through the surface. It may be used for interior as well as exterior walls.

. Emulsion Paint:

A variety of emulsion paints is available. It contains binding materials such as polyvinyl acetate, synthetic resins, etc. This paint is easy to apply and it dries quickly in about 1½ to 2 hours. The colour of the paint is retained for a long period and the surface of paint is tough and it can be cleaned by washing with water. There is absence of odour and the paint possesses excellent alkali resistance.

The application of emulsion paint can be carried out either by brush or spray gun. For long service life, it is recommended to apply two coats of emulsion paint. For rough cement plastered surface, a thin coat of cement paint may first be applied to smoothen the surface. It is necessary to have a sound surface to receive the emulsion paint.

. Enamel Paint:

This paint is available in different colours. It contains white lead or zinc white, oil, petroleum spirit and resinous matter. It dries slowly and forms a hard and durable surface. The surface provided with this paint is not affected by acids, alkalies, fumes of gas, hot and cold water, steam, etc.

It can be used for both internal and external walls. In order to improve the appearance, it is desirable to apply a coat of titanium white in pale linseed oil before the coat of enamel paint.

Graphite Paint:

The paint presents a black colour and it is applied on iron surfaces which come in contact with ammonia, chlorine, sulphur gases, etc. It is also used in mines and underground railways.

Inodorous Paint:

No turpentine is used in this paint, but white lead or zinc white is mixed with methylated spirit. The white lead or zinc white is well ground in oil. The shellac with some quantity of linseed oil and castor oil is dissolved in methylated spirit. The paint is not durable, but it dries quickly. The methylated spirit evaporates and a film of shellac remains on the surface.

Luminous Paint:

This paint contains calcium sulphide with varnish. The surface on which luminous paint is applied shines like radium dials of watches after the source of light has been cut off. The paint should be applied on surfaces which are free from corrosion or any other lead paint.

Oil Paint:

This is the ordinary paint and it is generally applied in three coats of varying composition. They are respectively termed as primes, undercoats and finishing coats. This paint is cheap and easy to apply and it possesses good opacity and low gloss.

It should be remembered that the oil paint should not be applied during humid and damp weather. The presence of dampness on wall surface also considerably affects the life of oil paint coating. It is advisable to redecorate the surfaces finished with oil paint with a coating of fresh oil paint only. The layer of old oil paint serves as a foundation for the fresh paint.

. Plastic Paint:

This paint contains the necessary variety of plastics and it is available in the market under different trade names. The application of plastic paint can be done either by brush painting or spray painting. This paint possesses pleasing

appearance and it is attractive in colour. This paint is widely used for show rooms, auditoriums, etc.

The plastic emulsion paints were introduced in our country in 1955 or so and they are becoming more and more popular day by day. An emulsion is a liquid having fine suspended particles of a substance. For plastic emulsion paints, the emulsion is composed of plastic compounds such as vinyl acetate and acrylate which are held in water.

The typical composition of one litre of plastic emulsion paint is as follows:

2	N	Binders
5	N	Pigments
1	N	Other solids
6	N	Water
14	N	Total weight

When the paint dries, the water evaporates and a film of binders, pigments and other solids is left behind. One litre of plastic emulsion paint covers about 15 m^2 of wall surface per coat at. For interior jobs, the two coats of paint are sufficient, each coat having a thickness of about 0.04 mm.

Following are the important guidelines for the use of plastic emulsion paints:

(i) Application:

It is observed that the plastic emulsion paints are widely used for interior jobs in our country because they cannot resist effectively the attack of enemies of paints such as salts, dust and gases carried by air, sunlight, fog, rain, rise and fall of temperature, etc.

(ii) Base Surface:

The success of paint will depend on the quality of plaster and characteristics of base surface. The surface to be painted should be cleaned of all dust particles and rubbed with sandpaper, if necessary. The levelling putty should be applied, if required.

(iii) Brushes:

The application of these paints should be done with clean brushes or sponge rollers. These paints possess good flow properties and hence the brush marks are automatically levelled off giving beautiful, uniform and washable surface in a short time.

(iv) Colour of Paints:

If dark colour plastic emulsion paints are required, they should be used as made by the manufacturers. For light colour paints, a white emulsion with certain other colours known as the tinters (available in tubes), may be added to the paints made by the manufacturers.

(v) Diluting the Paint:

These paints are usually supplied with thick consistency and for diluting the paints, the instructions given by the manufacturer should be strictly followed. In a general way, it can be stated that half litre extra water will be required for first coat and quarter litre extra water will be required for second coat.

(vi) Metallic Surfaces:

These paints are water based and hence, they are not suitable for metallic surfaces. These paints are not water-repellent and it is likely that some fungus growth may develop in unfavourable circumstances.

(vii) Moisture Resistance:

These paints allow moisture to evaporate through minute pores. But even then, it is desirable to allow 4 months, preferably one year, for moisture to escape from fresh masonry and fresh plaster.

(viii) Nature of Surface:

The plastic binders need not require a rough surface for adhesion and they even stick to a smooth surface. However the initial roughening of surface before the application of first coat is necessary to remove dust, salts, etc. A good plastic emulsion paint would not colour a moist cloth when rubbed on the painted surface.

(ix) Thickness of Coat:

The thickness of coat should neither be too thin nor too thick. In fact, it must possess elasticity to match the stresses in the plaster and should not separate out from the surface. However the film of paint can be made durable by thickening in successive coats and not in one coat at a time.

(x) Washing:

It is desirable to wash the painted surfaces with wet cloth lightly at least once in a month. If this precaution is not taken, the dust particles would adhere to the surface and the paint may lose its good appearance.

15. Silicate Paint:

This paint is prepared by mixing calcined and finely ground silica with resinous substances. The paint when dried forms a hard surface and it is durable. It can stand extreme heat and it adheres firmly to brickwork also. It is not affected by alkalies. No chemical action takes place on metals by this paint. The drier used with this paint should be of a special silicate drier type.

The silicate paint can directly be applied on brick, plaster or concrete surfaces. These surfaces should be made wet before the paint is applied.

The two or three coats of silicate paint are recommended and it is not necessary to have a priming coat. The tool which is used to apply silicate paint should be immediately cleaned with water after use. The surfaces should not be painted with silicate paint in hot weather.

16. Synthetic Rubber Paint:

This paint is prepared from resins.

It has the following advantages:

(i) It offers good resistance to the water and is not affected by heavy rains.

(ii) It dries quickly.

(iii) A uniform colour is maintained when this paint is applied on the surface.

(iv) It is little affected by weather and sunlight.

(v) It can be applied on surfaces which may not be completely dry e.g. fresh concrete.

(vi) It is moderate in cost and covers a sizeable area.

(vii) It is easy to apply on the surface.

(viii) It possesses excellent chemical resisting property.

VARNISH–

The varnishes are transparent or nearly transparent solutions of resinous materials and they are applied over the painted surfaces.

CHARACTERISTICS OF AN IDEAL VARNISH

It should render the surface glossy.

It should dry rapidly and present a finished surface which is uniform in nature and pleasing in appearance.

The color of varnish should not fade away when the surface is exposed to the atmospheric actions.

The protecting film developed by varnish should be tough, hard and durable.

It should not shirnk or show cracks after drying.

Varnishes have always been considered a mysterious blend of black art and science, but in reality there are only five main ingredients in a top quality marine varnish – oil, resin, solvent, driers and additives.

It should be dry quickly
On drying it should form a hard, tough and durable film.
It should have good weathering properties, resist abrasion and wear well.
It should be able to retain its colour and shine.
It should be uniform and pleasant looking on drying.

Different kinds of Varnishes:

Based on the different solvents used, varnishes are classified under the following categories:

Oil Varnish

These are made by dissolving hard resins like amber or copal in oil. They are slow to dry but are hardest and most durable of all varnishes. There are suited for being used on exposed surfaces requiring polishing or frequent cleaning and for superior works.

Turpentine Varnish

These are made from soft resins like mastic, common resin is dissolved in turpentine oil.

Spirit Varnish

Varnishes in which spirit is used as a solvent as known as spirited varnish or French Polish. Shellac is dissolved in spirit and the product is applied in a thin layer. This varnish gives a transparent finish thus showing the grains of the timber. These however, do not weather well and as such are used for polishing wood work not exposed to weather.

Water Varnish

They consists of lac dissolved in hot water with borax, ammonia, potash or soda just enough to dissolve the lac. Varnish so made withstands washing. It is used for painting wall paper and for delicate work.

VARNISHING

Clean and dry surface of wood work is given a cost of thin and clear hot solution of glue to which a little brown earth and ochre is added if the wood is of oily nature and the varnish does not dry on it. It is rubbed down smooth and is second

coat of thin clean glue with necessary quantity of burnt sienna is applied. It is rubbed with fine sand paper and a coat of varnish is then applied to the surface. Second coat of varnish should be applied when the firs one has dries and rubbed down smooth with sand paper.

French polish or spirit varnish

It is prepared by dissolving pure shellac varying from pale orange to lemon yellow in colour and free from resin or dirt, in methylated spirit at the rate of 0.15 kg of shellac per liter of spirit. It may be coloured by adding some pigments. The solution is then strained through a double thickness of coarse muslin.

It dries quicker and becomes harder and more brilliant than turpentine varnish but cracks and scale off. It does not withstand weathering and is used only for superior wood work not subjected to the vagaries of weather.

Before applying French polish the surface is cleaned of dust. It is then coated with filler made by mixing 250gms of whiting in one liter of methylated spirit. A suitable pigment like burnt sienna or umber if required may be added as

otherwise the French polish will get absorbed and a good gloss will be difficult to obtain.

A pad of woolen cloth is wrapped in a fine cloth and used for applying the polish. The pad is moistened with the polish and rubbed hard on the surface to be polished. The polish is used sparingly but uniformly on the surface. Rubbing is done in a series of overlapping circles. A trace of linseed oil on the pad facilitates this operation. Subsequent coats are applied after the previous one has dried. The finishing coat is applied with the pad moistened with methylated spirit and rubbing the surface lightly and quickly to give the surface a uniform texture and high gloss.

Wax Polish

Two parts of bees wax are mixed in two parts of boiled linseed oil over a slow fire. When dissolved, one part of the turpentine oil is added to it. The mixture is rubbed into the pores of wood with cotton pad. On rubbing, wax leaves a dull polish on surface which is far superior, more durable and takes longer to accomplish than the French polish. Rubbing is continued till the desired finish is

obtained. Brisk rubbing give bright surface. For good finish, normally three applications are required. Surface to be polished should be absolutely clean.

QUESTIONS

1.What is timber ?

The word timber is derived from an old English word ***timbrian*** which means to build.

The timber thus denotes wood which is suitable for building or carpentry or various other engineering purposes and it is applied to the trees measuring not less than 600mm in girth or circumference of the trunk.

2.write 2 advantages of timber .

Timber is strong than any other material. Timber can be easily worked to any size & shape. It can be jointed to required form.

Timber can used for furniture & decoration fittings. Structural connections can be easily made in timber. Timer are light in weight, quite durable.

3.How many types of timber are there ?

1)**Conifers or Evergreen Trees**

2)**Deciduous or Broad – Leaf Trees**

Conifers or Evergreen Trees : Soft Wood

Trees which remain evergreen & bear fruits.These trees usually yield soft wood & show distinct annual rings. They are light in color & weight.

Deciduous or Broad Leaf Trees : Hard Wood

Trees which shed their leaves in the autumn &put on new leaves in the spring season are known as deciduous or broad leaf trees.

These trees usually yield hard wood & dark in color, Hard, close grained and strong.They are useful for important engineering works. Example :Sal, Teak, Shishum, Babul, Ash, Mahogany etc.

4.What is macrostructure ?

The structure of wood visible to the naked eye or at a small magnification is called the macrostructure.

5.what is microstructure ?

The structure of wood apparent only at great magnification is called microstructure. When studied under a microscope, it become evident that wood consists of living and dead cells of various sizes and shapes.

6.why seasoning of timber is necessary ?write 2 points .

- To change and improve the properties of wood.
- To make a correct percentage of shrinking of woods.
- To make a confident use of woods.
- To reduce the adverse behavior of woods.

7.what is cast iron ?

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LONG QUESTION

1.What is timber ?Describe classification of timber .

2.Describe the structure of tree.

3.what is pain ?Described that types .

4.what is varnish ?Describe that types.

5.What are the characteristics of paints ?

6.what are the characteristics of varnish ?

7.Describe about seasoning of timber ?

BUILDING CONSTRUCTION

BUILDING

- It is a very simple word and having simple meaning.
- It is simply indicates any things that is built with walls and roof.

- The term building in civil engineering parlance is used to mean a structure having various components like foundations,walls,coloum,floors,roof,doors,windows,ventilators,stairs,lifts,various types of surface finishes.

TYPES OF BUILDING

- The building is defined as any structure for whatever purposed and of whatever materials constructed and every part there of wheather used human habitation or not and includes foundations,plinth,walls,floors ,roofs,chimeys,plumbing and enclosing or intended to enclosed any land or space and signs and outdoor display structure according to national building code of India.
- **RESEDENTAL BUILDING**
- The building which are provided with sleeping accommodation for normal residential purposed with or without cooking or dinning or both the facilities, are available.

Types of Residential Buildings

Residential buildings are divided into following types:

- Individual houses or private dwellings
- Lodging or rooming houses
- Dormitories
- Apartments
- Hotels

1. Individual houses or Private dwellings

Individual houses or private dwellings are generally owned by members of a single family only. If more than one family residing in that building then it is called as multiple family private dwelling.

2. Lodging or Rooming Houses

Lodging or rooming houses are multiple or group of buildings which come under one management. In this case, Accommodation is provided for separately for different individuals on temporary or permanent basis.

3. Dormitories

Dormitories are another type of residential buildings, in which sleeping accommodation is provided together for different individuals. School hostels, military barracks come under this category.

4. Apartments

Apartments or flats are big buildings which consists separate dwellings for different families. Apartment will resides minimum three or more families living independently of each other.

5. Hotels

Hotels are just like lodging houses and also managed by single management but they provide accommodation primarily on temporary basis. inns, motels etc come under this category.

2. Educational Buildings

These include any building used for school, college, or daycare purposes involving assembly for instruction, education, or recreation and which is not covered by assembly buildings.

3. Institutional Buildings

Institutional buildings are used for various purposes such as medical treatment other treatment or care of persons suffering from physical or mental illness, disease or infirmity, care of infants or old age persons care, and for penal or correctional detention in which the liberty of the inmates is restricted.

The institutional buildings are major including sleeping accommodations for the occupants.

They include hospitals, sanitoria, custodial institutions, or penal institutions like jails, prisons, and mental asylums.

Assembly Buildings

These are the buildings where groups of people meet or gather for amusement, recreation, social, religious, political, civil, travel, and similar purposes; such as theatres, motion picture houses, marriage halts, town halls, auditoriums, exhibition halls, assembly halls museums.

Also Included skating rinks, city halls gymnasiums, restaurants (also used as assembly halls), places of worship, dance halts, dub rooms, passenger stations, terminals of air, surface, and other public transportation services, recreation places and stadia, etc.

5. Business Buildings

These buildings are used for the transaction of business (other than that covered by mercantile buildings), for the keeping of accounts and records, and for similar purposes; offices, banks, professional establishments, courthouses, and libraries.

The major activities in this type of building are the transaction of public business and the keeping of books and records.

6. Mercantile Buildings

This type of building is used for selling a small product in which small shops, stores, markets, for display and sale of merchandise either wholesale or retail, office, shops, and storage service facilities incidental to the sale of merchandise and located known as Mercantile building.

8. Storage Buildings

Storage buildings are those in which material is stored or sheltering facilities are provided for goods like wares or merchandise.

This building is also being used for handling highly combustible material in warehouses, cold storage plants, freight depots, transit sheds, storehouses, trucks, marine terminals, garages, hangars (other than aircraft repair hangars), grain elevators, barns, and stables.

9. Hazardous Building

- The hazardous building is used for the storage of such materials or chemicals that are highly dangerous to humans or it may pollute the environment.

- They have majorly used storage, processing of highly combustible material handling, manufacture or explosive materials or products which are liable to burn with extreme rapidity and poisonous elements, manufacturing or processing of highly corrosive, toxic or noxious alkalies, acids or other liquids or chemicals producing flame, Poisonous, irritant or corrosive gases.

Basic Components of a Building or a Structure

A Building is any structure that is constructed to meet the needs and purpose of users. Residential / commercial / institution / educational / Assembly / Industrial / Storage etc. are some of types of building which are designed by an Architect / Structural designer and executed or constructed by Civil Engineer.

1. SUBSTRUCTURE

- It consists the parts of building below ground level. Function of sub structure is to transmit the load from super structure to the soil.

2. SUPER STRUCTURE

It is part of structure above ground level whose function is to serve the purpose of building.

FOUNDATION

It is part of sub structure forming the base is building .It's function is to transfer the load from building to the soil. Also it resists / withstands seismic loads exerted by the soil.

Material used is steel bars and concrete along with filling material such as stones, clay bricks etc. It varies from type of structures / buildings . Shallow foundation is adopted for Load Bearing and RCC Structure.

PLINTH

It is located between Foundation and Super Structure made up of damp proof course . It's function is to control differential settlements, to connect all columns to foundations , to control leaking of water.

COLOUMN

It is a vertical component which is erected from foundation to the top most portion of building .It's main function is to carry the loads of super structure and transferring them to foundation (in a framed structure).

Columns are usually made up of reinforcement steel bars and concrete. In some cases, columns can be made of timber, structural steel and other materials also. Column comes in various shapes like circular, rectangle , square , hexagonal , etc. This depends on the structural design, aesthetics and internal design of the building.

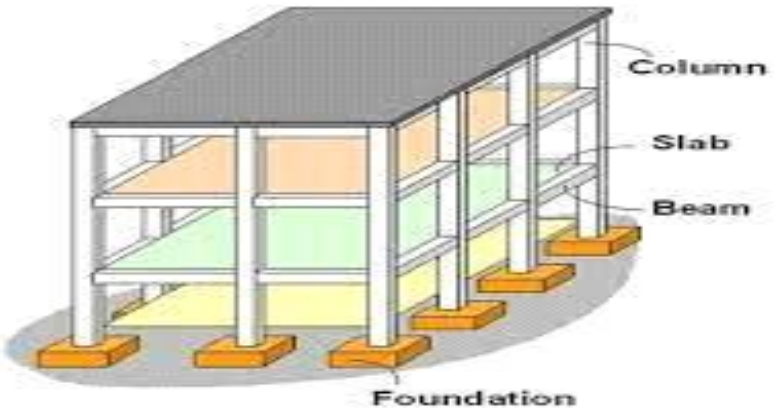
WALL

Walls are vertical components which act as partition between two spaces and form the outer limits of building. Its function is to separate spaces from each other internally and to cover all the external sides of the building.

In load bearing structures, walls also act as structural member and carry the weight of the building. This is then transferred to brickwork foundation done underneath the soil.

Walls can be constructed using various materials such as bricks (burnt clay / cement) , stones, AAC blocks, CLC blocks, Hollow or Solid Concrete blocks etc.,

Now a days the internal partition can be made using other materials also like plywood



Typical RC Frame Building

partitions,.

ROOF SLAB

Roof Slabs are horizontal structural member providing base to floor and ceiling to the users of adjacent storeys. Slab connects beams and columns. Also supports and distribute loads from beam and column . The lower portion of slab acts as ceiling and upper portion acts as floor between two adjacent storeys. Slab is made of material concrete and reinforcement steel bars.

BEAM

Horizontal components of building which acts as structural members connecting columns and slab . It carries dead and live load from building and transfers to columns . Varies in sizes as per total loads acting on it . Made of reinforcement steel and concrete .

FLOORING

Flooring is a finishing layer provided to the roof slab, which is a structural member and which separates two adjacent storeys from each other. The purpose of flooring is to provide even finish to the roof slab and ensure proper slope for drainage of water.

There are numerious materials available for flooring finishing. Materials such as tiles (vitrified, ceramic), granite, marble, special stones, wood, timber laminates, wooden flooring, brick flooring, etc.,

DOOR &WINDOWS

These are openings provided for entry or exit of users / occupants into different spaces inside a building. They play an important role in circulation of occupants from one room to another. Privacy of a space can be maintained by doors. It provides protection to interior of any space from exterior.

Doors are made up of many materials such as metal, wood, timber, etc., and are usually placed in a door frame made up of same material. The portion of brickwork above the doors and windows are usually supported below lintels

beams placed on the top of them. So keeping doors and windows height at one level is recommended in buildings.

WINDOW

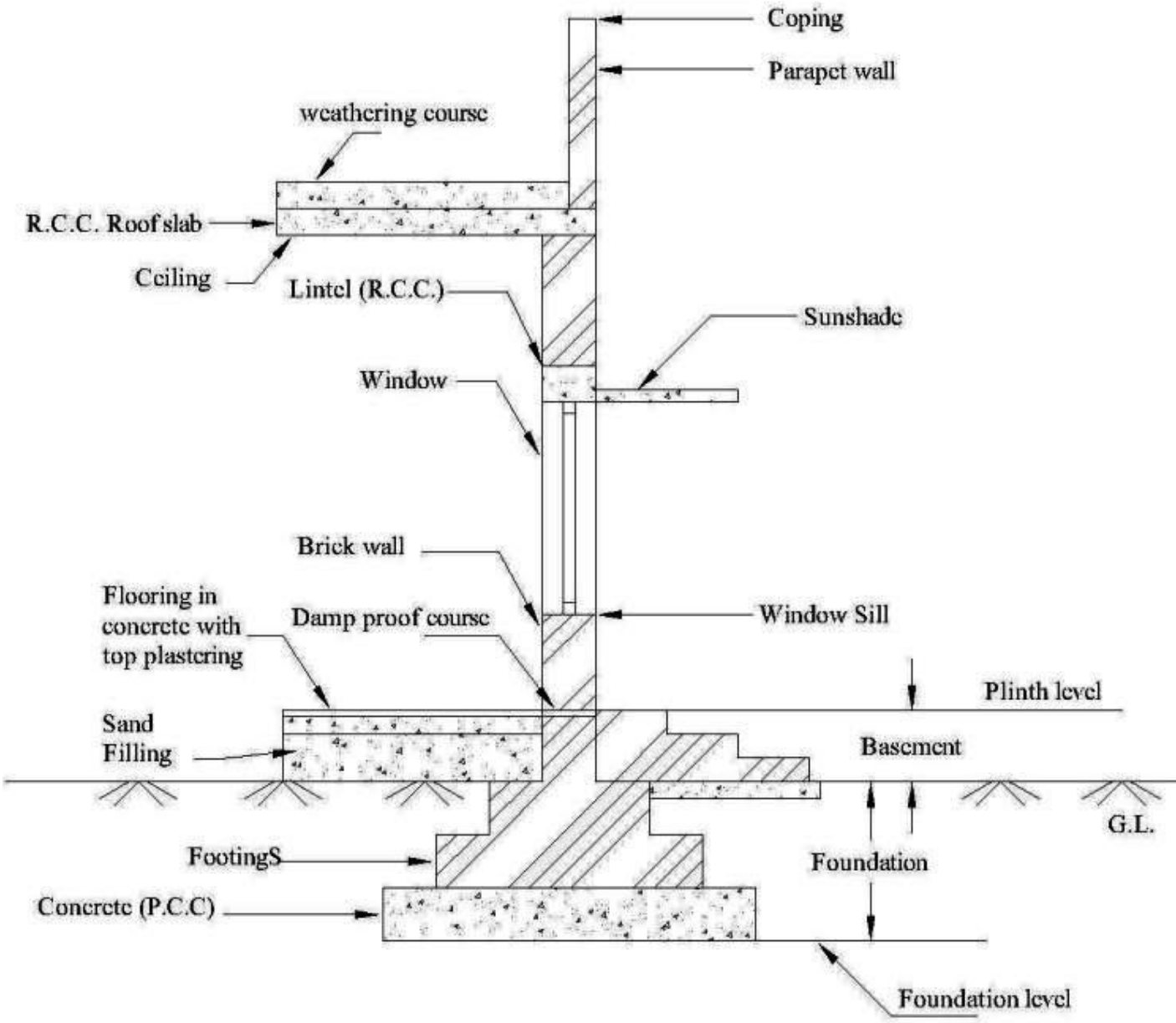
These are openings provided for circulation of air and to get natural light inside spaces of buildings. Windows are generally provided on external walls only.

Windows can be shape is rectangular, circular or elliptical. Windows are usually have glass with a framing material on top of it. The framing material can be aluminums, wood, UPVC etc., In olden Indian Houses, people used to cover entire windows with wooden shutters.

LINTEL & WINDOWS SILLS

Lintels are small beams provided over openings (windows and doors). It's function is to provide support to the wall above openings. Lintels are usually made up of reinforcedconcrete or wood so as to take the loads from above.

MAIN COMPONENTS OF A BULDING



STAIR

Vertical component which joins adjacent storeys of building and provide circulation of humans as well as materials from one storey to another. Stairs are

Located at centre or corner building. Stairs come in different types based on shapes and materials used.

Shapes – dog legged, circular, helix, semi circular, rectangular, square, double helix etc.,

Material – Metal, RCC (Steel and Concrete) timber, wood, combination of timber and wood etc.,

ROOF TERRACE WITH FLOORING AND PARAPET

Topmost horizontal part of building roof which can be used as roof terrace with floor finishes. Water tanks, solar panels are installed in roof terrace.

Parapet is a wall with short height (up to 1.2 m.) provided on roof terrace boundaries for protection / safety of users.

SITE INVESTIGATION

Site investigation can be defined as the process of investigating a proposed construction site for the purpose of collecting, assessing and reporting information and data regarding the site.

- Before site investication the site planning is most important for before construction of building.
- In site planning site selection is the first process of site planning.
- The site plan is a layout showing for good planning and design of building.
- The purpose of the building and extend of privacy is desired.
- The site should be located in fully developed or fast developing locality.

- The site should be located in such a way that community services like police station, and fire protection,cleaning of waste and street cleaning ,utility services like water supply ,electricity, drainage etc. Other like school,clg,hospital,market,cenema,bank etc. shopping facilities and means of transport are also available short distance.

- The site should be situated on an elevated place and also leveled with uniform slope from one end to quick drainage of rainwater.

SITE PLAN

- The site plan is a layout showing location of the area belonging to the building or property under consideration.

- It should be prepared before construction.

- The shape of the plot and the boundary of the plot with all exterior dimensions.

- Setback line at the front back and sides.

- Any permanents boundaries or marks if any existing on site.

- Grade elevation at the center line should also be indicated .grade elevation at the corners of the plot and the corners of the house should be indicated by means of contour line.

QUESTIONS

5X2

1.**What is building?**

- It is simply indicates any things that is built with walls and roof.
- The term building in civil engineering parlance is used to mean a structure having various components like, foundations,walls,coloum,floors,roof,doors,windows,ventilators,stairs,lifts,various types of surface finishes.

2.How many types of building are there ?

There are 9 types of building.

1.residental building

Educational building

Institutional building

Assembly building

Business buildings

Mercantile buildings

Industrial buildings

Storage buildings

Hazardous buildings

3.what is residential building ?

The building which are provided with sleeping accommodation for normal residential purposeds with or without cooking or dinning or both the facilities,are available .

4.what is industrial buildings ?

Industrial building means a building or part thereof wherein products or material are fabricated, assembled or processed, such as assembly plants, laboratories, power plants, refineries, gas plants, mills, dairies and factories.

5.what is site plan?

- The site plan is a layout showing location of the area belonging to the building or property under consideration.
- It should be prepared before construction.

LONG QUESTIONS

3x10

1.Explain what is building & types of buildings?

2.Explain components of building ?

3. why site investigation is necessary before constructed a building ?

CHAPTER -6

FOUNDATION

We know that every structure consists of following two part .

1.sub structure .

2. supper structure.

The **substructure** is the part of the building that is underneath the ground, while the **superstructure** is everything that is above ground.

So, the **foundation** is sub structure.

The lowest artificially prepared parts of the structures which are in direct contact with the ground and which transmit the loads of the structures to ground are known as the **foundations.**

OBJECTS OF FOUNDATIONS

The foundations are provided for the following purposes.

1.To distribute the total load coming on the structure on a larger area so as to bring down the intensity of load at its base below the safe bearing capacity of subsoil.

2. To support the structure.

3. To give enough lateral stability to the structures against various distributing horizontal forces such as wind rain earthquake etc.

4.To prepare a level and hard surface for concreting and masonary work.

5.To transmit the super imposed loads through side friction and end bearing in case of deep foundations.

6.To distribute the non uniform load of the superstructure evenly to the sub soil.

7.To provide the structural safety against undermining or scouring due to animals flood water etc.

8.To prevent or minimize cracks due to movement of moisture in case of weak or poor soils etc.

TYPE OF FOUNDATIONS

The foundations can broadly be classified into two categories .**shallow** and **deep.**

If the possible to construct foundations of a building at reasonable shallow depth, the foundations are termed as the **shallow foundations**. In such cases a spread is given under the base of a wall or a column. This spread is known as the footing and the foundation is known as the **spread footing.**

Strip Footing

A strip footing is provided for a load-bearing wall. A strip footing is also provided for a row of columns which are so closely spaced that their spread footings overlap or nearly touch each other. In such a case, it is more economical to provide a strip footing than to provide a number of spread footings in one line. A strip footing is also known as continuous footing.

Spread or Isolated Footing or Individual Footing

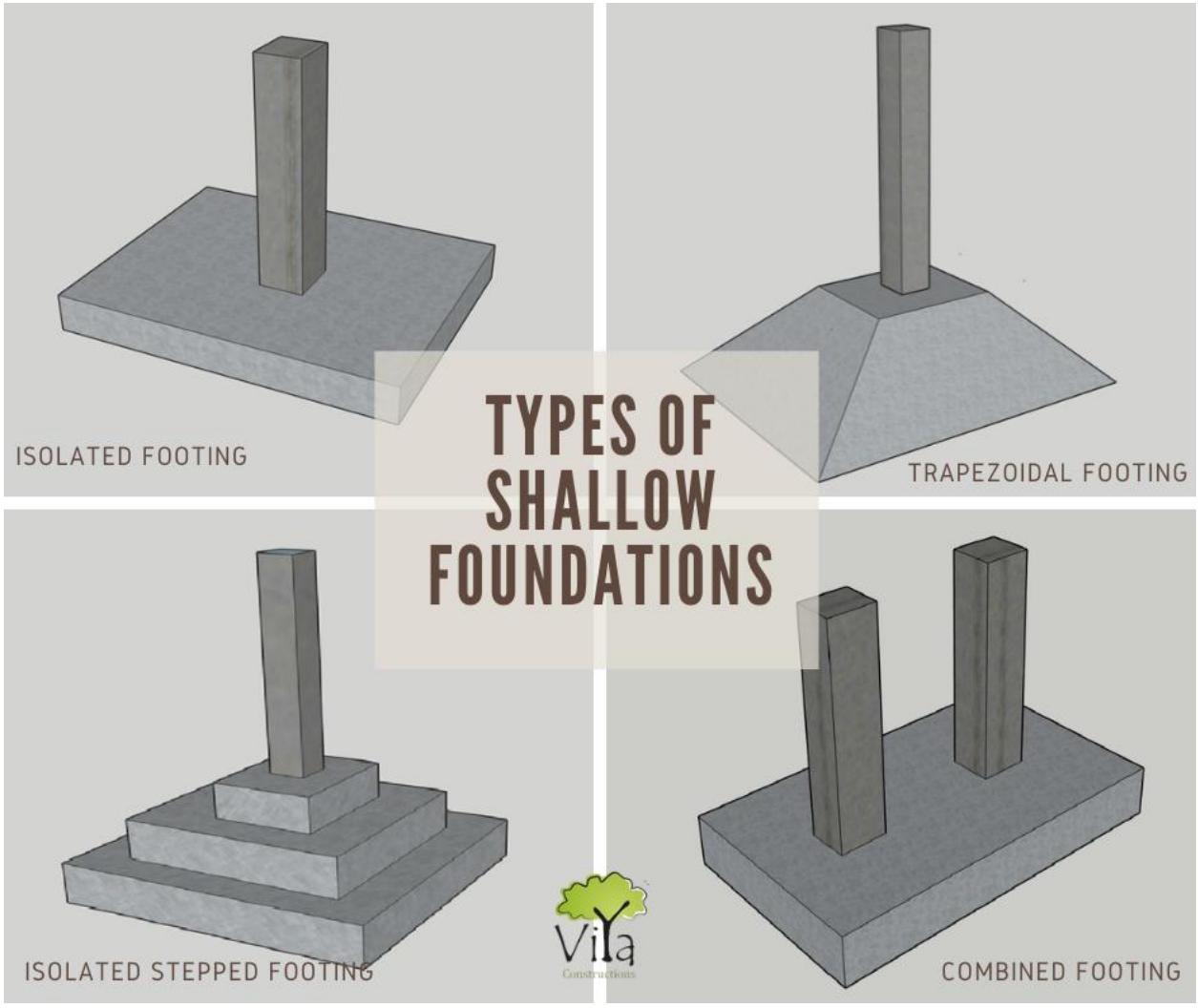
A spread footing also called as isolated footing, pad footing and individual footing is provided to support an individual column. A spread footing is circular, square or rectangular slab of uniform thickness. Sometimes, it is stepped or haunched to spread the load over a large area.

Combined Footing

A combined footing supports two columns. It is used when the two columns are so close to each other that their individual footings would overlap. A combined footing is also provided when the property line is so close to one column that a spread footing would be eccentrically loaded when kept entirely within the property line. By combining it with that of an interior column, the load is evenly distributed. A combined footing may be rectangular or trapezoidal in plan.

Strap or Cantilever Footing

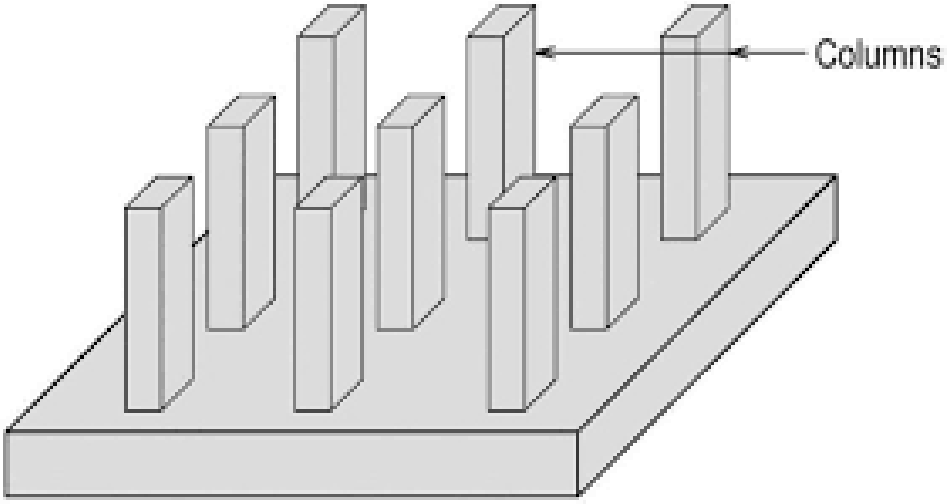
A strap (or cantilever) footing consists of two isolated footings connected with a structural strap or a lever. The strap connects the two footings such that they behave as one unit. The strap is designed as a rigid beam. The individual footings are so designed that their combined line of action passes through the resultant of the total load. a strap footing is more economical than a combined footing when the allowable soil pressure is relatively high and the distance between the columns is large.



Mat or Raft Foundations

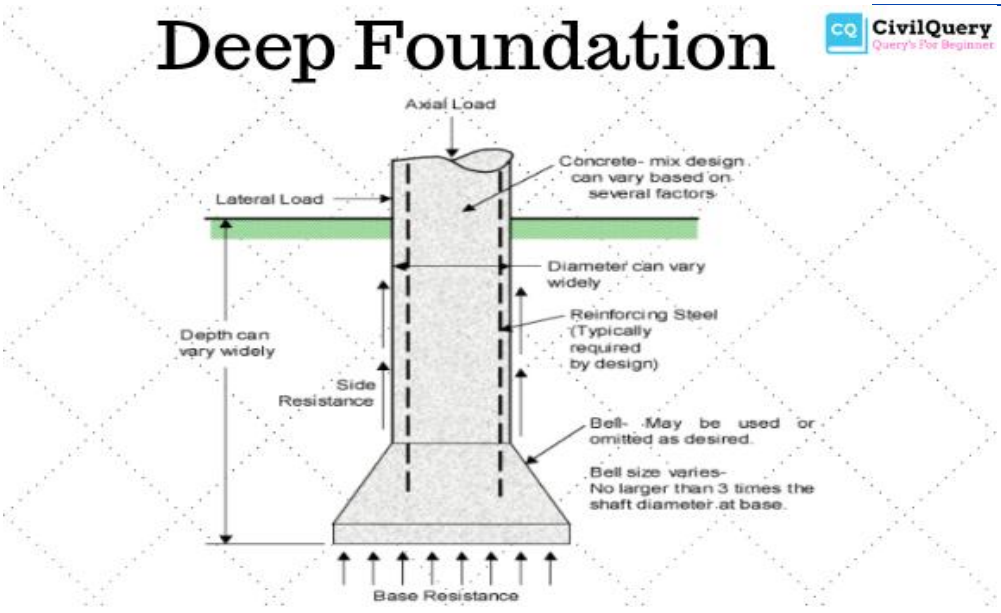
A mat or raft foundation is a large slab supporting a number of columns and walls under the entire structure or a large part of the structure. A mat is required when the allowable soil pressure is low or where the columns and walls are so close that individual footings would overlap or nearly touch each other. Mat foundations

are useful in reducing the differential settlements on non-homogeneous soils or where there is a large variation in the loads on individual columns.



Mat /Raft Foundation

A **deep foundation** is a type of foundation that transfers building loads to the earth farther down from the surface than a shallow foundation does to a subsurface layer or a range of depths. A pile or piling is a vertical structural element of a deep foundation, driven or drilled deep into the ground at the building site.



PILE FOUNDATION

Pile foundations are **deep foundations**. They are formed by long, slender, columnar elements typically made from steel or reinforced concrete, or sometimes timber. A foundation is described as 'piled' when its depth is more than three times its breadth.

When to Use Pile Foundation

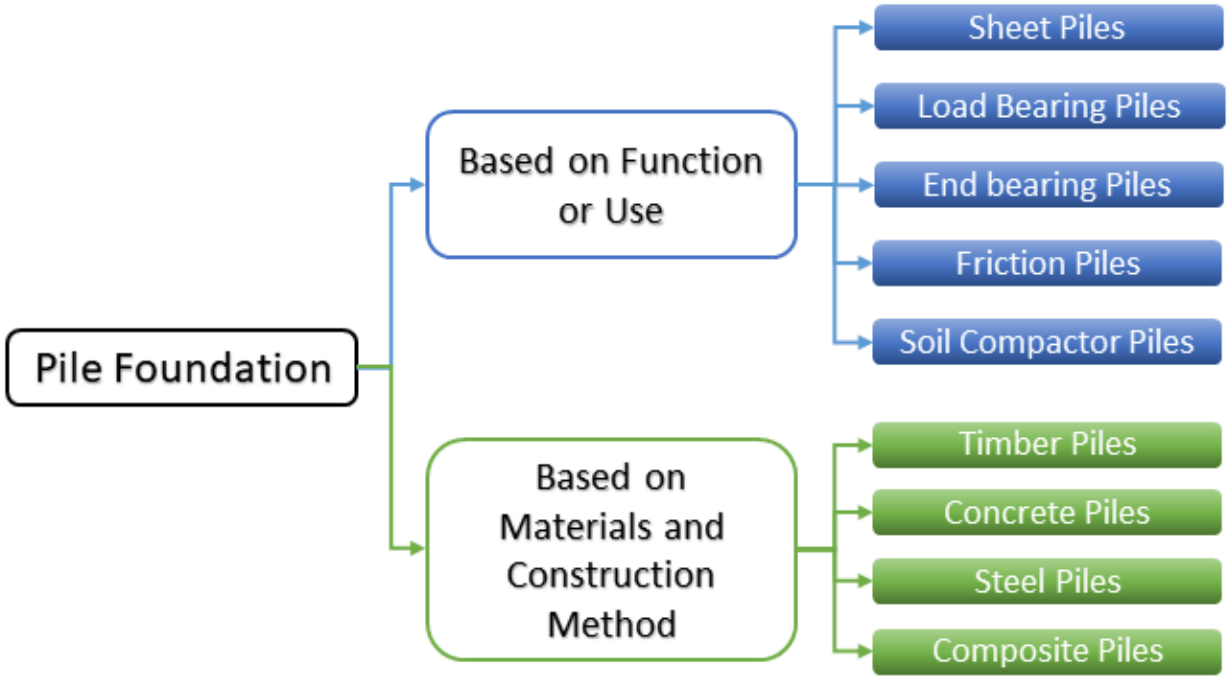
Often the question rises are the situations where pile foundation are suitable for. Following are the situations when using a pile foundation system can be beneficial.

- When the groundwater table is high foundation pilings are the best solution.
- Heavy and un-uniform loads from superstructure are imposed.
- Other types of foundations are costlier or not feasible.
- When the soil at shallow depth is compressible.
- When there is the possibility of scouring, due to its location near the river bed or seashore, etc.
- When there is a canal or deep drainage system near the structure.
- When soil excavation is not possible up to the desired depth due to poor soil conditions.
- When it becomes impossible to keep the foundation trenches dry by pumping or by any other measure due to heavy inflow of seepage.

Types of Pile Foundations

Piling foundations can be classified based on function, materials and installation process, etc. The followings are the types of pile foundations used in construction:

A. Based on Function or Use
    1. Sheet Piles
    2. Load Bearing Piles
    3. End bearing Piles
    4. Friction Piles
    5. Soil Compactor Piles
B. Based on Materials and Construction Method
    1. Timber Piles
    2. Concrete Piles
    3. Steel Piles
    4. Composite Piles



Sheet Piles

This type of piles is mostly used to provide lateral support. Usually, they resist lateral pressure from loose soil, the flow of water, etc. They are usually used for cofferdams, trench sheeting, shore protection, etc. They are not used for providing vertical support to the structure. They are usually used to serve the following purpose–

- Construction of retaining walls.
- Protection from river bank erosion.
- Retain the loose soil around the foundation trenches.
- For isolation of foundation from adjacent soils.
- For confinement of soil and thus increase the bearing capacity of the soil.

Load Bearing Piles

This type of building pile foundation is mainly used to transfer the vertical loads from the structure to the soil. These load-bearing pile foundations transmit loads through the soil with poor supporting property onto a layer that is capable of bearing the load. Depending on the mechanism of load transfer from pile to the soil, load-bearing piles can be further classified as flowed.

End Bearing Piles

In this type of piles foundation, the loads pass through the lower tip of the pile. The bottom end of the end-bearing piles rests on a strong layer of soil or rock. Usually, the pile rests at a transition layer of a weak and strong slayer. As a result, the pile acts as a column and safely transfers the load to the strong layer.

The total capacity of end bearing pile foundation can be calculated by multiplying the area of the tip of the pile and the bearing capacity at that particular depth of soil at which the pile rests. Considering a reasonable factor of safety, the diameter of the pile is calculated.

Friction Pile

The Friction pile transfers the load from the structure to the soil by the frictional force between the surface of the pile and the soil surrounding the pile such as stiff clay, sandy soil, etc. Friction can be developed for the entire length of the pile or a definite length of the pile, depending on the strata of the soil. In friction piles, generally, the entire surface of the pile works to transfer the loads from the structure to the soil.

The surface area of the pile multiplied by the safe friction force developed per unit area determines the capacity of the pile.

While designing a skin friction pile, the skin friction to be developed at a pile surface should be sincerely evaluated and a reasonable factor of safety should be considered. Besides this one can increase the pile diameter, depth, and the number of piles and make the pile surface rough to increase the capacity of the friction pile.

Soil Compactor Piles

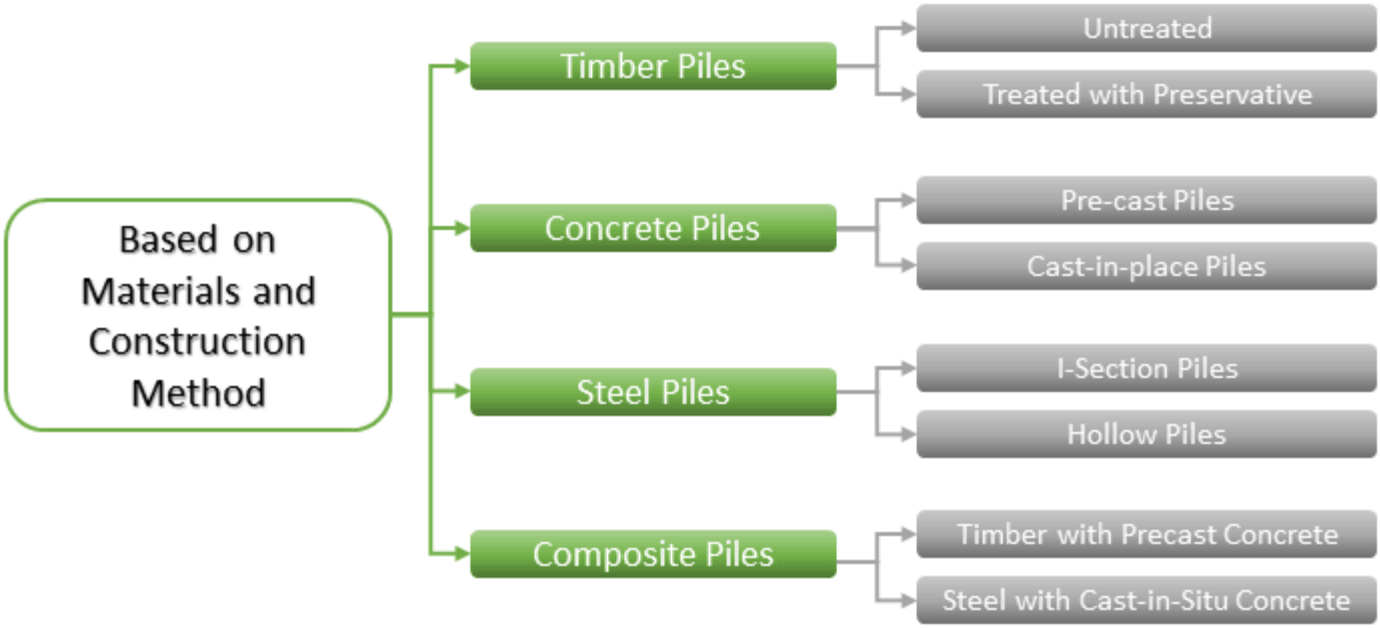
Unlike other pile foundation types, this type of pile does not carry any direct loads. This type of piles is driven at placed closed intervals to increase the bearing capacity of soil by compacting.

Types of Piles Based on Materials and Pile Foundation Construction Method

Primarily piles can be classified into two parts. Displacement piles and Non-displacement or Replacement piles. Piles that cause the soil to be displaced vertically and radially as they are driven to the ground are known as Displacement piles. In the case of Replacement piles, the ground is bored and the soil is removed and then the resulting hole is either filled with concrete or a pre-cast concrete pile is inserted. On the basis of materials of pile foundation construction and their installation process load-bearing piles can be classified as follows:

1. Timber Piles

    i. Untreated
    ii. Treated with Preservative
2. Concrete Piles
    i. Pre-cast Piles
    ii. Cast-in-place Piles
3. Steel Piles
    i. I-Section Piles
    ii. Hollow Piles
4. Composite Piles



Timber Piles

Timber piles are the types of piled foundations that are placed under the water level. They last for approximately about 30 years. They can be rectangular or circular in shape. Their diameter or size can vary from 12 to 16 inches. The length of the pile is usually 20 times the top width.

They are usually designed for 15 to 20 tons. Additional strength can be obtained by bolting fish plates to the side of the piles.

Advantages of Timber Piles

- Timber piles of regular size are available.

- Economical.
- Easy to install.
- Low possibility of damage.
- Timber pile footings can be cut off at any desired length after they are installed.
- If necessary, timber piles can be easily pulled out.

Disadvantages of Timber Piles

- Piles of longer lengths are not always available.
- It is difficult to obtain straight piles if the length is short.
- It is difficult to drive the pile if the soil strata are very hard.
- Spicing of timber piles is difficult.
- Timber or wooden piles are not suitable to be used as end-bearing piles.
- For the durability of timber piles, special measures have to be taken. For example- wooden piles are often treated with preservatives.

Concrete Piles

Pre-cast Concrete Pile

The precast concrete pile foundation is cast in a pile bed in horizontal form if they are rectangular in shape. Usually, circular piles are cast in vertical forms. Precast piles are usually reinforced with steel to prevent breakage during their mobilization from the casting bed to the location of the foundation. After the piles are cast, curing has to be performed as per specification. Generally curing period for pre-cast piles is 21 to 28 days.

Advantages of Pre-cast Piles

- Provides high resistance to chemical and biological cracks.
- They are usually of high strength.
- To facilitate driving, a pipe may be installed along the center of the pile.
- If the piles are cast and ready to be driven before the installation phase is due, it can increase the pace of work.

- The confinement of the reinforcement can be ensured.
- The quality of the pile can be controlled.
- f any fault is identified, it can be replaced before driving.
- Pre-cast piles can be driven under the water.
- The piles can be loaded immediately after it is driven up to the required length.

Disadvantages of Pre-cast Piles

- Once the length of the pile is decided, it is difficult to increase or decrease the length of the pile afterward.
- They are difficult to mobilize.
- Needs heavy and expensive equipment to drive.
- As they are not available for readymade purchase, it can cause a delay in the project.
- There is a possibility of breakage or damage during the handling and driving of piles.

Cast-in-Place Concrete Piles

This type of pile footing is constructed by boring soil up to the desired depth and then, depositing freshly mixed concrete in that place and letting it cure there. cast in situ concrete pile foundation is constructed either by driving a metallic shell to the ground and filling it with concrete and leaving the shell with the concrete or the shell is pulled out while concrete is poured. Usually, round piles are used in cast-in situ piling.

Advantages of Cast-in-Place Concrete Piles Foundation

- The shells are light weighted, so they are easy to handle.
- The length of piles can be varied easily.
- The shells may be assembled at sight.
- No excess enforcement is required only to prevent damage from handling.
- No possibility of breaking during installation.
- Additional piles can be provided easily if required.

Disadvantages of Cast-in-Place Concrete Piles

- In this type of pile foundation, installation requires careful supervision and quality control.
- Needs sufficient place on site for storage of the materials used for construction.
- It is difficult to construct cast in situ piles where the underground water flow is heavy.
- The bottom of the pile may not be symmetrical.
- If the pile is un-reinforced and uncased, the pile can fail in tension if there acts an uplifting force.

Steel Piles

Steel piles may be of I-section or hollow pipe. They are filled with concrete. The size may vary from 10 inches to 24 inches in diameter and the thickness is usually ¾ inches. Because of the small sectional area, the piles are easy to drive. They are mostly used as end-bearing piles.

Advantages of Steel Piles

- They are easy to install.
- They can reach a greater depth compared to any other type of pile foundations.
- Can penetrate through the hard layer of soil due to the less cross-sectional area.
- It is easy to splice steel piles
- Can carry heavy loads.

Disadvantages of Steel Piles

- This piling type is prone to corrosion.
- Has a possibility of deviating while driving.
- Comparatively expensive.

QUESTIONS

1. What is foundations ?
2. What is shallow foundations ?
3. What is deep foundations ?
4. What are the type of shallow foundations ?
5. What is footing ?
6. What is pile foundations?
7. What are the types of pile foundations ?
8. What are the advantages and disadvantages of pile foundations ?

CHAPTER–7

DOORS WINDOWS AND LINTELS

DOOR–

Door may be defined as an openable barrier secured in an opening left in a wall for the purpose of providing access to the users of the structure.

It basically consists of two parts, namely, frame and shutter. The door shutter is held in position by the door frame which in turn is fixed in the opening of the wall by some suitable means.

WINDOWS–

A windows may be defines as opening made in a wall for purposes of providing day light, vision and ventilation. It also like door consists of two parts that is frame and shutter. The windows frame is suitably fixed in the opening of the wall and the window shutter is held in position by the windows frame.

IMPORTANT CONSIDERATIONS FOR DOORS AND WINDOWS

PURPOSE– The main function of doors in a building is to serve as a connecting link between the various internal parts.

The number of doors in a room should be kept minimum due to the fact that more number of door will cause obstruction and reduce the effective usable carpet area of the room .

The windows are generally provided to give light and ventilation both to the interior parts of a building.

SIZE– In general a door should have such dimensions as will allow the movement of the largest object likely to use the door.

The minimum widths for interior doors, external doors in public buildings such as hospitals ,library ,etc.

Height =width+1m approximately

Width =0.4 to 0.6 of height.

The size of window depends on the dimensions of the room, use of the room, location of the room, direction and speed of the wind ,obstruction to light by neighboring buildings and trees, dry bulb temperature, relative humidity, climatic conditions of the region, etc.

LOCATION–The doors and windows are generally located by the architect of the building.

1. The door should preferably be located near the corner of a room, at a distance of about 200mm from the corner.
2. The sill of a windows opening should preferably be located at a height of 700mm to 800mm from inside of the floor level.
3. The factors such as distribution of light, control of ventilation, prevalent direction of wind ,privacy,etc should be considered in the location of windows.

MATERIAL–The usual materials for doors and windows are wood ,glass, plywood and metals. The wood is the most common material for doors and windows as it can be molded in a verity of shapes and can thus present a decent appearance.

The glass is used for panels to admit more light. The plywood can be used as a covering material. The metals, such as aluminum and steel, are now commonly used, especially for the windows.

TYPES OF DOORS

1. Battened and Ledged Doors

- Battens are vertical bonds which are having grooves are attached together by horizontal supports called ledges as shown in below figure.
- General Dimensions of batten are 100-150mm width and 20-30mm thick.
- General dimension of ledges are 100-200mm width and 25-30mm thick.
- This type of battened and ledged doors suitable for narrow openings.

2. Battened, Ledged and Braced Doors

- To make more rigid, braces are provided diagonally in additional to battens and ledges as shown in figure.
- Braces are having 100-150mm width and 25-30mm thickness are preferable.
- Braces should place upwards from handing side, then they acts as struts and take compression
- These type of doors can be used for wider openings.

3. Battened, Ledged and Framed Doors

- For the simple battened and ledged door, frame work is provided in the form of two verticals, known as stiles.
- Stiles are generally 100mm wide and as far as thickness is concerned, the thickness of stile should be equal to the combined thickness of ledge and batten. Preferably 40 mm.
-

4. Battened, Ledged, Braced and Framed Doors

- In this type, the door made up of battens, ledges, stiles and braces. So, it is more rigid.
- The braces are connected diagonally between the ledges, at about 40mm from the stiles.

5. Framed and Paneled Doors

- These are very strong and will give good appearance when compared to battened doors. These are the widely used doors in almost all types of buildings.
- Stiles, vertical members and rails, horizontal members are grooved along the inner edges of frame to receive the panels.
- The panels are made up of timber or plywood or A.C. sheets or glass.
- These doors may be single leaf for narrow openings and double leaf for wider openings.
- Minimum width of stile should be 100mm and minimum width of bottom and locked rail should be 150mm.

6. Glazed Doors

- Glazed doors are generally provided in interior wall openings or in hospitals, colleges etc.
- The interior of room is visible through glazed doors and light also passes through glazed portion of the door.
- These may be fully glazed or partly glazed and partly panelled. Glass panels are provided for glazed doors.

7. Flush Doors

In flush doors, a solid or semi-solid or core portion is covered on both sides with plywood or face veneer. Now a days these type of doors are widely used because

of good appearance, economic, ease of construction and greater durability. **There are two types of Flushed doors:**

Solid Core or Laminated Core Flush Door

- The core part in solid core flush door consists of core strips of timber which are glued under high pressure condition. Similarly in the laminated core, battens of 25mm width are glued under high pressure.
- These doors consists of wooden frame with stiles and rails for holding the core.
- Finally plywood sheets or face veneer and cross-bands are glued under pressure on both side of doors.

Hollow core and cellular core flush door

- In this case also stiles and rails are provided for frame. But, a minimum of two intermediate rails should be provided.
- The inner space of door consists of equally space battens of width 25mm each. Other space is called void space which does not exceed 40% of the area of door.
- Here also face veneer and cross-bands are glued under high pressure.

8. Louvered Doors

- The louvers permit natural ventilation when the door is closed and also provide privacy in the room.
- These are generally used for toilets of residential and public buildings.
- The door may be fully louvered are partly louvered.
- Louvers are made up of timber or glass or plywood and these may be either fixed or movable.

9. Wire Gauged Doors

Wire gaged doors permits natural ventilation and restrict the entry of flies, mosquitoes, insects etc.. These doors are commonly used in hotels, restaurants and for cup boards containing eatables.

10. Revolving Doors

Revolving doors are only provided in public buildings like museums, banks, libraries etc., because of constant visitors. It consists mullion at its center to which four radiating shutters are attached.

11. Sliding Doors

In this type, with the help of runners and guide rails the door slides to the sides. The door may have one or more sliding shutter depending up on the opening available.

12. Swing Doors

In this case, the shutter is attached to frame by double action spring which helps the shutter to move inwards as well as outwards.

13. Collapsible Steel Doors

Collapsible steel doors are generally used for workshops, sheds, warehouses etc.. It acts like a steel curtain which will opened or closed by horizontal pull or push. Vertical double channel units of (20x10x2 mm) are spaced at 100 to 120 mm thick and are braced flat iron diagonals 10 to 20mm wide and 5mm thick.

14. Rolling Steel Shutter Doors

Rolling steel shutter doors are commonly used for warehouses, garages, shops etc.. These are very strong and offer proper safety to the property. The door consists frame, drum and a shutter of thin steel plate inter locked together. A horizontal shaft is provided in the drum which helps to open or close the shutter.

15. Mild Steel Sheet Doors

- The door frame is made up of angle or T-sections.

- Shutter is made up of frame of angle of iron, having 2 verticals at least 3 horizontal.
- Mild steel plates are welded to the shutter frame.

16. Corrugated Steel Sheet Doors

These are same as mild steel sheet doors, but in place of mild steel sheet corrugated steel sheet is welded.

17. Hollow Metal Doors

Hollow steel sections are used to make these doors. The rails and stiles etc., are strengthened by welding small T or I sections inside.

18. Metal Covered Plywood Doors

- This type of door is a composite construction of hollow metal door and wood door.
- The door is encased in tight fitting sheet metal, having tightly folded joints to exclude air so that the core of the door does not ignite. So, it acts as fire proof.

1) Fixed Windows

These windows are anchored to the wall and cannot be opened or closed, but the light can be easily transferred into the room through completely glazed shutters attached to the window frame. The shutters that come with the house are usually waterproof. These windows are sometimes known as pictured windows because they are sometimes solely used to observe natural views outdoors.

- The fixed window's main disadvantage is that it prevents airflow. Where ventilation is not required, fixed windows are employed.

2) Sliding Windows

The window shutters of this type are moveable within the frame. Depending on our needs, the movement could be horizontal or vertical. The addition of roller bearings allows the shutters to move. This style of window is commonly found in buses, bank counters, and shops, among other places.

- The main problem with this sort of window is that it cannot be fully opened, leaving one side of the window closed at all times. There are two types of sliding windows: double track and triple track. This form of window has the advantage of being able to move within its own internal

space, requiring no additional space to work properly.

3) Ordinary Windows

It is also called casement windows. These days, casement windows are very popular. This window type has a larger ventilation space than other types. Generally, this style of window is not permitted near sidewalks or traffic areas. The casement windows' shutters are open and close like doors. The frame has been given enough room to accommodate the shutters. The construction of this sort of window is very similar to that of a door. The window shutter panels

might be single or many.

4) Glazed/ Sash Windows

The casement window and the glazed/ Sash window are comparable. The window shutters' panels, however, are completely glazed, as the name implies. Top, bottom, and intermediate rails make up this structure. Small panels known as sash bars or glazing bars are used to separate the area between the rails.

5) Pivoted windows

Pivoted windows are similar to casement windows, with the exception that the frame does not require rebates and the shutter action differs slightly. The pivots that allow the shutter to oscillate can be made horizontally or vertically, and they are easy to clean. In addition, it lets in more light than side-hung windows do. 

6) Metal Windows

Metal windows, in general, are made of mild steel. These are less expensive and more durable. As a result, these are increasingly widely used, particularly in public and private structures.

Aluminum, copper, stainless steel, and other metals are also utilized to construct windows. However, they are more expensive than mild steel windows. Metal

shutters are also available for standard casement windows to offer substantial

support for the panels.

7) Corner Windows

A room's corner windows comprise of two perpendicular faces at the room's corners. This style of window can let light and air in from two sides. When this sort of window is built, a unique lintel is installed in the wall to support the

masonry work above the window's opening. The room is enhanced by the presence of corner windows.

8) Bay Windows

Bay windows are typically projected against an exterior wall and begin at the floor or sill level. These sorts of windows allow for better air and light ventilation. Bay windows come in a variety of shapes, including triangular, rectangular, and polygonal. If you simply have a few bay windows, you might be able to improve

the view of your home.

9) Louvered Windows

These windows enable ventilation without allowing outside visibility, ensuring appropriate privacy even when the window is open. The top and bottom rails of the window shutters are made of louvers and are fixed with louvers. Louvers have a 45-degree slant (recommended). By tilting and lifting the string, the louver's slope can be maintained. Louvers are often formed of wood, glass, or metal and

are used in restrooms, toilets, and other private areas.

10) Double Hung Window

A pair of shutters is linked to a single frame in a double-hung window. Each shutter is stacked on top of the other. Within the frame, these two shutters can be moved vertically. As a result, we can adjust the top or bottom windows to meet our needs.

A chain or string made up of metal weights that are strung over pulleys is used to operate the double-hung windows. The shutters can now be moved vertically simply by drawing the cord weights. The windows can then be adjusted to provide

the ventilation or light that we require.

11) Dormer Windows:

Dormer windows are built into the roof's sloping surface. The primary characteristics of these windows are that they allow for appropriate light and air circulation in the room. Dormer windows are built into roof slopes. It also adds to

the room's beauty.

12) Clerestory Windows

These windows are typically used in rooms with varying ceiling heights, meaning that one room has a higher ceiling height than the others and the window is located at the top of the main roof. When the front side of the room is obstructed from light and air circulation, this style of window is usually installed.

13) Gable Windows:

Gable windows are windows that are typically installed at the gable end of a building's sloping roof. This sort of window improves the building's outlook and has been used since ancient times.

14) Lantern Windows:

If the room is blocked from all sides and there are no windows in the room's wall to offer appropriate light and air circulation, lantern windows are installed on the

flat top of the structure. However, if the window is to be fixed for air ventilation, hinged shutters must be installed with a string or pulley system to open and close the window. Glass panels should be used to cover the window shutters.

15) Skylight Windows:

Skylight windows are usually waterproof and are installed in a parallel manner on the sloping surface of a pitched roof with glass panels. The primary function of skylight windows in a structure is to allow more light into the space. It can be opened whenever necessary.

16) Ventilators:

Ventilators are typically installed near the room's ceiling and are quite modest in comparison to the window size. It is set in place and opens upwards and outwards for room ventilation. In the case of ventilators, swivel shutters are provided

horizontally. Wire mesh is often used instead of shutters with a parasol to keep rainwater out.

Questions

1.what is door ?

2.what is windows ?

3.what are the important of windows & door ?

4. what are the different types of windows are there ?

5.what are the different types of doors are there ?

-

Floor roofs and stairs

Floors–

In order to sub divide the portion between the plinth level or basement level and roof level ,the solid constructions are carried out.

These constructions are known as the floors and the exposed top surfaces of floors are termed as the floorings.

The ground floors or basement floors which directly rest on the ground do not require the provision of a floor .but they are provided with suitable type of floor covering or simply flooring.

The other floors of each storey above the ground level are known as the upper floor.

TYPES OF FLOOR

1. Mud Floor:

Earthen Flooring also commonly known as Adobe flooring is made up of dirt, raw earth or other unworked ground materials. In modern times, it is usually constructed with mixture of sand, clay and finely chopped straw.

Mud flooring is commonly constructed in villages where by using stabilizers the properties of the soil are enhanced by manipulating its composition by adding suitable stabilizers. The tensile and shear strength of the soil is increased and shrinkage is reduced.

Suitability:

These floors are not prepared in commercial or professional buildings but only in residential buildings in rural areas where the cheapest and easiest option is selected. The mud flooring is easy to maintain, remains warm in winter and cold in summer and hence it is most suitable for places where the temperature is extreme during these seasons.

2. Brick floor:

Brick flooring is one of the types of floors whose topping is of brick. These are easy to construct and repair but the surface resulting from these is not smooth and is rough, hence, easily absorbs and retains moisture which may cause dampness in the building.

Method of Construction of Brick Floor:

For constructing a brick floor, the top surface of earth or murram filling is properly consolidated. Over this compacted earth, a layer of clean sand about 10 cm thick is evenly spread. Then a layer of lime concrete (1:4:8) or lean cement concrete (1:4:16) is laid, compacted and cured. Over this base concrete well soaked bricks are laid in cement mortar (1:4) in any suitable bond. In case pointing is to be done, the minimum thickness of joints should not exceed 2 mm and and the mortar in joints is struck off with a trowel. When the pointing is to be done, the minimum thickness of joints is kept 6mm and the pointing may be done.

Suitability:

The floors are suitable for stores, godowns etc.

3. Tile floor:

The floor whose topping is of tiles is called tile floor. The tiles used may be of any desired quality, color, shape or thickness.

Method of construction of Tile Floor:

For constructing a tile floor, the base course is prepared in the same manner as in case of brick flooring.Over the base course thus prepared, a thin layer of lime or cement mortar is spread with the help of screed battens. Then the screeds are properly leveled and fixed at the correct height. When the surface mortar has hardened sufficiently, the specified tiles are laid on a 6 mm thick bed of wet cement mortar.(1:5). The surplus mortar which comes out of the joints is cleaned off. After 3 days, the joints are well rubbed a carborundum stone so as to smoothen the surface, specially the edges.

Suitability:

These floor are used for paving courtyard of buildings. Glazed tiles floors are used in modern buildings where a high class building is desired.

4. Flagstone floor:

The floors whose topping consists of stone slabs is called flagstone floor. The stone slabs used here may not be of the same size but should not be more than 75 cm length and not less than 35 cm in width and 3.8 cm in thickness.

Method of construction of Flagstone Floor:

For constructing a flagstone floor, the same method is applied as in case of tile floor. The slabs are soaked well in water at least one hour before laying. They should be evenly and firmly bedded in mortar. The thickness of joints should not exceed 4mm and they should be struck off with a trowel while laying.

Suitability:

These type of flooring are suitable in go-downs, motor sheds, stores, pavements etc.

5. Cement concrete floor:

The types of floors whose topping consists of cement concrete is called cement concrete floor or conglomerate floor. These floors consists of 2.5 cm to 5cm thick concrete layer laid over 10 cm thick base concrete and 10 cm thick clean sand over ground whose compaction and consolidation is done. These floors are commonly used these days.

Following are the advantages of concrete floors:

1. They are hard & Durable.
2. Provide a smooth & non absorbent surface.
3. They are more fire resistant.
4. They provide more sanitary surface as they can be cleaned & washed easily.
5. They are economical as they require negligible maintenance cost.
6. They can be finished with a pleasing appearance.

Types of cement concrete floors:

1. Non-Monolithic or bonded floor finish floor.
2. Monolithic floor finish floor.

Terrazzo floor

IT is a special type of cement concrete flooring. This special type of cement concrete is prepared by mixing of marble chips or other materials with cement or colored cement. In this case, marble chips or other decorative materials are used as an aggregate, and white cement or colored cement is used as a binder.

Generally, the ratio of cement and marble chips is 1:3. Although, this ratio depends upon the size of marble chips, is used.

This special type of concrete is known as terrazzo cement concrete. The floor in which topping or finishing is made of terrazzo cement concrete is known as terrazzo flooring. The thickness of the **Terrazzo flooring** varies between 8 mm to 12 mm.

Terrazzo flooring is more attractive than normal cement concrete flooring. These days, it has become a more popular flooring type. It has more wear-resisting properties. This flooring is mostly used in hotels, offices, and public buildings.

Timber flooring

IT is a product of nature. It's also commonly known as wood flooring and hardwood flooring in the market. Timber flooring is a product that manufactured from timber to provide warm and an easy feeling on the feet.

- Timber flooring that constructed with **more than 1 layer** of wood
- Can be 2 layers, 3 layers, 4 layers to 11 layers or more
- Majority in the market now is 3 layers and multilayer (above 5 layers)
- Usually is odd number construction, however is not necessarily odd number
- Basically the construction of engineered timber flooring can be divided in to 3 part: Top, Core and Bottom

ROOF

A roof is defined as the uppermost part of a building which is constructed in the form of a framework to give protection to the building 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.

Requirements of a good roof

Following are the requirements of a well planned roof

1.it should be durable against the adverse effects of various agencies such as wind,rain,sun,etc.

2.it should grant the desirable insulation against sound and heat.

3.it should be structurally stable and sound and it should be capable of taking the loads likely to come over it.

4.it should be well drained.

5.it should have efficient water proofing arrangement.

6.it should be fire resistant.

Types of roofs

The shape or plan of a building, the climatic conditions of a location, and the type of construction materials available all influence the type of roof chosen. Roofs can be divided into three main types:

1. Sloping or pitched roof:

A pitched roof is defined as a roof having a slanting surface. The following are the several types of pitched roofs:

a) Lean-to-roof:

This is the most basic style of the sloping roof, which can be used for a small room or a verandah. Only one side of this has a slope.

b) Gable Roof:

The triangle produced when the two pitched portions of the roof meet are referred to as a gable.

The gable roof is a particularly common style of the roof because it is simple to construct, sheds water well, allows for ventilation, and can be used with almost any building design.

c) Hip Roof:

A conventional hip roof is made up of four slopes of equal length that meet at the ridge to make a simple ridge. There are a few varieties, including the half-hip, which has two shorter sides with eaves. The construction of a hip roof is slightly more challenging. It's a popular option, however, it doesn't have any ventilation. In high-wind situations, they function better.

d) Gambrel Roof:

It's also known as barn roof because it's commonly seen on barns. It adds to the attic's headroom. A gambrel roof is a symmetrical two-sided roof with a shallow upper portion and steeper lower slope on either side, most typically found in barns. This design maximizes the space within a building's loft, but it's generally utilized on outhouses and barns because it's ineffective in locations with high winds or snowfall.

e) Deck Roof:

A deck roof, like a hip roof, has slopes in all four directions, but the top is covered with a deck or plane surface.

f) Mansard or club roof:

It's a French design that's more challenging to construct than a hip or gable roof. On each side, it has two slopes within one. The roof slope is greater at the bottom, thus the pitch of the roof hardly begins. This provides for more inside space and, in most circumstances, creates additional space.

2. Flat or terraced roof:

This type of roof has a slope of less than 10 degrees and is either horizontal or nearly horizontal. Even a completely horizontal roof must have a slight incline at the top to allow rainfall to drain quickly. The flat roof can be built using flagstone, R.S.J., and flagstones, reinforced cement concrete, reinforced brickwork, jack arch

roof, or precast cement concrete modules in the same way as the upper level. The flat roof, on the other hand, differs from the upper floor mainly in terms of the top finish, which is known as terracing, which protects it from rain, snow, heat, and other elements.

3. Curved roof:

Curved roofs are an important part of a pitched roof because they protect the roof framework from rain, snow, sun, wind, and other environmental factors.
Any building with a curved roof has a very modern and intriguing feature. The flexibility of metal components is used to create one huge curving framework in modern roofing. Curved roofs help reduce wind resistance, but they're mostly chosen for the outstanding aesthetic value they may provide to a structure.

The type of building, type of roof structure, initial cost, maintenance requirements, fabrication facilities, aesthetic and particular features of the locality, durability, availability of the material itself, and climate of the locality are all factors to consider when selecting a roofing material.

Some other types of roofs:

a) Butterfly Roof:

With two tandem sections of roofing angled upwards to form a V-shape, a butterfly roof, also known as an inverted pitch roof, mimics the wings of a butterfly. The style gives buildings an eye-catching, modern aspect while also

allowing for wider walls and windows, as well as an easily managed rainwater collection system through the roof's center channel.

Fig 6: Butterfly Roof

b) Dormer Roof:

A dormer is more of an extension to a roof that already exists. Dormers have a vertically projecting window that creates an extra window in the roof from a regular pitched roof. This type of roof is most commonly used in loft conversions since it allows for easy space expansion and natural light in the converted loft room.

c) M Shaped Roof:

An M-shaped roof is basically a double gable roof with two pitches. The roof is supported by two bearing walls, with two sloping walls forming a 'M' shape in the centre. During the winter season, central guttering runs between the two pitches to prevent snow and rain accumulation.

Stairs

A stair is defined as a sequence of steps and it is provided to afford the means of ascent and descent between the floor or landings. The apartment or room of a building, in which the stair is located, is known as A Staircase and the opening or space occupied by the stair is known as a stairway.

The humble staircase can open up a wealth of terminology that can cause confusion.

The diagram below highlights the core components of a staircase

Key components

Strings: A span of timber to which treads and risers are attached to support a flight or run of stairs

Tread: The horizontal part of the stair that is stepped on.

Risers: The vertical part of the stair (where no risers are present this would be referred to as "open risers"). The number of steps in a staircase is counted by the number of risers, not the number of treads.

Balustrade: A row of balusters (spindles) topped by a handrail serving as a safety guarding and along the edge of a staircase.

Handrail: Following the staircase to support and guide during ascending or descending a staircase and an element to grasp in case of a fall

Newel: A large baluster or post acting as a structural element to anchor the balustrade to the floor or stair.

Spandrel: The triangular space underneath a staircase (when there is not another flight underneath).

Winder: A stair that is narrower on one side to enable a turn in the staircase. A series of winders form a circular or spiral stairway. When three steps are used to turn a 90° corner, the middle step is called a kite winder as a kite-shaped quadrilateral.

Apron: A facia covering the ends of rough strings, carriage pieces, and the joists of landings.

Other key terms:

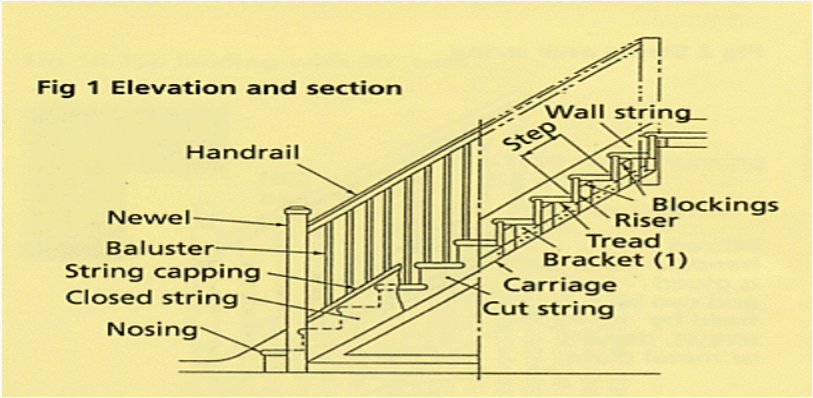
Flight: An uninterrupted series of steps.

Rise: The height of an individual step (i.e. this differes from the hight of a riser as it refers to the height that must be stepped)

Going: The depth of an individual step

Pitch: The slope of the staircase measured as the ratio between the rise and going

Walkline: The path that an individual would follow up or down a staircase



TYPES OF STAIR

Stairs can be broadly classified into three types:

1. Straight stairs

2. Turning stairs
3. Continuous stairs

1. **Straight stairs**

Generally for small houses, available width is very retractable. So, this type of straight stairs are used in such conditions which runs straight between two floors. This stair may consists of either one single flight or more than one flight with a landing.

2. **Turning stairs**

Turning stairs are sub classified as:

1. Quarter turn stairs
2. Half turn stairs (dog legged stairs)
3. Three – quarter turn stairs
4. Bifurcated stairs

3. **Quarter turn stairs**

A quarter turn stair is the one which changes its direction either to the right or to the left but where the turn being affected either by introducing a quarter space landing or by providing winders. In these type of stairs the flight of stair turns 90 degrees art landing as it rises to connect two different levels. So it is also called as L-stair. Again these quarter turn stairs are two types.

3.1. **Newel quarter turn stairs**

These type of stairs have clearly visible newel posts at the beginning of flight as well as at the end. At the quarter turn, there may either be quarter space landing or there may be winders.

Geometrical quarter turn stairs

In geometrical stairs, the stringer as well as the handrail is continuous without any newel post at the landing area.

Half turn stairs

In case of half turn stairs its direction reversed, or changed for 180°. Such stairs are quite common. Again these are three types.

Because of its appearance in sectional elevation this name is given. It comes under the category of newel stairs in which newel posts are provided at the beginning and end of each flight.

Open newel half turn stair

In this type of open newel half turn stairs, stair has a space or well between the outer strings. This is the only aspect in which it differs from the doglegged stair.

Geometrical half turn stairs

In case of geometrical half turn stairs the stringers and the hand rails are continuous, without any intervening newel post. These stairs may contains either with half space landing or without landing.

Three quarter turn stairs

The direction of stairs changed three times with its upper flight crossing the bottom one in the case of three quarter turn stairs. These stairs are may either be newel or open newel type. This type stairs are generally used when the vertical distance between two floors is more and as well as length of the stair room is limited.

Bifurcated stairs

Bifurcated stairs are commonly used in public building at their entrance hall. This has a wider flight at the bottom, which bifurcates into two narrower flights, one turning to the left and other to the right, at landing.it may be either of newel type with a newel post or of geometrical type with continuous stringer and hand rails.

Continuous stairs

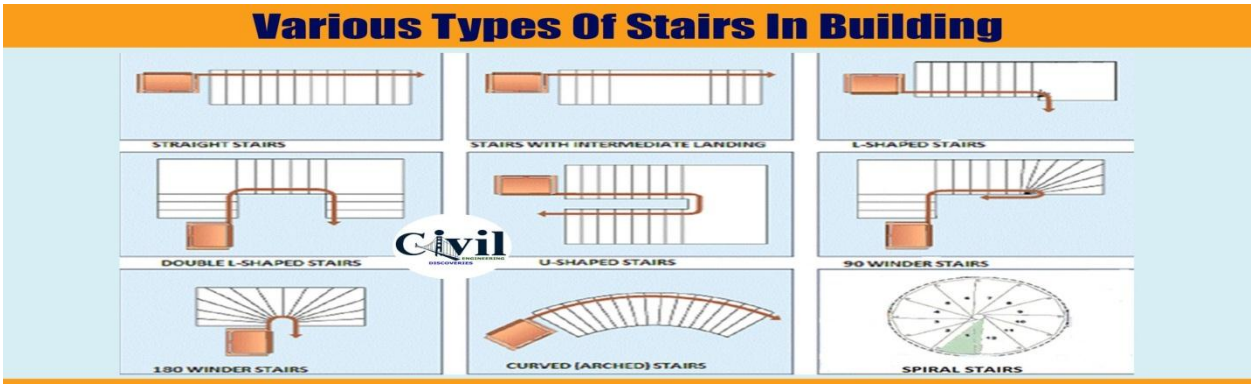
This type of stairs neither have any landing nor any intermediate newel post. They are geometric in shape. These are may be of following types.

- Circular stairs

- Spiral stairs
- Helical stairs

Circular stairs or spiral stairs are usually made either of R.C.C or metal, and is placed at a location where there are space limitations. Sometimes these are also used as emergency stairs, and are provided at the back side of a building. These are not comfortable because of all the steps are winders and provides discomfort.

A helical stair looks very fine but its structural design and construction is very complicated. It is made of R.C.C in which a large portion of steel is required to resist bending, shear and torsion.



Questions

1.what is floor ?

In order to sub divide the portion between the plinth level or basement level and roof level ,the solid constructions are carried out.

These constructions are known as the floors and the exposed top surfaces of floors are termed as the floorings.

2.what is roof ?

A roof is defined as the uppermost part of a building which is constructed in the form of a framework to give protection to the building against rain, heat, snow,wind,etc.

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Long questions

1.what is floor &described its types.

2.what is stair & described its parts .

3. what are the types of stairs ?

4.what is roof & described its types .

Walls & masonry works

Purpose of walls

The main purpose of walls in building construction is not only to protect buildings from damage but also to divide them for different rooms or spaces.

There are various functional requirements of walls that should satisfy to perform its functions adequately.

Functional Requirements of Walls in Building Construction

Following are the functional requirements of walls in a building construction:

1. Strength
2. Stability
3. Weather and ground moisture resistance
4. Durability
5. Fire safety
6. Resistance to heat passage
7. Sound resistance

1. Strength Requirements of Walls

Strength requirements of walls in building construction is governed by strength of material that is employed to build the wall and how materials are fitted together. The strength of materials is determined by its compressive and tensile strength which can be achieved from tests. Material ultimate strengths at failure are obtained from testing samples and strength reduction factor is applied for the ultimate strength to compute allowable material strength. This factor is used to consider both material strength variations and their response under stresses. Stone, brick, steel and concrete are examples of materials that could be used to construct walls. Generally, the entire compressive strength of bricks and stones are not employed in small building such as houses by functional stability of the building.

2. Stability Requirements of Walls

Stability of walls greatly depends on stability of its foundation, load eccentricity, temperature effects, lateral loads such as earthquake and wind loads, and changing in moisture. Overturning tendency of the wall is due to loads that are not acting on the center of the wall like loads from roofs and floors and lateral

loads. If both lateral loads and eccentric loads increases wall deformation is increasing and thus the wall will be unstable. Building codes provide recommendation for wall height and width to prevent instability resulted from loads. Moreover, horizontal restrictions such as tie between walls and roofs and intersection between walls and piers prevent deformation due to lateral loads. Furthermore, walls with irregular configurations as shown in Figure-1 are more stable than regular straight walls because buttress actions come into effect in the former.

3. Weather and Ground Moisture Resistance of Walls

Walls should have enough resistance against moistures (water vapor and liquid water) that might penetrate through foundation walls by absorbing water from ground or by falling of rain on the walls. Damp-proof layer with a thickness of 150 mm can be employed above ground level for all foundation walls. This could prevent water absorption from the ground which could have a detrimental effect if it is not dealt with properly. The water that might penetrate walls from the rainfall depends on many factors such as quality of materials and the way of assembling those materials together and prevailing winds. There are several solutions for situations such as using greater thickness for walls, construction brick, stone, or block walls in two skins with 50 mm cavity between them, protecting wall outer face by cladding or plastering, and utilizing a glass sheet as a curtain wall. Moreover, environmental features such as hills, trees, or other constructed buildings around should be taken into consideration in determining proper solutions, because these can change severity of exposure conditions to prevailing winds that direct rain on the walls

4. Durability Requirements of Walls

Durability of walls is determined by frequency and the amount of work that is required to make the wall meet the minimum requirements functionally and aesthetically acceptable. Functional requirements might include the wall capability to resist rain and thermal properties. It is difficult to specify standard

acceptable appearance of walls especially in cases where unusual materials such as glass and plastic sheets are used. This is because the minimum acceptable appearance can be varied from person to another. However, this not the case when familiar materials are employed such as high quality bricks or stones which are chosen with good judgments. The wall that is constructed with bricks will be durable and need not be repairing over its lifespan if good burned bricks and high quality mortars is used, proper attentions is paid to wall openings, and exposure conditions is considered. When lime mortar is used for brick wall construction is will be necessary to repoint the lime mortar to avoid moisture penetration and regain good appearance.

5. Fire Safety Requirements of Walls

The first and most important measure against fire is providing a convenient way to escape from it because at early stages of breaking out life of occupant will be in danger because of fumes and smokes. Safety against spreading of fire is the second measures which include restricting lining, structural, external fire spread in addition to provide access for fire fighters. The restrictions are carried out by providing fire resistance for walls and specify level of flammability of materials used to cover inside walls and floors.

6. Resistance to Heat Passage

It is very important to contain heat and prevent its loss because it leads to obtain cost effective, desirable, and comfortable thermal conditions in buildings. Therefore, it is recommended to construct a wall that is thermally insulated to avoid too much loss of heat. The loss of heat can be prevented by using light weight and low conductive materials. Moreover, dense high conductive materials have great capacity for thermal storing compare with lightweight materials with low conductivity. If a building has a continuous source of heating it would be useful to apply low density materials for the outside face of the wall and high

density material for inside face. In contrary, using light weight material is advantageous when the building is heated intermittently.

7. Sound Resistance of Walls

Impact and airborne are the two ways of transmitting sounds. The latter is induced as cyclical disturbances of air from a source such as radio while the former is generated because of an impact on solid surfaces for example footsteps that induce floor vibration and in return the air around is vibrated and heard as sound. High density materials can be used to resist airborne sounds such as concrete walls, cavity wall, and solid wall. However, impact sounds are transmitted quickly through dense materials therefore, materials which can cushion or interrupt path of the impact sound should be employed.

Different types of walls used in Building Construction

Wall:

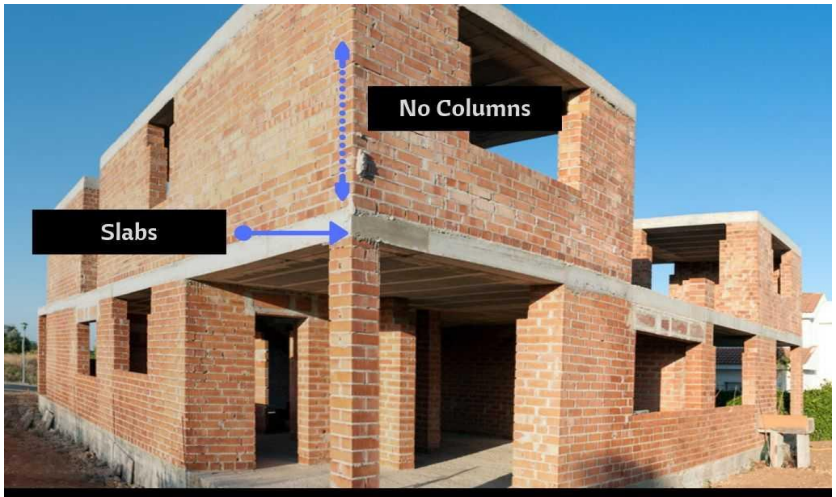
Wall is a structural element which divides the space (room) into two spaces (rooms) and also provides safety and shelter. Generally, the walls are differentiated as a two types outer-walls and inner-walls. Outer-walls gives an enclosure to the house for shelter and inner-walls helps to partition the enclosure into the required number of rooms. Inner walls are also called as Partition walls or Interior Walls and Outer walls are also called as Exterior walls.

In the technical point of view the walls are divided into the following types:

Different Types of Walls:-

1.Load Bearing Wall :

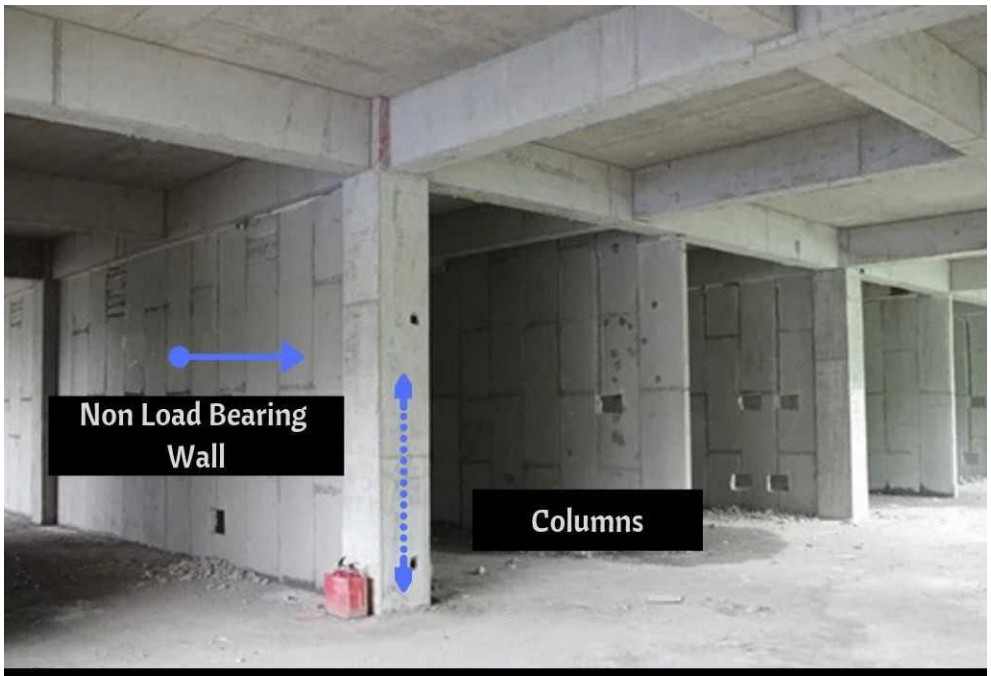
As the name itself suggests that, the whole building structure is rested on walls instead of columns. In general, the loads from slab transfers to the beams, from beams to the columns and then spread to the foundation.



From the above image, you can identify that the structure has beams and slabs but not columns. In simple words, whether its exterior or interior walls, the wall which is bearing the whole weight of the structure, including self-weight of structural elements is called Load bearing wall. Strip foundation is adopted for the load-bearing type of wall.

2. Non-load Bearing wall or Drop Wall:

This type of wall doesn't support floor or roof loads above them which means it wont carry any of the weight of the structure above it. Partition walls inside the building are the best example of it, where these are constructed only to divide the rooms and these walls don't possess any structural integrity. The non-load bearing wall can be removed or shortened without affecting the building structure.



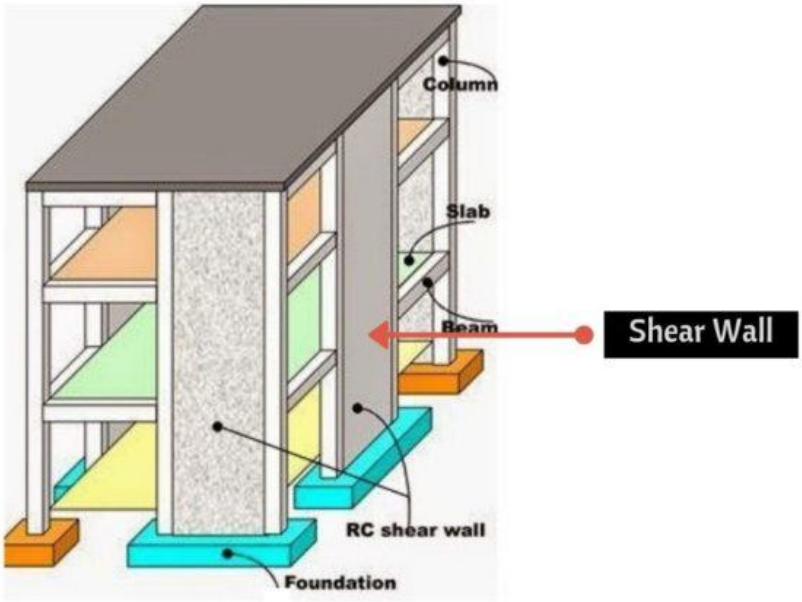
Non-Load Bearing Wall

Non-Load bearing walls are also called as Drop wall or Filling wall.

The thickness of Non Load bearing wall generally lies in between 100mm to 125mm.

3. Shear wall:

Shear wall is the wall which is constructed around the lift pit, Water sump or Staircase to retain the soil. Any shear wall bears two pressures on it either it may be wind pressure and soil pressure or wind pressure or water pressure . Shear wall is adopted to resist these forces. These walls are used to carry the lateral force exerted on the structure due to wind, earthquake or any other lateral load.



Shear Wall

To make it clear, Let us take an example of the overhead water tank. Overhead tank is exposed to the wind as it is constructed on heights which share Wind pressure on it. The water tank has water in it which creates water pressure inside the tank. Shear wall resists these forces without any deflection. We will explain more about shear wall soon in a separate post.

4. Retaining Wall:

The wall which is built to maintain the unequal level of the ground on its two faces is called a Retaining wall. The wall which is constructed around the plot below ground level to retain the soil at one end and land sliding after the earthwork on site are called retaining wall. Retaining wall can be made of RCC or CRS.

Retaining walls are further divided into the following types:

1. Gravity retaining wall
2. Reinforced Concrete retaining wall
3. Brick masonry retaining wall
4. Anchored earth walls
5. Stone made Retaining wall

5. Brick masonry wall:

The wall which is constructed with the help of bricks is called Brick masonry wall. Masonry is used to join the bricks in the wall. The thickness of the brick wall could be 20cm or 10cm

- The 20cm wall is adopted for outer walls.
- The 10cm wall is adopted for inner walls.

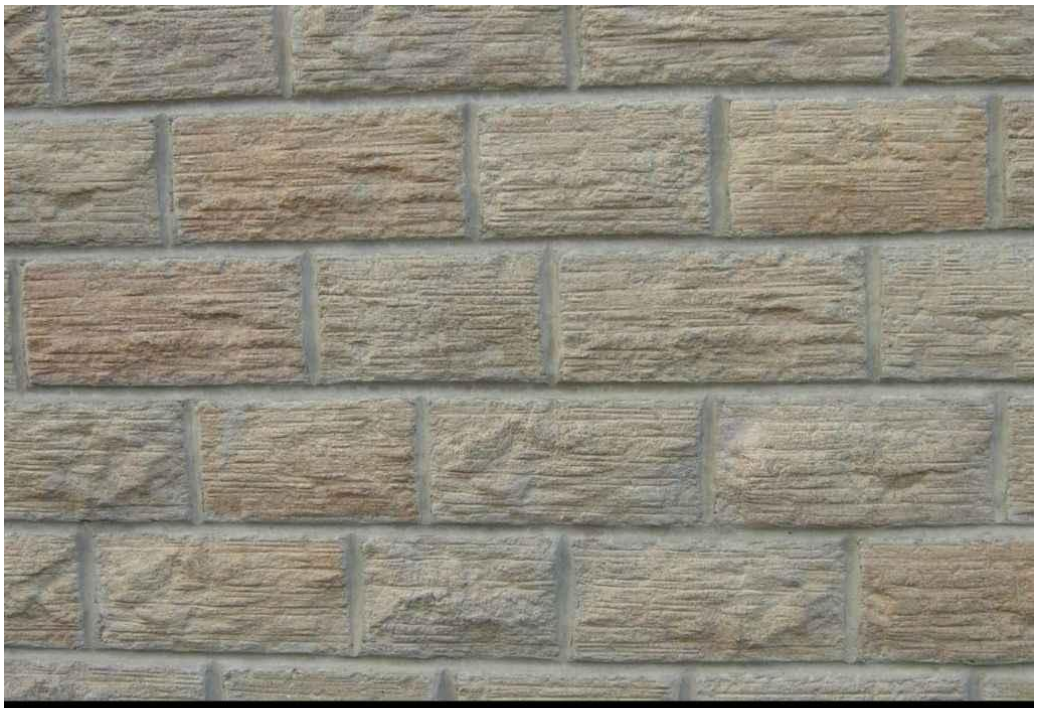
Brick Wall

Remember, the length of the brick wall in a single stretch should not exceed more than 4m. If it exceeds, a column must be constructed with RCC.

You can also read more about how to do **brickwork calculation for a a building here.**

6. Course Rubble Stone masonry wall:

The wall which is constructed with regular size of stones which are well finished & dressed is called Course Rubble Stone masonry wall. This type of wall is generally adopted for abutments of bridges, compound walls or boundary walls.



Course Rubble Stone Masonry Wall

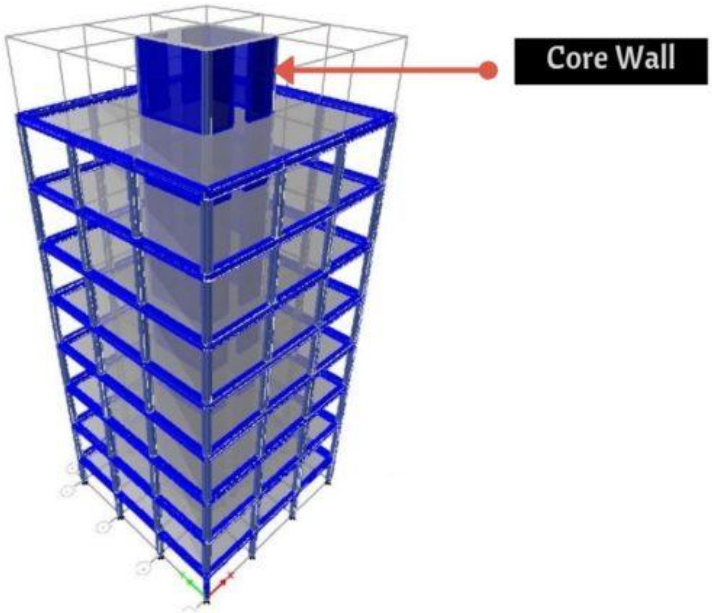
7. Random rubble stone masonry wall:

The wall which is constructed with the irregular size of stones is called Random rubble masonry wall. This type of wall consumes more masonry than Course rubble stone wall.

Random Rubble Stone Masonry Wall

8. Core wall:

Core wall is constructed from the foundation and it raised upto the height of the building. In this type of wall, the wall itself acts as a column. Core wall is built to carry the lateral force exerted on the structure due to wind, earthquake or any other lateral load.



Core Wall

Core walls are a combination of shear walls. They are organized and arranged like a core and installed at the geometric centre of the building to void the torsion effect.

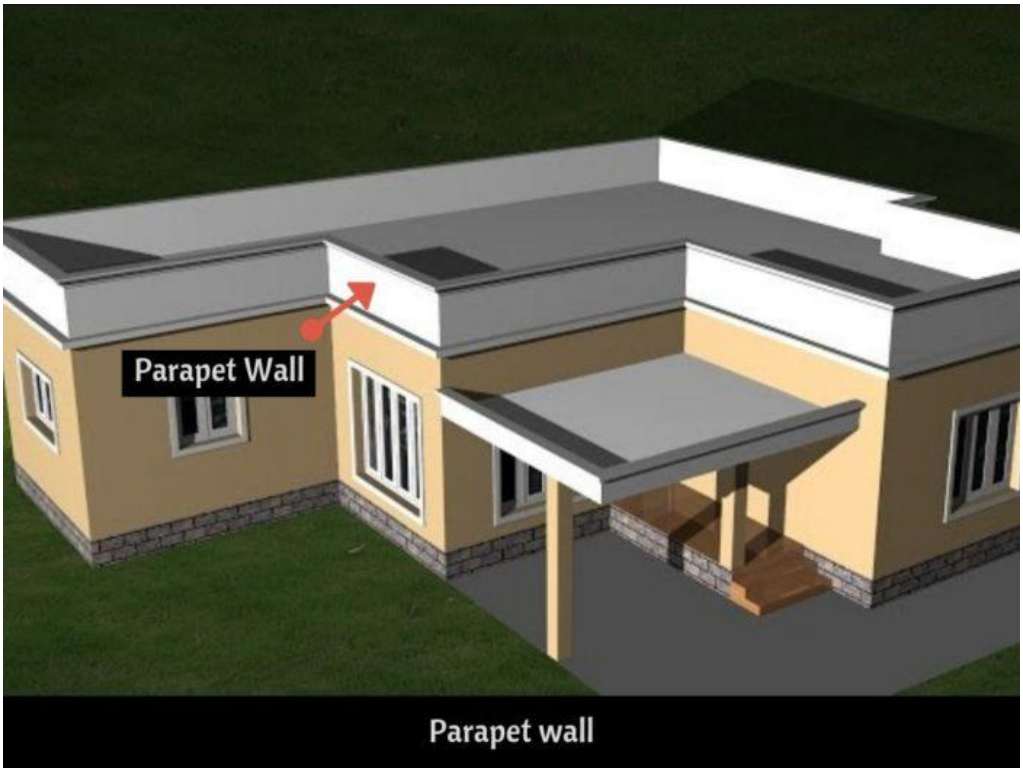
9. Precast wall:

As the name itself proving that it is a ready-made wall where the wall is cast in the factory and bought to site to install it. Yes, the precast wall is possible in the current world. Many companies brought this to market. You need to specify the length and height of the wall. The wall is cast and transported to the site. This type of wall is preferred where there is limited to space to work and where there is less chance of labour. The best part of Precast walls is companies themselves provide skilled labour to install the walls at your site.

Precast wall

10. Parapet wall:

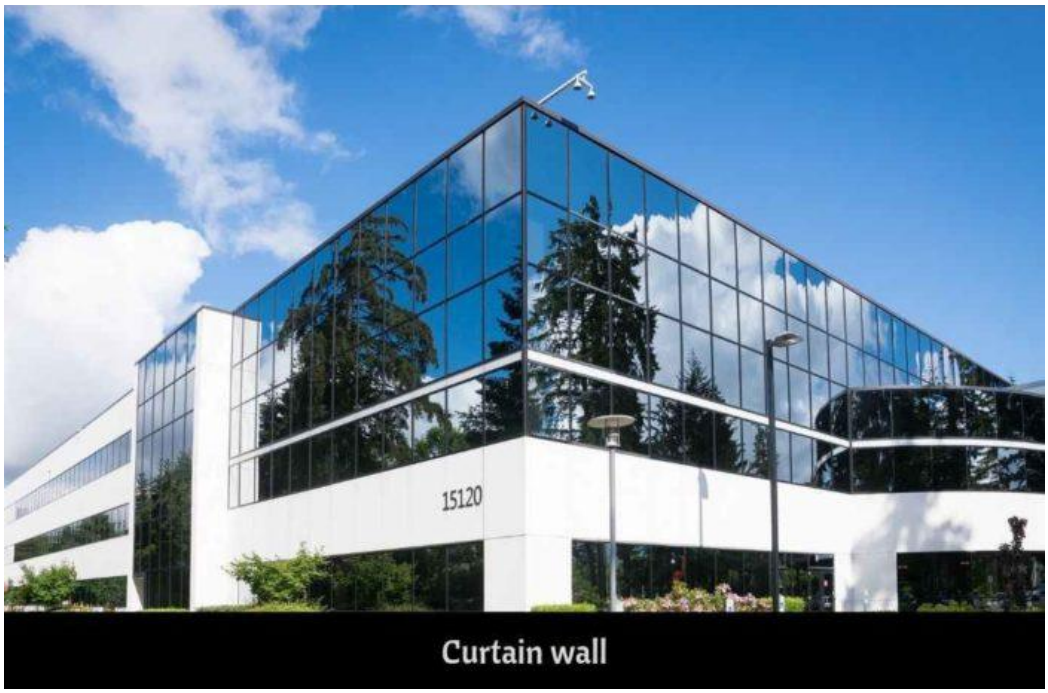
The wall which is constructed on the top floor of the building to prevent the falling in anything from the roof. The height of the parapet wall is 3ft.



Parapet wall

11. Curtain wall:

The wall which is constructed with glass, aluminium or with a steel frame is called a Curtain wall. This type of walls is generally adopted in offices, Hospitals and other public buildings.



Curtain wall

Partition walls

A partition wall may be described as a wall or separation constructed up of bricks, studding, glass, or other such types of material and utilized to separate one part of a room from another part of a room.

Advantages Of Partition Walls

- It helps to divide one room into many rooms.
- It provides adequate privacy from sight and sound both.
- Most of the partition materials are good in thermal insulation.
- Partition walls are lightproof.
- Built from lightweight materials.
- Some partition materials are also fire-resistant.
    - Partition walls are prepared as non-load-bearing walls. It can be off,
    - **Folding,**

- **Collapsible** or
- **Fixed type**.
- If partition walls are load-bearing then it is called 'internal walls'.

Types of Partition Walls

The different types of partition walls are as follows:

1. Brick partitions,

2. Hollow block partitions,

3. Concrete partitions,

4. Glass block partitions,

5. Wooden partitions,

6. Straw board partitions,

7. Plaster slab partitions,

8. Metal partitions,

9. Asbestos cement partitions, and

10. Double glazed window

3. Requirements of a Good Partition Wall

The requirement that must be in the partition wall to be good are as follows:

Thin in cross-section so that maximum floor area can be utilized.

Provide sufficient privacy to clients in the room both in respect of sight and sound.

Constructed from light, sound, uniform, homogeneous, durable, and sound-insulated materials.

Simple in nature, ease, and low cost in construction having proper coherence with the variety of building structures.

It offers enough resistance to fire, heat, dampness, white ant or fungus, etc.

Rigid enough to take the vibrations caused due to loads.

It is sufficiently strong to support sanitary fittings and heavy fixtures.

Brick masonry

it is defined as the placement of bricks in a systematic manner using mortar to bind the bricks together and create a solid mass that can withstand a great deal of pressure. There are different types of bricks and mortars that are used to construct brick masonry. From the Egyptian Pyramids to the Great Wall of China, some of the most famous architectural masterpieces around the world have been constructed from brick masonry.

Different Types of Brick

Bricks come in many different colors and variations. The key is to use high quality bricks to get the best results. Although, not all brick masonry involves the typical bricks you envision – it can also involve terra-cotta, stone, concrete, blocks, and tiles. Most commonly, clay brick and concrete block are utilized by masons.

Some of the most common types of bricks include:

- Concrete bricks
- Common burnt clay bricks
- Sand lime bricks (Calcium silicate bricks)
- Fly ash clay bricks
- Engineering bricks

Types of Bonds in Brick Masonry WallConstruction and their Uses

Types of bonds in brick masonry wall construction are classified based on laying andbonding style of bricks in walls. The bonds in brick masonry is developed by the mortar filling between layers of bricks and in grooves when bricks are laid adjacent toeach other and in layers in walls.

Mostly used material for bonds in brick masonry is cement mortar. Lime mortar andmud mortar are also used.

Types of Bonds in Brick Masonry WallConstruction :

The most commonly used types of bonds in brick masonry are:

1. Stretcher bond
2. Header bond
3. English bond and
4. Flemish bond

Other Types of bonds are:

1. Facing bond
2. Dutch bond
3. English cross bond
4. Brick on edge bond
5. Raking bond
6. Zigzag bond
7. Garden wall bond

1. Stretcher bond

Longer narrow face of the brick is called as stretcher as shown in the elevation of figure below. Stretcher bond, also called as running bond, is created when bricks arelaid with only their stretchers showing, overlapping midway with the courses of bricksbelow and above.

Stretcher bond in the brick is the simplest repeating pattern. But the limitation of stretcher bond is that it cannot make effective bonding with adjacent bricks in full width thick brick walls. They are suitably used only for one-half brick thick walls suchas for the construction half brick thick partition wall.

Walls constructed with stretcher bonds are not stable enough to stand alone in caseof longer span and height. Thus they Then need supporting structure such as brick masonry columns at regular intervals.

Stretcher bonds are commonly used in the steel or reinforced concrete framed structures as the outer facing. These are also used as the outer facing of cavity walls. Other common applications of such walls are the boundary walls, gardens etc.

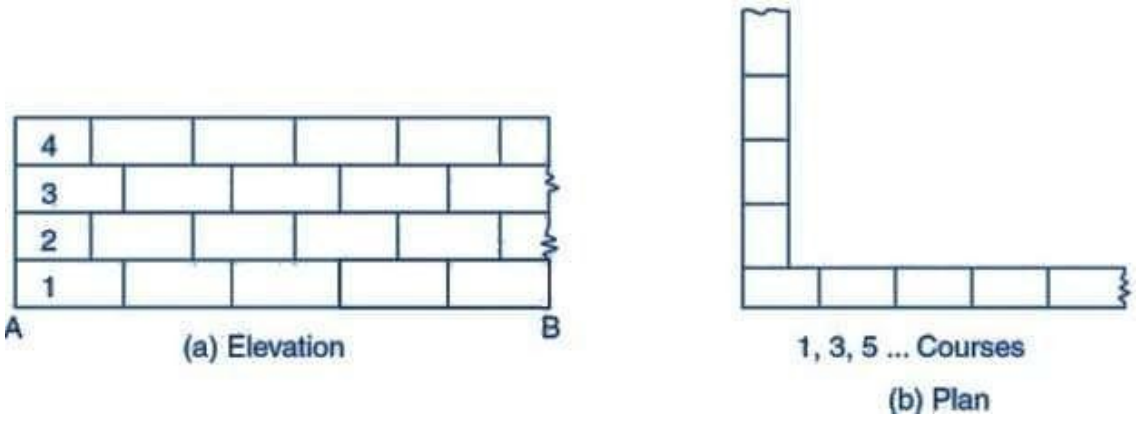


Fig-1: Stretcher Bond

2. Header bond

Header is the shorter square face of the brick which measures 9cm x 9cm. Header bond is also known as heading bond. In header bonds, all bricks in each course areplaced as headers on the faces of the walls. While Stretcher bond is used for the construction of walls of half brick thickness whereas header bond is used for the construction of walls with full brick thickness which measures 18cm. In header bonds, the overlap is kept equal to half width of the brick. To achieve this, three quarter brick bats are used in alternate courses as quoins.

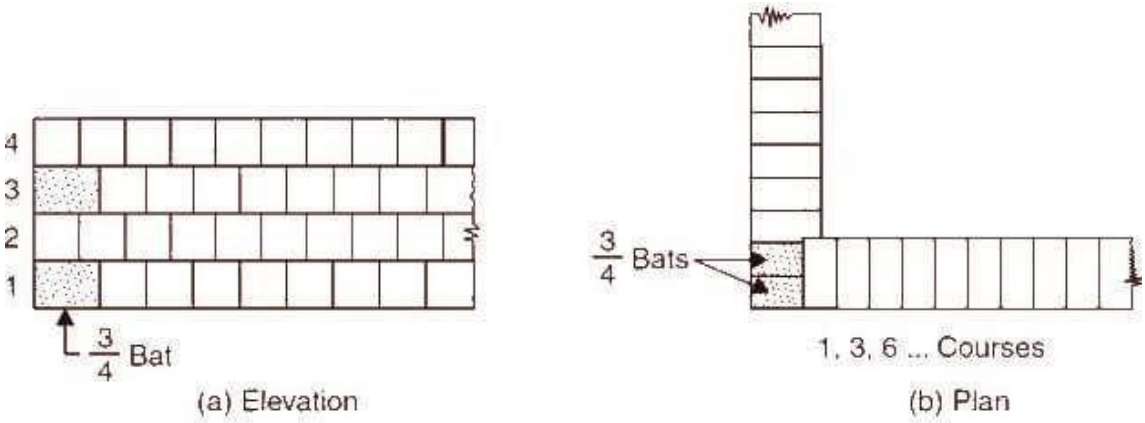


Fig-2: Header Bond

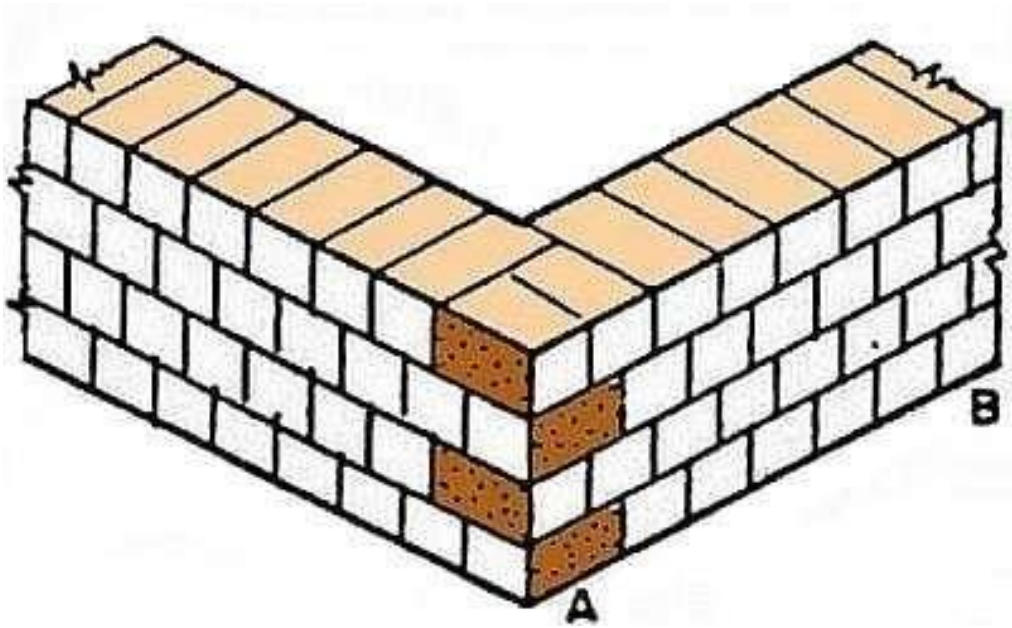


Fig-3: Header Bond Isometric View

3. English Bond

English bond in brick masonry has one course of stretcher only and a course ofheader above it, i.e. it has two alternating courses of stretchers

and headers.

Headers are laid centered on the stretchers in course below and each alternate rowis vertically aligned.

To break the continuity of vertical joints, quoin closer is used in the beginning and end of a wall after first header. A quoin close is a brick cut lengthwise into two halvesand used at corners in brick walls.

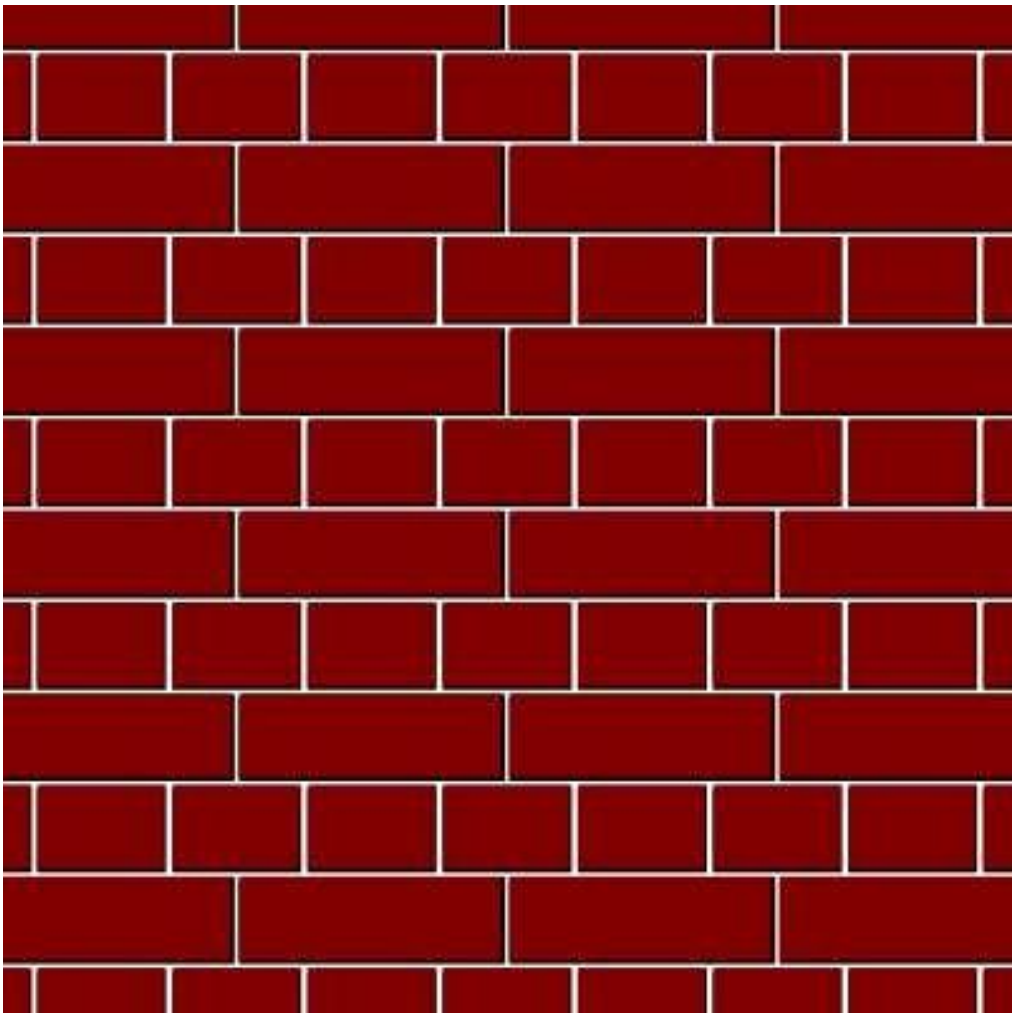


Fig-4: English Bond

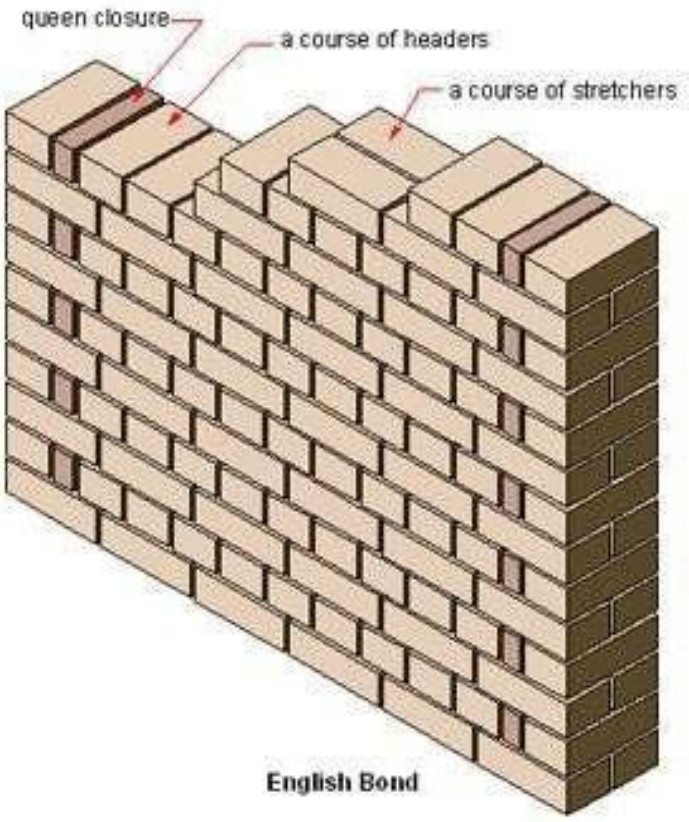


Fig-4: English Bond – Isometric View

4. Flemish Bond

For the breaking of vertical joints in the successive courses, closers are inserted in alternate courses next to the quoin header. In walls having their thickness equal to odd number of half bricks, bats are essentially used to achieve the bond.

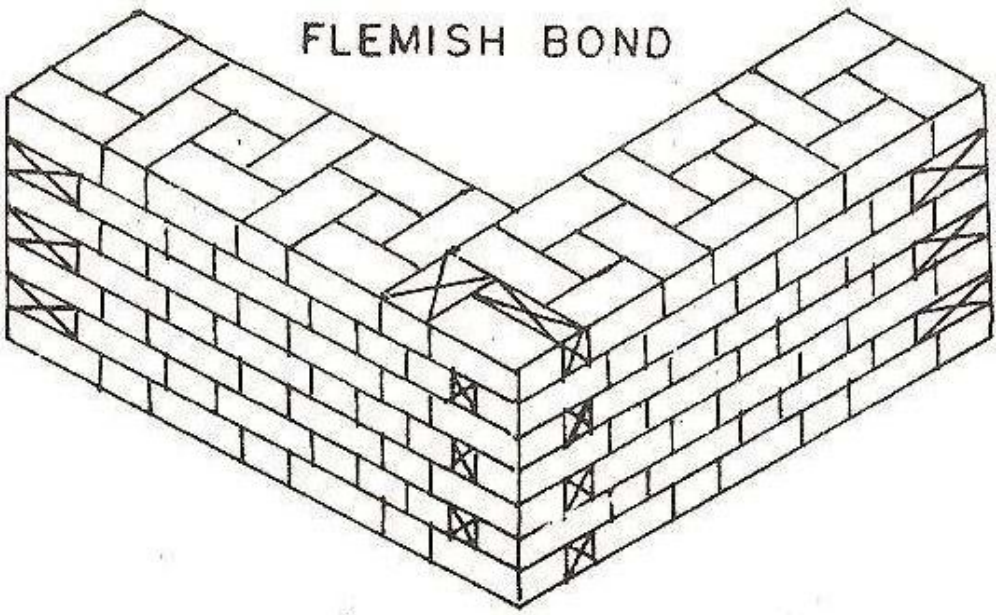
Flemish bond, also known as Dutch bond, is created by laying alternate headers andstretchers in a single course. The next course of brick is laid such that header lies in the middle of the stretcher in the course below,

i.e. the alternate headers of each course are centered on the stretcher of course below. Every alternate course of Flemish bond starts with header at the corner.

The thickness of Flemish bond is minimum one full brick. The disadvantage of usingFlemish bond is that construction of Flemish bond is difficult and requires greater skill to lay it properly as all vertical mortar joints need to be aligned vertically for besteffects. For the breaking of vertical joints in the successive courses, closers are

inserted in alternate courses next to the quoin header. In walls having their thicknessequal to odd number of half bricks, bats are used to achieve the bond.

Flemish bonds have better appearance but are weaker than English bonds for loadbearing wall construction. Thus, if the pointing has to be done for brick masonry walls, then Flemish bond may be used for better aesthetic view. If the walls have tobe plastered, then it is better to use English bond.



$1\frac{1}{2}$ BRICK WALL

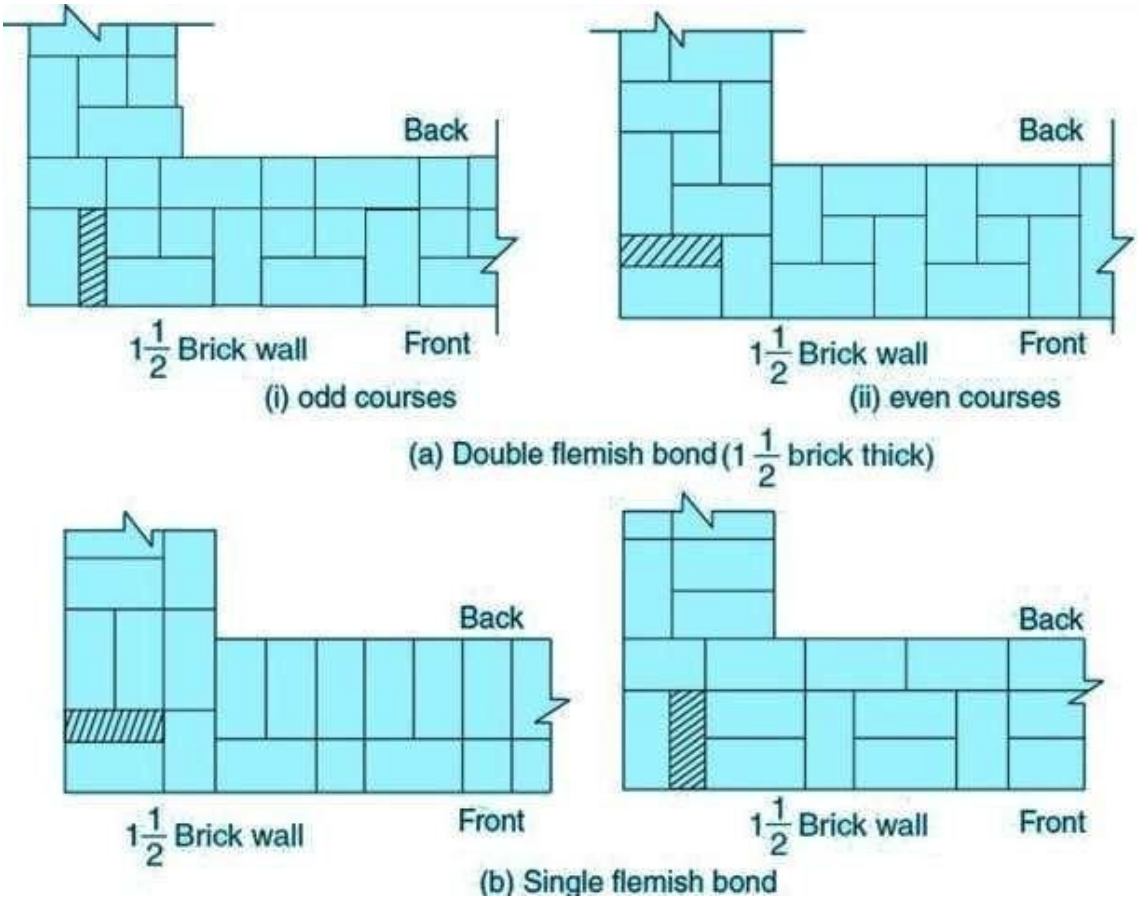


Fig-5: Flemish Bond

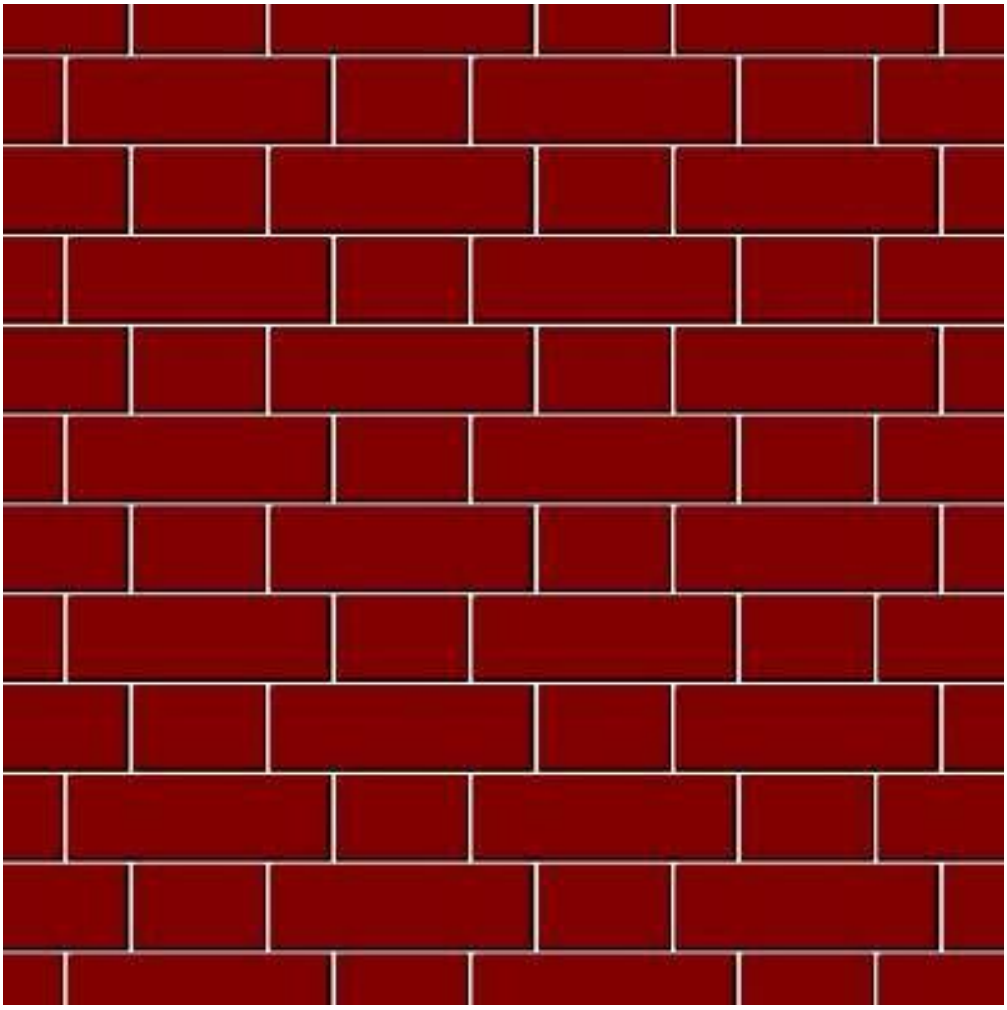


Fig-6: Flemish Bond Front Appearance

Flemish bonds are classified as:

- Single Flemish Bond
- Double Flemish Bond

Single Flemish bond is a combination of English bond and Flemish bond. In this typeof construction, the front exposed surface of wall consists of Flemish bond and the back surface of the wall consists of English bond in each course. Minimum thicknessrequired for single Flemish bond is one

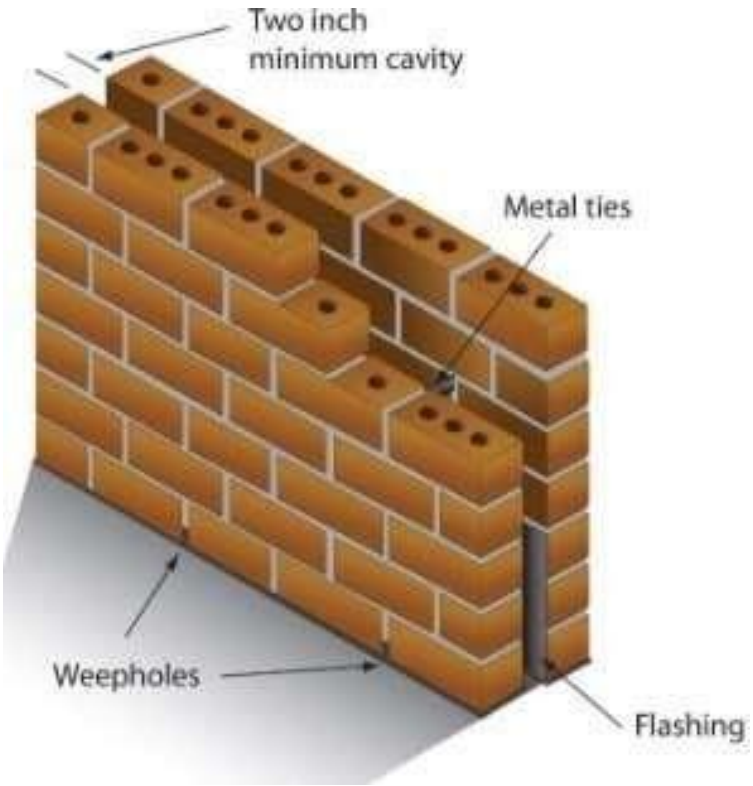
and a half brick thickness. The main purposeof using single Flemish bond is to provide greater aesthetic appearance on the front surface with required strength in the brickwork with English bond.

Double Flemish Bond has the same appearance both in the front and back elevations, i.e. each course consists of alternate header and stretcher. This type ofbonding is comparatively weaker than English bond

Cavity Walls Construction andAdvantages

What is a Cavity Wall?

Cavity walls are constructed with two separate walls for single wall purpose with some space or cavity between them. These two separate walls are called as leavesof cavity wall. The inner wall is called as internal leaf and outer wall is called as external leaf. Cavity wall is also called as Hollow wall.



For non-load bearing cavity wall, two leaves are of equal thickness or sometimes internal leaf with more thickness is provided. The cavity size

should be in between 4 to 10cm. The internal and external leaves should have at least 10mm thickness. Thetwo leaves are interconnected by metal ties or links as shown in above figure.

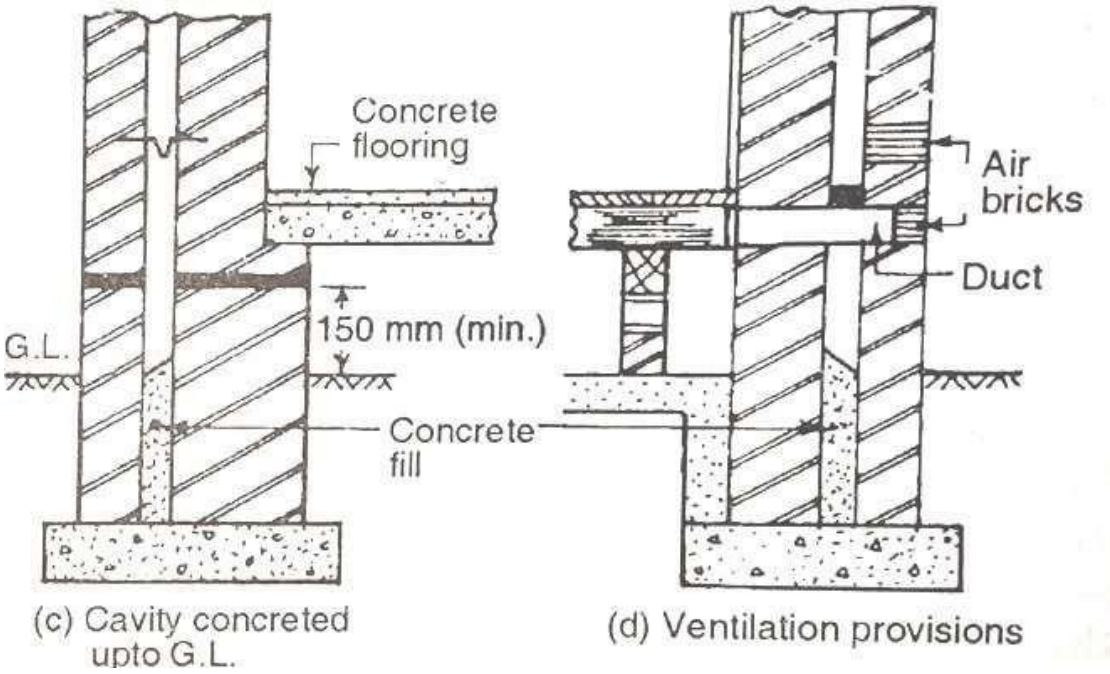
Advantages of Cavity Walls

Following are the advantages of cavity wall when compared to solid walls.

- Cavity walls give better thermal insulation than solid walls. It is because of thespace provided between two leaves of cavity walls is full of air and reduces heat transmission into the building from outside.
- Economically they are cheaper than solid walls.
- Moisture content in outer atmosphere is does not allowed to enter because ofhollow space between leaves. So, they also prevent dampness.
- They also act as good sound insulators.
- They also reduce the weights on foundation because of their lesser thickness.
- Outer Efflorescence is also prevented.

Construction of Cavity Walls

In general, cavity wall doesn't require any footings under it, just a strong concrete base is provided on which cavity wall is constructed centrally. Two leaves are constructed like normal masonry, but minimum cavity must be provided in betweenthem. The cavity may be filled with lean concrete with some slope at top up to few centimeters above ground level as shown below.



(c) Cavity concreted upto G.L.

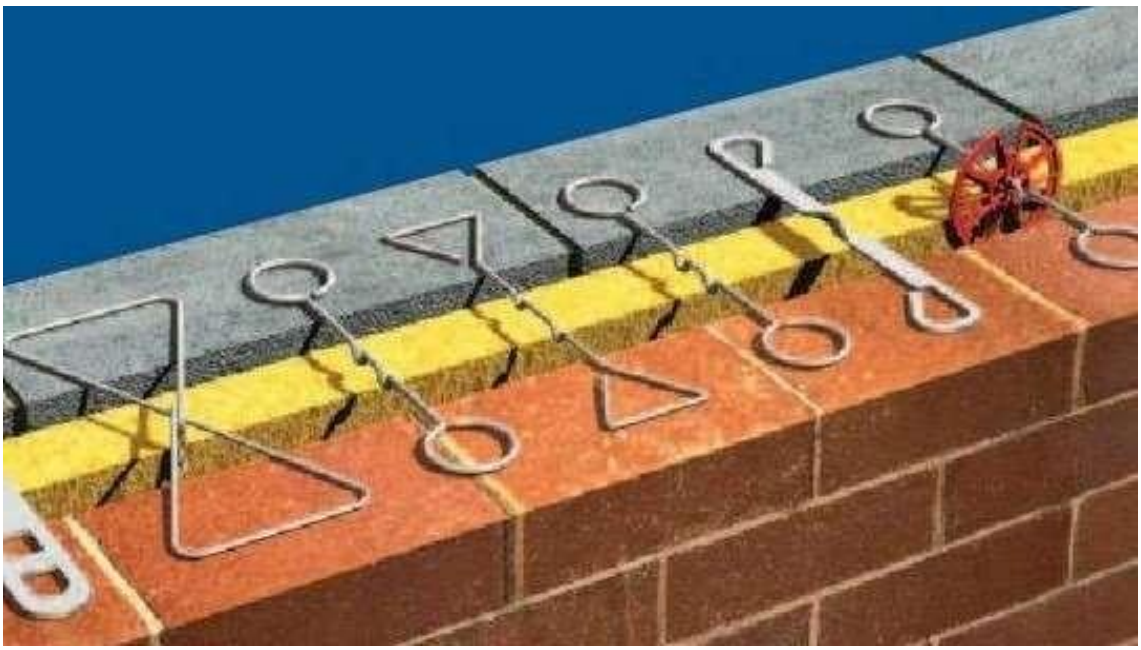
(d) Ventilation provisions

Weep holes are provided for outer leaf at bottom with an interval of 1 m. Normalbricks are used for inner leaf and facing bricks are used for outer leaf.

Different

masonry is also used for cavity wall leaves. The leaves are connected by metal tiesor wall ties, which are generally made of steel and are rust proof.

The maximum horizontal spacing of wall ties is 900mm and maximum vertical spacing is 450mm. The wall ties are provided in such a way that they do not carry any moisture from outer leaf to inner leaf. Different shapes of wall ties are shown inbelow figure.



For half brick thickness leaves, stretcher bond is provided. And for one brick thickness or more thickness, English bond or Flemish bonds type constructions areprovided. While laying bricks, care should be taken without filling the cavity with cement mortar.

To prevent mortar dropping in cavity, wooden battens are provided in the cavity withsuitable dimensions. These battens are supported on wall ties and whenever the height of next wall tie location is reached, then the battens are removed using wires or ropes and wall ties are provided.

Two leaves should be constructed simultaneously. Spacing should be uniform and it is attained by predetermining the location of wall ties. Damp proof course is providedfor two leaves separately. In case of doors and windows, weep holes are provided above the damp proof course.

Types of Partition Walls for Homes andOffices

Partition walls are vertical dividers which are used to separate building internal spaces into rooms and circulation areas like corridors.Partition wall types and theirapplications are discussed in the following sections.

Depending upon the material used partition walls may be divided into the followingdifferent types:

1. Brick partitions wall
2. Clay brick partition wall
3. Glass partitions wall
4. Concrete partitions wall

5. plaster slab partition wall
6. Metal lath partition wall
7. A.C. sheet or G.I. sheet partitions wall

8. wood-wool partition wall
9. Timber partitions

1. Brick Partitions

There are three types of brick partition walls which include plain brick partition wall,reinforced brick partition wall, and brick nogging partition wall.

Plain brick partition wall

- It is constructed from plain bricks, and it is common and cost effective
- The bricks are laid as stretchers in cement mortar.
- Thickness of plain brick partition wall is 10cm or half a brick.
- Recommended height is maximum 2m for construction in a day
- It is plastered on both sides
- Strong and fire resistant if the brick wall is constructed properly

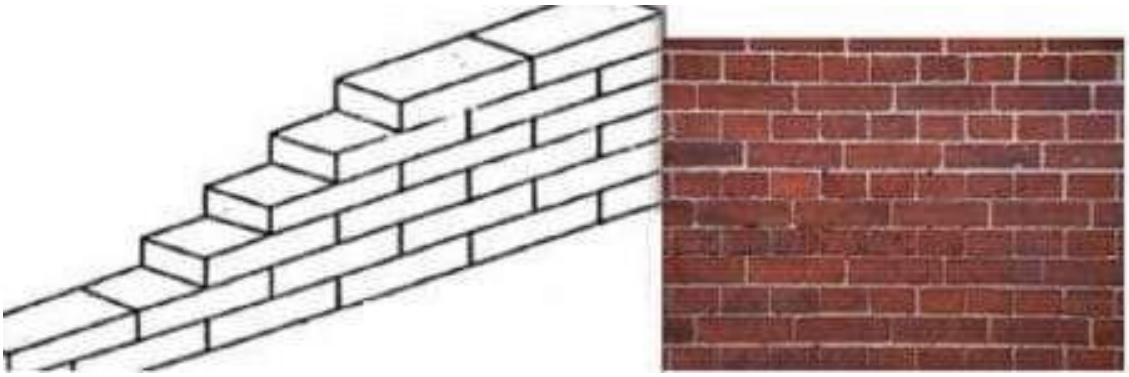


Fig. 1: Plain Brick Parition Wall

Reinforced brick partition wall

- It is similar to plain brick partition but reinforced brick is much stronger due tothe placement of reinforcements.
- Reinforcements, which is in from of wire mesh strips or iron bare, are placedat every third or fourth course.
- Reinforced wire strip width ranges from 25mm to 28mm and thickness is1.6mm.

- Steel bar diameter is 6mm
- The thickness of the wall equal to 10cm or half a brick
- This type of partition wall used when better longitudinal bond is need andwhen the partition wall has to support other super imposed loads.

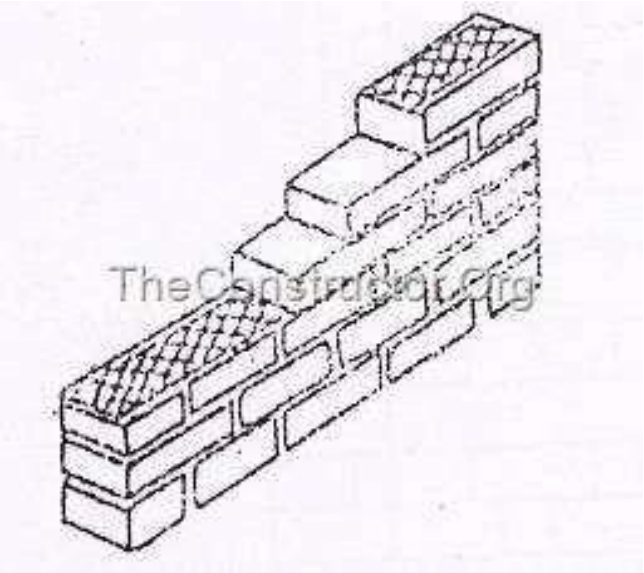


Fig. 2: Reinforced Brick Partition wall

Brick nogging partition wall

- Brick nogging partition wall consists of brickworkbuilt within a framework ofwooden members.
- The timber framework consists of vertical posts (studs). Horizontal members(nogging), sill, and head as explained in
- Studs spaced at 60 cm to 150 cm and held in position by nogging pieces.
- The nogging pieces are housed into the studs at 60 cm to

90cm apartvertically.

- The wooden framework provide stability to the partition against lateral loadsand vibrations caused due to opening the adjoining door and windows
- The bricks are commonly laid flat, but they also may be laid on edge
- The brickwork is plastered from both sides.
- Cement mortar proportion 1:3 is used

- The size of the studs and nogging depends upon the thickness of partition wall.
- For 10cm thick partition wall, the studs and nogging should be 15 cm wide so that after the brickwork is plastered from both the faces, the timber framework may finish flush with the wall face.
- The surfaces of the timber frame work coming in contact with brick work arecoated with coal tar.
- This type of partition wall suffers from the drawback of the timber gettingdelayed.
- The mortar used may not stick well to the timber members and thus thebrickwork is likely to become loose after sometime.

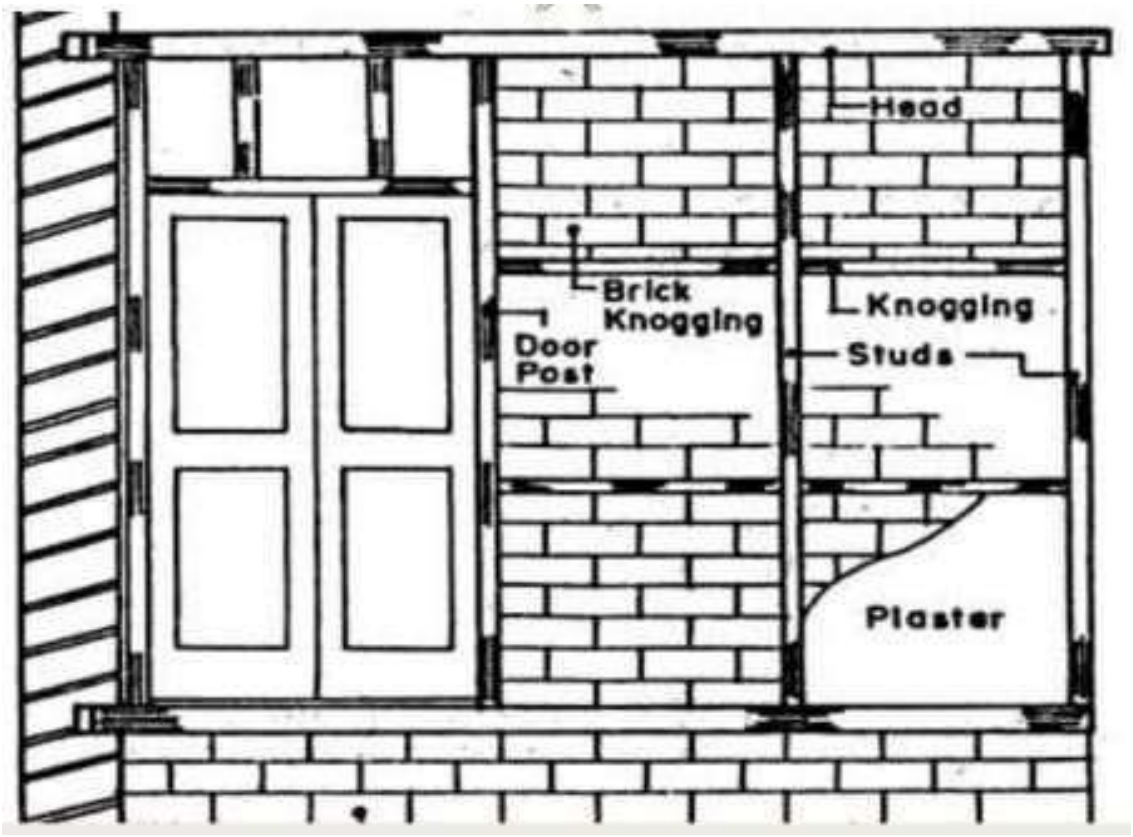


Fig. 3: Timber framework in brick nogging partition wall

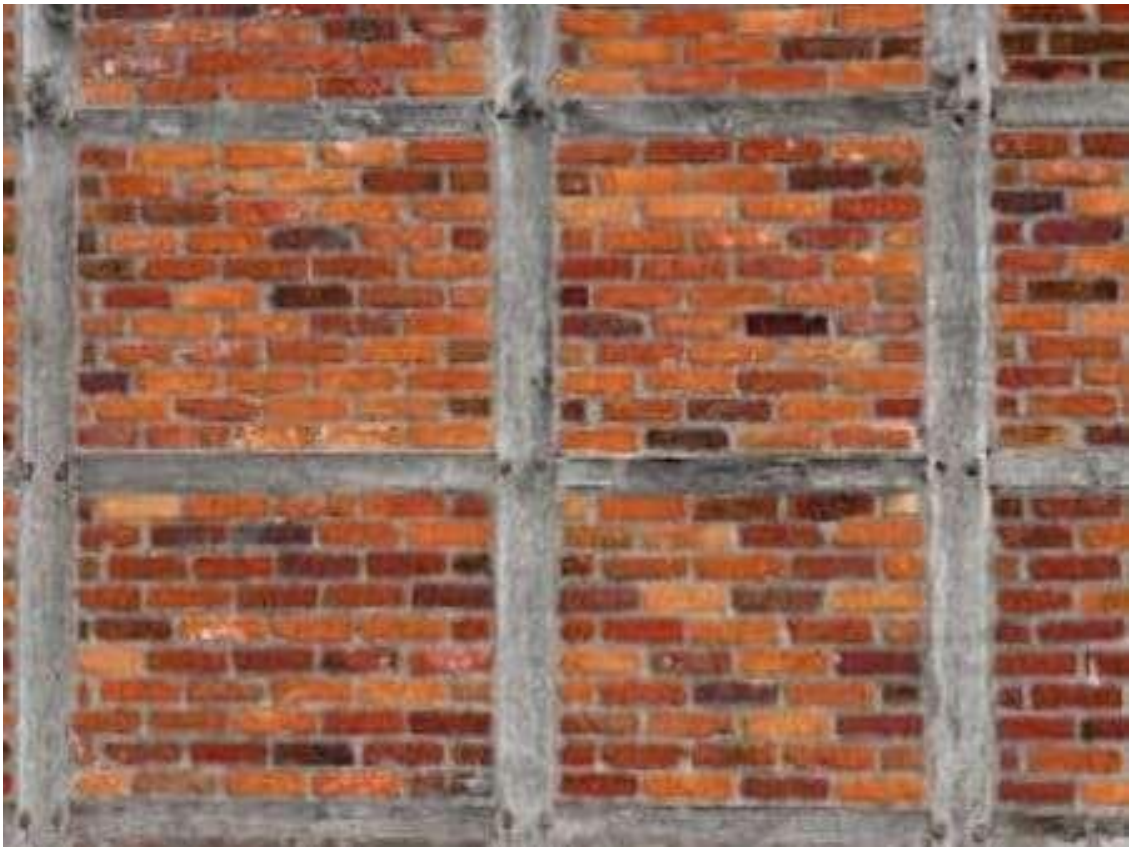


Fig. 4: Brick nogging partition wall; bricks are liad flat

Fig. 5: Brick nogging partition wall; bricks are laid on edge

2. Clay brick partition wall

- The blocks which are used for clay brick partition wall, is manufactured fromclay or terracotta.
- Blocks may hollow or solid
- Hollow clay bricks are commonly employed for light partition wall
- The blocks are placed in mortar
- Hollow brick partition walls are rigid, economical, strong, fire resistant, andgood heat sound insulator.
- The sizes of the hollow blocks differ with the texture of the material.
- The thickness of this type of partition wall varies between 6 cm to 15 cm.

- Hollow brick partitions walls are constructed in similar manner as structuralload bearing walls.

- Grooves are provided on top, bottom, and sides of block to improve the bondbetween the block and plaster.

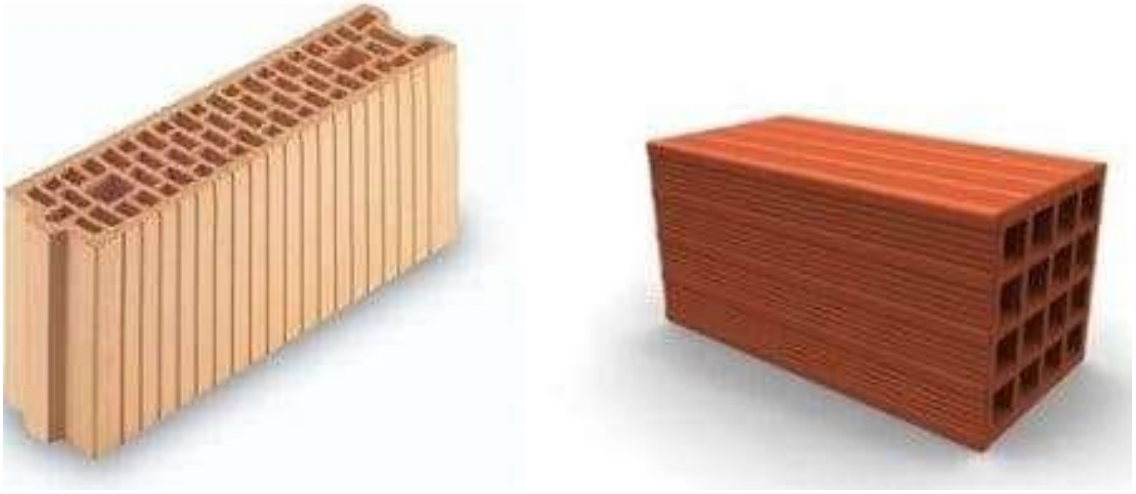


Fig. 6: hollow clay brick units

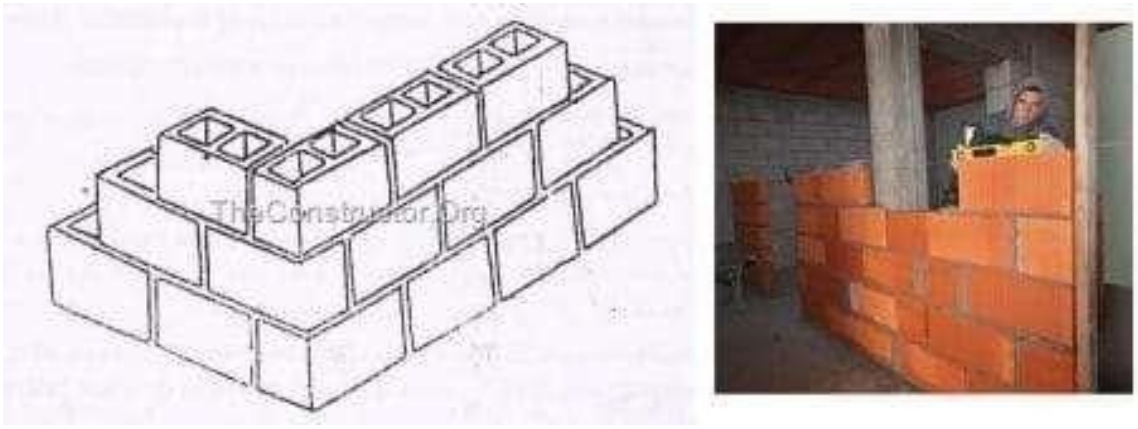


Fig.7: Hollow Clay Brick Partition wall

3.Glass partition walls

They are cheap, light, and easy in construction and provide reasonable privacy and sound insulation. such walls are constructed from glass sheet or hollow glass blockswhich will be discussed below

Glass sheet partition wall

- It is constructed by fixing sheet of glass in a wooden framework.

- Glass sheets are fixed in timber framework using using timber beadings or byputty.
- The wooden framework consists of a number of horizontal and vertical posts,suitably spaced, to divide the entire area into a number of panels.
- The panels might be rectangular or square and their size varies with thechoice of individual.
- Glass sheet partition wall is light, vermin proof, damp proof, and sound proof.
- Wired glass, bullet proof glass, and three-ply glass are examples of strongglass sheets which are suitable for glass sheet partition wall construction.

Fig.8: glass sheet partion wall

Hollow glass block partition wall

- It is constructed from hollow glass blocks.
- Hollow glass blocks are translucent glass units which are light andmanufacture with various thicknesses, shapes, and sizes.
- The size of square hollow glass blocks, which is most widely used, is14X14cm or 19X19cm with a thickness of 10cm.

- The hollow blocks are
- The jointing edges are painted internally and sanded externally

  to help thebond between mortar and glass block.
- The front and back sides are either decorated or left plain.
- Block glass is laid in cement- lime mortar- fine sand (1:1:4)
- All joints shall be filled adequately
- Metal strip reinforcement is placed at every third or fourth

  course for blockheight up to 15.
- Reinforcement is placed at every course if the blocks height exceeds 25cm
- There is another type of glass block with joggles and end grooves as well.

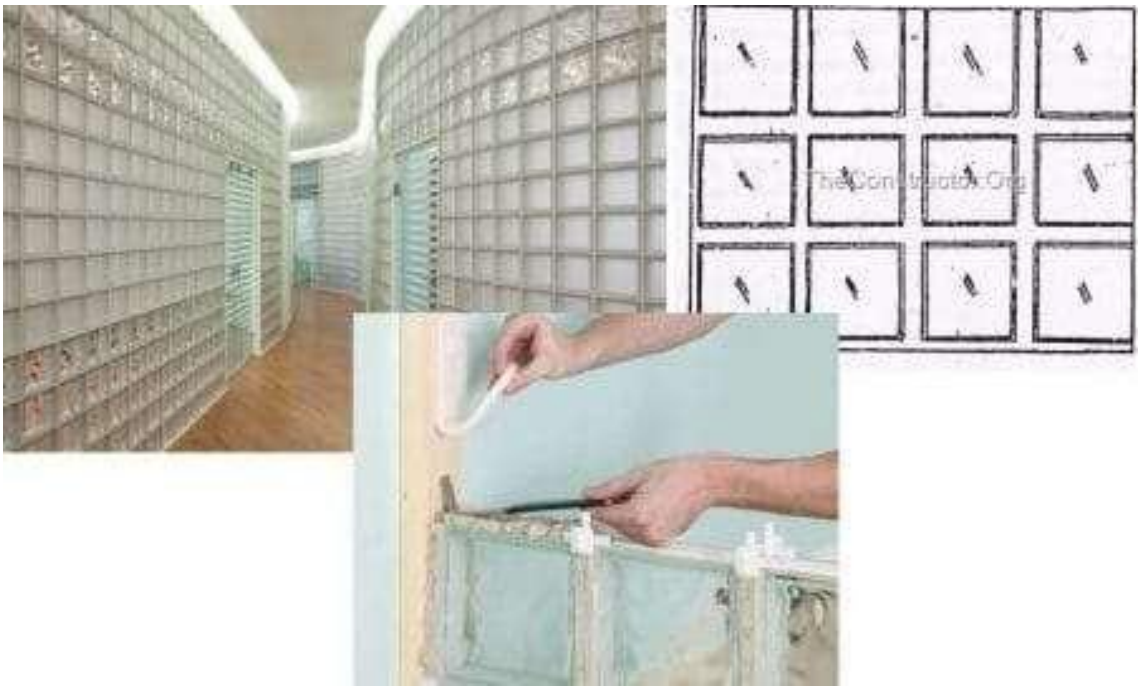


Fig.9: Glass block partition wall

4. Concrete Partition wall

It consists of concrete slab, plain or reinforced, supported laterally by verticalmembers. These slabs may be either precast of cast in situ.

Cast in situ concrete partition wall

- Thickness ranges from 80mm to 100mm

- It is poured monolithically with intermediate columns
- It is rigid and stable both in vertical and horizontal directions but theframework is costly.
- The reinforcement consisting of mild steel bars or B R C fabric is placed in thecenter of the wall thickness.
- Concrete mix usually adopted in the work is M15 (1:2:4).

Fig.10: Cast in situ concrete partition wall

Precast concrete slab partitions wall

- the wall is built from precast concrete slab units
- precast unit thickness ranges from 25mm to 40mm
- precast units are secured to precast posts
- joints shall be filled with mortar
- Concrete mix is M15 (1:2:4).

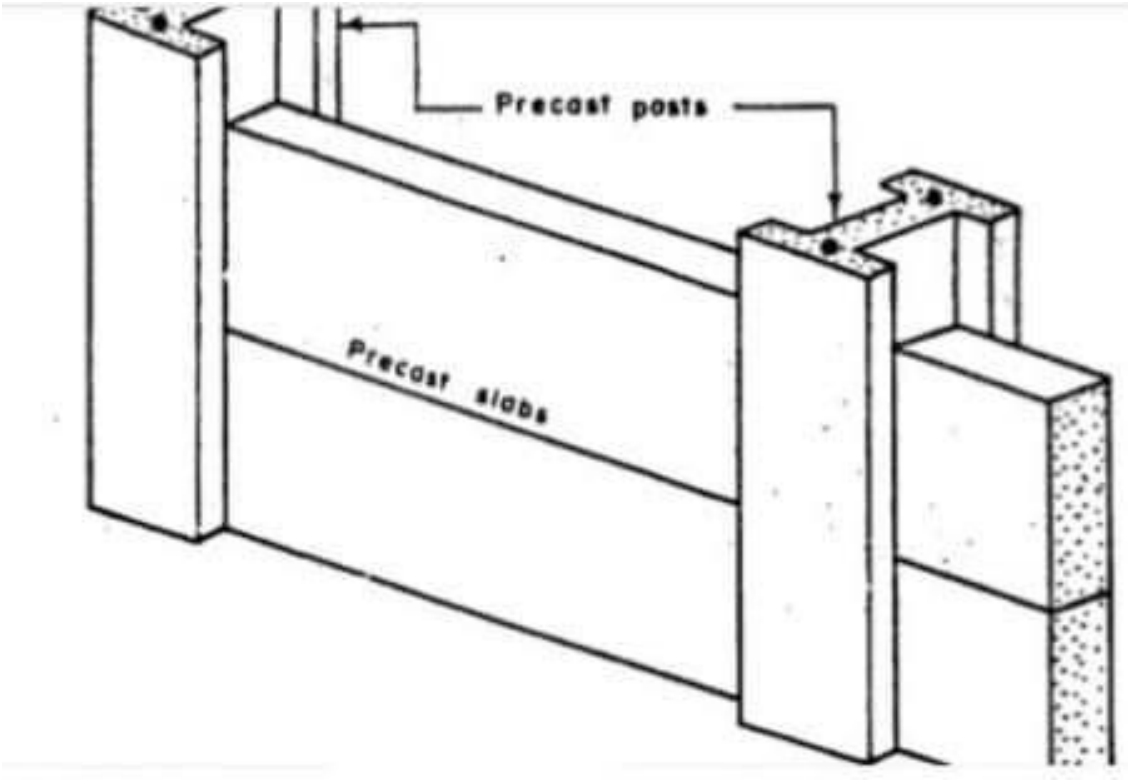


Fig.11: Precast concrete partition wall

Wall partitions constructed from special precast units

- the wall is constructed from precast T-shaped or L-shaped units
- light weight, hollow partitions can be built without the need for vertical posts
- cement mortar mix proportion of 1:3 is used for jointing

5. Plaster slab partition wall

- Plaster slabs or plaster boards are made from burnt gypsum

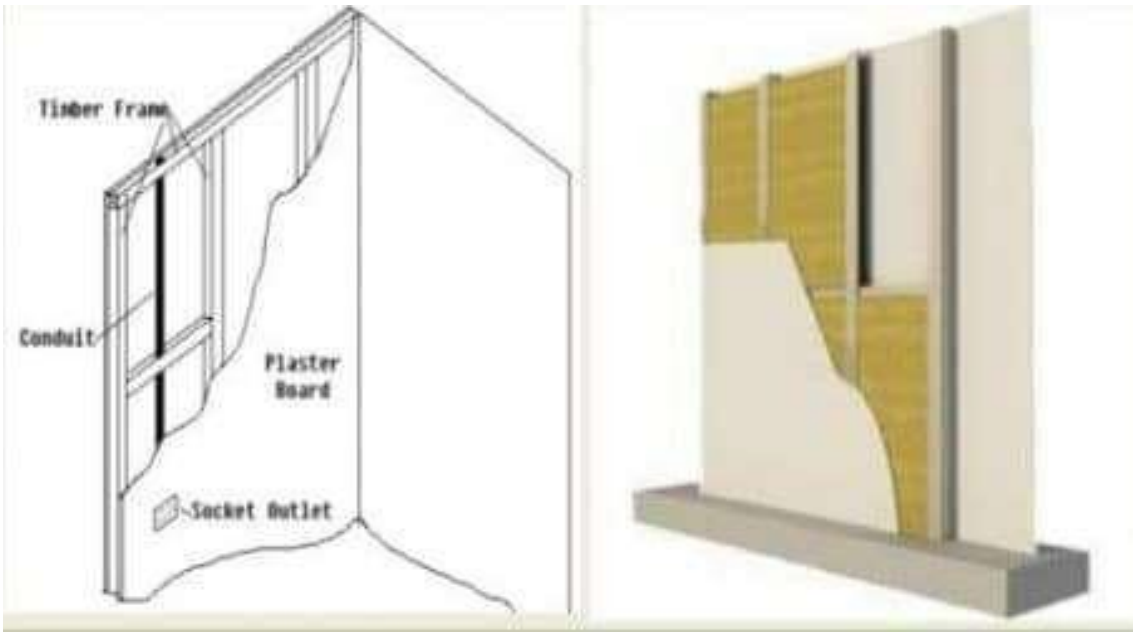
  or plaster ofparis, mixed with sawdust or other fibrous

  material to reduce its weight

- Units of plaster slab prepared in an iron or timber mould with

size 1 to 2mlong, 30cm high and 50 to 100mm thick.

- they are equipped with suitable grooves to create rigid joints
- Plaster slab surface may be smooth or rough. The former is not plastered butrough surface act as key for plaster.

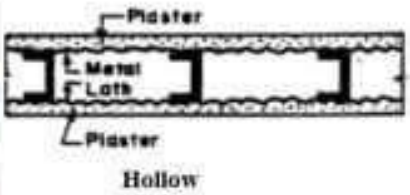


- Fig.12: Plaster slab partition wall

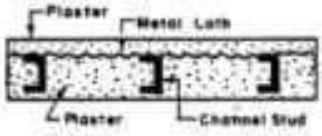
6.Metal lath partition wall

- Metal lath partition wall are thin, strong, durable and considerably fireresistant.
- Metal lath partition walls are constructed by placing 2cm or 2.5cm channelsvertically (called studs) and fixing metal lath to it on one side.

- Plaster is applied to both the sides of the metal
- If hallow partition is required, metal lath is fixed to the channels on both thesides and then plaster is applied.



Hollow



Solid

Fig.13: Metal lath partition wall

7. A.C. Sheet or G.I. Sheet partition wall

- Partition walls constructed from asbestos cement sheeting or galvanizedsheet fixed to wooden or steel frame.
- It is mostly adopted in works of temporary character.
- Such walls are economical, light and fairly rigid if constructed properly.
- Slab consists of core or corrugated asbestos cement sheet with the plain asbestos cement sheet attached to it on either side. The use of such slabs renders the partition wall more fire-resistant and makes it have good heat andsound insulation properties.

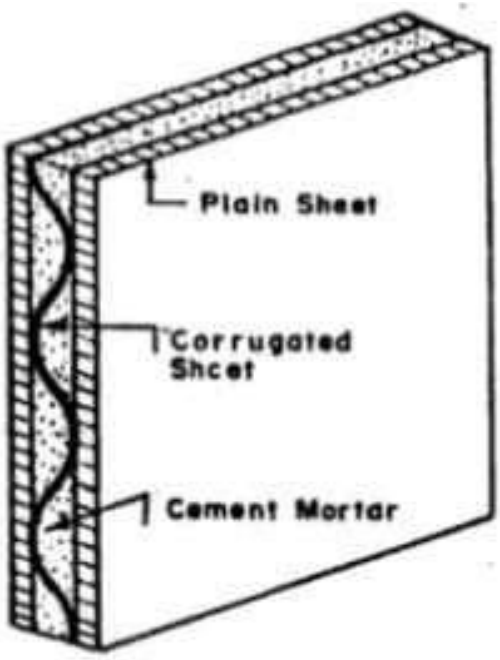


Fig.14:Asbestos sheet or GI sheet partition wall

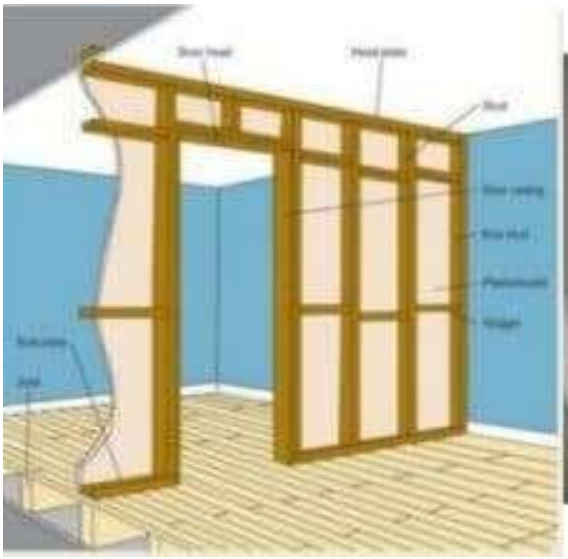
8. Wood-wool partition wall

- Wood wool consist of long tangled wood fibers, uncompacted, coated and bound together with cement or plaster, and with a rough open surface whichprovides an excellent key for plaster.
- It is good heat and sound insulator

Fig.15: Wood-wool partition wall

9.Timber partitions wall

- This type of partition walls that consists of a wooden framework is eithersupported on the floor below or by side walls.
- The framework consists of a rigid arrangement of timber members which maybe plastered or covered with boarding etc from both the sides.
- Such partitions are not fire-resistant and the timber forming the partition islikely to decay or be eaten away by white ants.
- The use of timber partition walls is decreasing.



Stone masonry

The construction of stones bonded together with mortar is termed as **stone masonry**. Where the stones are available in an 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, tootings, arches, beams, etc..

Stone masonry being stronger, durable and weather-resistant as compared to brick masonry is used in the construction of piers, docks, dams lighthouse, and other marine structures.

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
    - Coursed Rubble masonry
    - Uncoursed rubble masonry
- Ashlar masonry
    - fine masonry
    - Ashlar Rough-tooled masonry
    - Ashlar Rock faced masonry

Rubble masonry

In rubble masonry, the stones are either undress or roughly dress having wider. This can further subdivide as unconcerned, coursed, random, dry, polygonal, and bint.

Uncoursed rubble masonry

This is the cheapest, roughest and poorest form of stone masonry. The Stones used in the type of masonry very much in their shape and size and directly obtain from the quarry. Unconursed rubble masonry can divide into the following.

- (a) Uncoursed random rubble
- (b) Uncoursed squared rubble

(a) Uncoursed random rubble

The week comers and edges remove with mason's hammer. Generally, bigger stone blocks employ at quoins and jambs to increase the strength of masonry.

(b) Uncoursed squared rubble

Squared rubble stone blocks make roughly square with a hammer. Generally, the facing stones give a hammer-dressed finish. Large stones used as quoins. As far as possible the use of chips in bedding is avoid.

Built to a regular course

In this type of stone masonry, the uniform height stones are used in horizontal layers not less than 13 cm in height. Generally, the stone beds are hammered or chisel stones are arranged in such a 10 cm from the face. The stones are arranged in such a manner so that the vertical join inside with each.

Polygonal rubble masonry

In this type of masonry, the stones roughly dressed to an irregular polygonal shape. The stones should arrange as to avoid long vertical joints in face small stone chips should facing.

Flint rubble masonry

In this type of masonry used in the areas where the flint is available in plenty.

Dry rubble masonry

Dry rubble masonry use in the construction of retaining walls pitching earthen dams and canal slopes in the form of random rubble masonry without any mortar. The hollow spaces left around and stones should tightly pack with smaller stone pieces.

Ashlar Masonry

masonry is built from accurately dressed stones in uniform and fine joints of about 3 mm thickness by arranging the stone blocks in various patterns.

The backing of masonry Ashlar walls may be built of Ashlar masonry or rubble masonry. The size of the stones blocks should be in proportion to wall thickness.

Ashlar Fine Masonry

In this type of ashlar masonry, the beds, sides, and faces finely chisel-dressed. The stones arrange in proper bond and the thickness of the mortar joints does not exceed 3 mm. This type of construction gives a perfectly smooth appearance, but it is costly in construction.

Ashlar rough-tooled masonry

In this type of ashlar masonry, the beds and dies are finely chisel-dressed. But the face is made rough by means of tools. A strip, about 25 mm wide and made by means of a chisel, is provided around the perimeter of every stone exposed for view. The thickness of the mortar joints does not exceed 6 mm. This type of work is also known as the bastard ashlar.

Ashlar Rock faced Masonry

In this type of ashlar masonry, a strip about 25 mm wide and made by means of a chisel, is provided around the perimeter portion of the face is left in the same form as received from the quarry. Only projections on the face, known as the bushings, exceeding 80 mm remove by a hammer. This type of construction gives a massive appearance.

Uses of stone masonry

1. Building foundation, walls piers, pillars, and architectural work
2. Roofs and Roof coverings
3. Cladding works
4. Dams, lighthouses, monumental structures.

5. paving jobs
6. Railway, ballast, blackboards, and electrical switch building.
7. Lintels, beams, beams Arches, domes, etc.

Selection of stone for stone masonry

- Availability
- Ease of working
- Appearance
- Strength and stability
- Polishing characteristics
- Economy
- Durability

Principal of Stone

- The stones to use for stones masonry should be hard, tough and durable pressure acting on stones should be vertical.
- The stones should perfect dressed as per the requirements.
- The heads and bond stones should be of a dumbbell shape.
- In order to obtain a uniform distribution of load, under the ends of girders, roof trusses, etc large flat stones should be used.
- The mortar to use should good quality and in the specified face.
- The construction work of stone masonry should realize uniformly.
- The plumb bob should use to check the verticality or erected wall.

- The stones masonry section should always design to take compression and not the tensile stresses.
- The masonry work should proper cure after the completion of work, for a period to 2 to 3 weeks.
- As far as possible broken stones or small stones chips should not be used.
- Double scaffolding should use for working at a higher level.
- The masonry heart should properly pack with mortar and chips if necessary to avoid shallows.
- The proper water stones should use to avoid mortar moisture being suck.

Masonry construction of stones

The headers in the heart of the wall are the same size as in the face and extend at least 12 into the core of backing.

Headers in "Walls of feet (600mm) or less in thickness" extend entirely through the wall. The headers shall occupy at least 20% of the face of the wall.

Lay the courses with leaning beds parallel to the natural bed of the material.

Regularly diminish the thicknesses of the courses, if varied, from the bottom of the top of the wall, keep a surplus supply of stones at the site in select from.

Before laying the stone in the wall, shape and dress it so that it will not loosen after it is the place. No dressing of hammering which will loosen the stone will be permitted after it is placed.

Clean each stone and saturated it with water before setting it. Clean and moisten the bed that will receive it.

Bed the stones in a freshly made mortar with full joints. Carefully settle that stones in place before the mortar sets. The joints and beds have an average thickness of not more than 1 inch. (25 mm).

The complete process of working stones masonry construction

The vertical joints in each course brack with the adjoining course at least 6 inches. (150 mm). If a stone is more or if the joints are broke after the mortar has set, take the stone up and thoroughly clean the mortar from the bed and joints. Reset the stone in fresh mortar.

Whenever possible, properly point the face joints before the mortar sets. If joints cannot be the point, rake them out to a depth of 1 inch (25mm) before the mortar sets.

Do not smear the stone face surfaces with the mortar forced out of the joints of the mortar used in pointed. Drive the mortar into the joints and finish with an approved pointing tool.

Keep the wall wet while pointing. In hot or dry weather, protect the point masonry from the sun and keep it wet for at least three days after the pointing is finish.

questions

1.what are the purposes of walls?

The main purpose of walls in building construction is not only to protect buildings from damage but also to divide them for different rooms or spaces.

2.what is load bearing walls ?

the whole building structure is rested on walls instead of columns. In general, the loads from slab transfers to the beams, from beams to the columns and then spread to the foundation.

3.what is non load bearing walls ?

This type of wall doesn't support floor or roof loads above them which means it wont carry any of the weight of the structure above it. Partition walls inside the building are the best example of it, where these are constructed only to divide the rooms and these walls don't possess any structural integrity. The non-load bearing wall can be removed or shortened without affecting the building structure.

4.what is partition wall ?

A partition wall may be described as a wall or separation constructed up of bricks, studding, glass, or other such types of material and utilized to separate one part of a room from another part of a room.

5.What is stone masonry ?

The construction of stones bonded together with mortar is termed as **stone masonry**. Where the stones are available in an 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, tootings, arches, beams, etc..

Long questions

1. What is stone masonry & what are that types ?
2. What are the classification of walls as per materials of construction ?
3. What is brick masonry & what is brick bond ?

Protective, decorative finishes, damp and termite proofing

Plastering-

Plastering is the process of covering rough walls and uneven surfaces in the construction of houses and other structures with a plastic material, called plaster, which is a mixture of lime or cement concrete and sand along with the required quantity of water.

Purpose-

During your home's construction, plastering **makes the rough surfaces of the walls smooth**. Plastering covers rough edges and uneven surfaces, thus increasing durability and strengthening walls. Plastering also gives a good finish to the walls of your house and this will make your home look appealing.

Types of plastering-

There are different types of plasters are available such as:

1. Lime plaster
2. Cement plaster
3. Mud plaster
4. Stucco plaster

1. Lime plaster :-

- When lime is used as a binding material it is called lime plaster.
- Lime plaster is a type of plaster composed of hydrated lime, sand and water.
- Lime plaster is similar to lime mortar, the main difference is based on use rather than composition.
- Mortar for lime plaster is usually prepared by mixing sand and lime in equal proportions, to improve the strength small quantity of cement is added to it.

Cement plaster:-

- When cement is used as a binding material it is called cement plaster.
- It is specially suited for damp condition.
- Cement plaster is usually applied in one coat.
- Thickness of coat can be 12 – 15mm or 20mm depending upon site conditions and type of building.
- 6mm thickness of plastering of 1:3 or 1:4 Ratio is recommended for cement plastering of RCC surfaces.

Mud plaster:-

- The surface to be prepared exactly in the same manner as that of for lime plaster or cement plaster.
- Mud plaster is generally applied in two coats, the first coat being 18mm thick while the thickness of second coat kept 6mm.

Stucco plaster:-

- Stucco is the name given to decorative type of plaster which gives an excellent finish.
- Stucco plaster can be used for interior as well as exterior surfaces.
- It is usually laid in three coats making the total thickness of plaster about 25mm. The first coat is called scratch coat, the second coatis called fine coat, it is also known as brown coat and the third coat is called white coat or finishing coat.

Types of finishing:-

1. Smooth cast

2. Pebble dash
3. Rough cast
4. Texture finish
5. Scrapped finish

1. Smooth cast:-

- It is a finish which presents levelled and smooth surface.
- The mortar for finish is made by mixing of cement and fine sand in the ratio of 1:3.

2. Pebble dash:-

- It is a finish in which the small pebbles or crushed stones of suitable size are throne on to a freshly applied finish coat of plaster and left exposed.
- The mortar finish is made by cement and coarse aggregate of 1:3 rati

Rough cast:-

- It is a finish in which the mortar for the final coat contains a proportion of fairly big size coarse aggregates.
- The mortar for finishing is made by mixing cement, fine sand and coarse aggregate in the ratio of 1: 1/2:3

Textured finish:-

- In this finish ornamental patterns or textured surface are produced by working with various tools in the freshly applied final coat.

Pointing–

pointing, in building maintenance, **the technique of repairing mortar joints between bricks or other masonry elements**. When aging mortar joints crack and disintegrate, the defective mortar is removed by hand or power tool and replaced with fresh mortar, preferably of the same composition as the original.

Pointing is the finishing of mortar joints in brick or stone masonry construction. Pointing is the implementing of joints to a depth of 10 mm to 20 mm and filling it with better quality mortar in desired shape. It is done for cement mortar and lime mortar joints.

In exposed masonry, joints are considered to be the weakest and most vulnerable spots from which rainwater or dampness can enter.

Types of Pointing

1. Flush Pointing

In this type, mortar is pressed hard in the raked joints and by finishing off flush with the edge of masonry units. The edges are neatly trimmed with trowel and straight edge. It does not give good appearance. But, flush pointing is more durable because of resisting the provision of space for dust, water etc., due to this reason, this method is extensively used.

2. Recessed Pointing

In this case, mortar is pressing back by 5mm or more from the edges. During placing of mortar the face of the pointing is kept vertical, by a suitable tool. This type gives very good appearance.

3. Beaded Pointing

It is formed by a steel or ironed with a concave edge. It gives good appearance, but it will damage easily when compared to other types.

4. Struck Pointing

This is a modification of flush pointing in which the face the pointing is kept inclined, with its upper edge pressed inside the face by 10mm which drains water easily.

5. Rubbed, Keyed or Grooved Pointing

This is also a modification of flush pointing in which groove is formed at its mid height, by a pointing tool. It gives good appearance.

6. Tuck Pointing

In this case mortar is pressed in the raked joint first and finishing flush with the face.

While the pressed mortar is green, groove or narrow channel is cut in the center of groove which is having 5mm width and 3mm depth. This groove is then filled with white cement putty, kept projecting beyond the face of the joint by 3 mm. if projection is done in mortar, it is called bastard pointing or half tuck pointing.

Painting–

Painting is normally carried out for the following reasons: **Protecting surfaces from insects, rain, solar radiation and other external factors**. Simpler

maintenance: Well painted surfaces are easier to keep clean and safe. Increasing the visual appeal of a surface. Waterproofing

The objectives of painting are as under. It **protects the surface from weathering effects and effect of other gases and fumes**. It prevents decay of wood and wood based products. It prevents corrosion in metals used in dairy plants.

Since painting enhances the look of buildings, it is a common element of renovation projects. However, paints have additional uses beyond improving appearance. Knowing the performance features of each type of paint is important to select the best product for each application.

Painting is normally carried out for the following reasons:

- Protecting surfaces from insects, rain, solar radiation and other external factors
- Simpler maintenance: Well painted surfaces are easier to keep clean and safe
- Increasing the visual appeal of a surface
- Waterproofing
- Increasing surface durability

Before selecting the type of paint for a specific application, its physical properties must be considered. A good paint will offer the following benefits:

- Ease of application
- Reasonable drying period
- Forming a thin film without cracking
- Forming a hard and durable coating
- Its performance should not be affected by the weather
- Not harmful for users

Types of Paint

Oil Paint

Oil paints use white lead as a base, and are applied in three coats: primer, undercoat and finish coat. Oil paints can achieve mat and glossy finishes, while being durable and affordable. They are characterized by their ease of application, and painted surfaces are easy to clean. Oil paint is commonly used in walls, doors, windows and metal structures.

Note that oil paint is not suitable for humid conditions, and it takes time to dry completely. Also, before applying oil paints, linseed oil and pigments must be added.

Enamel Paint

This type of paint is produced by adding lead or zinc to varnish. Pigments are added to achieve a wide variety of colors. Enamel paints form hard and glossy coatings, which are easily cleaned. They are characterized by being waterproof and chemically resistant, offering good coverage and color retention.

The following are some common uses of enamel paint:

- Interior and exterior walls
- Wood trims, doors, and flooring
- Windows
- Stairs
- Surfaces like wicker, masonry, concrete, plaster, glass, and metals.

The main limitations of enamel paint are slow drying, and requiring a titanium coating before application.

Emulsion Paint

Emulsion paints use polyvinyl acetate and polystyrene as binding materials, and they contain driers like cobalt and manganese. They can be water or oil based, and pigments are used to achieve the desired color. Emulsion paints are characterized by their fast drying and hardening, and surfaces can be cleaned easily with water. Once applied, enamel paints offer durability, good color retention, and alkali resistance.

Emulsion paints are commonly used for interior walls, ceilings and masonry work. Some specialized types of emulsion paints can be used for woodwork.

Cement Paint

Cement paint is available in powder form, which is mixed with water to achieve paint consistency. The base material is white or colored cement, and it may also contain pigments, accelerators and other additives. Cement paint is durable and waterproof, and it is commonly used in rough internal and external surfaces.

Consider that cement paint has a long drying time, typically 24 hours. It must also be applied in two coats to prevent dampness issues.

Bituminous Paint

This type of paint is made from dissolved asphalt or tar, which gives it a characteristic black color. It is waterproof and alkali-resistant, but not suitable for applications where it will be exposed to the sun, since it deteriorates.

Bituminous paint is commonly used in underwater ironworks, concrete foundations, wooden surfaces and iron pipes. It also helps provide rust resistance when applied in metals.

Aluminium Paint

This type of paint is produced by mixing aluminium particles with oil varnish. It is resistant to corrosion, electricity and weather exposure. Aluminum paint is commonly used for metals and wood, and some specific applications are gas tanks, oil tanks, water pipes and radiators.

Anti-Corrosive Paint

Anticorrosive paint is characterized by its chemical resistance, as implied by its name. It is made from linseed oil, zinc chrome and fine sand. Anticorrosive paint has a black color, and it is durable and affordable. It is normally used for metallic surfaces and pipes.

Synthetic Rubber Paint

This paint is made from dissolved synthetic resins, and can include pigments. It has a moderate cost and its main benefits are chemical resistance, fast drying and weather resistance. Synthetic rubber paint is used for concrete surfaces in general, and this includes fresh concrete.

Cellulose Paint

Cellulose paint is produced from celluloid sheets, amyl acetate and photographic films. Adhesion can be improved by adding castor oil, and surfaces can be easily cleaned and washed once the paint has dried. This type of paint is characterized by its quick drying, smooth finish and hardness, while offering resistance to water, smoke and acids. Thanks to its properties, cellulose paint is commonly used in cars and airplanes.

The main disadvantage of cellulose paint is its high price.

Plastic Paint

This paint uses water as a thinner, and it is available in a wide range of colors. It dries very quickly and offers high coverage. The following are some common applications:

- Walls and ceilings of auditoriums, showrooms, display rooms, etc
- Slabs
- Decks

Silicate Paint

Silicate paint is made from a mixture of silica and resinous substances. Its performance benefits include good adhesion, hardness, heat resistance, and being chemically unreactive with metals. Therefore, this type of paint is commonly used in metal structures.

Casein Paint

This paint is made from casein mixed with white pigments. It is available in powder and paste form, and pigments can be added. Casein paint is commonly used to paint walls, ceilings and wood.

White washing-

Whitewash is **an inexpensive coating that historically has been used to decorate, protect and sanitize a wide range of materials**. Whitewash typically has a bright white color. However, lime-fast pigments, can be added to provide a broad range of colors. The principal ingredients in whitewash are hydrated lime and water.

Colour washing-

Colour washing is prepared by adding colouring pigment to the screened white wash. Generally used pigments are yellow earth red ocher and blue vitriol. These are crushed to powder, before mixing. The colour wash is applied in the same

fashion as the white wash. For colour washing on new surface, the first primary coat should be of white wash and the subsequent coats should be of colour wash.

Termite proofing

it is **the treatment given to a building, to control or prevent the termite growth in the building**. The termites enter into buildings through cracks, walls, pipes and floor joints etc. Once termites developed in the building area, it is very difficult and costly to finish.

Wood plays an important role in construction. Wherever there is wood, there are bound to be termites and if left unchecked, these pests can cause substantial damage to the structure. **To combat the menace of termites**, you must get an expert to spray anti-termite chemicals at various stages of the construction.

Long questions

1.what is plastering & described its types .

2.what is pointing & described its types .

3.what is painting & described its types .

4.what is white washing & colour washing ?

Green buildings, energy management and energy audit of buildings and project

Green building-

Green building (also known as green construction or sustainable building) refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition.

A parallel concept is natural building, which is usually on a smaller scale and tends to focus on the use of natural materials that are available locally. It is a holistic concept that begins with the understanding that the built environment can have both a positive and negative impact on the natural environment as well as the people living in the buildings every day. Green building is an attempt to reduce the positive and negative of these effects throughout the life cycle of a building.

Other related topics include sustainable design and green architecture. Sustainability can be defined as meeting the needs of current generations, without compromising the ability to meet the needs of future generations.

A **green building** is one which uses less water, optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. IGBC is a leading green building movement in the country.
The Indian Bureau of Energy Efficiency (BEE) launched the Energy Conservation Building Code (ECBC). The code is set for energy efficiency standards for design and construction with any building of minimum conditioned area of 1,000 m^2 and a connected demand of power of 500 KW or 600 KVA. The energy performance index of the code is set from 90 kW·h/sqm/year to 200 kW·h/sqm/year where any buildings that fall under the index can be termed as **"ECBC Compliant Building"**

Green building materials

Renewable sources: Forests
Reuse from waste: old plumbing, doors, etc.
Solar Tiles: Exist to simply protect a building. They spend a large portion of the day absorbing energy from the sun.
Paper Insulation: Made from recycled newspapers and cardboard then filled with chemical foam. Insect-resistant &fire retardant

Wool brick: Obtained by adding wool and a natural polymer found in seaweed to the clay of the brick, 37% more strength than burnt bricks. Resistant for cold and wet climate
Sustainable Concrete: Crushed glass, Wood chips or slag – a byproduct of steel manufacturing. Reduces the emission of CO_2

Green building benefits

- Energy Efficiency
- Water Efficiency
- Efficient Technologies
- Easier Maintenance
- Return on Investment
- Improved Indoor Air Quality
- Waste Reduction
- Temperature Moderation
- Water Conservation
- Economical Construction For Poor
- Healthier Lifestyles and Recreation

- Improved Health.

Examples of green buildings

ITC Green Centre, Gurgaon

Patni (i-GATE) Knowledge Center, Noida

Olympia Tech Park, Chennai

Indira Paryavaran Bhawan

Definition

Energy management is the process of tracking and optimizing energy consumption to conserve usage in a building.

There are few steps for the process of energy management:

1. Collecting and analyzing continuous data.
2. Identify optimizations in equipment schedules, set points and flow rates to improve energy efficiency.
3. Calculate return on investment. Units of energy saved can be metered and calculated just like units of energy delivered.
4. Execute energy optimization solutions.
5. Repeat step two to continue optimizing energy efficiency.

Building Energy Management Systems (BEMS)

In the years since the introduction of the BMS, another important application for commercial buildings has emerged with regard to energy efficiency: building energy management systems.

Although BEMS is very similar to BMS, BEMS is a slightly more sophisticated energy management system for commercial buildings. A BMS provides the ability to monitor *all* systems and control them centrally; BEMS provides monitoring and information specifically focused on systems involving energy use and demand that facilities managers can then act upon to create savings.

For example, if a utility calls a demand response event, a BEMS can receive that external signal from the utility and send control instructions to building systems in response. To reduce the overall load, BEMS may direct lights to dim in certain areas, increase the temperature set point, and/or shift from utility generation to a battery storage system. BEMS are also capable of monitoring, aggregating, and processing data at a basic level to inform logic-controlled responses. Yet, while BEMS are useful, they are still primarily used in a reactionary manner to address issues after the fact. Rarely do organizations use them in such a way that would be useful for predicting and optimizing future building performance.

The more advanced functionality of BEMS does make it a better choice for new construction than BMS. However, the future of energy management in buildings is heading away from these traditional systems and toward the more innovative IoT-based energy management platforms.

IoT-Based Analytics Platforms: Building Energy Management Solutions For The Future

IoT-based analytics platforms are the latest evolution in energy management for commercial buildings. More than a control system since the IoT actually complements traditional building management systems, an IoT-based platform gives facilities managers an unprecedented level of insight into their building systems, allowing them to proactively control operations, as well as the overall building environment. Knowing where, when, and how their building is consuming energy allows facilities managers to adopt load-shedding schedules to reduce energy demand (and thus utility costs) actively and strategically.

Using wireless IoT sensors placed throughout your building, you can collect real-time, detailed information about your commercial building's energy consumption. These sensors can monitor various operations remotely, including:

- Individual machinery
- Lighting
- HVAC
- Ventilation systems
- Refrigeration units
- Hot water systems
- Heat pumps, and more

IoT-based platforms are not only capable of monitoring and measuring various aspects of your building but also bringing in various other data inputs to extrapolate anomalies, make correlations, and help end users gain knowledge to make smart operational decisions that will affect the bottom line. Depending on your goals and the specific strategies you're employing, some of the data inputs that will lead to insights include:

- **Total energy consumption of systems and equipment connected to the electrical network.** Some of your systems are always operational; other pieces of equipment and machinery may be connected only occasionally. Either way,

it's crucial to understand both the total daily electrical consumption of your building and the role individual devices play in your overall energy use.

- **Occupants' behavior.** Activity levels, behavior patterns, and comfort preferences of occupants may be a consideration for all energy efficiency measures (and for all types of buildings), but they are a more significant factor for certain types of buildings and saving strategies.
- **Energy usage patterns.** Knowing when and how your building uses energy—and attempting to reshape those patterns to your advantage—are key components of some cost-reduction strategies (see demand response below).
- **Utility time of use charges.** Shifting your energy use away from high-priced time periods set by utility companies is a common way to generate savings. IoT-based platforms can help identify periods where energy costs are the most expensive.
- **Cyclical or seasonal factors.** Over time, your building's energy consumption may follow predictable change patterns that an IoT-based analytics platform can take into consideration when generating proposed solutions.
- **Weather data.** Weather conditions can have a direct impact on energy use, specifically as they relate to HVAC systems. Collecting, compiling, and analyzing weather data in connection with other building information allows you to be proactive about HVAC energy consumption on especially hot or cold days.

energy Audit: Types And Methodology

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme. As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of

technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

3.2.1Need for Energy Audit

- n any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists.
- The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit programme will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.
- In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame.
- The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a " bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

Type of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus Energy Audit can be classified into the following two types.

i. Preliminary Audit
ii. Detailed Audit

3.2.3 Preliminary Energy Audit Methodology

Preliminary energy audit is a relatively quick exercise to:

- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely (and the easiest areas for attention
- Identify immediate (especially no-/low-cost) improvements/ savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data

3.2.4 Detailed Energy Audit Methodology

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems.

This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges. Detailed energy auditing is carried out in three phases: Phase I, II and III.

Phase I – Pre Audit Phase

Phase II – Audit Phase

Phase III – Post Audit Phase

Questions

1.what is green building ?

Green building is a holistic concept that starts with the understanding that the built environment can have profound effects, both positive and negative, on the natural environment, as well as the people who inhabit buildings every day. Green building is an effort to amplify the positive and mitigate the negative of these effects throughout the entire life cycle of a building.

2 what is energy management ?

A building energy management system (BEMS) is **a sophisticated method to monitor and control the building's energy needs**. Next to energy management, the system can control and monitor a large variety of other aspects of the building regardless of whether it is residential or commercial.

3.what is energy audit in construction of building ?

Energy audit is **an investigation and detailed analysis of the energy (and water) entering and leaving a building**, and is carried out to pinpoint the areas where there is potential for energy efficiency measures and savings.

4 what are .types of energy audit ?

Energy Audit can be classified into the following two types.

i. Preliminary Audit

ii. Detailed Audit

LONG QUESTIONS

1. What is green building ?Explain briefly.
2. What is energy management ?Explain briefly.
3. What is energy audit ?Explain its types .

THANK YOU