BUILDING MATERIALS

&

CONSTRUCTION TECHNOLOGY

TH-3

3rd SEM

CIVIL ENGG.

Under SCTE&VT,Odisha

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CONSTRUCTION TECHNOLOGY

SUBJECT CODE-CET 305

3RD SEMESTER

TOPICS TO BE COVERED:-

- INTRODUCTION
- SITE INVESTIGATION
- FOUNDATION
- WALLS
- DAMP PROOFING
- ARCHES & LINTELS
- DOORS & WINDOWS
- FLOORS
- ROOFS
- STAIRS
- SURFACE FINISHES
- GENERAL IDEA OF SEISMIC PLANNING & DESIGN OF BUILDING
- CONSTRUCTION MACHINERIES

TOTAL MARKS=100

END SEMESTER EXAM INATION =70
CLASS TEST =20
TEACHER ASSESSMENT =10

TEXT BOOKS :-BUILDING CONSTRUCTIN OF S C RANGAWALA

REFERENCE BOOK :-BUILDING CONSTRUCTION OF (i) S.P. ARORA & S.P. BINDRA

(II)SUSHIL KUMAR

(III)VERMA & MAHESH

CHAPTER -1

TOPICS TO BE COVERED

*DEFINE BUILDING

*CLASSIFICATION OF BUILDING

* COMPONENTS OF BUILDING

INTRODUCTION

What is building?

A building is a structure used for the purpose of providing sheltered accommodation.

*It may be a residential building ,comprising of essential rooms like drawing room ,bed room , dining hall, kitchen , toilet etc.

*A non-residential building like shop ,office, school, theatre, hospital etc.

Components Of Residential Building

*Drawing room

*Bed room with attached toilet

*Kitchen

*Dining room

*Guest room

*Study room

*Verandah

Building Components

A building structure consists of two parts

1.Foundation or Sub structure

2.Super structure

1.Foundation Or Substructure-It is the portion of the building below the ground level.

*It transmits the load coming from the super structure to the ground.

EX:-Footing ,p.c.c

2.Superstructure:-It is the portion of the building above the ground level.

*It includes plinth, flooring, DPC, windows, & ventilators, lintels & sunshades, roof, parapet wall.

CHAPTER -2

TOPIC TO BE COVERED

*SITE INVESTIGATION
*OBJECTIVES OF SITE INVESTIGATION
*SITE RECONNAISSANCE
*SITE EXPLORATION
*METHODS OF SITE EXPLORATION

Site Investigation

What Is Site Investigation ?

It is desirable to visit the site of work & inspect the same carefully from the view point of foundation details. The nature & thickness of strata of soil may be estimated by studying the excavation details of nearby constructions or by examining the open side of a nearby well etc. The general inspection of site of work serve as a good guide for determining the type of foundation to be adopted for the proposed work.

Objectives Of Site Investigation

*Behaviour of ground due to variations in depth of water table
*Disposal of storm water at site
*Nature of soil by visual examination
*Movement of ground due to any reason, etc

Site Reconnaissance:-An inspection of the site & study of topographical features is often helpful in setting useful information about the soil & ground water conditions & in deciding the feature programme of exploration.

Site Exploration:-The object of the site exploration is to provide reliable, specific & detailed information about the soil & ground water conditions of the site which may be required for a safe & economic design of foundations.

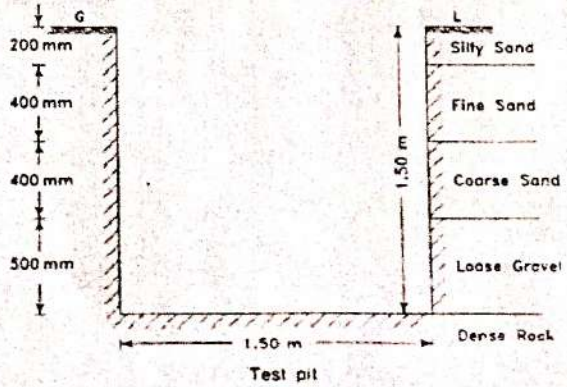
Methods Of Site Exploration:-

The following methods of site exploration are as follows

1. Test pits
2. Probing
3. Auger boring
4. Wash boring
5. Test piles
6. Deep boring

1. Test Pits:-A square pit is known as trial pit or a test pit, with side as about 1.5m ,is excavated up to a depth at which sufficiently hard soil is available.

*This method is useful when hard soil is available within a maximum depth of 1.5m.

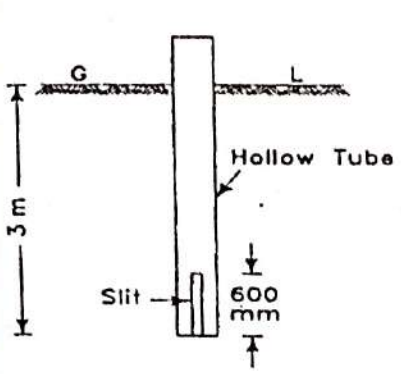


Test pit

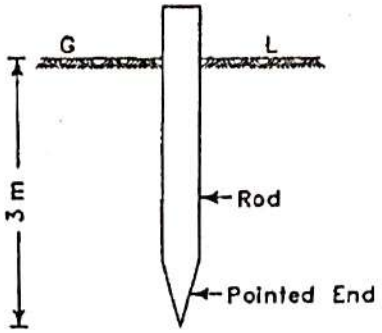
2. Probing:-The probing consists of a hollow tube or a steel rod or an iron rod in to the ground. A hollow tube of diameter 35mm to 50mm is taken . The tube is driven in to the ground 300mm or so at a time. It is then withdrawn & the material caught in the slit is inspected.

*In other case, the rod is frequently withdrawn & the material stuck up at the pointed end is examined.

*It is possible to examine the ground for a maximum depth of 3m.

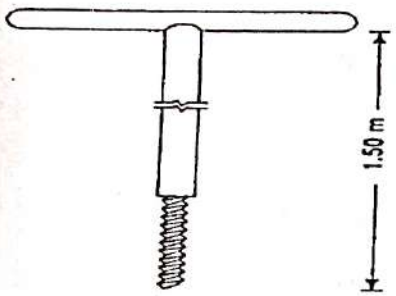


Hollow tube

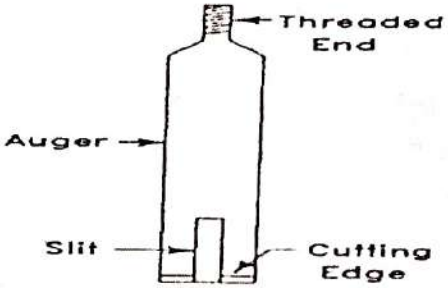


Rod

3. Auger Boring:- It consists of a hollow tube of diameter 75mm to 100mm.The tube is provided with a cutting edge at the bottom . A slit extending over a length of 600mm to 900mm is provided at the bottom of the tube to catch the material. The length of the tube is about 1.5m . The auger is driven in to the ground & turned like a screw. With the help of this method , it is possible to inspect the ground for a depth of 6m to 8m & in case of loose sand , the auger may be useful even up to a depth about 15m or so.



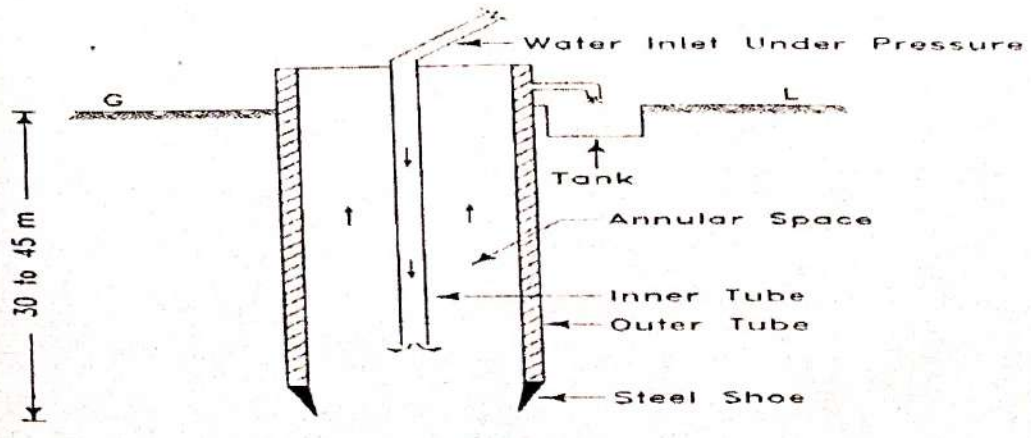
Screw auger



Shell auger

4. Wash Boring:-

The wash boring consists in driving an inner tube of diameter 25mm to 50mm, inside an outer tube of diameter 100mm to 150mm. The water is simultaneously forced with driving of tube under pressure through the inner tube. This facilitates easy driving of tube & makes the soil loose enough to flow through the annular space . The quantity of water required is usually about 100 to 300 litres per minute under a pressure of 36.28 KN/m^2. The process is continued till hard surface is met with. The washed material is collected in a tank.



Wash boring

5. Test Piles:-

Test piles are driven in to the ground to obtain the information of solid strata. With the help of this process, it is not possible to know definitely the kinds of strata through which the test piles pass, as the material is not available for inspection.

6. Deep Boring:-

It becomes essential to carry out deep boring for big important engineering structures.

Ex:-Dams

*In such structures, in addition to the stability of the superstructure, the importance is to given to various other factors such as non-leakage of stored water, seepage through porous strata, etc.

*The machines used for deep boring are as follows;

(i)Percussion boring machine

(ii)Core or rotary drilling machine.

(I)Percussion Boring Machine:-In this process, the heavy cutting tool is dropped in to the ground by means of a series of blows. The broken material is brought to the ground by adding water in to the core. & then the paste is lifted to the ground. The material thus obtained is made dry & it is then examined. The percussion boring machine is very much use full for hard material like rock

(Ii)Core Or Rotary Drilling Machine:-

In this process a hollow tube is driven by rotary motion which cuts a solid core. The water is used to facilitate the cutting process. The machine can be used either for a soft or hard material. The machine can be used either for soft or hard material. If the tube passes through the soft material, no core is obtained & the slurry formed has to be pumped out after the tube is withdrawn. When the tube passes through the hard material, no core is retained & this has to be cut at the bottom & lifted up. This is done by pouring sand at the inner side i.e. between the core & the inner surface of the tube & then the tube is slightly rotated. The core is then broken & caught in the tube & it is lifted up.

CHAPTER -3

FOUNDATIONS

TOPICS TO BE COVERED

- ***CONCEPTS OF FOUNDATION AND PURPOSES***
- ***TYPES OF FOUNDATIONS- SHALLOW AND DEEP***
- ***SHALLOW FOUNDATION – CONSTRUCTIONAL DETAILS OF , SPREAD FOUNDATIONS FOR WALLS, THUMB RULES FOR DEPTH & WIDTH OF FOUNDATION AND THICKNESS OF CONCRETE BLOCK, STEPPED FOUNDATION, COMBINED FOOTING***
- ***DEEP FOUNDATION:***

Definition of foundation.:-

The lowest artificially prepared parts of the structures which are direct contact with ground and which transmit the loads of the structures to the ground are known as the foundation or substructure.

Purpose of foundation:-

- To distribute the total load coming on the structure on a larger area .
- To support the structure.
- To give enough lateral stability to the structures against various disturbing horizontal forces such as wind, rain, earth quake etc.
- To prepare a level and hard surface for concreting and masonry work.
- To distribute the non-uniform load of the superstructure evenly to the sub-soil.
- To provide the structural safety against undermining or scouring due to animals , flood water etc.
- To prevent or minimize cracks due to movement of moisture in case of weak or poor soil etc.

Types of foundation:-

(i)Shallow foundation

(ii)Deep foundation

(i)Shallow foundation:-Foundation is shallow means if its depth is equal to or less than its width. It is also known as open foundation.

(ii) Deep foundation:-Deep foundation are those in which the depth of the foundation is very large in comparison to its width .

Shallow foundation of footings are of following types:-

1.Spread footing

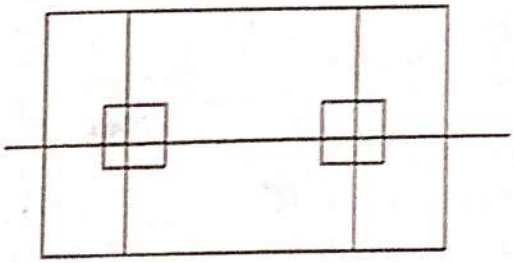
2. Combined footing

3. Strap footing

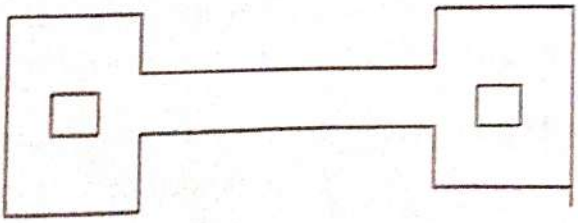
4.Mat or raft foundation

1.Spread footing:-A spread footing is the one which supports either one wall or column.

2.Combined footing:-It is the one which supports two columns .If the footing supports more than two columns .It is known as a continuous footing.



3. Strap footing:- A strap footing comprises of two or more footings of individual columns , connected by a beam , is called a strap.



4. **Mat or raft foundation** :-It is a combined footing that covers the entire area beneath a structure & supports all the walls & columns.

- It is a foundation unit continuous in two directions covering an area equal to or greater than the base area of the building .
- When the allowable soil pressure is low or the building loads are heavy , the use of spread footing would cover more than one half of the area & it may prove more economical to use mat or raft foundation.

(ii) **Deep foundation**:- Deep foundation may be of the following types

1.Pile foundation
2. Pier foundation
3. Caisson or well foundation

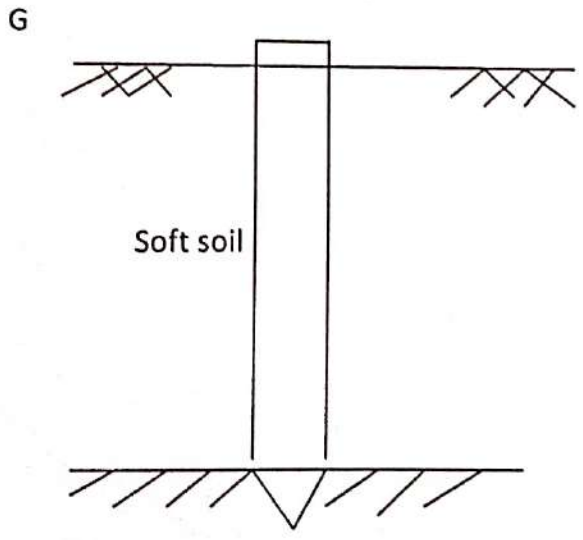
1. **Pile foundation**:-It is that type of deep foundation in which the loads are taken to a low label , by means of a vertical members which may be of concrete, timber or steel.

Pile foundation s are of the following types

(a) End bearing pile
(b) Compaction pile
(c) Friction pile

(a)**End bearing pile** :- End bearing piles are used to transfer load through water or soft-soil to a suitable bearing stratum.

*Such piles are used to carry heavy loads safely to hard strata & the settlements are minimized.



(b) **Friction pile**:-Friction piles are used to transferred load to a depth of a friction load carry material by means of skin friction along the length of the pile . Such piles are used in triangular soil where the depth of hard strata is very depth.

(c) **Compaction pile**:- Compaction piles are used compact loose granular soils, thus increasing their bearing capacity.

2. Pier foundation:- Pier foundation consists of a cylindrical column of a large diameter to support & transfer large super-imposed loads to the firm strata below.

3. Well foundation:- Well foundation or caisson's are box liked structure i.e. circular or rectangular which is sunk from the surface of either land or water to some desired depth.

Example:-Break water, sea walls

Bearing capacity of soil:-The load of the structure is ultimately coming on the soil and hence it is of utmost importance to know the strength and behaviour of the soil . The term bearing capacity or bearing power of soil it is use to indicate the maximum load per unit area which the soil will resist safely with displacement.

Bearing capacity of soil in KN/m^2 = Maximum load /Area of steel plate

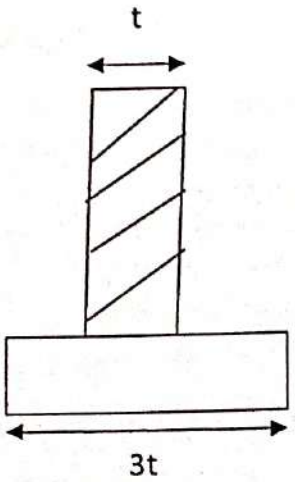
Design of shallow foundation:-

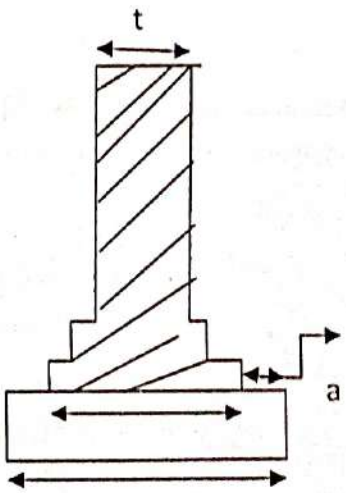
Following data are required before the design of shallow foundation:-

- The total load to be transmitted by the wall or pier to the foundation bed.
- The results of trial pits and the corresponding bearing capacity of each strata of soil.
- The design of shallow foundation involves two aspects:-
  (i)Width of foundation
  (ii) Depth of foundation

(i)Width of foundation:-

- If no footings are to be provided to the wall that is for simple footing .The width of foundation should be equal to three times of the thickness of wall.
- The total load including dead load , wind load, live load, coming on the wall per meter length or in case of a pair at the centre of pair is worked out.
- Then the width of the foundation is obtained in following relation
  For walls:-
  Width of foundation = Total load per metre length/ Allowable bearing capacity of soil
  For piers:-
  Width of foundation = Total load on the pier/ Allowable bearing capacity of soil
- Usually the walls and piers are given footing such that the width at the base become to twice the width of wall at the plinth level. By adding width of offsets of concrete the total width of foundation can be obtained for stepped footing.





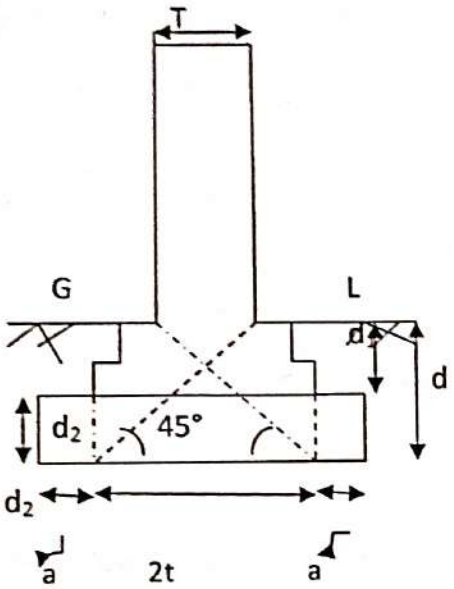
Where t= thickness of wall

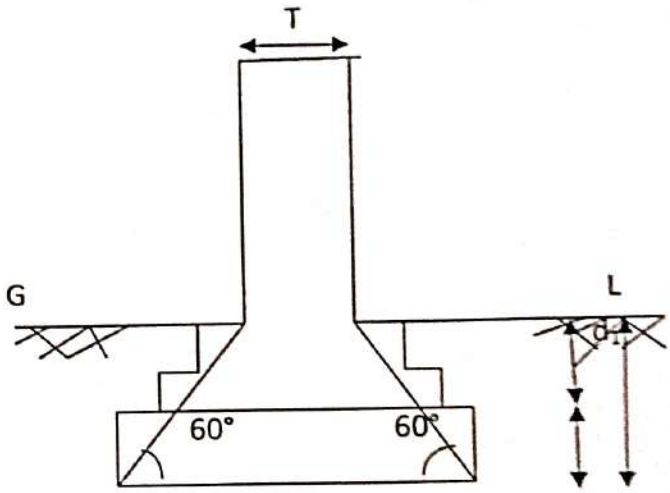
a= offset of concrete

Then width of foundation=2(t+a)

(ii)Depth of foundation:-

- As a general rule ,all the shallow foundations should be taken to a minimum depth of 800mm below natural ground level unless hard soil is available within 800mm.
- The total load to be transferred to the soil per square metre can be worked out and after the study of the results of the trial pits, the foundations should be taken to such a depth at which the soil has allowable bearing capacity greater than this value.
- The depth of foundation can also be obtained by drawings the lines of angles 45° and 60° as shown in figure...





Let d_1=Depth of footings

d_2=Depth of concrete block

d= Total depth of foundations

Then $d=d_1+d_2$

- For loose soil ,Rankin's formula , can be used to find the minimum depth of foundations.
- For loose soil Rankin's formula can be used to find the minimum depth of foundation.

  Rankin's formula (d) = $p/w \{(1-\sin \emptyset/1+\sin \emptyset)\}^2$

  Where d= minimum depth of foundation in meters

  W = weight of soil in Kg/m^3

  ϕ= Angle of repose

  p = Load of soil in Kg/m^2

For finding out the depth of concrete block , the following formula can be used

(i) Depth of concrete block = 1/58 √ pal/m

(ii) Depth of concrete block = 5/6 t

Where ,p= total load on foundation bed Kg/m^2

a=offsets of concrete in cm

m= safe modulus of structure in kg/cm^2

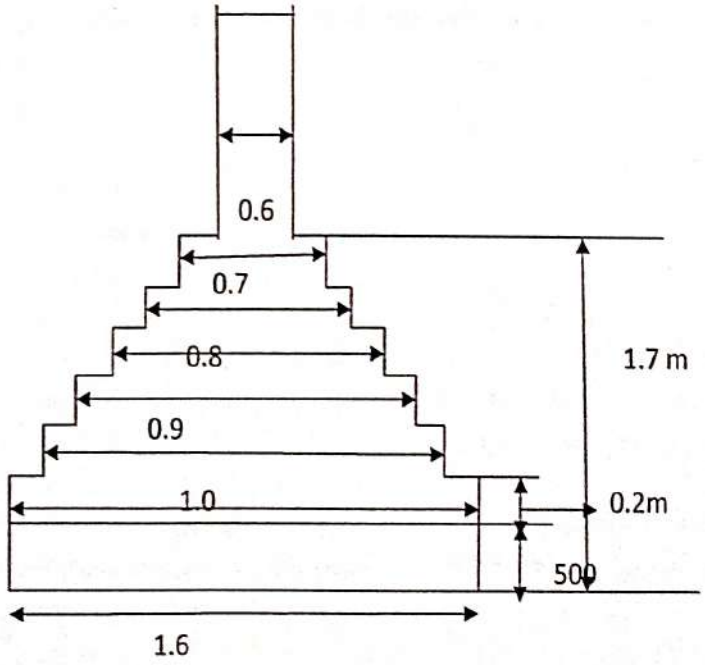
t= thickness of wall in cm above plinth label.

Problem-1

A brick pier 600mm×600mm is 4m high it has to carry an axial load of 520KN.The allowable bearing capacity of soil on which the pier is to rest is $250KN/m^2$ .The weight of brick masonry is $18.84KN/m^3$. The angle of repose is 30° and the weight of earth is $16KN/m^3$ .Design a suitable foundation for pier.

Solution:-

Width of the foundation:-
Load on pier = 0.6×0.6×0.4×18.84=27.13KN
Total load on foundation= 520+27.13+52.87=600KN
Area of base foundation=600/250= $2.4m^2$
Side of base = √2.4= 1.55m
Provided area = (1.6×1.6)m
Width of footing on top of concrete = (2×0.6)=1.2m
Offset of concrete= 0.2m
Total width = 1.2+2×0.2=1.6m
Depth of foundation= d = 3/2 t
=3/2 ×0.6 =0.9m
By use Rankin's formula
$d= p/w \{(1-\sin \phi)/(1+\sin \phi)\}^2$
Load on soil (p) = 600/ (1.6×1.6) =234.37 KN/m^2
w= $16KN/m^3$
ϕ= 30°
Depth of foundation (d) = $234.37/16 \{(1-\sin 30°)/(1+\sin 30°)\}^2$
= 1.62 m =1.7m
Depth of concrete block = 5/6 × 0.6 = 0.5m =500mm



Chapter-4
WALLS

Topics to be covered:

- *Purpose of walls*
- *Classification of walls*
- *Classification of walls as per materials of construction*
- *Brick masonry: definition of terms*
- *Bond- meaning and necessity: English bond for 1,1-1$\frac{1}{2}$ and 2 brick thick walls*
- *T, X and right angled corner junctions*
- *Construction of brick walls- method of laying bricks in walls, precautions observed in construction of walls*
- *Construction, expansion and contraction joints; purpose and constructional details*
- *Stone masonry: definition of terms*
- *Types of stone masonry*
- *Partition walls: constructional details, suitability and uses of brick and wooden partition walls*
- *Mortars- preparation, use, average strength and suitability of mason's brick layer and tubular scaffolding*
- *Shoring and underpinning: types and uses*
- *Safety in construction of low and high rise building*

Purpose of wall:-

- Wall is one of most essential, component of a building.
- The primary function of a wall is to enclose or divide spaces of the building to make it more functional and useful.
- Walls provide privacy and gives protection against heat, sun, rain, cold.
- Walls provide support to floors & roofs.
- Walls should be designed as to have provision of the following adequate.
  - i. Strength & stability
  - ii. Durability
  - iii. Weather resistance
  - iv. Fire resistance
  - v. Thermal insulation
  - vi. Sound insulation

Types of walls: - A wall may be classified as bearing and non-load bearing.

i. Load bearing wall:-a load bearing wall is a wall that bears a load resting upon it by conducting its weight to a foundation structure. The materials most often used to construct load-bearing wall in large building are concrete, block or brick.

ii. Non-load bearing wall:-Non-load bearing walls are those which are designed to carry only own load. They generally serve as divide walks or partition walls.

iii. Retaining walls:- A retaining wall is constructed to retain the artificial filling.

Brick masonry:-

Definition of terms:-Mortar:-The mortar is required to keep the stones in position. It is prepared by mixing lime or cement with sand and after adding water it is placed in the joints. The type of mortar to be used will depend on the strength required. The usual varieties are lime mortar, cement, mortar etc.

Classification of walls as per materials of construction:

Brick: A brick is a block or a single unit of a kneaded clay – bearing soil, sand and lime or concrete material , fire hardened or air dried used in masonry.

Reinforce concrete: Reinforce concrete is a composite material in which concrete's relatively low tensile strength & ductility are constructional by inclusion of reinforcement having higher tensile strength and/or ductility.

Composite masonry: Sometimes the facing and backing of a wall are constructed with different classes of masonry or different materials. This is known as the composite masonry.

Precast concrete: Precast concrete is a construction product produced by casting concrete in a reusable mold or form which is then cured in a controlled environment, transported to the construction site and lifted into place.

Solid concrete blocks: solid concrete blocks of si9ze 400mm × 200mm × 150 mm are commonly manufactured. The blocks should satisfy the strength requirement of 4 N/mm^2. The density should be as low as possible, so that handling is not difficult. These block need less mixes.

Hollow concrete blocks: Hollow concrete blocks of size 400mm× 200mm ×190 mm are commonly manufactured. These blocks need richer mixes. Fine aggregates up to 60% & course aggregates up to 40% are used less in weight.

Masonry:-the term masonry is used to indicate the art of building the structures in either stones or bricks.

- Stone masonry
- Brice masonry

Stretcher:-This is a brick laid with its length parallel to the face or front or direction of a wall. The course containing stretchers is called stretcher course.

Header:-This is a brick laid with its breadth or width parallel to the face or front or direction of a wall. The course containing header is called header course.

Frog:-A frog is a mark of depth about 10mm to 20mm which is placed on the face of a brick to form a key for holding the mortar.

Quoin:-A brick which is cut such that an angle other than a right angle is formed in plan is known as squint quoin.

Closer:-A piece of brick which is used to close up the bond at the end of brick course is known as closer.

Queen closer:-This is obtained by cutting the brick longitudinally in two equal parts.

King closer:-This is obtained by cutting a triangular portion brick such that half of a header & half of a stretcher are obtained on the adjoining act faces.

Bed:- The lower surface of the brick when laid flat is known as bed.

Jambs:-The vertical sides of the opening which are left in walls to receive door, windows etc are known as the jambs.

Heating:-In winter it becomes necessary to supply slightly heated air to the inside of the building. This will also compensate head loss from the room.

Facing:-The material which is used in the face of the wall is known as facing.

Face:-The surface of wall exposed to the weather is known as the face.

Back:-The inner surface of wall which is not exposed to the weather is known as the back.
Backing: - The material used in the formation of the back of the wall is known as the backing.
Hearting: - The portion of wall between facing and backing is known as the hearting.
Plinth:-The projecting course at ground floor level is known as the plinth.
Soffit:-This is the inner surface of the arch.
Reveals: - The exposed vertical surfaces at right angles to the door or window frames are known as the reveals.
Bond: - A bond is arrangement of layer of stones or bricks by which no continuous vertical joints are formed.

Types of bond:

The various types of bond with their patented names have been constructed. Following are the types of bonds in brickwork:

1. Stretcher bond
2. Header bond
3. English bond
4. Flemish bond
5. Garden wall bond
6. Raking bond
7. Dutch bond
8. Brick on edge bond
9. English cross bond
10. Facing bond

Stretcher bond: In this type of bond, all the bricks are arranged in the stretcher courses. The stretcher bond is useful for one- brick partition walls as there are no headers in such walls. As this bond not develop proper internals bond, it should not be used for walls having thickness greater than that of one- brick wall.

Header bond: in this type of bond, all the bricks are arranged in header course. This type of bond is use only when the thickness of the wall is equal to one brick i.e. 19 cm. it is achieved by using three- quarter brick bats in each alternate course as quoins. This bond does not have strength to transmit pressure in the direction of the length of the wall. Hence it is not suitable for load bearing walls.

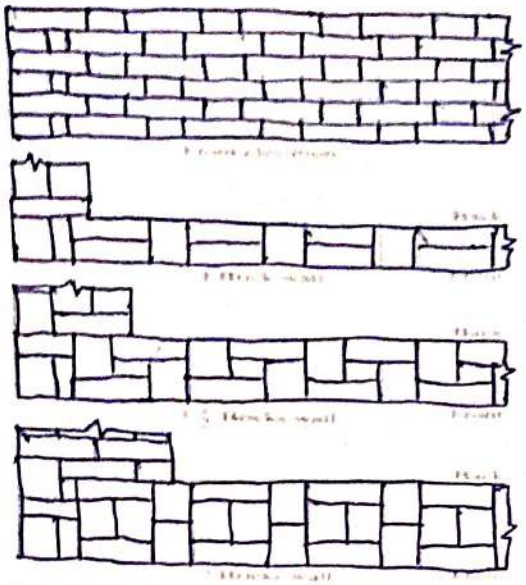
English bond: this is most commonly used bond for all type of walls. It is considered as the strongest bond in brickwork. The alternate course consists of stretcher and headers. Each alternate header is centrally supported over a structure.

Flemish bond: in this type of bond is created by alternatively laying header &stretchers in a single course. The next course is laid so that a header lies in the middle of the stretcher lies in the middle of the stretcher course below.

These are of two types.

1. Double Flemish bond
2. Single Flemish bond

THE FIGURE OF FLEMISH BOND:



Junctions: A connection between a main wall and a partition wall is termed as a junction. Following points should be kept in view while providing a junction:

i. The header course of the cross wall enters the stretcher course of the main wall.
ii. The alternate course of the cross wall are simply touching the main wall.

A junction is classified in two categories:

i. Right- angled junction
ii. Squint junction

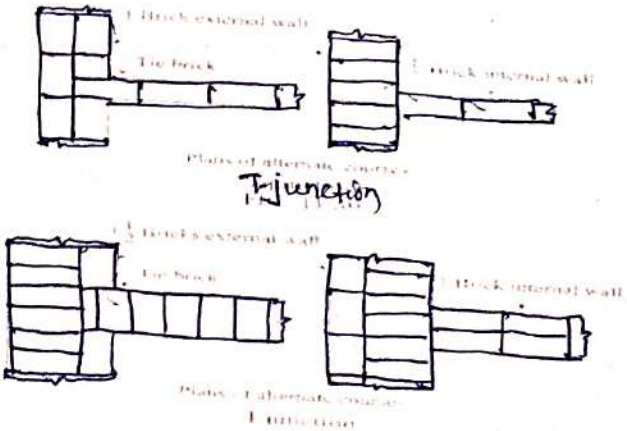
1. **Right- angled junction :**

This type of junction has two forms:

a) Tee- junction
b) Cross- junction or intersection

Tee junction:

This type of right-angled junction forms the shape of the English letter T in plan.



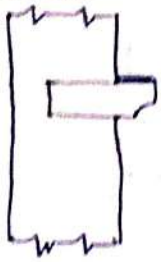
Cross junction or intersection: When two continuous walls cross or intersect each other.

Squint junction: A Squint junction is formed when two walls meet each other at an angle other at an angle other than a right without making a quoin. It may be in the English bond or Flemish bond. The squint junction is however not common in brickwork and it is rarely adopted because great difficulty is experienced in accurately forming it in practice.

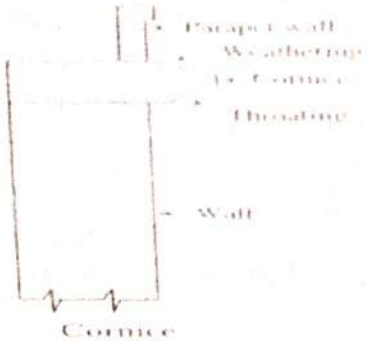
Expansion joints: the provision horizontal and vertical expansion joints in wall helps in reducing the crack to a considerable extent. The horizontal expansion joints absorb vertical movement and vertical expansion joints absorb horizontal movement. An expansion joints is considered necessary in brick walls its length exceed 15m and they are usually provided in long walls at offsets or junction and near corners.

Stone masonry:

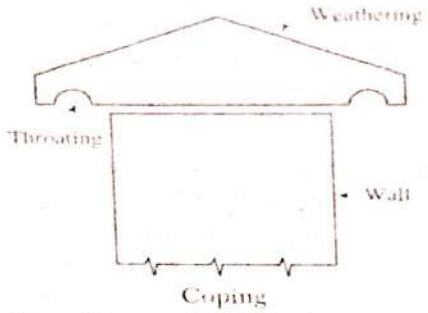
- ***Natural bed:*** The building stones are obtained from rocks. These rocks have a distinct plane of division along the stones can easily be split. This plane represents the natural bed.
- ***String course:*** The horizontal courses provided at suitable levels between the plinth and the cornice is termed as a string course.
- ***Corbel:*** A corbel is a projection stone which is usually provided to serve as support for roof truss, beam, and weather shed etc.



- ***Cornice:*** A cornice is a course of stone provided at the top of the wall.



- ***Coping***: A coping is a course of stone which is laid at the top wall so as to protect the wall from rain water.



- ***Throating***: A groove is provided on the underside of sill, cornice and coping so that the rain water can be discharged clear of the wall surface. This is known as to throating.
- ***Through stone***: In stone work some stones are regular intervals are placed right across the wall such stones are known as the through stones.
- ***Parapet:*** It is the portion of low height wall constructed along the edge of the roof to protect the users.
- ***Pilaster***: A right angled columnar projection from a wall or a pier is known as a pilaster.
- ***Buttress***: A buttress is a sloping or a stepped pier and it is provided to work as lateral support to the wall.
- ***Template:*** A bedding block is generally provided at the end of a truss. This block is known as a template. A template may be of wood or stone or R.C.C.
- ***Moulding:*** this is a term which is used to indicate the process of formation of moulded sections. It can be done either by hand or by machine.
- ***Bedding planes***: It is the line separating one layer of compressed rock from the next layer of compressed rock.

Types of stone masonry:

The stone masonry is classified under two categories.

- Rubble masonry
- Ashlar masonry

Rubble masonry: the stone masonry in which either undressed or roughly dressed stone are laid in a suitable mortar is called rubble masonry. In this masonry the joints are not of uniform thickness.

i. Coursed masonry

ii. Un Coursed masonry
iii. Random masonry
iv. Dry masonry
v. Polygon masonry
vi. Flint masonry

I. ***Random masonry***: the random masonry in which either undressed or hammer dressed stone are used, that is called random masonry. Further random rubble masonry is also divided into the following types:

- ***Uncoursed Random masonry***: The Random rubble masonry in which stones are laid without forming courses is known as Uncoursed Random masonry. The stones are used in the masonry are of different sizes and shapes.
- ***Suitability:*** Used for construction of walls of low height in case of ordinary buildings.

2. ***Coursed random rubble masonry***: The random rubble masonry in which stones are laid in layers of equal height is called coursed random rubble masonry.
   - ***Suitability***: Used for construction of walls of low height in case of ordinary building.

II. ***Coursed masonry***: In this type of rubble masonry the height of stones vary from 50mm to 200 mm. The stones are shorted out before the work commences. The masonry work is then carried out in courses are of equal heights. This type of masonry is used for the construction of public buildings, residential buildings etc.

- ***Ashlar masonry:*** The stone masonry in which finely dressed stones are laid in cement or lime mortar is known as Ashlar masonry. This type of masonry is much costly as it requires dressing of stone.
- ***Suitability:*** This masonry is used for heavy structures, architectural buildings, etc.
  i. ***Ashlar fine***: In this type of stone masonry stone blocks of same height in each course are used. Every stone is fine tooled on all sides. It is an expensive type of stone masonry as it requires heavy labor and wastage of material while dressing.
  ii. ***Ashlar facing***: Ashlar facing is the best type of ashlar masonry. Since this type of masonry is very expensive, it is not commonly used throughout the whole thickness of the wall, expect in works of great importance strength.
  iii. ***Ashlar rough masonry***: In this type ashlar masonry, the beds and sides are finely chisel dressed. But the face is made by mean of chisel, is proved around the perimeter of every stone exposed for view. The thickness of the mortar joints does not exceed 6 mm.
- **Sections for coursed rubble masonry:**
  Stone shall be hard sound, free from decay and weathering. Stones with porous matter or with bolder skin shall be rejected. The size of stones shall not be less than 15 cm in any direction. Cement and sand for cement mortar or lime mortar shall be of standard specification.

Partition walls:

A dividing or a screen wall which is constructed inside the enclosed area is known as a partition and it can be constructed either on ground floor or upper floors.

Types of partitions:

Following are the usual types of partitions:

1. Brick partitions
2. Clay block partitions
3. Concrete partitions
4. Glass partitions
5. Timber partitions
6. Metal partitions
7. Plaster slab partitions
8. Asbestos cement sheet partitions
9. Wood wool slab partitions
10. Strawboard partitions

1. ***Brick partitions***

   The half-brick partitions are very common and they may be plain, reinforced. The plain brick partitions of half-brick thickness can not take heavy load and their height is restricted to about 2 meters or so.

   The reinforced brick partitions of half-brick thickness are more durable and possess more strength.

   Following points should be noted:

   I. The brickwork should be carried out in cement mortar of proportion 1:3.
   II. The surfaces of timber framework coming in contact with the masonry should be coater with coal tar.
   III. The brickwork should be well-watered before plastering of the surface commences.

2. ***Clay block partitions:***

   The blocks are prepared from clay or terra-cotta and they may be either solid or hollow. The blocks are usually of section 300 mm × 200 mm and the thickness of hollow blocks varies from 50 mm to 150 mm. the blocks are provided with grooves on top, bottom and sides. They are light in weight and are non-shrinkable.

3. ***Concrete partitions:***

   It is possible to construct partitions of concrete which may be either pre-cast or cast-in-situ. In case of pre-cast concrete work, the concrete slabs of suitable sizes are prepared and they are secured to pre-cast posts.

4. ***Glass partitions:***

   In this type of partitions, the glass is used either in the form of sheets or hollow blocks. A timber framework is prepared and the sheets of glass are inserted in the panels. The sheets of glass are kept in position in panels by applying putty which is a mixture of linseed oil and whiting chalk.

5. ***Timber partition:***

   In this type of partitions, the wooden framework is properly supported on floor and fixed to the side walls. The framework which consists of horizontal and vertical members can either be plastered or covered with boards, etc. from both the sides.

6. ***Metal partitions:***

It is possible to use metals for forming partitions. The mild steel and bronze are the common metals used for this purpose. The vertical posts of mild steel are ejected and then panels are formed by fixing sheets of mild steel or bronze. The hollow spaces may be filled with some good insulating material.

7. ***Plaster slab partitions:***

A number of varieties of plaster slabs or boards are available in the market under different trade names. They are generally made of burnt gypsum or plaster of Paris and in order to reduce their density, the sawdust or some such fibrous material is added. The plaster slabs are prepared in moulds which may be of iron or wood.

8. ***Asbestos cement sheet partitions:***

It is possible to use the asbestos cement sheet for forming partitions. A framework of wood is prepared and the asbestos cement sheets, suitably cut, are fixed either to one side or to both the sides of the frame. These partitions are light in weight, durable, impervious to water, economical and fire-resistant.

9. ***Wood wool slab partitions:***

These slabs are prepared from a mixture of Portland cement and wood wool or wood shavings. A small quantity of gypsum is sometimes added. The partitions of these slabs have sufficient heat and sound insulating properties. The slabs are available in the market under different trade names.

10. ***Strawboard partitions:***

In this type of partitions, the slabs prepared from compressed straw and covered with thick paper or hardboard is used. These slabs possess good heat and sound insulation and the partitions of these slabs can be3 easily constructed. The partitions of strawboard are useful at places where frequent removal of partitions is anticipated.

Preparation of mortars:

For preparing mortar the water is added to an intimate mixture of binding material and sand. The water should b e free from clay, earth and other impurities. The water which is fit for drinking should only be used for preparing mortar. The different mortars are the following ways:

i. ***Lime mortar:***

The lime mortar is prepared either by prepared either by pounding or grinding. The pounding is adopted for preparing small quantities of mortar. The grinding is adopted for preparing large quantities of mortar and to ensure a steady and continuous supply of mortar.

Pounding: In this method, the piles are formed in hard ground and they are provided with lining of bricks or stones at their sides and bottom.

Grinding: in this method, the grinding mills are used to prepare mortar.

ii. ***Surkhi mortar:***

The mix of fat lime and surkhi or fan lime, surkhi and sand is decided and it is converted into a good paste by grinding in a mortar mill or by pounding.

iii. ***Cement mortar:***

This mortar does not require pounding or grinding. The cement and sand are mixed in required proportions in dry state on a watertight platform or steel through. The mixing in dry state is done twice or thrice. The water is then added and the ingredients are again thoroughly mixed.

iv. *Gauged mortar:*

The required quantity of cement is then added and the ingredients are thoroughly turned up and down to cause intimate mixing.

Use of mortar:

Following are the uses of mortar:

1. To bind the building units such as bricks, stones etc. into a solid mass.
2. To carry out pointing and plaster work on exposed surfaces of masonry.
3. To form an even and soft bedding layer for building units,
4. To form joints of pipes,
5. To improve the general appearance of structure
6. To prepare moulds for coping, corbels, cornice etc
7. To serve as a matrix or cavity to hold coarse aggregates etc.
8. To hide the open joints or brickwork and stonework.
9. To fill up the cracks detached in the structure during maintenance process etc.

Scaffolding:

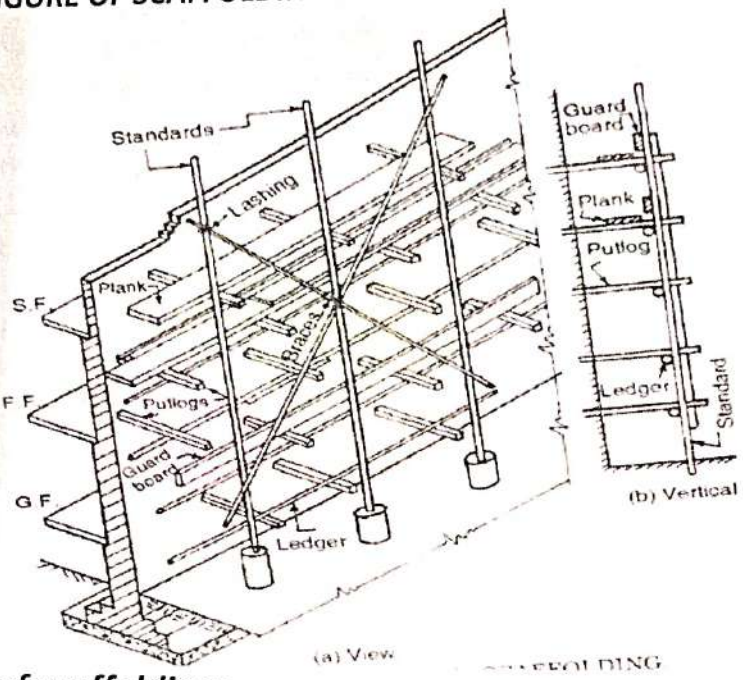
When the height of wall or column or other structural member of a building exceeds about 1.5 m, temporary structures are needed to support the platform over which the workmen can sit and carry on the constructions. These temporary structures, constructed very close to the wall, are in the form of timber or steel framework, commonly called scaffolding.

Component parts:

Scaffolding has the following components:

i. ***Standards:*** These are the vertical members of the frame-work, supported on the ground or drums, or embedded into the ground.
ii. ***Ledgers:*** These are horizontal members, running parallel to the wall.
iii. ***Braces***: These are diagonal members fixed on standards.
iv. ***Putlogs:*** These are transverse members, placed at right angles to the wall with one end supported on ledgers and other end on the wall.
v. ***Transoms:*** These are those putlogs whose both ends are supported on ledgers.
vi. ***Bridle:*** This is a member used to bridge a wall opening; supports one end of putlog at the opening.
vii. ***Boarding:*** These are horizontal platform to support workmen and materials; these are supported on the putlogs.
viii. ***Guard rail:*** This is a rail, provided like a ledger, at the working level.
ix. ***Toe board:*** These are boards, placed parallel to ledgers, and supported on putlogs, to give protection at the level of working platform.

FIGURE OF SCAFFOLDING:



Types of scaffolding:

Scaffoldings can be of the following types:

i. Single scaffolding or brick-layers scaffolding
ii. Double scaffolding or masons scaffolding
iii. Cantilever or needle scaffolding
iv. Suspended scaffolding
v. Trestle scaffolding
vi. Steel scaffolding
vii. Patented scaffolding

i. Single scaffolding or brick-layers scaffolding:

This consists of a single frame work of standards, ledgers, and putlogs etc., constructed parallel to the wall at a distance of about 1.20 meters. The standards are placed at 2 to 2.5 m interval. Ledgers connect the standards, and are provided at a vertical interval of 1.2 to 1.5 m. putlogs are placed with one end on the ledgers and other end on the ledgers and other end in the hole left in the wall, at an interval of 1.2 to 1.5m such a scaffolding is commonly used for brick laying, and is also called putlog scaffolding.

ii. Double scaffolding or masons scaffolding:

In stone masonry, it is very difficult to provide holes in the wall to support putlogs. In that case a more strong scaffolding. Each row thus forms a separate vertical frame work. The first row is placed at 20 to 30cm away from the wall while the other frame work is placed at 1 m distance from the first one. Putlogs are then supported on both the frames.

iii. Cantilever or needle scaffolding:

Cantilever scaffolding is used under the following circumstances:

a) Ground is weak to support standards.
b) Construction of upper part of the wall is to be carried out.
c) It is required to keep the ground, near wall, free for traffic etc.

iv. *Suspended scaffolding:*

This is a light weight scaffolding used for repair works such as pointing painting etc. the working platform is suspended from roofs by mean of wire ropes or chains etc. The platform can be raised or lowered at any desire level.

v. *Trestle scaffolding:*

Such type of scaffolding is used for painting and repair works inside the room, up to a height of 5 m. The working platform is supported on the top of movable contrivances such as tripods, ladders etc. mounted on wheels.

vi. *Steel scaffolding:*

Steel scaffolding is practically similar to timber scaffolding except that wooden members are replaced by steel tubes and rope lashings are replace d by steel couplets or fittings. Such scaffolding can be erected and dismantled rapidly.

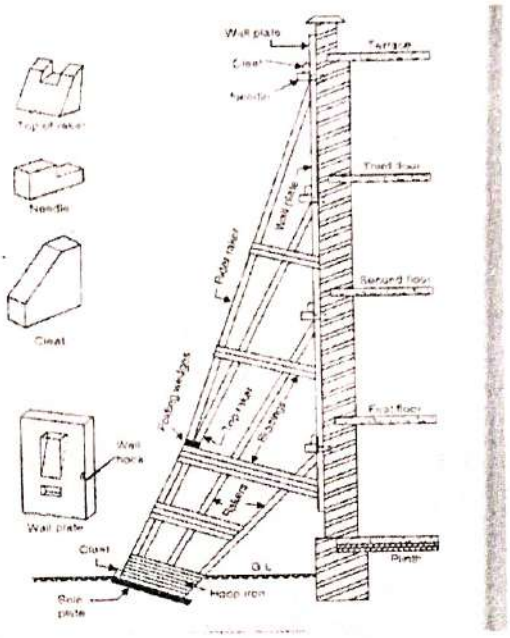
vii. *Patented scaffolding:*

Many patented scaffolding, made of steel, are available in the market. These scaffoldings are equipped with special couplings, frames etc. The working platform is supported on brackets which can be adjusted at any suitable height.

Shoring:

Sometimes the structures are to be temporarily supported. This is achieved by what is known as the shoring.

FIGURE OF SHORING:



Types of shoring:

Depending upon their supporting characteristics, the shores are classified into the following three categories:

1. Ranking or inclined shores
2. Flying or horizontal shores
3. Dead or vertical shores

Ranking or inclined shores:

In this arrangement, the inclined supports are given to the external walls from the ground. A ranking shore consists of wall plate, needles, cleats, rackers, bracing and sole plate. The wall plate is placed against the wall and is secured by means of needles which penetrate in to the

wall for a distance of about 150 mm. the wall plate distributes the pressure evenly. The needles, ion turn, are secured by cleats which are nailed to the wall plate. The rackers are interconnected by struts or braces or lacings. They are connected with the sole plate by means of iron dogs.

Flying or horizontal shores:

In this arrangement, the horizontal supports are given to parallel walls which have become unsafe due to the removal or collapse of the intermediate building. A single flying shore consists of wall plate, needles, cleats, struts, straining pieces and folding wedge. The flying shore should have a depth not less than one-thirtieth of the clear span and width not less than one- fiftieth of its length.

Dead or vertical shores:

In this arrangement, the horizontal members, known as the needles are supported by vertical members known as the dead shores. The needles are driven at right angles to the wall through the holes made in the wall. A dead shore is used under the following circumferences:

i. The lower part of the wall has become defective.
ii. The foundations are to be deepened.
iii. The lower part of the wall is to be rebuilt or reconstructed.
iv. The large openings are to be in the existing wall.

Underpinning:

the placing of new foundation below an existing foundation or the process of strengthening the existing foundation is known as the underpinning of foundations.

Methods of underpinning:

Following are the methods of underpinning:

i. Pit method
ii. Pile method
iii. Miscellaneous methods

Pit method:

In this method, the existing wall is divided into suitable sections of width about 1.20 m to 1.50 m.

The holes are then made in the existing wall. The needles with bearing plates are then inserted through these holes and supported on jacks and supported on jacks. The pit is excavated and the existing foundation is taken up to the required level. Following precautions are necessary:

i. One section should be excavated at a time.
ii. The alternate section should be taken in succession.
iii. If the length of wall is more, the underpinning is started from the middle and it is then extended in both the direction.
iv. The proper timbering should be provided for the trench.
v. It is desirable to carry out the new foundation work in concrete.
vi. If space to support needles on outside is not available the cantilever needles projecting inside and provided with fulcrums and loading may be adopted.

Pile method:

In this method, the piles are driven along both the sides of the existing wall and then needles in the form of piles caps are provided through the existing wall as shown in fig . Thus the existing wall is relieved of the loads coming on it.

This method is useful in clayey soils and for water-logged areas and form walls carrying heavy loads.

Miscellaneous methods

Following are some of the specialized underpinning methods which may sometimes be successfully aborted:

1. Cement grouting
2. chemical consolidation
3. freezing
4. vibroflotation

Each of the above method will now briefly describe.

1. ***Cement grouting:***

   This method is used to restore slab or pavement which has settled. The operation is simple. The holes are drilled in the slab and the cement grout is forced under pressure through these holes.

2. ***Chemical consolidation:***

   In this method, the soil under the existing footing is consolidated by using chemicals. This method is useful when the soil consists of sand or granular materials and the cost of consolidation depends on nature of soil, depth of consolidation, site work, etc.

3. ***Freezing***:

   In this method, the freezing pipes are driven below the existing footing and the soil is frozen. This method is rarely adopted, mainly because of two reasons:

   i. It is expensive and
   ii. More time is required for the installation of freezing pipes.

4. ***Vibrofloatation:***

   In this method, the underpinning is carried out by vibrating the sand and thereby increasing its density which ultimately results in the increase of bearing capacity of soil. This method is useful for granular or sandy soil and before the process of underpinning starts, the building or any of its structural components is shored carefully.

.....THE END.....

CHAPTER-5
Damp proofing

Topics to be covered:

- *Dampness and its ill effects on bricks, plaster, wooden fixtures, metals fixtures and reinforcement, damage to aesthetic appearance, damage to heat insulting materials, damage to stored articles and healthy, sources and caused of dampness*
- *Types of dampness*
- *Moisture entrapped during construction i.e. moisture in concrete, masonry construction and plastering work etc.*
- *Damp proofing materials and their sections*
- *Methods of damp proofing basement, ground floors plinth and walls etc.*

One of the basic requirements of a building is that it should remain dry or free from moisture travelling through walls, roofs or floors. Dampness is the presence of hydroscopic or gravitational moisture. Dampness gives rise to hygienic conditions, apart from reduction in strength of structural components of the building. Damp prevention is therefore one of the important items of building design. Every building should be damp proof. Provision of damp proof course prevents the entry of moisture in the building.

Following are various causes of dampness in building:

1. Moisture rising up the walls from ground
2. Rain travel from wall tops
3. Rain beating against external walls
4. Condensation

Effects of dampness:

The following are the ill effects of entry of dampness:

1. Dampness gives rise to breeding of mosquitoes and create unhealthy living conditions.
2. Travel of moisture through walls and ceiling may cause unsightly patches.
3. Moisture travel may cause softening and crumbling of plaster, specially lime plaster.
4. The wall decoration is damaged, which is very difficult and costly to repair.
5. Continuous presence of moisture in the wall may cause efflorescence resulting in disinfection of bricks, stones, tiles etc.
6. The flooring gets loosened.
7. Timber fittings, such as doors, windows, almirahs etc., coming in contract with damp walls, damp floors etc., get deteriorated.

8. Electrical fitting get deteriorated, giving rise to leakage of electricity and causing short circuiting.
9. Floor coverings are damaged.
10. Moisture causes rusting and corrosion of metal fittings attached to walls, floors and ceilings.

Methods of damp proofing:

Following methods are adopted to make a building damp proof:

1. Use of damp proofing course (D.P.C) : membrane damp proofing
2. Integral damp proofing
3. Surface treatment
4. Cavity wall construction
5. Guniting
6. Pressure grouting.

1. ***Use of damp proofing course (D.P.C) : membrane damp proofing***:
   This consists of introducing a water repellent membrane or damp proof course between the source of dampness and the part of building adjacent to it. Damp proofing course may consist of flexible materials such as bitumen, mastic asphalt, bituminous felts, metal sheets, cement concrete etc.
2. ***Integral damp proofing:***
   This consists of adding certain water proofing compounds of materials to the concrete mix, so that it becomes impermeable.
3. ***Surface treatment:***
   The surface treatment consists of application of layer of water repellent substances or compounds on these surfaces through which moisture enters. The use of water repellent metallic soaps such as calcium and aluminum oletes and stearates are much effective against rain water penetration. Pointing and plastering of the exposed surfaces must be done carefully, using water proofing against like sodium or potassium silicates, aluminum or zinc sulphates and magnesium sulphates etc.
4. ***Cavity wall construction:***
   This is an effective method of damp prevention, in which the main wall of a building is shielded by an outer skin wall, leaving a cavity between the two.
5. ***Guniting:***
   This consists of depositing under pressure, an impervious layer of rich cement mortar over the exposed surfaces for water proofing or over pipes, cisterns etc. for resisting the water pressure. Cement mortar consists of 1:3 cement sand mix, which is shot on the cleaned surface with the help of a

cement gun, under a pressure of 2 to 3 kg/cm^2. The nozzle of the machine is kept at a distance about 75 to 90 cm from the surface to be get an impervious layer. The layer should be properly cured at least for 10 days.

6. ***Pressure grouting:***
This consists of forcing cement grout, under pressure, into cracks, voids, fissures etc. present in the structural components of the building, or in the ground. Thus the structural components and the foundations which are liable to moisture penetration are consolidated.

Materials used for damp proofing course:

1. The material should be perfectly impervious.
2. The materials should be durable.
3. The materials should be strong, capable of resisting super-imposed loads/ pressure the building.
4. The materials should be such that leak-proof jointing is possible.
5. The materials should not be costly.

Following materials are commonly used for damp-proofing course:

i. ***Hot bitumen:***
This is highly flexible material which is applied with a minimum thickness of 3 mm. it is placed on the bedding of concrete or mortar, while in hot condition.

ii. ***Mastic asphalt:***
Mastic asphalt is semi-rigid material which is quite durable and completely impervious. It is obtained by heating asphalt with sand and mineral fillers. However, it should be laid very carefully, by experienced persons.

iii. ***Bituminous or asphaltic felts:***
This is a flexible material which is available in rolls of various wall thicknesses. It is laid on a leveled flat layer of cement mortar. An overlap of 10cm is provided at the joints and full width overlap is provided at angles, junctions and crossings.

iv. ***Metal sheets:***
Sheets of lead, copper aluminum can be used as D.P.C. These sheets are of flexible type. Lead sheets are quite flexible. Their thickness should be such that its weight is not less than 20 kg/m^2. They are laid similar to the bituminous felts. Lead sheets have the advantages of being completely impervious to moisture, resistant to ordinary atmospheric corrosion and resistant to sliding action.

Copper sheet, of minimum 3 mm thickness, are embedded in lime or cement mortar. It has high durability, high resistance to dampness, and high resistance to sliding and reasonable resistance to ordinary pressure. Aluminum sheets, if used, should be protected with a layer of bitumen. It is not as good as lead or copper sheets.

v. ***Combination of sheets and bituminous felts:***
Lead foil sand wiched between asphaltic or bituminous felts can be effectively used as D.P.C. The combination, known as lead core possesses characteristics of easy laying, durability, efficiency, economy and resistance to cracking.

vi. ***Bricks:***
Special bricks, having water absorption not less than $4\frac{1}{2}$ % of their weight may be used as D.P.C. in locations where damp is not excessive. These bricks are laid in two to four courses in cement mortar. The joints of bricks are kept open.

vii. ***Stones:***
Dense and sound such as granite, trap, slates, etc. are laid in cement mortar (1:3) in two courses or layers to form effective D.P.C. The stones should extend to the full width of the wall.

viii. ***Mortar:***
Cement mortar (1:3) is used as bedding layer for housing other D.P.C. materials. A small quantity of lime may be added to increase workability of the mortar.

ix. ***Cement concrete:***
Cement concrete of 1:2:4 mix or $1:1\frac{1}{2}:3$ mixes is generally provided at plinth level to work as D.P.C. The thickness may vary from 4 cm to 15 cm.

x. ***Plastic sheets:***
This is relatively a new type D.P.C. materials, made of black polythene, 0.5 to 1 mm thick in usual walling width and roll lengths of 30 m. C.B.R.I. Roorkee has recently suggested a new comprises a 400 gauge thick alkathene laid over 12 mm thick 1:4 cement mortar.

D.P.C TREATEMENT IN BUILDINGS:

1. Treatment to foundations against gravitational water:
   Foundation may receive water percolating from adjacent ground, and this moisture may rise in the wall. This can be checked by providing air drain parallel to the external wall. The width of air drain may be about 20 to 30

cm. the outer wall of the drain is kept above the ground to check the entry of surface water. A R.C.C. roof slab is provided.

2. ***Treatment to basements:***

When basements in damp soils are constructed, three methods may be adopted:

i. Provision of foundation drains and D.P.C.
ii. Provision of R.C.C. raft and wall slab
iii. Asphalt tanking.

a. Provision of foundation drains and D.PC.

When basement rests on soils which are not properly drained, great hydrostatic pressure is exerted and the floor as well as wall receives water continuously oozing out. In such a case it becomes necessary to make a trench all round, up to foundation level and fill it with gravel, coke and other pervious materials. Open jointed drains may be provided to collect the under- ground water. Drainage pipes, embedded in gravel bed, may also be provided before foundation concrete. Horizontal and vertical D.P.C. is provided in wall as well as foundation concrete.

b. Provision of R.C.C. raft and wall slab

Where underground water pressure is severe, the drainage system may not solve the problem effectively. Also, constant pumping out water may be costly. In such a case, floor slab as well as walls may be constructed in ridge R.C.C. structure. Horizontal and vertical D.P.C. is also provided.

c. Asphalt tanking.

This is adopted when the subsoil water table is not very high. The treatment consists of horizontal D.P.C in the form of asphaltic layer of 30 mm thick in three coat5s over the entire area of basement floor and then extending it in the form of vertical D.P.C. on the external faces of the basement walls.

3. ***Treatment to floors:***

For locations where ground moisture is not present, subsoil is rammed well and a 7.5 to 10 cm thick layer of coarse sand is spread over the entire area under flooring. Alternatively, stone soiling may first be provided and then 7.5 cm to 10 cm thick layer of lean cement concrete may be provided under it.

4. ***Treatment to walls:***

For basement walls, a vertical D.P.C. is laid over the external face of walls. This vertical D.P.C. is laid over the base of water – cement plaster grounted

on the external face of the wall. This vertical D.P.C. is further protected by external protective wall of half brick thickness. The vertical D.P.C. should be carried at least up to a level 15 cm above G.L. similarly, horizontal D.P.C. in external wall, extending from the floor, is provided at least 15 cm above G.L.

.....THE END.....

Om Sai Ram

CHAPTER -9

ROOFS

TOPICS TO BE COVERED

- *TYPES OF ROOF*
- *CONCEPT & FUNCTION OF FLAT , PITCHED, HIPPED, & ARCHED & CELL ROOFS*
- *GLOSSARY OF TERMS FOR SLOPED ROOFS & FLAT ROOFS*
- *MATERIALS USED FOR DIFFERENT ROOFS*
- *DIFFERENT TYPES OF WEATHER PROOF COURSE*

Roof:-

A roof is defined as the uppermost part of the building, provided as a structural covering, to protect the building from weather (i.e. from rain, sun, wind,etc.)

Requirements of a roof:-

- It should have adequate strength and stability to carry the super-imposed dead & live loads.
- It should effectively protect the building against rain, sun, wind etc.
- It should be water – proof, and should have efficient drainage arrangements.
- It should be fire re3sistant

Types of Roof:-Roofs may be divided in to three categories:-

(i)Pitched or sloping roofs

(ii)Flat roofs or terraced roofs

(iii)Curved roofs

(i)Pitched roofs:-Pitched roofs have sloping top surface. These are suitable in those areas where rain fall /snow fall is very heavy. Broadly, buildings with limited width and simple shape can generally be covered satisfactorily by pitched roofs.

(Ii)Flat Roofs: - Flat roofs are considered suitable for buildings in plains or in hot regions, where rainfall is moderate, and where snow fall is not there. Flat roofs are equally applicable to buildings of any shape & size.

(Iii)Curved Roof:-

Curved roofs have their top surface curved. Such roofs are provided to give architectural effects. Such roofs include cylindrical and parabolic shells and folded slabs. Such roofs are more suitable for public buildings like libraries, theatres, recreation centres etc.

Glossary of Terms for Pitched Roof: - A roof with sloping surface is known as a pitched roof.

Pitched roofs are of the following types:-

1. Lean to roof
2. Gable roof
3. Hip roof

4. Gambrel roof
5. Mansard or curb roof
6. Deck roof

1 .Lean –to roof:-This is the simplest type of sloping roof, provided either for a room of small span, or for the veranda. It has slope only one side.

2. Gable roof:-This is the common type of sloping roof which slopes in two directions. The two slopes meet at the ridge. At the end face, a vertical triangle is formed.

3. Hip roof:-This roof is formed by four sloping surfaces in four directions. At the end faces, sloped triangles are formed.

4. Gambrel roof:-This roof, like gable roof, slopes in two directions, but there is a break in each slope, at each end, vertical face is formed.

5. Mansard roof:-Mansard roof like a hip roof slopes in the four directions, but each slope has a break. The sloping ends are obtained.

6. Deck roof: - A deck roof has slopes in all the four directions, like a hip roof, but a deck or plane surface is formed at the top

Various elements of pitched roof :-

Span:-It is the clear distance between the supports of an arch, beam or roof truss.

Rise:-It is the vertical distance between the top of the ridge and the wall plate.

Pitch:-It is the inclination of the sides of a roof to the horizontal plane. It is expressed either in terms of degrees or as a ratio of rise to span.

Ridge:-It is defined as the apex line of sloping roof. It is thus the apex of the angle formed by the termination of the inclined surfaces at the top of a slope.

Eaves:-The lower edge of the inclined roof surface is called eaves. From the lower edge, the rain water from the roof surface drops down.

Hip:-It is ridge formed by the intersection of two sloping surfaces, where the exterior angle is greater than 180°.

Valley:-when two roof surfaces meet together and formed an internal angle,a valley is formed.

Hipped end:-It is the sloped triangular surfaces formed at the end of a roof.

Verge:-The edge of a gable, running between the eaves and ridge, is known as a verge.

Common rafters or spars:-These are inclined wooden members running from the ridge to the eaves. They are bevelled against the ridge beam at the head, and are fixed to purlins at intermediate point. They support the battens or boarding to support the roof coverings. Depending upon the roof covering material, the rafters are spaced 30 to 45 cm centre to centre.

Purlins:- These are horizontal wooden or steel members. , used to support common rafters of a roof when span is large. Purlins are supported on trusses or walls.

Hip rafters:-These are the sloping rafters which form the hip of a sloped roof.

Cleats:-These are short sections of wood or steel (angle iron), which are fixed on the principal rafters of trusses to support the purlins.

Truss:-A roof truss is a frame work, usually of triangles, designed to support the roof covering or ceiling over rooms.

Types of roof covering materials used for pitched roof:-

1. Thatch
2. Ordinary half- round country tiles
3. Shingles
4. Patent tiles
5. Trafford asbestos-cement tiles
6. Eternit slates
7. Corrugated galvanised iron sheets
8. Asbestos cement corrugated sheets
9. Ruberoid

1. Thatch:-This is very light roof covering. But it is combustible, absorbs moisture rapidly and is easily liable to decay. It is unstable against high winds. A bed of matting is prepared to receive the thatch and in order to drain the roof easily; a pitch of 45 degrees is kept. The thatch is used in rural areas because it is the cheapest form of roof covering and it is simple in construction.

2. Ordinary half round country tiles:- These are used for cheap buildings. If tiles are laid in two layers, the roof is known as a double –tiled roof. An overlap of at least 80mm should be provided when these tiles are used. These tiles are liable to break easily and hence they require frequent replacement.

3. Shingles:-The wood shingles are obtained from the well- seasoned timber with lengths varying from 300mm to 380mm and widths varying from 60mm to 250mm. They are laid in a similar fashion as tiles and slates. And this roof covering is found to be useful especially in hilly areas where the wood is easily and cheaply available.

4. Patent tiles:- It is used as a roof covering . The Mangalore tiles are one of the patterns. They are red in colour & made of doubled channelled Basel Mission Mangalore pattern. The special Mangalore tiles are available for ridge. It is found about fifteen Mangalore tiles are required for covering one square metre of roof area.

5. Trafford asbestos – cement tiles: - These are made of cement and asbestos. They possess less corrugation and are laid with laps of 150mm and 100mm at the ends and at the sides respectively.

6. Eternit slates:-These are fire –resisting, light and cool. They are not easily affected by weathere. About eight slates are required for covering one square metre of roof area. These slates are available in three colours:-Grey, Black, & Red.

7. Corrugated galvanized iron sheets:-The galvanized iron sheets are prepared by pressing flat wrought –iron plates between rollers with grooves or teeth and then they are galvanized with a coat of zinc. These are commonly known as the G.I. sheets.

- It is economy, productivity, and labour savings.
- It helps to increase strength & rigidity and they permit easy flow of rain water.
- They are costly & do not offer resistance to fire and sound.

8. Asbestos cement corrugated sheets:-

- The cement is mixed with about 15 percent of asbestos fibres and the paste so formed is pressed under rollers with grooves or teeth. Thus the sheet is commonly known as A.C. sheets.
- It is used for factories, workshops, garages, big halls, etc.
- This helps to increase strength and rigidity and they permit the easy flow of rain water.
- They are available under different trade names such as big-six sheets, standard sheets, Trafford sheets, etc.

- They are cheap, fire –resisting, light in weight, strong, tough, and sound – proof, imperious and durable.

9. **Ruberoid:-**This is a light , flexible and water –proof material .This material is not affected by extreme heat or cold & it is not attacked by white ants. This material is available in two colours------red & slate (grey).

Different types of weather proof course:-

Water proofing on flat roofs:-In a flat roofs water proof made by four methods

1. Finishing
2. Bedding concrete & flooring
3. Mastic asphalt & jute cloth
4. Use of water proofing compounds

1. Finishing:-The finishing of roof surface is done at the time laying cement concrete. The finishing of flat roof is carried out in cement mortar of proportion 1:4 i.e. one part of cement to four parts of sand by volume.

2. Bedding concrete & flooring:-The concrete may be brick bats lime concrete 1:6:12 or 1:5:10. The thickness of the concrete layer is about 100mm .The surface of the bedding concrete is provided by a suitable flooring such as tiles, terrazzo, Indian patent stone , etc..

3. Mastic asphalt & jute cloth:-In this method, a layer of hot mastic asphalt is laid on the roof surface. The jute cloth is spread over this layer. Then one more layer of mastic asphalt is applied, so that the jute cloth is sand witched between the two layers of mastic asphalt. The sand is then sprinkled over the entire surface of roof.

4.Use of water –proofing compounds :-Some of the water –proofing compounds like Pudlo, Impermo, etc. are available in the market and when a such a compound is added to cement , mortar and concrete . The quantity of water- proofing compound to be added is very small, say 2%.

* The water –proof compounds are available in the power form & they are to be mixed thoroughly with cement by hand before the cement is mixed with aggregate.

Chapter: 11
Surface finishes

Topics to be covered

- *Plastering – classification according to use and finishes like grit finish, roughens, pebble dashed, plain plaster etc, dubbing, proportion of mortars used for different plasters, preparation of mortars, techniques of plastering and curing*
- *Pointing- different types of pointing, mortar used and method of pointing*
- *Painting- preparation and application of paints on wooden, steel and plastered wall surfaces*
- *White washing, colour washing and distempering, application of cement and plastic paints*
- *Commonly used water repellent for exterior surfaces, their names and application*

Plastering:

The plastering is used to describe the thin plastic covering that is applied on the surfaces of walls and ceilings. The plastering removes the unevenness of the surfaces and sometimes the plastering is used to developed decorative effects.

1. **Requirements of good plaster:**
   Following are the qualities of the plastering material so as to turn out good plaster:
   i. It should adhere to the background and should remain adhered during all variation of the climatic changes.
   ii. It should be cheap and economical.
   iii. It should be hard and durable.
   iv. It should possess good workability.
2. **Mortar for plastering**:
   The selection of type of mortar for plaster depends on various factors such as availability materials, atmospheric conditions, durability required, finishing desired, location of the surface, etc. There are mainly three types of mortar which can be used for the process of plastering:
   i. Lime mortar
   ii. Cement mortar
   iii. Water-proof mortar

Lime mortar:

The lime mortar consists of equal volumes of lime and sand, these two materials are carefully ground in a mortar mill. The fat lime is recommended for plaster work because the fat lime contains 75% of CaO and it combines with CO_2 of atmosphere and gives $CaCO_3$ quickly. Thus, the lime sets quickly, but it imparts low strength and hence, it can be used for plaster work.

Cement mortar:

The cement mortar consists of one part of cement to four parts of clean, coarse and angular river sand by volume. The materials are thoroughly mixed in dry condition before water is added to them. The mixing of materials is done on watertight platform and mortar of one cement bag only prepared at a time and this quantity of mortar is consumed within 30 minutes after adding water.

Water-proof mortar:

This mortar is water –proof and it is prepared by mixing one part of cement, two parts of sand and pulverized alum at the rate of 120 n per m^3 of sand. In the water to be used, 0.75 n of soft soap is dissolved per one liter of water and this soap water is then added to the dry mix.

Tools for plastering:

Following tools are generally use4d for plastering works:

i. Gauging trowel: this is the ordinary trowel and is useful for applying mortar to mouldings, corners, etc. It has a pointed or bull- nosed end.

ii. Float: This tool is used to spread the mortar on the surface. It is made of thin tempered steel. It is also known as the laying trowel. The wooden float is known as the skimming float and is used for final or finishing coat of plaster. A float provided with nails projecting by about 3 mm from the surface is known as the devil float and it is used to make zigzag lines on the plastered surface so as form a key for the subsequent.

iii. Floating rule: This tool is used to check the level of the plastered surface between the successive screeds.

iv. Plumb bob: This tool is very much useful in forming screeds in the same vertical plane.

v. Miscellaneous tools: In addition to the above tools, other tools such as brushes, spirit level, set squares, straight edges, etc. are used for the plastering work.

Methods of plastering:

The plaster may be applied either in one, two or three coats. It is in the cheapest from of construction that plaster is applied in one coat. For works of ordinary nature, the plaster is applied i9n two coats and for works of superior quality, the plaster is applied in three coats.

Special materials for plastered surfaces:

Following are the usual special materials for plastered surfaces:

1. Acoustic plaster: This surface is prepared when it is desired to give acoustical treatment to the hall or room. The plastered surface is provided with minute openings which absorb the sound. The plaster is usually applied in two coats, each having a thickness of 6 mm.
2. Asbestos-marble plaster: This is a mixture of finely crushed marble, asbestos and cement. A beautiful marble like finish is obtained by the use of this material.
3. **Barium plaster**: This material is used as a final coat for surfaces of x-ray rooms so as to protect the persons working in and around x-ray rooms. It is essentially made from barium sulphate.
4. **Granite silicon plaster**: This material is quick-setting and highly elastic. It is therefore not liable to crack. It is used for superior type of work.
5. **Gypsum plaster**: When finely ground gypsum is heated at temperature of 160^0 C to 170^0 C, it loses about 14.7 per cent of its water content in the form of steam. The resulting product is hemihydrates of calcium sulphate and it is known as first settle plaster or plaster of Paris. When water is added to plaster of Paris, it hardens in three to four minutes. Hence, to extend the setting time, suitable retarders are added to it.

Pointing:

The term pointing is used to denote the finishing of mortar joints of either stone masonry or brick masonry. The joints are racked out to a depth of about 20 mm and then, these spaces are filled up by suitable mortar in the desired shape.

1. **Mortar for pointing:**

The pointing is generally adopted for the finishing of exposed external walls of a structure. It is cheap in the first coat, but it requires frequent replacement.

The pointing may be carried out either in lime mortar or cement mortar:

The lime mortar consists of equal volumes of lime and sand. These two materials are carefully ground in a mortar mill. The sand to be used for preparing lime mortar should be clean, fine and free from any organic impurities.

The cement mortar consists of equal volumes of cement and sand. The cement should comply with standard requirements and sand should be clean, fine and free from any organic impurities. The materials are thoroughly mixed in dry condition before water is added to them.

2. **Method of pointing:**

The pointing is carried out as follows:

i. The mortar of the masonry joints to be covered by pointing is raked out least to a depth of 20mm.
ii. The dust from the masonry joints is removed by the brushes.
iii. The surface is then washed with clean water and it is kept wet for a few hours.
iv. The mortar is then carefully placed in desired shape in these prepared joints.
v. The finished surface is well-watered for a period of at least 3 days, if lime mortar is used and 10 days, if cement mortar is used.

3. **Types of pointing:**

The pointing can be carried out in a number of shapes. The choice of a particular type will depend on the nature of masonry and the effect required.

Following are the usual types of pointing:

i. Beading pointing: this type of pointing is formed a steel or iron rod with a concave edge. The beaded pointing is good in appearance. But it is difficult to maintain as it can be easily damaged.

ii. **Flush pointing:** This type of pointing is formed by removing the excess mortar from the joint. The joint is made flush with the face. This type of joint does not give appearance. But it is durable as it does not provide any space for accumulation of dust, water, etc and hence, it is extensively used.

iii. **Recessed pointing:** This type of pointing is kept vertical and it is pressed inside the wall surface by a suitable tool to a depth of about 5 mm or more. This pointing gives very good appearance.

iv. **Rubbed or keyed or grooved pointing:** In this type of pointing, a groove is formed at the center of height by a pointer. This type of pointing gives better appearance and is generally adopted.

v. **Struck pointing:** In this type of pointing, the face of pointing is kept inclined. This joint disposes water easily. If the lower edge of joint is kept inside the face of masonry, it is known as the overhand struck pointing. But it will not form a satisfactory joint as water will be collected in the joint.

vi. **Tuck pointing:** In this type of pointing, a groove is formed at the center of joint. The width and depth of groove are respectively 5mm and 3 mm.

vii. **Vee- pointing:** In this type of pointing, a Vee-shaped groove is formed in the mortar joint.

viii. **Weather pointing:** In this type of pointing, a projection in the form of a Vee-shaped is formed.

Painting:-

The paints are coating of fluid materials & they are applied over the surface of metal or timber.

Purpose of painting a surface:-

Painting on a surface is carried out for the following purposes.

- To protect the surface from weathering effect of atmosphere.
- To prevent decay of wood & corrosion of metal.
- It is used to give good appearance to the surface.

Characteristics of an ideal paint:-

Following are the characteristics of an ideal paint.

- It should possess a good spreading power.i.e. Maximum area of the surface should be cover with minimum quantity of the paint.
- The paint should be cheap& economical.
- The paint should be such that it can be easily applied on the surface.
- The paint should form hard & durable surfaces.
- The paint should not be affected by weathering action of the atmosphere.
- The paint should possess attractive appearance.
- The paint should not affect health of worker.
- The paint should be such that its colour is maintained for a long period.
- The paint should be such that it dries in a reasonable time not too rapidly.
- The surface coated with paint should not show cracks.

Ingredients of paint:-

The paint consists of following ingredients.

a) A base
b) A vehicle
c) A drier
d) A colouring pigment
e) A solvent

a) **A base :-**

A solid substance in a fine state of division is known as paint. It determines the characteristics of paint, & gives durability to the surface which is painted. It reduces the crack formed on drying.

Ex: - white lead, red lead, oxide of iron etc.

b) **A vehicle:-**

The liquid substances which hold the ingredients of paint in liquid solution is known as vehicle. Due to this ingredient, it is possible to spread the paint uniformly on the surface in the form of thin layer.

Ex:- linseed oil, poppy oil, etc.

c) **A drier:-**

The substance which accelerates the process of drying is known as a drier. A drier absorbs oxygen from the air &transfer it to the linseed oil which in turn & get hardens.

Ex:-cobalt, lead. Manganese etc.

d) **A colouring pigment:-**

When a different colour of paint is required, colouring pigment should be added. The pigments are available in the form of fine powder in various colours.

Ex: - natural earth colour such as umbers, iron oxide. & calcined colour such as Indianred, carbon black etc.

e) **A solvent:-**

The function of a solvent is to make the paint thin, so it can be easily applied on the surface.

Ex:-sprit, turpentine etc.

Process of painting:-

The process of painting should be depends upon the nature of surface to be painted. The painting should be carried out on the following surface.

a) New wood work
b) Repainting of old wood work
c) New iron & steel work
d) Repainting of old iron & steel work

a) **New wood work:-**

4 coats of paint is carried out for new wood work.

Process:-

- The surface of wood work is prepared to receive the paint. The wood should be well seasoned. The surface of wood work is thoroughly cleaned.
- The surface of wood work is then knotted.
- Then priming coat is on the surface of new wood work.
- The process of stopping is then carried out.
- Then under coat & finishing coat are then applied on the surface.
- The extreme care should be taken to see that the finishing coat present smooth surface, so that no brush mark are seen on the finished surface.

b) **Repainting of old wood work:-**

If paint on old wood work has cracked, it is to be removed. The old paint can be removed by applying; a solution containing 2 N of caustic soda to a liter of water is prepared & used to wash the surface. The paint dissolves and the surface become clean.

Then painting should be carried out.

Process:-

- The surface of wood work is prepared to receive the paint. The wood should be well seasoned. The surface of wood work is thoroughly cleaned.
- The surface of wood work is then knotted.
- Then priming coat is on the surface of new wood work.
- The process of stopping is then carried out.
- Then under coat & finishing coat are then applied on the surface.
- The extreme care should be taken to see that the finishing coat present smooth surface, so that no brush mark are seen on the finished surface.

c) **New iron & steel work:-**

The surface of iron or steel work to receive the paint should be free from rust grease etc. The water with caustic soda or lime is used to remove gas & a wire brush is required to remove all the marks from the surface.

- The cleaned surface is provided with a film of phosphoric acid, to protect the surface from rust.
- The suitable paint should select for iron & steel surface & then applied.
- The finishing coat should give a smooth surface & precaution should be taken to avoid the presence of brush mark on the final painted surface.

d) Repainting of old iron & steel work:-

The old surface should be thoroughly cleaned by application of soap water& if grease is present, it should be removed by washing the surface with lime water. After the surface is prepared painting should be carried out.

Process:-

- The cleaned surface is provided with a film of phosphoric acid, to protect the surface from rust.
- The suitable paint should select for iron & steel surface & then applied.
- The finishing coat should give a smooth surface & precaution should be taken to avoid the presence of brush mark on the final painted surface.

Plastered surface:-

For successful application of paint on cement plastered surfaces, the following factors should be carefully considered:

i. There is considerable amount of moisture in newly constructed wall with cement plaster. It is necessary to allow the moisture content to escape. The actual time required for drying of wall surface will depend on atmospheric conditions and ventilation. But it usually requires about 3 to 6 months for the surface to ready receiving paint.

ii. The cement plaster is alkaline in nature because lime is liberated during the hydration of cement.

iii. The defects in cement plastered surfaces develop due to various reasons. Such defects should be removed and the surface should be prepared to receive the paints.

iv. The spots showing efflorescence should be brushed off and the surface should be watched for few days.

v. If there are chances for the discolouration of the painted surface, it is necessary to clean the surface and to sterilize it with antiseptic wash. The organisms reasonable for discolouration are algae, mould, and lichen etc.

Distempering:-

A coat provided to the plastered surface to create a smooth surface is known as distempering.

Purpose:-

The main purpose of providing distemper to give smooth surfaces.

Properties of distemper:-

Following are the properties of distemper.

- They are generally light in colour & they provide a good reflecting coating.
- They are less durable than oil paints.
- They exist poor workability.
- The coats of distemper are thick& they are more brittle.
- On drying the film of distemper is shrinking, if the surface to receive distemper is weak.
- They can be applied on brick work, cement plastered surface etc.
- They prove to unsatisfactory in damp location such as kitchen, bath etc.

Ingredients of distemper:-

The distemper is consists of following ingredients.

i) A base:-For base, the whiting or chalk is used.

ii) A carrier:-For carrier water is used.

iii) A colouring pigment:-when it is required to different colour colouring pigment should be added.

iv) Size:-

Process of distempering:-

Distemper is applied in the following way.

Procedure:

- Preparation of surface: - the surface to receive distemper is thoroughly rubbed & cleaned.
- Priming coat: - after preparing the surface to receive the coats of distemper, a priming coat is applied & it is allowed to become dry.

➢ Coats of distemper: - the 1st coat of distemper is then applied on the surface. It should be of a light tint applied with great care. The 2nd coat of distemper is applied after the first coat has dried & become hard.

Application of white washing:-

White washing is carried out in the following way.

- ✓ The fresh lime is mixed thoroughly with sufficient quantity of water in a tub.
- ✓ It is then screened through a clean cloth. The clean gum is dissolved in hot water is then added at the rate of 20 N/m^3 of lime. The rice may be used in place of gum.
- ✓ Then the surface to be white wash should be cleaned before the work is started.
- ✓ For white washing walls, which are white washed before, the old white wash should be 1st removed. & repairing to the plastered work is carried out.
- ✓ The white wash is applied with jute brush. Three coats are generally applied each after the previous coat has completely dried.
- ✓ White washing is more used for interior wall surface, &ceilings of house.
- ✓ The process of white washing is sometimes used for exterior wall surfaces.

Application of colour washing:-

- ✓ Colour washing is carried out in the following way.
- ✓ This is prepared by adding colouring pigment to the screened white wash.
- ✓ It should be seen that the colouring pigment is not affected by the lime.
- ✓ Generally, the yellow earth is popular for colour washing.
- ✓ Generally the walls are colour washed & ceilings are white washed.
- ✓ Then the surface to be white wash should be cleaned before the work is started.
- ✓ For colour washing walls, which are white washed before, the old white wash should be 1st removed. & repairing to the plastered work is carried out.
- ✓ The colour wash is applied with jute brush. Three coats are generally applied each after the previous coat has completely dried.

.....THE END.....