Unit-I

STONES AND BRICKS, TILES

Stones:- It is a naturally available construction material obtain carve from earth surface.

The properties of stones depend upon the parent rock from this extracted.

Quarrying:- Its a process of extracting stones from the natural rock bed

Quarry:- open part of the natural rock which useful stones from construction obtain.

Various aspects to be consider

Geological formation of the rock bed

That is Igneous sedimentary metamorphic

⇒ Availability of sufficient quantity of stone for different purposes like building compound walls arches and or namental works.

⇒ There should be a proper transport facility from quarry side to our construction side

i.e:- road bay, railways, or sea coast

⇒ There should be availability labour easily

⇒ A contionues power supply should be ensured in case of use of cutting drilling machinery

⇒ for quarring by using plastic method

There should not be permanent structure like building because it may causes vibration discom part to the people living and residiance.

=> In case of heavy rains a proper driange should be provided so that it will not cause any water loging in the side

=> There should be a waste dumping side so the all the unecessary waste which optain drilling (or) blasting operation can be disposed.

* Classification of various method of quarring

Depending upon the nature of the rock and purpose for which the stone is to be used the quarrying metal can be classified in

* digging by hand tools
* heating
* wedging
* Blasting

This method adopted when soft stones occur in the from small blocks buried (or) crowbars pick are, chisel, small hammer are the instrument which are use to dug out stones.

Heating :- In this method the horizontal wave is ferred small spieces of wood and fuel are places at regular intervals and heating done fore a period of two three hours.

Due to unequally expansions stone will be crack

The stones pieces formed are finally taken out with help of crobalts.

Wedging:- This method of spliting rock is suitable for quarrying of sedmentary are salt rocks. If the rocks surface contains cracks are pressu steel wedges are used by mean of hammer to split the rock.

If natural cracks do not exist then artificial cracks are made with help of small equipments to the this a line of wholes is drilled along the rock surface at regular short interval.

Blasting:- This method is adopted for quarrying hard and compact stones having no packs. In this process explosive are used. The four operation used in the process plastic are

i) Boring holes (or) drilling holes of blasting are
ii) Charing the holes with explosive
iii) Tampering
iv) fireing the Explosives.

Dressing:- The freshly quarry are irregural in shape and have rough structure, use can not use the stones for construction depending upon the purpose which it used like arches still building or columns. The stone are cut into suitable site and required shapes is given.

* properties of good building stone

* strength
* hardness
* thaughness
* water absorption
* specific gravity
* colour and appearance
* textur
* structure
* work ability
* durability
* Seasoning
* cast
* resistance to fire.

* strength :- A good building stone should have safecient in order to resist the loads when used has a construction material if no the structure will be a ~~collapse~~ collapse.

The minimum of a stone should be 100 MPa

Mpa = N/mm^2

* Hardness :- Resistance to rubbing action (or) wear and tear when stones are used railway ~~(ballast)~~ blast (or) pavement this property play a key role.

permenent

→ Mohr's scale

The least hardness → 1

The high hardness – 10 – diamond [5]

* toughness :- resistance to impact load (or) sudden load.

Stones of sudden loads (or) impact 20%.

* water absorption :- Ability of a material to absorbs water its should not exist 5% by weight of stone.

* Specific gravity :-

$$\text{Specific gravity} = \frac{\text{weight of any substance}}{\text{Equivalent weight of water}}$$

specific gravity of stone is having 2.7 one stone having a high specific gravity if is a good and strong stone.

* Colour and appearance :- where stone is used has the material for face work appearance plays a key role. A stone is exposed to Extream condition its should able to retain its original colours.

* texture :- stone should posses at compact & crystalline surface.

* Structure :- The arrangement of the minerals inside of the stone and chemical composition of stone will defined of the structural capacity of the building material. It should be free

from crack and voids.

* workability :- The easy the wave hang in the naturally available materials. for different purposes in its like time.

This property help in dressing operation of the stone. Its ability to take polish.

* durability :- A stone should be able to resist Exstream wind condition, frist actions and different temperature conditions.

* seassoning :- process of removing moisture from any material after Externing stone they are left to dry open shade forever 8 to 10 months.

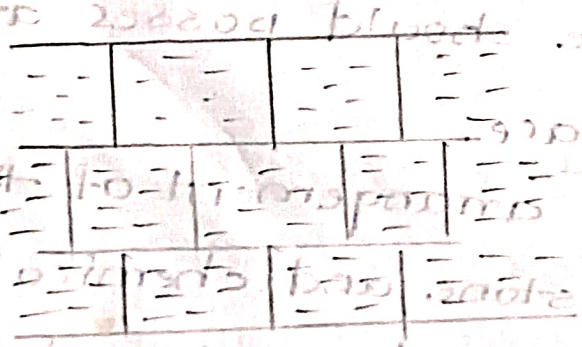
* cast :- The should be economical keeping in mind of labour cast transportation cast.

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* Different types of finishes :-

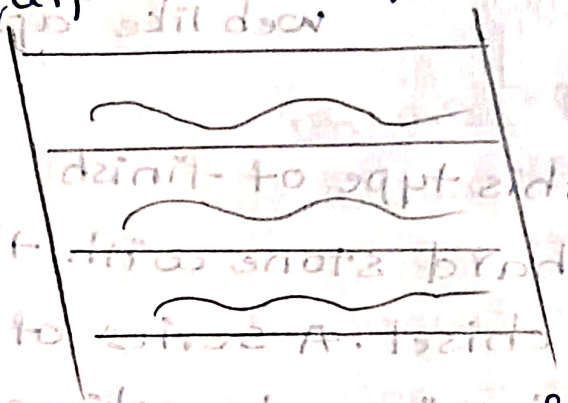
* hammered finish :- This type of finish is given for hard stone which is used as a building material for compound walls.

This is done with is the help of hammer

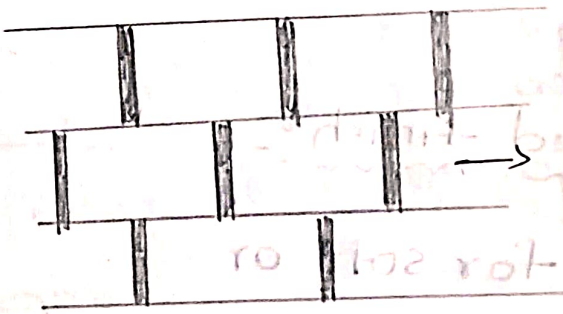


* polished finish :- This type of finish is preferred where glassy finish is required.
Ex :- floor for marbles stone & granite stone.
This can be done either by hand made tools or using machines.

* punched finish :- punched finish appears as a series of hollows and ridges.
This is preffered has where stone is used as foundation material. This can be done using machine equipment only.



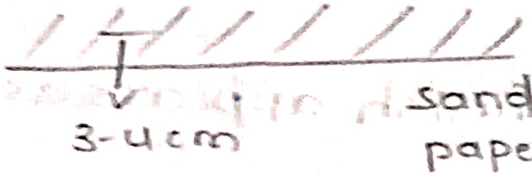
* moulded finish :- moulded finish look similar to a brick work it is used for external work.



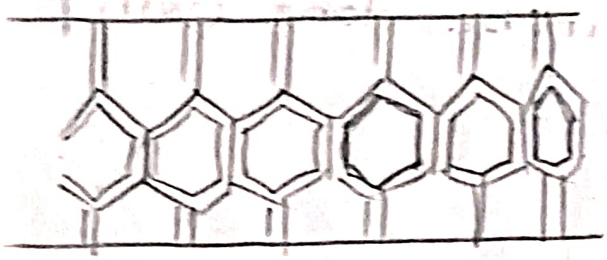
→ External using like concreat cement

* Rubbed finish :- This type of finish is free from sharp projections but not completely polish.

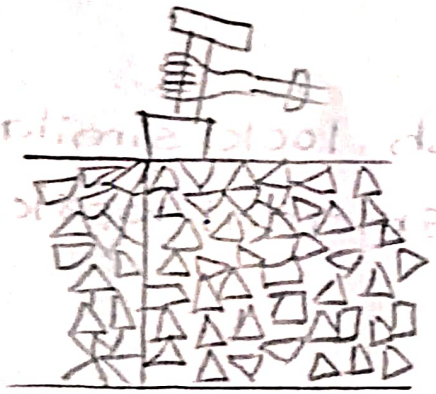
* **Drooved / boasted finish:-** In this type of finish series of parallel lines of 3 to 4 cm are drooved.



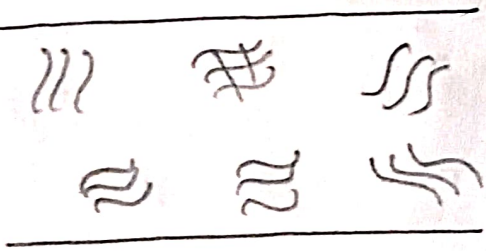
* **Reticulated finish:-** A series of hexagonals or duck out with the help of chisels giving and overal web like appearance.



* **Axed finish:-** This type of finish is done for hard stone with the help of chisel. A series of hammer gloss is given to achieve a plane surfac



* **Dragged / combed finish:-**



This is suitable for soft or hard stones are sedimentary rocks.

A small tool which is made up steel and having teeth similar to that of comb is used to achieve this type of finish.

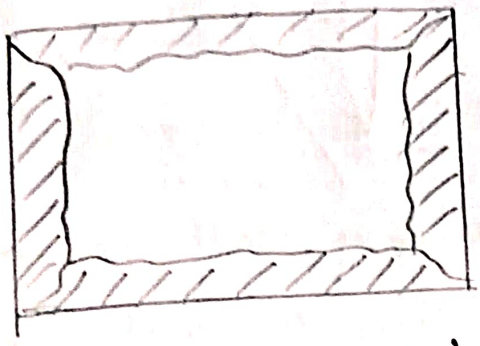
* Circular finish:-

This is suitable for columns



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* Chisel draughted finish



In this type of finish the edges of stone are cut with the help of chisel to give a decorative finish.

* Furrowed finish



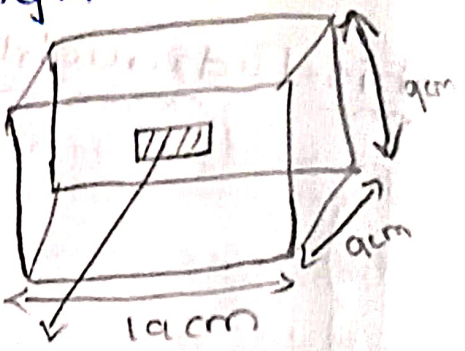
In this type of finish a furrow of semi cirular radia of 2cm to 3cm diameter is dugout along the length of the stone as parallel lines at regular intervels.

* Plane finish

The surface of the stone is made approximately smooth with the help of minor instrument like chisel and hammer.

BRICKS

The manufacturing process of bricks involves mixture of various ingrediens in appropriate proportions to obtain a high strength uniform shape and durable bricks



Composition

* silica (SiO_2) ⟶ 50 - 60%.
* Alumina (Al_2O_3) ⟶ 20 - 25%.
* lime (CaO) ⟶ 5 - 10%.
* Iron oxide ⟶ ≤5%.
* magnesia ⟶ upto 1%.
* other ingredients CO_2
  sulphur dioxide
  water

* **Silica** :- It is the major ingredient require in the preparation of bricks.

Silica imparts strength to the bricks it will prevent warping and shrinkage in a good brick. Silica should be around 50 - 60%. If silica in excess quantity it will provide brittle bricks.

* **Alumina** :- Alumina imparts plasticity composition the composition of Alumina should be 20 - 25% if it prevent in excess quantity. It will lead to warping and cracking.

* lime :- lime acts as a binding material thus helps in obtaining homogenous mixture.
* Iron oxide :- Iron imparts red colour to the brick it also acts as the using material or binding material.
* magnesia :- magnesia is responsible for colour and hardness property of brick.

manufacturing of bricks

* preparation of clay
* moulding of bricks
* drying
* Burning

various steps involved in preparation of clay.

unsoiling :-

The top layer of clay upto 15-20 cm of ground levells is removed it contains pebbles, dead leaves and roots of small booshes making it unsutable for the preparation of clay.

Digging :-

clay of required amount is dugout and pored as heeps of 15cm on levelled ground.

cleaning :-

The clay obtained from digging needs to be clean to get rid

weathering of clay :- weathering is a process of exposing clay Environmental elements air, water

and sunlight. This will help in oxidation organic matter and washing out of soluable salts in presents.

Tempering:-

Adding water to the clay mix.

Blending:-

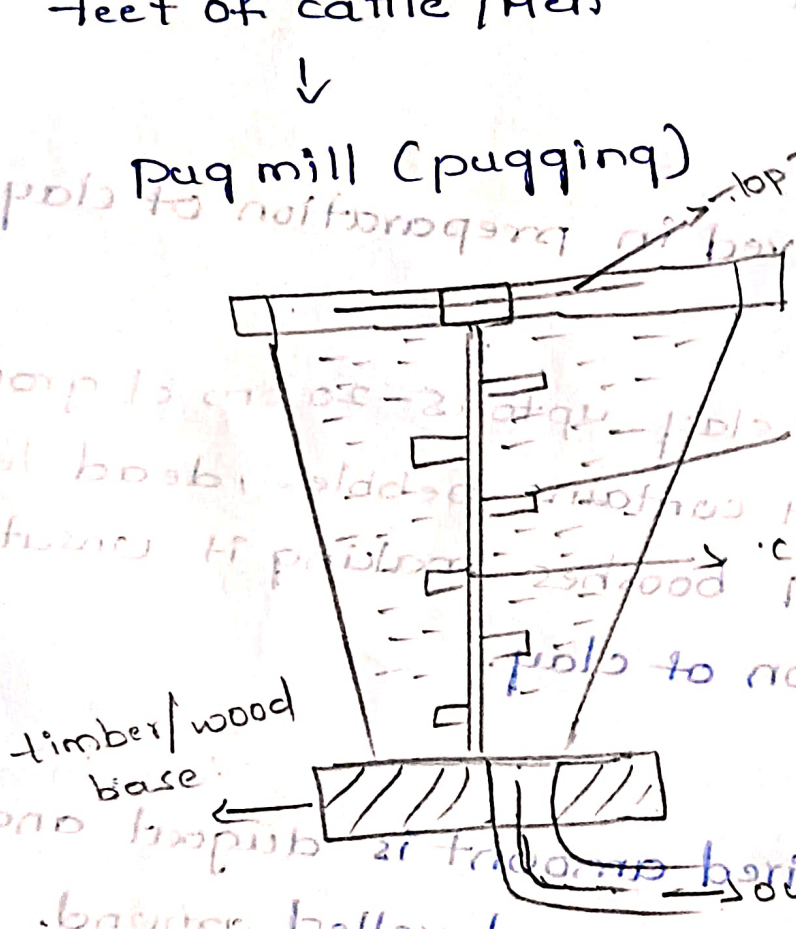
mixing the all ingredients in sufficient proportions

kneading:-

feet of cattle / Men

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Pug mill (pugging)



After mixing the ingredients of the clay the mix is placed under the feet of cattle or men to obtain a uniform mix.

pugging:- If the kneading process is done in a pug mill it is called as pugging a pug mill is the conical shaped chamber consisting of a rotating shaft

with no. of blades which is fixed to the timber or wooden piece. It is made up of iron or steel with about 8m height. It consists of ram of a which clay mix is obtained.

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* Moulding

The clay obtained from the pug mill is moulded into uniform shape bricks either using manual labour with the help of and machines.

It is classified into two types

* Hand moulding
* machine moulding

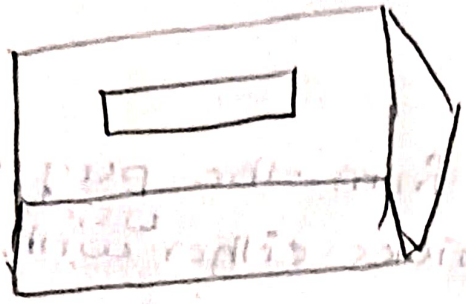
Hand moulding:- The clay mix is presed into standard moules made up of steel iron or seasoned wood. This moulds have inner dimensions similar to that of standard size of brick.

It can also divided into two types

* Ground hand moulding
* Table hand moulding

Ground hand moulding:- For this type of moulding a large open surface is required. Sand is sprinkilled on the leveled surface and also do the inner side of the mould. The amount moulded bricks are left for drying. There is no frog impression. on the top of the brick.

Frog :- An impression of 1-40 2cm depth on the top surface of the brick which helps in bonding the brick with the cement mortar.



Bottom surface of bricks are very rough in nature

Table Hand moulding :-

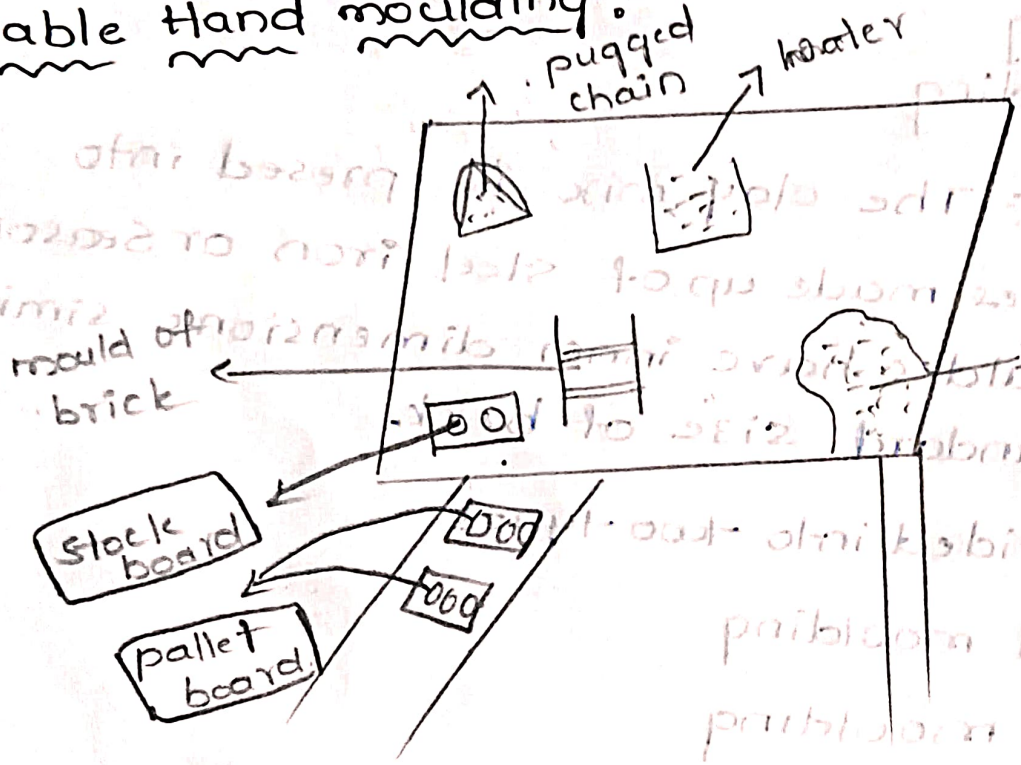


Table moulding

The clay is pressed into the mould placed on a table. by using manual labour/human labour.

Stock board :- It is the wooden board having dimensions used to similar brick having dimension similar to brick.

pallet board :- It is made up of any suitable material like wood or plastic, iron.

* The bricks formed by the table moulding are placed on the pallet board and transported to strong side or construction side.

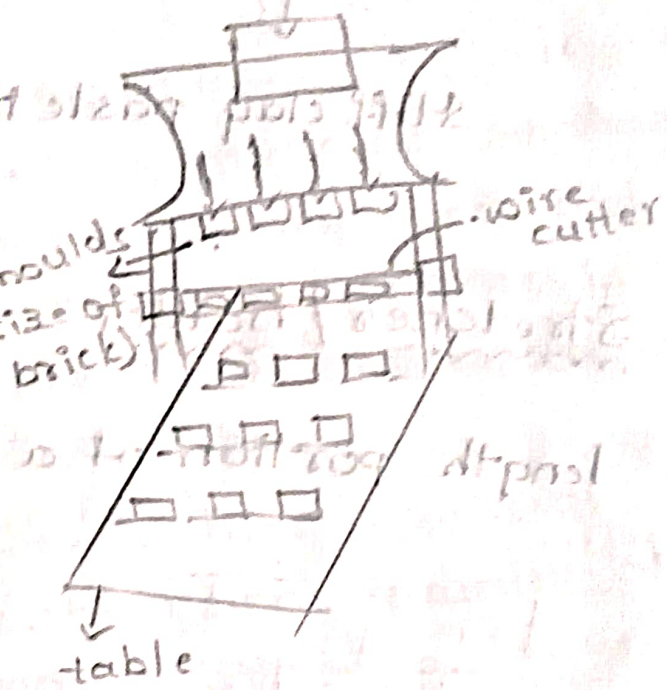
machine moulding:-

* plastic clay machine :-

Moulding of bricks that takes place automatically using machines wearth there is no involvement of manual labour.

It is consist of two types.

* plastic clay machine
* dry press machine



plastic clay machine :-

clay obtained from the pug mill is poured poured into the machine. machine consists of large no. of mould of dimensions which are integrated to the machine or attached to the machine, having inner dimensions to the machine having brick.

machine consists single or large no. of bricks moulds. There is a continuous supply of clay from the mould which are cut with the help of wire There is a continous supply of bricks. These types of bricks also called as wire cut bricks. The arrangement of made in such that a way that trip of bricks obtain have the dimensions equal to the thickness of the brick

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* dry press machine (or) method

Used for hard & stiff clay.

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Initially made into powder the machine

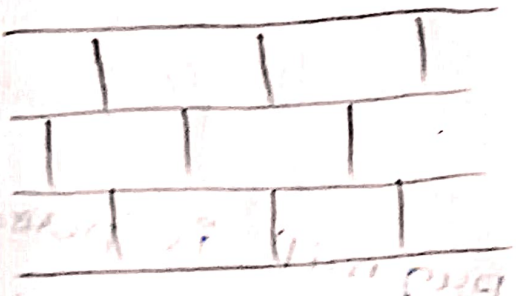
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stiff clay paste is prepared in the machine

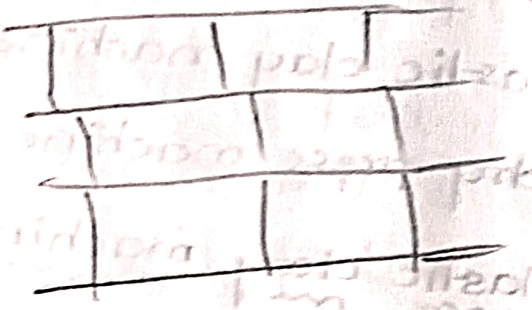
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* Stretcher / header

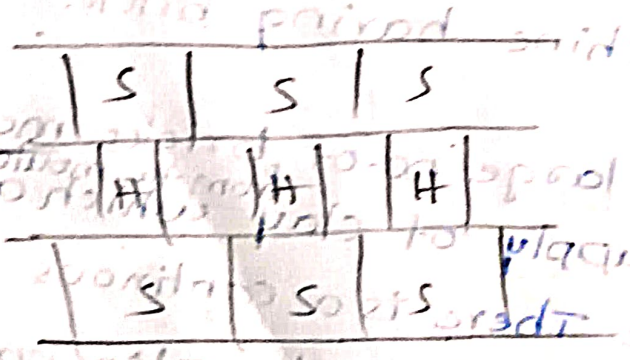
length portion of a brick is called stretcher.



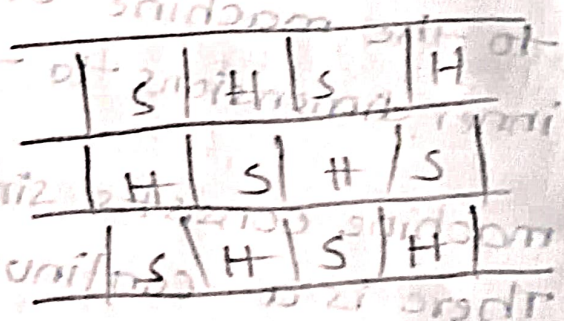
stretcher bond



header



english bond



flemish bond

Machine moulding

economical method when bricks are required in bulk quantities again classified into 2 types.

i) plastic clay machines —> for soft clays

ii) Dry press method —> for stiff clay

→ The pugged clay is procesed by the machine containing rectangular openings of size equal to the Dimension of the brick. It is cut into strips with the help of wires fixed to the frames. This arrangement is made in such a way that the strips thickness is equal to the thickness of brick As the bricks are cut by wires it is also called wire cut bricks.

→ In this machine, hard clay is first processed converted into powdered form, A small quantity of water is then added to form a stiff paste. such a clay is placed in moulds & pressed by machines to form hard & well shaped bricks. These bricks are also called pressed bricks

These type of bricks do not practically aquire changing. they are sent directly for burning.

Note:- wire cut & pressed bricks have sharp, edges & corners & also smooth External surface unlike hand moulded bricks

→ They have higher strength compared to ordinary moulded bricks.

* Drying of bricks

The object of drying is to remove the moisture & control the shrinkage so that time and fuel is save during burning process divided into 2 types:

i) Natural drying

ii) Artificial drying

Natural drying :- The process of drying bricks in open air either under the sun or under shed is calle natural / open air drying.

It depends the environmental conditions and th time may vary from 10-14 days.

Artificial drying :- process of drying bricks in special cabins is artificial drying Adopted when bricks are acquired in large no. in short interval Hot air gases are sent in order to dry the bricks it may take anywhere from 4-7 days for drying.

* Burning

last stage of preparation of brick where the ingredients are fused well to form a perfect brick which is hard, durable and partially water resistant Bricks are burnt with any one of the following methods

i) clamp burning

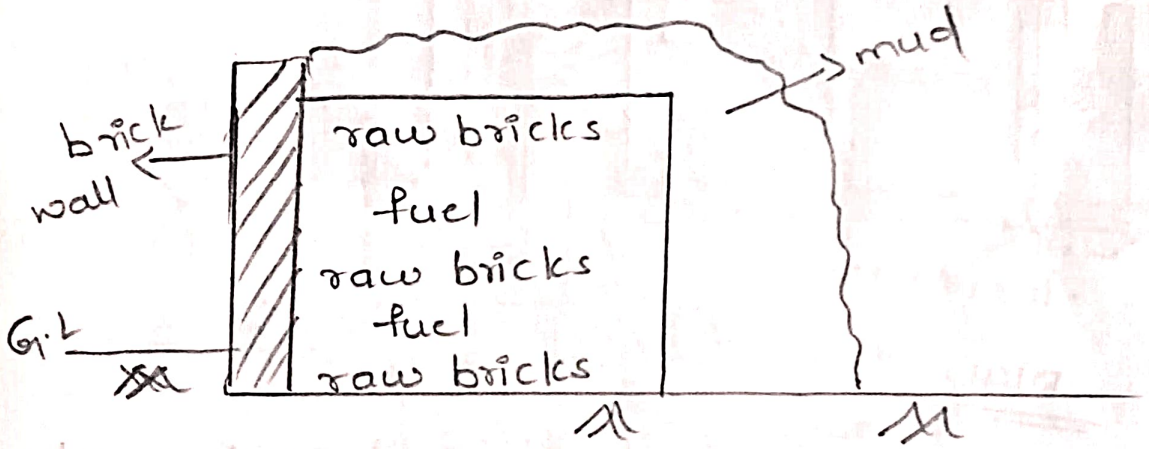
ii) kilh burning

clamp burning:-

Burning of bricks done in an open kiln is clamp burning. It is an method of burning bricks shape of clamp in plan may be trapezoidal/rectangular/circular. Where fuel is placed in alternate layers of brick.

Bricks are burnt all at once. Time period for burning is 1 month and cooling period is around 2-3 months.

* Bricks are unloaded only after complete cooling
* Dried grass, rice hosk, cow dung and coal are the types of fuel we use here.
* one side there is a brick wall which is built, for support and rest is carried by mud so there is no loss of heat from the clamp.



Amount of fuel is decreased as we reach top of the clamp

Disadvantages

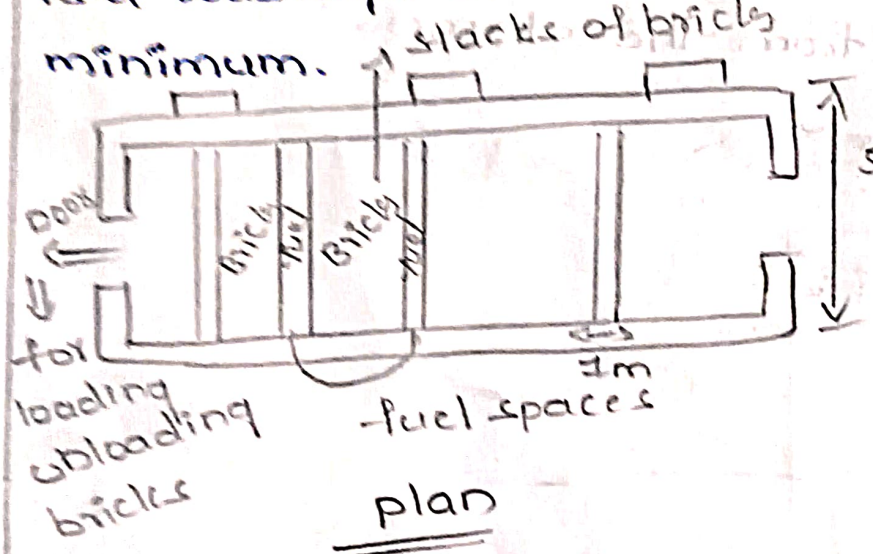
* Non uniform distribution of heat as there is no control over the burning process
* Bricks in the lower layer over burnt
* quality of bricks obtained is low

Kiln: Kiln is a large ... there are 2 types of kiln that are used for burning bricks they are

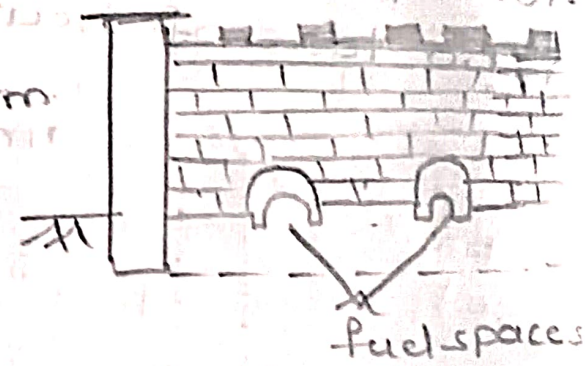
i) Intermittent kilns
ii) continuous kiln
a) Hoffmann's kiln
b) Bull's trench

Intermittent kiln:- It is a permanent structure, here the production of bricks is discontinous.

After loading the kiln, it is burnt, cooled, unloaded then it is ready for next batch of loading hence the production of bricks is not continuous. By the next batch is ready the walls & floor of the kiln gets cooled hence there is a wastage of fuel & heat efficiency is minimum.



plan

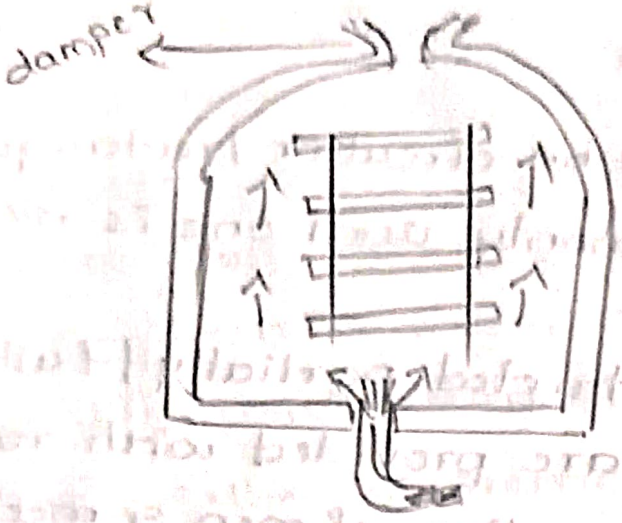


Section

Up draught kiln:- In these type of kilns, The flame is introduced at the buttom of the kiln, It consists of 3 parts firebox, damper & stack area.

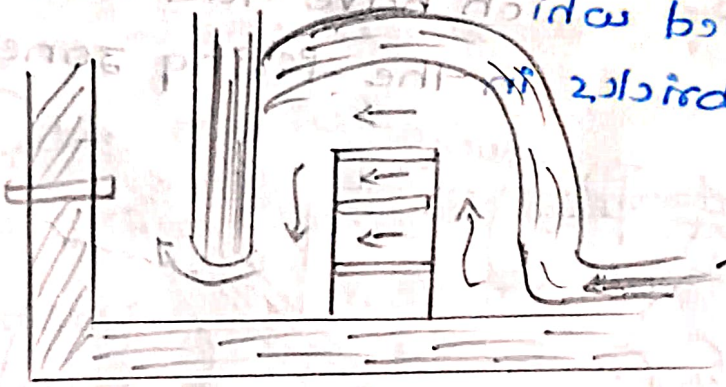
damper is provided at top of the kiln to control the exhaust stack area is where the bricks are set up.

i) Burning of bricks is not uniform as heat is lost from the top layer of bricks.



ii) less fuel-efficient

down-draught kiln:- These are designed to force the flame & heated air to circulate through the kiln. flame is introduced bottom and it flows naturally upward



Burning of bricks is uniform

There is a better heat control hence also useful for burning clay tiles, terracotta etc.

continuous kiln

In this method bricks are burnt continuously without gap of the time i,e, loading, burning & cooling unloading all are done simultaneously.

popular type of cont kilns are

i) Hoffman's kiln

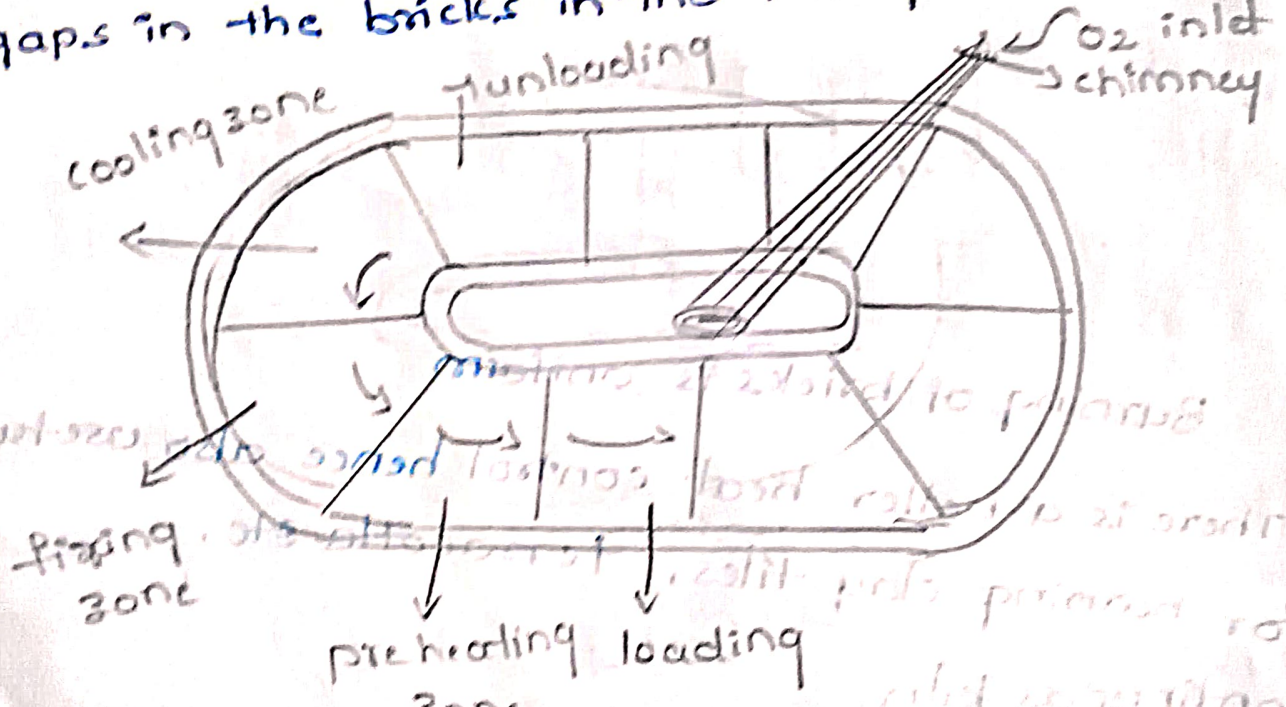
ii) Bull's trench kiln

Bull's trench: It may be circular / rectangular / oval in a plan most commonly used one is oval shaped one.

It is a trench constructed partially / fully under ground where kilns are provided with ramp to facilitate the transportion of men & material.

Iron plates / dampers divide the kiln into suitable sections along with outer & inner brick walls / Dimensions of kiln vary from 50–100 m length, 5–15 m wide & 2–3.5 m depth.

A continous movement of semi circular rubbis plate is observed which have fuel holes to fill the gaps in the bricks in the firing zone.



while firing operation is in progress the hot air gases moves to the pre heating zone there by removing any residue amount of moisture &,

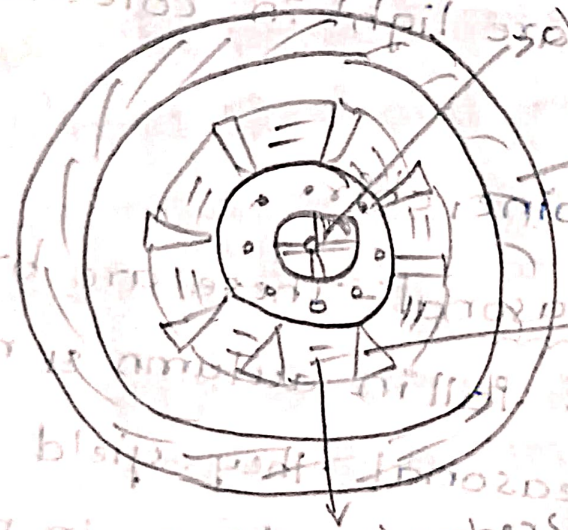
aiding in drying of bricks.
CO_2 inlet from chimney given cooling effect to the bricks in the cooling zone.

Hoffmann's kiln

constructed above ground level, circular in plan & has a roof top hence, production of bricks is done fast even in rainy conditions. It has a 8-15 chamber kiln provided with common chimney (depending on the requirement) each chamber has

1) Main door for loading & unloading of bricks
2) communicating doors are arranged between the chambers which acts as fuel openings when in open conditions.
3) A radical outlet is connected to a central chimney for ignition
4) fire holes covers are at top of each chamber to feed provided cont. fuel

Hoffmen differs from bull strench mainly interms of many numbers of permanent structure are constructed.



plan

* Timber

Hard & fibrous substance which is a major part of trunk of tree is used as building material. It provides good sand absorption & electrical resistance compared to others.

classification

i) Endogeneous treess →



Trees that grows inwards in vertical direction.

eg:- palm, bamboo

ii) Exogeneous tress

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Trees that grow radially outwards



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further classified as conifers & deciduous

Endogeneous are used for limited engineering works.

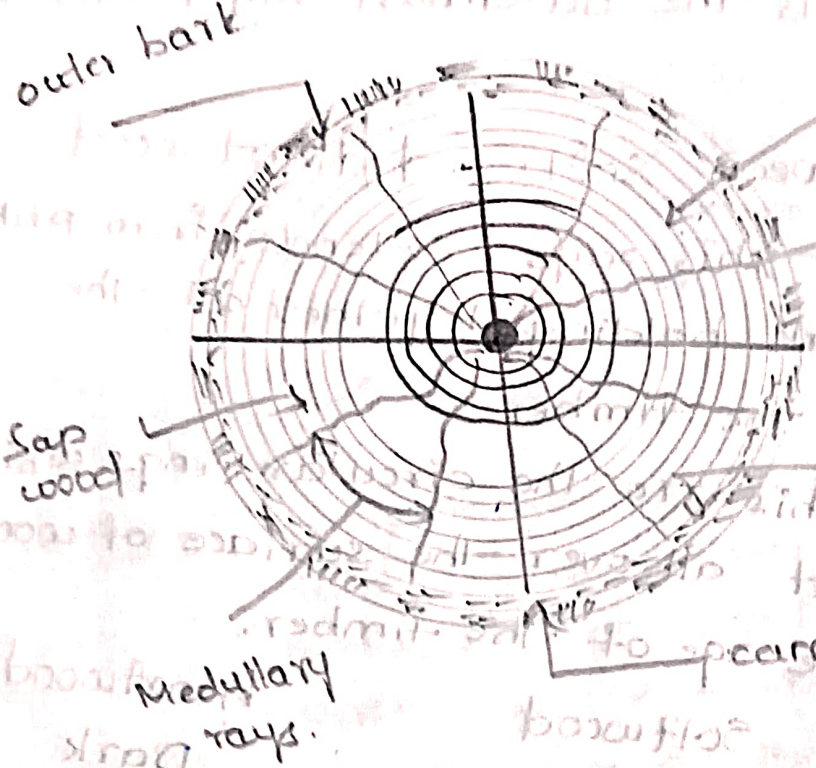
Conifers | evergreen | softwood :- They have narrow shaped leaves the leaves of trees do not fall until new ones are grown. These type of trees yield soft wood which are light in colour & less dense

eg:- deoder, pine, chir

Deciduous | hard | seasonal :- These are broad shaped leaves bf such trees fall in autumn & new ones appear in spring seasonal they yield hard wood which is dark in colour & strong in nature.

Ex:- teakwood, shishum, maple.

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Pith :- It is the inner most or core part of the tree.

Heart wood :- It is the portion of the surrounding the pith it is the oldest non-living part of the tree. consisting of dead matter it is bright in colour it is not suspectable fungas or insect attach.

Sap wood :- The portion of trees are surrounding the heart wood wood and nutrients of the tree it is light in colour, and it is a leaving part of a brick it is more likely to be attack by insects or fungas.

Cambium layer :- portion of tree which is between sap wood and inner bark it is a jelly like substance which is get to be converted into sap wood.

inner bark :- It provides protection to the cabium layer from external attack.

outer bark :- It is the outermost layer (or) skin of the stem

Differences between softwood / heart wood

Medullary rays :- This rays extends from pith to the outer bark holding together all the components of the timber.

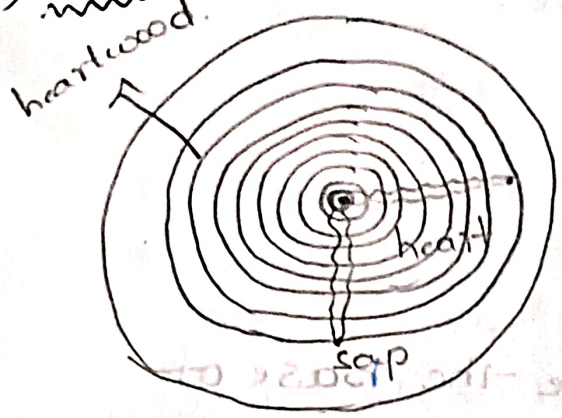
annual ring :- This are the circular rings which are extend that all over the surface of wood determining the age of the timber.

* property	Softwood	heartwood
Colour	light	Dark
growth	faster	lower
Annual rings	Distinguishable	can't be distinguishable
Weight & Density	light	Heavy
conversion to wood	easy	wood difficult
Strength	strong for direct tension	Equally strong for tension compression & shear
Examples	chir, deodar, pine	sal, Teak, shishum,
Structure	Can be split easily & have resins	can't be split easily & less resins
heart & sap	can't be disting	can be disting

2/8/25

* Defects in timber

i) heart shakes :- This extend from pith

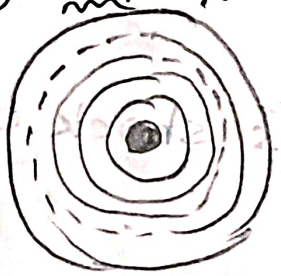


* Cracks is wide at center and diminish outside.
* It is due to shrinkage of heart wood when tree is over matured.

ii) star shake :- The temperature variation of the surroundings is very high, Alternate wet & dry condition causes the tree outer surface to shrink extending larger space at the exterior which diminish towards the interior it is limited to the sap wood.



iii) cup shake :- * It is caused due to rupture of tissue in circular direction.



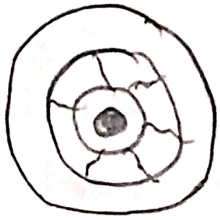
* cup shake appears as curved split which partly or wholly separates annual rings from each other.

iv) ring shake :-



* when cup shake cover the Entire ring

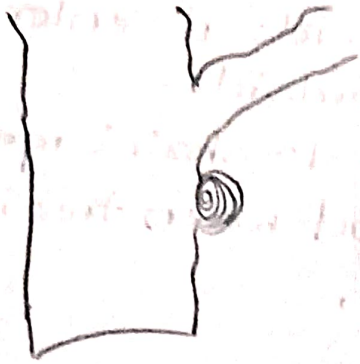
v) radial shake :-



* occured when timber is exposed to sun for seasoning after being felled down.

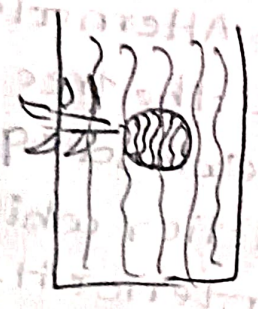
vi) Rindgall

* Abnormal growth or covered swellings on the body of tree.

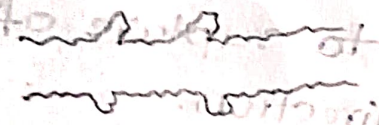


vii) knot

* These are the base of branches which are broken or cut-off from the trees.



viii) Burl



* Burl is the growth of tree in which the grain has grown in a regular projection or the timber body.

* It formed when the tree receives shock or injury in its young age.

* Seasoning of timber

The process of drying out the water from 'wet' or 'green' timber is termed as "seasoning" of timber. Drying the moisture out of wood enhances its properties to such an extent that the resulting timber is given the special name "seasoned" rather than dried" although the terms are identical. The process of seasoning of timber may be of the following types.

- Seasoning
  - Natural
    - * Air seasoning
    - * water seasoning
  - Artificial
    - * Boiling
    - * kiln seasoning
    - * chemical seasoning
    - * electrical seasoning

Natural seasoning

Seasoning of woods or timbers using natural elements is called natural seasoning. may be of two types namely water and air seasoning.

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

ii) Air seasoning:- This process involves exposing of woods to air for seasoning. At first, a platform is required that is built on the ground at 300mm height above the ground. Next process is the arrangement of woods in layers. Air circulation is maintained between logs because it helps to reduce the moisture which is important for seasoning. A clean, shady, dry, cool place is preferred for this process. sometimes 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. Using this process good quality of seasoned wood can be obtained.

Artificial Seasoning

In this method timber is seasoned artificially in a chamber with regulated heat, controlled humidity and proper air circulation. Seasoning can be completed in 4 to 5 days and it may be of the following types.

i) 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.

ii) Air seasoning:- This process involves exposing of woods to air for seasoning. At first, a platform is required that is built on the ground at 300mm height above the ground. Next process is the arrangement of woods in layers. Air circulation is maintained between logs because it helps to reduce the moisture which is important for seasoning. A clean, shady, dry, cool place is preferred for this process. sometimes 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. Using this process good quality of seasoned wood can be obtained.

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ii) kiln seasoning:- Seasoning of wood by using a large chamber or kiln where there is a good process for the circulation of hot air. fully saturated air with a temperature 35°c to 38°c is forced in the kiln.

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

iv) electrical seasoning:- Dry wood is non-conductor for 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 by creating heat. As electricity is used, it's called electrical seasoning.

4/8/25

* Wedging

Defects due to fungus

dry rot → lack of ventilation

The portion of tree where there is a lack of ventilation is attacked by fungus converts the wood in that portion to powdered form. This portion is not suitable for engineering works. so, it is cut off from the wood.

wet rot

This is decay of wood where alternate wet and dry conditions exist. The preservatives like

Cresoete oil & coal tar are added so that moisture is not lost from the wood.

White rot

The fungus will feed on the cellulose & light of the wood to that the natural form of timber is not grown there by causing whitish patches inside the wood indicating defective timber.

* Paints 5/8/25

* Types of paint	Base	vehicle	Use
Aluminium paint	Aluminium powder	spirit oil varnish	painting in poles, tower, metal roofs, storage tank etc.
Asbestos paint (most fire proof paint)	Asbestos mineral	–	stopping leakage in supply roofs painting of gutters etc. * It is fire resistant paints.
Bituminous paint	Natural asphalt or residual bitumen	spirit or naptha or petrol of ethyl acetate	It provide highly protective surface
plastic paint	plastic powder	water	Interiors of auditorium, showrooms and offices
Cellulose paint /Duco paint (costly)	Methyl or ethyl cellulose	varnish or petroleum	painting car, ships, aeroplanes and other costly things

Enamel paint	white lead or zinc white	varnish	It is acid resistance, alkali and water proof. * Used on both internal and External surface.
luminous paint	calcium sulphide	varnish	Metal surface and sign board
Distemper paint or water paint	chalk powder	water	It is used on interior surface, not exposed to weather. * 0.6 litre water are required for 1 kg distemper. * It is also called Snow-cem.
cement paint [IS-5410]	white cement	water	Used on Exterior or interior surface of the building. * It is used on radiator of vehicle.

* It is a metallic oxide which is the principal constituent / integredient of paint.
=> It provide opaque layer and possesses binding properties and prevent the shrinkage and cracks in the film on drying.
=> It provides liquidity and forms the body of the paint.
=> It is also known as binder

* vehicle is an oil in which the base
* It holds the constituents of paint is suspens and helps spread it over the surface to be painted.
* It imparts durability, toughness smoothness and water proofness to the paint film and resistance to weathering and glazing to the painted surface.

ex:- linseed oil, Nut oil, Tung oil, poppy oil etc

* It is used to thin and increase the spread capacity of the paint.
* It make the paint of workable consistency and evaporate during drying of the film, so it is known as volatile substance of the paint,

ex:- Turpentine oil, Naptha, spirit, petroleum Alcohol, Benzene etc.

Driers

* It is used for accelerate the drying process of the paint.
* The percentage quantity of drier in paint is limited to 8%. Excess of it affects the elasticity of paint and leading to flaking failure,

Ex:- litharge (PbO), Red lead (Pb_3O_4), lead acetate, cobalt, Manganese dioxide, zinc and lead chromate.

* It protect the paint film by reflecting the destructive ultra violet light.

pigment	colour
Indigo, prussian blue	Blue
Iron oxide	Red
Amber	Yellow
lamp Black, Ivory black	Black
Burnt Amber	Brown
chromium oxide, copper sulphate	Green
Zink oxide	white

6/8/2025

* Glass Composition

⇒ Silica sand ⟶ base of glass gives strength

⇒ lime ($CaCO_3$) ⟶ rolling, pressing malleable

⇒ Soda (Na_2CO_3) ⟶ lowers melting point & fusion of ingredients

⇒ potash ⟶ free resistavice

heating ⟶ Amorphous liquid

↓

Transparent.

Silicon dioxide (SiO_2):- commonly known as sand, it forms the basic frame work of glass.

Sodium carbonate (Na_2CO_3):- Also known as soda ash, it lowers the melting point of silica, making it easier to work with.

Calcium carbonate ($CaCO_3$):- Commonly known as limestone, it stabilizes glass structure and

improves its durability.

These three main ingredients are melted together at high temperatures, forming a molten liquid. When this liquid is cooled rapidly, it solidifies into a transparent, amorphous solid that we call glass.

Fly ash:- It is a fine powder generated by the burning of pulverised coal in electric power plants. It is a pozzolan, a substance combining aluminous & siliceous material that makes cement when mixed with water. When combined with water and lime, fly ash produces a chemical that is comparable to portland cement. Fly ash can be used as a primary component in mosaic tiles hollow blocks, and blended cement, among many other construction materials.

* Glass is an amorphous substance having homogeneous texture and mixture of metalli silicates.

Constituent of glass their function

Constituent	Function
Silica / Sand	It is the major constituent of glass
lime	It makes the glass fluid and suitable for blowing, drawing, rolling, pressing, or spinning.

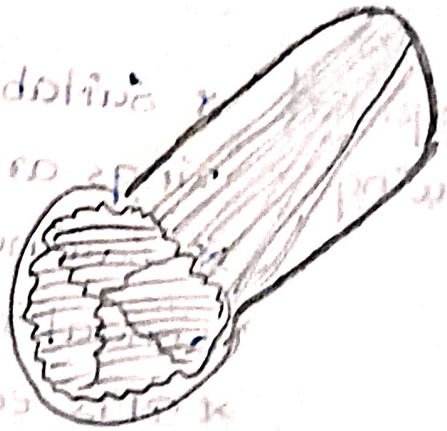
Soda	Impart durability and toughness. Acts as an accelerator for the fosion of glass.
potash	It renders glass infosible and makes fire resistance.

Method	property
Ordinary Sawing	Best method of sawing and most commonly used. * easiest and economical method * wastage of timber is very less Disadvantage. * strong possibility of twisting and warping.
Tangential Sawing	* Suitable for timber whose annual rings are clearly visible. * sawing is done tangentially to the annual rings. * It is economical due to very less wastage. Disadvantage * this timber has low strength due to less annual ring and medulary rays. * possibility of warping and twisting also occurs.

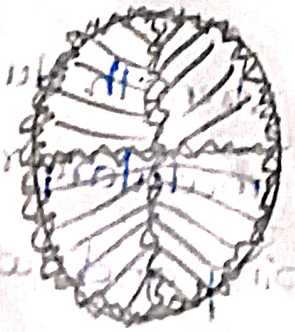
Quarter Sawing	* each log is into four quarters. * This method is popular for oak and maple. * It is defined as wood where the annular growth rings intersect the face of the board at 60° to 90° angle. *
Radial Sawing	* sawing of timber is done perpendicular to the annual ring and parallel to medullary rays. * Shrinkage and twisting are least * Time and labour is more * wastage of timber is more.



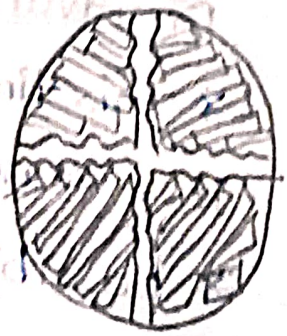
ordinary sawing



tangential sawing



quarter sawn



radial sawing

Decreasing order of strength of timber according to sawing -

radial > ordinary > quarter > Tangential

Unit-2

12/8/25

Cement & Admixtures

* adhesive and cohesive material

It is adhesive and cohesive material which are obtained by burning and grinding of calcareous and argillaceous material at very high temperature and grinding the clinder

* cement is commonly used as binding material
* Range of cement particle size 75-150μ
* General ingredients of cement

i) calcareous rocks - 65%.

ii) Argillaceous rocks - 35%.

Chemical composition of cement

oxide/composition/ Average composition	function
lime (CaO) 60-65%. ≈63%.	strength & soundness control, deficiency reduce strength
silica (SiO_2) 17-25%. ≈20%.	Due to excess reduces strength and slow setting
Alumina (Al_2O_3) 3-8%. ≈6%.	Responsible for quick setting if in Excess then lowers strength
Iron oxide (Fe_2O_3) 0.5-6%. ≈3%.	Used as flux
Magnesia (MgO) 0.5-4%. ≈1%.	Imparts colour & hardness

Unit-2 12/8/25

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Alumina (Al_2O_3) 3-8% ≈ 6%	Responsible for quick setting if in excess then lowers strength
Iron oxide (Fe_2O_3) 0.5-6% ≈ 3%	Used as flux
Magnesia (MgO) 0.5-4% ≈ 1%	Imparts colour & hardness

gypsum 2-5%. ≈ 4%.	Used as retarder
Sulphur(SO_3) 1-3%. ≈ 1%.	impart soundness
Alkalies 0.2-1%. ≈ <1%.	Used as flux & imparts efflorescene

High lime content generally increases the setting time and strength.

It react with other ingredient and participate the formation of Boque compounds.

The presence of excess un-burnt or free lime is harmful since it results in delayed hydration causing expansion (unsoundness) and deterioration of mortar and concrete.

Deficiency of lime in cement reduces it strength and causes it to set quickly.

Silica (SiO_2)

It is responsible for strength.

High silica content prolongs the setting time.

Responsible to make C_3S and C_2S compound

Alumina (Al_2O_3)

It is responsible for quick setting.

In excess quantity causes lower the strength.

Iron oxide (Fe_2O_3)

It is responsible for colour

It act as flux

Magnesia (MgO)

It is responsible for colour and hardness

If present in excess quantity it causes unsoundness

Sulphur Trioxide (SO_3)

If SO_3 is present in larger quantities it increases the setting time and causes of unsoundness.

Calcium sulphate ($CaSO_4 \cdot 2H_2O$)

It is added in the form of gypsum during grinding of clinker to increase the setting time of cement.

It acts as a retarder.

Alkalis

It causes efflorescence

Alkalis accelerate setting of cement paste

C_3S, C_2S } Responsible for strength (mainly C_3S)

Tri-calcium silicate ($3CaO \cdot SiO_2$)

It help (render) the clinker easier to grind.

increases resistance to freezing and thawing and develops an early hardness and strength.

If C_3S content raising to beyond the specified limit increase the heat of hydration.

Di-calcium silicate ($2CaO \cdot SiO_2$)

It hydrates and harden slowly and take long time to impart strength

It imparts resistance to chemical attack

It is responsible for ultimate strength

Order of rate of heat of hydration / hardening

$$C_3A > C_3S > C_4AF > C_2S$$

Order of strength

$$C_3S > C_2S > C_3A > C_4AF$$

Tricalcium aluminate (C_3A)

A major phase of OPC

* Hydrates and hardness the quickest
* It liberates a large amount of heat almost immediately and contributes somewhat to early strength.
* gypsum is added to ordinary portland cement to retard C_3A hydration.
* without gypsum, C_3A hydration could cause ordinary portland cement to set almost immediately after adding water.

Tetra-calcium alumina ferrite (C_4AF)

A major phase of OPC

* Hydrates rapidly but contributes very little to strength
* Most ordinary portland cement colour effects are due to C_4AF.

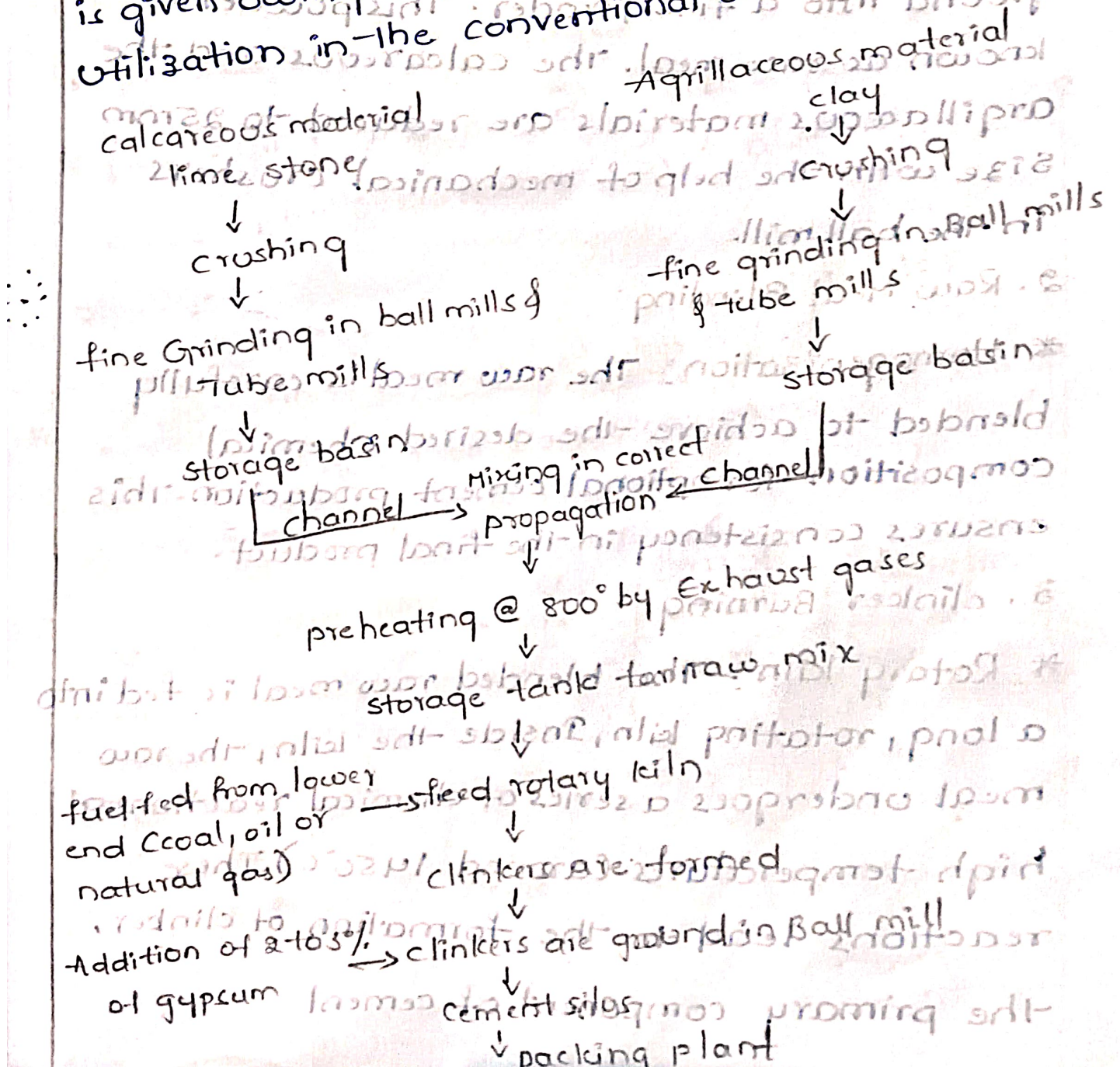
13/8/25

* Mid

Dry process of manufacture of cement

The Dry process of cement manufacture involves grinding and mixing raw materials limestone and clay, into a powder and then heating the mixture to a temperature that causes the raw materials to react and form a hard, clinker material.

It is a newly evolved process that is mostly adopted in modern days. precedence to this method is given owing to the excessive power and fuel utilization in the conventional wet process.



The dry process of cement manufacturing involves a series of steps to transform raw materials into the final cement product. Here's a breakdown of the key stages.

1. Raw material preparation

* Mining and quarrying :- limestone and clay, the primary raw materials, are extracted from the earth.
* Crushing and Grinding :- This raw materials are crushed into smaller pieces and then ground into a fine powder. This powder is known as raw meal. The calcareous and the argillaceous materials are reduced to 25mm size with the help of mechanical crushers in the ball mill.

2. Raw Meal Blending

* Homogenization :- The raw meal is carefully blended to achieve the desired chemical composition for optional cement production. This ensures consistency in the final product.

3. clinker Burning

* Rotary kiln :- The blended raw meal is fed into a long, rotating kiln, Inside the kiln, the raw meal undergoes a series of chemical reactions at high temperatures (around 1450°C). These reactions lead to the formation of clinker, the primary component of cement.

4. clinker cooling

* coolers :- The hot clinker from the kiln is cooled down to manageable temperatures. This is typically done using air or water-cooled coolers.

5. cement Grinding

* Grinding Mills :- The cooled clinker is ground into a very fine powder, often with the addition of small amounts of gypsum to regulate setting time. This fine powder is the final cement product.

6. packaging and storage

* packaging :- The finished cement is packaged in bags or bulk containers for transportation and storage.

14/8/25

* Composition of cement clinker

It is also known as Bogue compound and formed during clinkering process.

Name of compound	percentage	other Name	Heat of hydration	function
Tri-calcium, silicate (C_3S)	25-50% = 40%	Alite	500 J/g	7 days hardness and strength
Di-calcium silicate (C_2S)	25-40% = 32%	Belite	260 J/g	Ultimate strength
Tri-calcium Aluminate (C_3A)	5-11% = 10%	Celite	865 J/g	flash set
Tetra-calcium Aluminoferrite (C_4AF)	8-14% = 9%	felite	420 J/g	poorest cementing value.

* Wet process of manufacture of cement

The wet process is a method of manufacturing cement that involves mixing raw materials with water to form a slurry, which is then heated in kiln to produce clinker.

Calcareous material lime stone.
↓
Crusher
↓
Storage basins (silos)
↓ channel
Wet grinding mill (Ball mill) to make slurry

Argillaceous material clay
↓
Wash mill
↓
Storage basins (silos)
↓ channel

↓
Blending of slurry to correct composition
↓
Storage of corrected slurry
↓

Fuel fed from lower end (coal, oil or natural gas) → corrected slurry fed to rotary kiln (from upper end)
↓
Slurry converted into clinkers
↓
Addition of 2 to 3% of gypsum → clinkers are ground in Ball mill
↓
Cement silos
↓
packing plant.

* Flow diagram of wet process

The wet process of cement manufacturing involves a series of steps to transform raw materials into the final cement product.

* Raw material preparation

* Mining and Quarrying :- limestone and clay, the primary raw materials, are extracted from the earth.
* Crushing :- The raw materials are crushed into smaller pieces.

* Raw material Grinding

* Wet Grinding :- The crushed materials are ground into a fine slurry by adding water. This slurry typically contains 35-40% water.
* Slurry preparation and Homogenization
* Mixing :- The raw material slurry is thoroughly mixed to ensure a uniform composition. This is crucial for producing consistent cement quality.
* gypsum plays an important role in controlling the rate of hardening of the cement. A small amount of gypsum is added to the clinker upon its cooling during the final grinding process. It controls the setting of cement. If it is not added, the cement immediately sets postmixing water and there is no time left for concrete placing.

* Test of cement

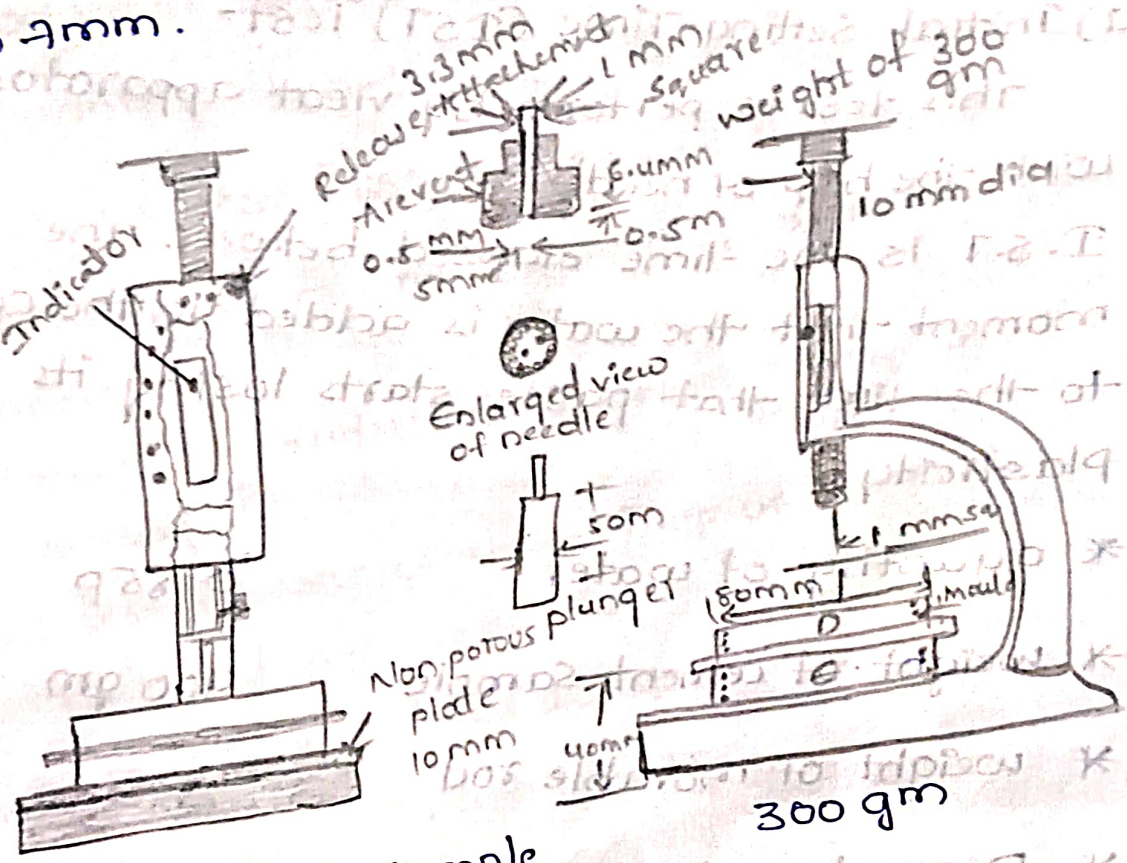
Field Test

Colour test	The colour of opc should be greenish grey.
lump test	The presence of lumps in cement indicates that it has absorbed moisture. Cement should be free from presence of any lumps.
Float test	Take a hand-ful of cement and throw it in a buclcet filled with water cement particle should sink in water it should not float over the water surface.
Temperature test	Thrust your hand into the cement bag. It most give you a cool feeling. If hydration reaction takes place inside the bag, it will become warm.
Rubbing test	When cement is rubbed between fingers, there should be smooth feeling.
Smell test	A thin paste of cement with water should feel sticky b/w the fingers.

* If the cement contains too much pounded clay and silt as an adulterant, the paste will give

* Normal / standard consistency Test [IS: 5513 - 1976, IS: 4031 (part-4 1988)]

The standard consistency of the cement paste is defined as percentage of water added in 300g weight of cement which will permit a vicat plunger to penetrate in cement paste to a depth of 33 to 35 mm from the top of the mould or test from buttom 5 to 7mm.



* weight of cement sample — 300 gm
* size of mould — Dia - 80mm, Height - 40mm
* size of plunger — Dia - 10 mm, Height - 50 mm
* Depth of penetration — 33 to 35 mm from the top, 5 to 7mm from the bottom

⇒ The value of normal consistency is depends upon the compound composition and fineness of cement.

=> The water requirement for various test of Cement depend on the normal consistency of the cement, so this test is perform before than other test of cement.

* Initial and final setting time [IS: 4031 (part-5), IS: 5513-1976)

This test is perform into two parts

a) Initial setting Time (IST) Test-

This test is perform by vicat apparatus with the help of needle.

I.S.T is the time elapsed between the moment that the water is added to the cement to the time that paste starts losing its plasticity.

* quantity of water	0.85P
* weight of cement sample	400 gm
* weight of movable rod	300gm
* Diameter of needle	1mm
* penetration of needle	33 to 35mm (from top of the mould)

b) final setting time (FST) Test

This test is done by vicat apparatus with the help of needle with collar.

F.S.T is the time elapsed b/w the moment that the water is added to the cement and the time when cement paste loses its plasticity completely and has attain sufficient firmness to resist certain defined pressure at this time the mark of needle is left on the surface of sample but the mark of the collar is not formed.

* weight of cement sample - 400 gm
* quantity of water - 0.85 p.

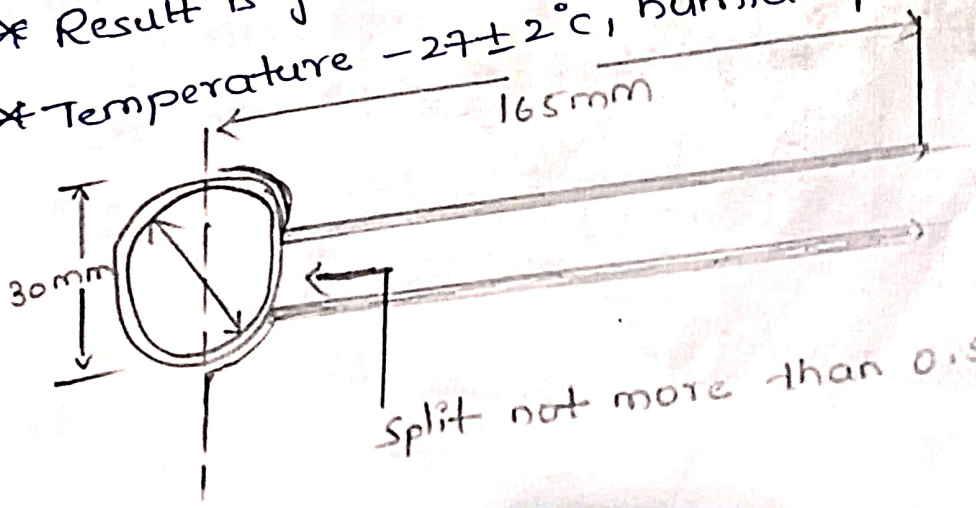
* Soundness Test [IS: 4031 (part-III)]

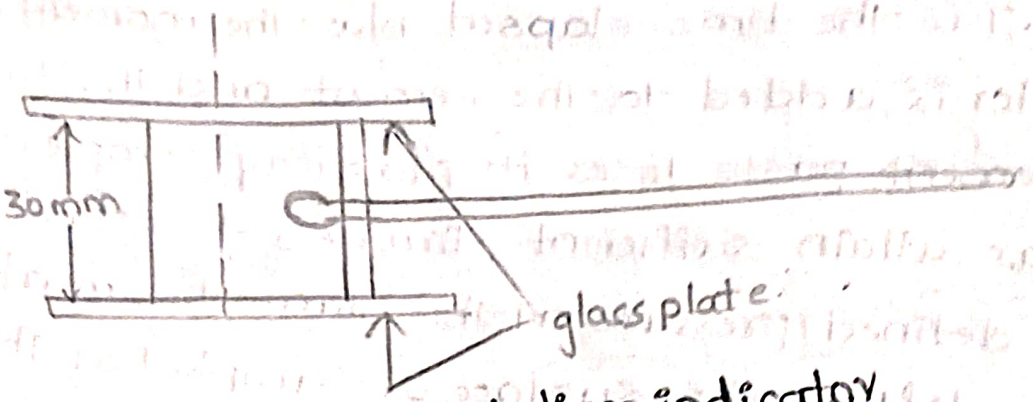
Soundness means the ability to resist volume Expansion.

* This test is conducted to detect change in volume after setting.
* This test is done with the help of Le-chatelier apparatus and Autoclave test.

i) Le-chatelier's Method (IS: 4031 part 3-1988)

* unsoundness of cement is due to free lime only
* weight of cement sample = 100 gm
* quantity of water = 0.78 p
* Result is given in 'mm'
* Temperature - 27 ± 2°C, humidity 65 ± 5%.





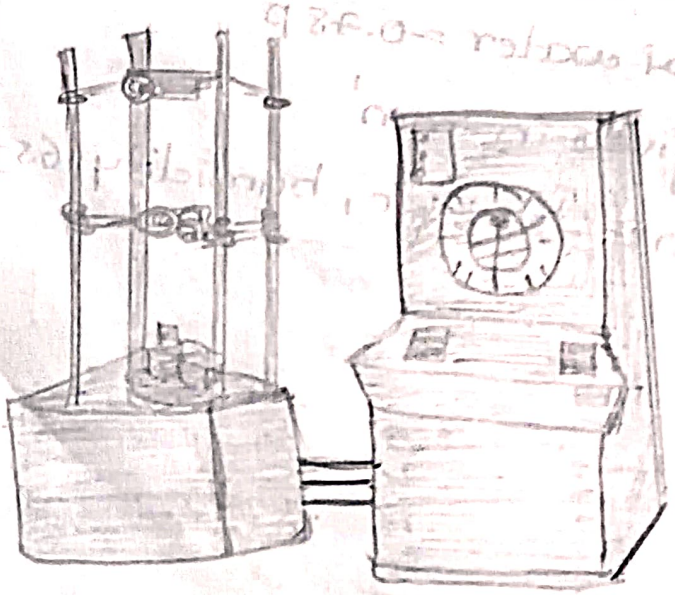
Expansion of Le-chatelier indicator

Max. expansion	Type of cement
10mm	OPC, PPC, RHC & LHC
5mm	Quick setting cement, High alumina cement and Super Sulphate cement.

Compressive Strength Test - [IS : 4031 (part-VII)]

Aim :- To determine the compressive strength of Cement.

Test apparatus :- compression test machine or Universal testing machine.



No. of cube sample - 6 with cement mortar 1:3 (cement: Ennore sand)

Size of cube $\pm 0.6mm \times \pm 0.6mm \times \pm 0.6mm$

Surface area $5000\ mm^2$

water required $\left[\frac{P}{4} + 3.5\right]$ % weight of cement and sand

Rate of loading 35 $N/mm^2/min$ or 350 $kg/cm^2/min$

Strengths

At 3 days - 50% (strength of 28 days)

At 7 days - 2/3 (strength of 28 days)

At 28 days - 33 N/mm^2

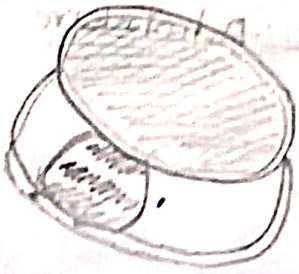
Lab test/ physical test

1. Fineness Test [IS: 4031 (part-I)]

This is used to check proper grinding which has direct impact on rate of hydration, rate of gain of strength and evolution of heat.

* there are three methods for testing - fineness

a) Sieve Method



* In this method particle size of cement is measured.
* Size of sieve - 90 micron (sieve No.9)
* Sieving time - 15 minutes
* weight of cement sample - 100 gm

Result -

The residue should not exceed the limits specified below (after sieving)

Types of cement.	percentage of Residue by weight.
ordinary portland Cement (opc)	10
Rapid Hardening Cement (RHC)	5

18/8/25

* Admixtures

Admixtures are the additional ingredients added to cement/ concrete mix to modify the characteristics of fresh / hardened concrete. like setting time, strength gain, permeability, durability workability.

Admixtures are two types

i) chemical manufacture Admixture

ii) mineral Admixture.

✓ chemical manufactured for this purpose

i) Plasticizers

They help in reduction of water content (for same amount of workability) without composing workability (or) they provide improvement in workability for same amount of watercontent

Ex:- polyglycolesters, lignosulphonic acid

upto 15% water is reduced

ii) superplasticizers

Same as plasticizers but allows for much higher reduction in the water content upto 30%. preferred in making high strength Concrete

Ex:- modified lignosulphonic acid like melhamine & formaldehyde based sulphonates

iii) Accelators

They accelerate/speed up the setting process of Concrete & helps in the strength development Commonly used in cold weather conditions (or) work is needed to be done quickly

Ex:- Sodium chloride (NaCl)

calcium chloride ($CaCl_2$)

iv) Retarders

Slow down is the setting process hence used in hot weather conditions where there is long distance transport from concrete mix to concrete site

Eg:- gypsum, starch, cellulose

v) Air entraining admixtures.

These introduce microscopic bubbles into Concrete mix there by providing resistion to freezing & thawing reactions & improving overall workability.

Eg:- sulphonated hydrocarbons, vinsolresins

19/8/25

* mineral Admixtures

These comprise of finely ground materials that enhancing some properties of cement. These are by products of industry (or) naturally available materials. They ponterntially replace cement.

flyash

By product of coal combustion in thermal power plants. Improves workability & reduces heat generation & provides longterm strength.

Silica fume

By product of silica & ferrosilicon alloy production. helps in improvement of strength & makes concrete impermeable.

GGBS

By product of iron production in blast furna partially replace the cement ↑ used. resistance to sulphate attack there by providing longterm strength.

Types of cement

Rapid hardening cement:- Obtained by increasing C_3S content and decreasing C_2S content as C_3S helps in attaining early strength and C_2S imparts ultimate strength. Accelerators such as $CaCl_2$ is added to speedup the hardening process it is suitable for road maintenance work. It requires more curing compared to normal cement.

Quick setting cement

C_3A is increased gypsum ↓ inorder to decrease the setting time ↓ of the cement i.e., fast setting in underwater structure to prevent washing out of structure from heavy water current cement needs

IST = 5 min to set quickly

FST = 30 min

Uses:- underwater structures, Basement

low heat cement

C_3A ↓ C_2S & C_4AF ↑ inorder to prolong setting process (increase setting time) because if there is mass (heavy) concretting works there the heat of hydration will be more & it leads to high amount of shrinkage & water loss from structure. To reduce it lower the alumina content.

IST = 60 min

FST = 10 hrs

Uses:- Mass concreting like dams, Raft foundation

Hydrophobic cement

OPC + Boric acid, oleic acid, steric acid

These is a water repellant cement. Used for Construction of water tanks (or) structures where there is more dampness (or) wetness.

Blast-furnace slag cement

OPC clinkers (30%)

slag (70%)

Uses:- Mass concreting (or) sulphate attack possibility areas.

portland pozzoland cement

OPC + 10-25%. (pozzolanic materials)

A load of cement is replaced by pozzolanic materials there by the cement available for hydration is also decreased. More over this type of cement have less permeability compared to other cement

Uses:- Runing water structures, sewerpipes

supersulphate cement

Aluminates are prone to sulphate attack ie, alumina reacts with sulphate in an aggressive manner creating toxic precipitates. In order to reduce this we decrease the alumina content

$C_3A, C_4AF \downarrow$ addition of slag (reduce from manufacturing industries)

$C_3S, C_2S \uparrow$

Uses:- Marine Works, lining of canals.

20/8/25

* Steel

Most widely used construction material known for its properties like ductility, Malleability & high tensile properties.

Uses :- Reinforcement material in slabs, beams, columns & trusses, railings

properties :- density = 7850 kg/m^3

Young's modulus = 2×10^5 N/mm^2

poisson's ration = 0.25 - 0.3

Mild steel

* Iron + 0.1 - 0.26% carbon + silicon + ph
* high ductility
* less yield strength
* less brittle

High yield strength steel

* Iron + 0.3 - 0.5 % carbon + chromium + silicon + ph
* less ductility
* More yield strength
* More brittle

25/8/25

Unit-3

Building Components

* lintels

lintel is a horizontal structure element placed across the opening blw the top of window frame and the wall come over it.

width of the lintel = width of the wall and ends are build's into the wall

* It will support the structure over the opening by transpering the loads to the adjacent members They do not require strong Abartments when Compare to arches they are stable as they acta beams. They are simple & easy in construction.

Galvanisation

The process of zincoating into the steel/iron is called. Galvanisation.

Types of materials (lintels) based on the material used for construction

Stone lintel:- Stone lintels are used where there is abundent availability of stone near the site. These lintels provide good architecture comparens quarrying
* They not economically as there require transpo -tation. and dressing.

* These lintels ... as stones
poor in resisting tensile loads.

* timber / wood lintels :- These types of lintels are commonly used in hilly areas as there is good availability of timber. They are comparatively weak and vulnarable to fire and decay.

* Brick lintels :- These are mostly used for small openings and light loading. Bricks which are used in these lintels should be hard well burn & first class bricks. (comp 10.5 N/mm²)
water absorption 20%.

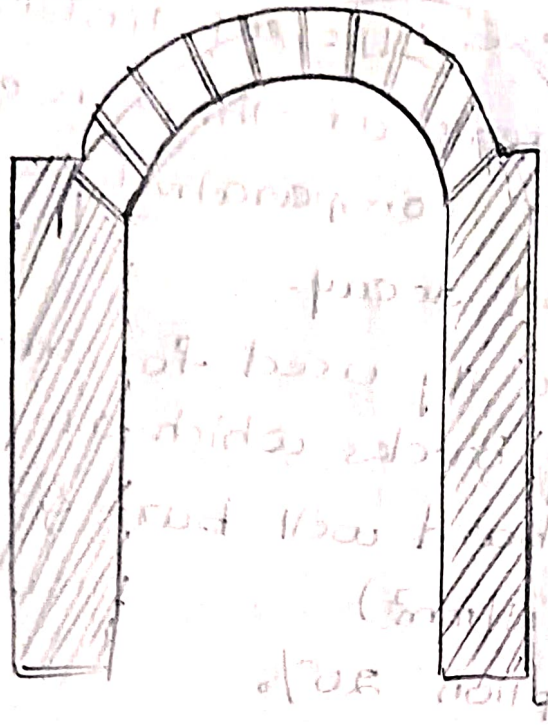
* steel lintels :- They consist as rold steel section and are used for large openings. They can support heavy loads

* Reinforced brick lintels :- These lintels are used along with steel reinforcement as bricks can't take heavy loads.

* Reinforced concrete cement lintels :- These are widely used in as they are strong durable & fire proof
* easy in construction
* These can be used for variable span & loading conditions.

Arches

plain bricks



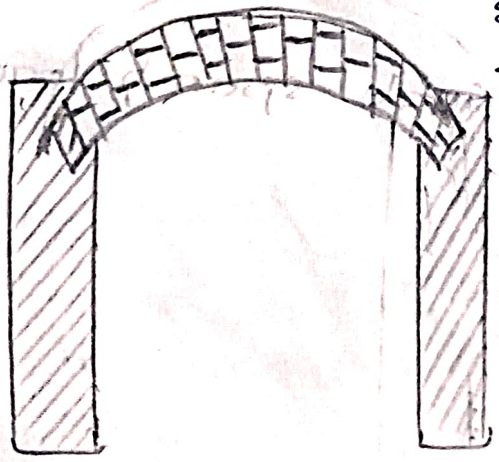
These are constructed with ordinary bricks without any cutting & wedging. This is seen where appearance is not prove importance curve shape is obtained by filling with mortar.

Axed brick



used for fancing work where appearance is not key not wedges are precify cut along the surface with brick axes. uniform thickness of mortar is applied in blw the bricks to gived aesthetic view unlike ordinary brick arch.

Gauge brick

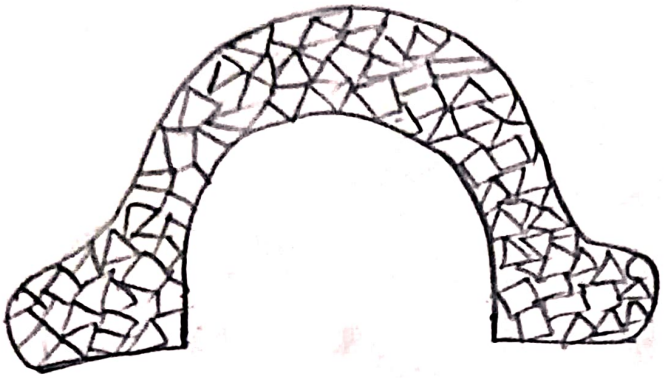


Bricks are rubbed against a stone float to let it fix into the required position. Generally that type of arch is built to one & half end 2- brick thickn walls. lime putty is used to join the brick work.

* Stone Arches

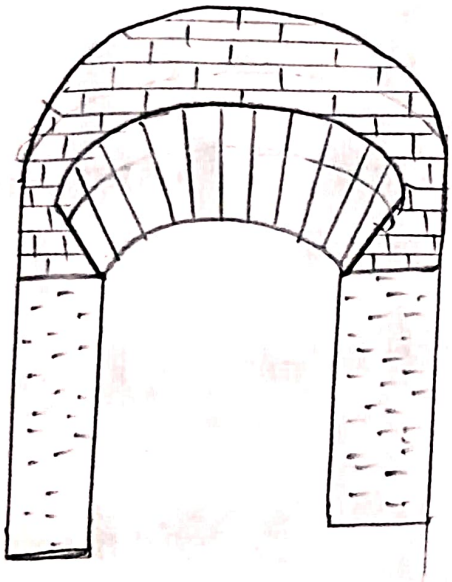
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i) Rubber stone Arch



eg:- Entrance parks

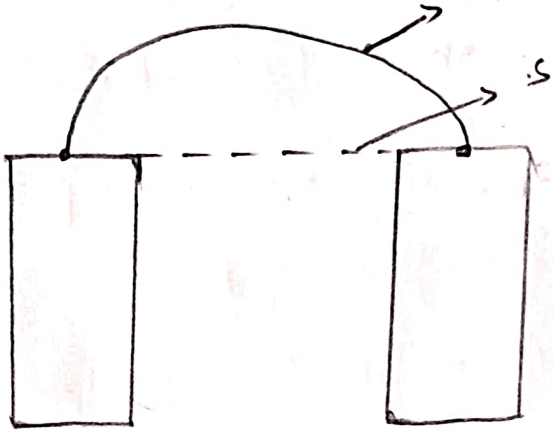
ii) Ashlar Arch

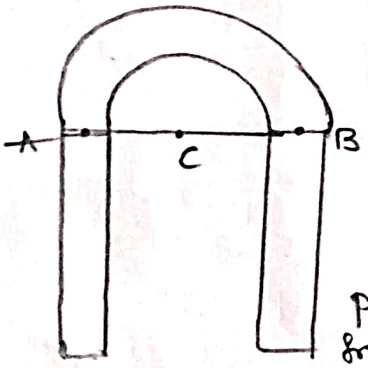


* Classification of arches based on geometry

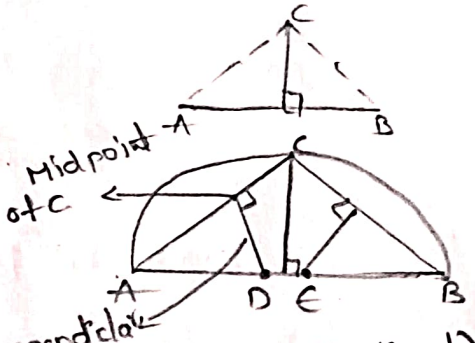
-There are five types of geometry points

i) one centered arches
ii) two centered arches
iii) Three centered arches
iv) four centered arches
v) five centered arches

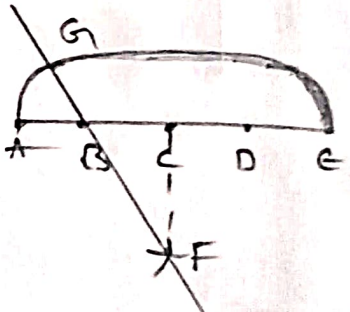




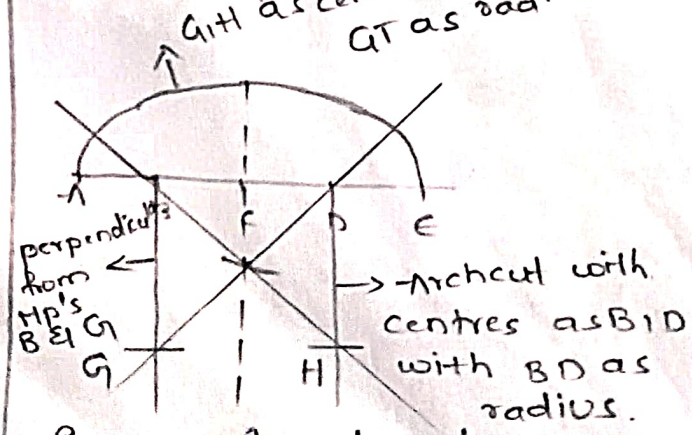
one centered arch



(Semi elliptical) two centered arch



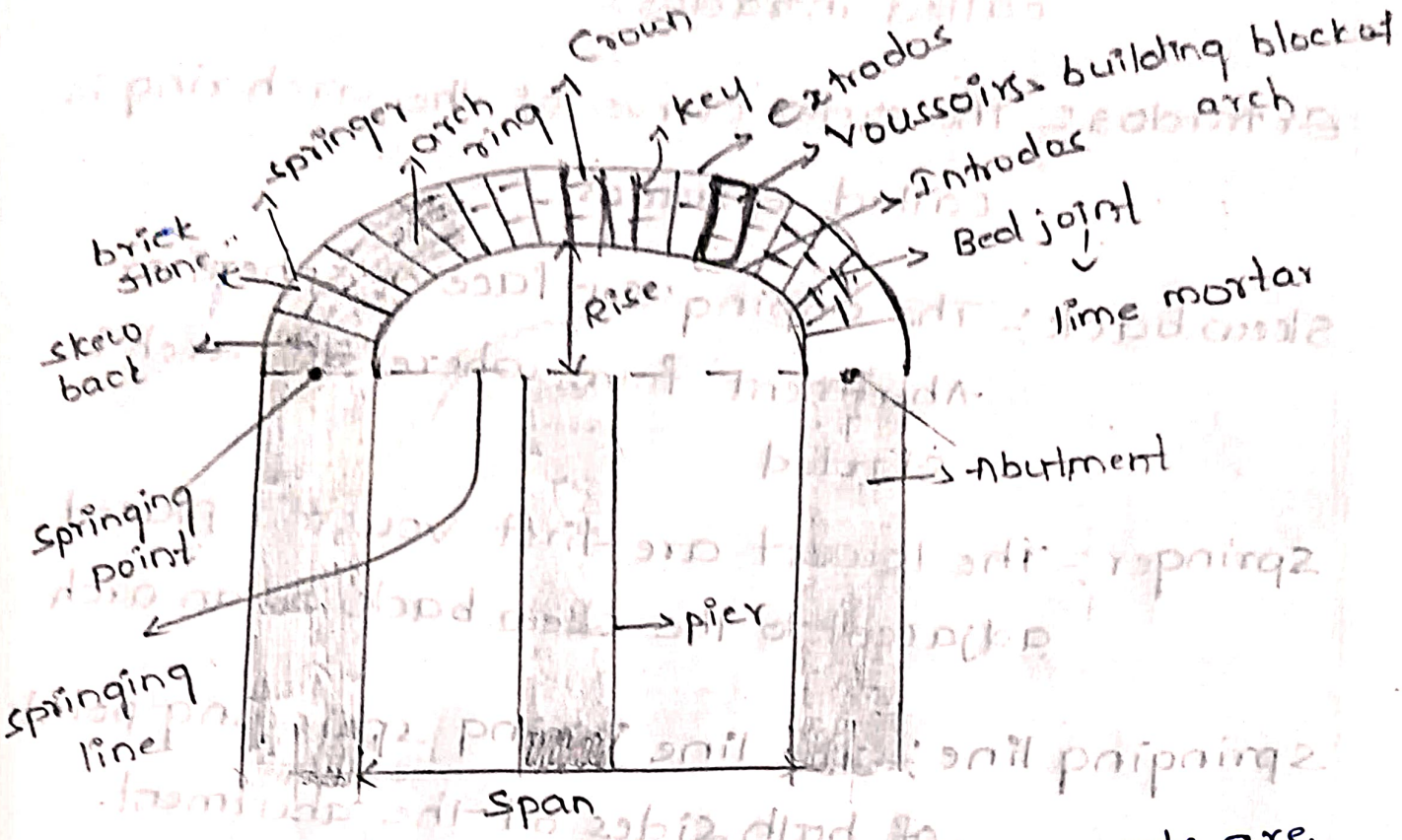
three centered arch
(elliptical)



four centered arch

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* Components of arches



Abutments :- Abutments are the end supports are of an arch

pier :- Any intermediate supports in series of arches

Arch ring :- A curved ring of masocentry forming the arch is called arch ring

Bedjoint

voussoirs :- The wedge shape of bricks or blocks forming an arch

key :- The central voussoir of an arch ring is called as key.

Bedjoint :- The radial joints of motor made of lime or cement which hold togethe voussoirs of arch

Intrados :- The inner curve of the arch ring is called intrados.

Extrados :- The outer curve of the arch ring is called extrados.

Skew back :- The sloping surface of sphere or Abutment from where the arch is started

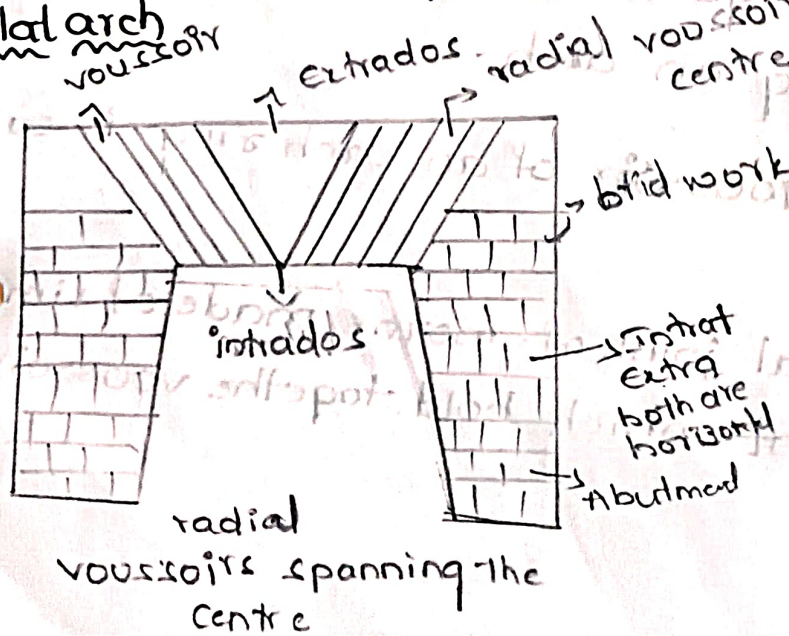
Springer :- The lowest are first voussoir placed adjacent to the skew back of an arch

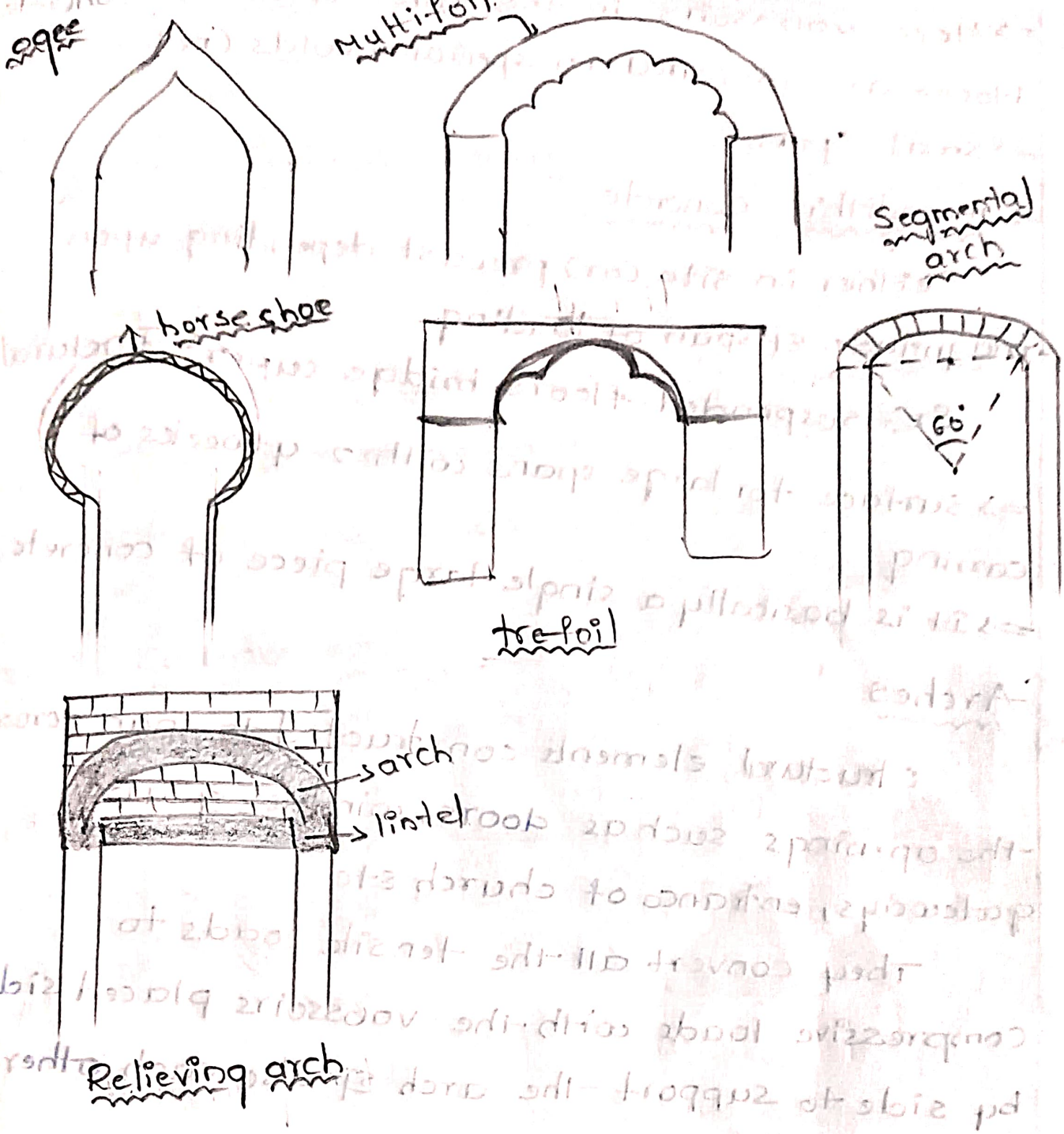
Springing line :- The line joining springing points of both sides of the abutment.

Crown :- The highest point on the Extrados on the arch.

Span :- The clear horizontal distance blw the support of the arch.

Rise :- The clear vertical distance blw the springing line, intrados.





* Concrete arches

3rd type based on material used for construction

(1st brick, 2nd stone < Rubble arch, Ash arch

* precast concrete * Monolithic concrete.

=> precast are durable for high class buildings work, where good quality of bricks aren't cheaply available & also in large quantity

=> Here voussoirs
blocks are prepared in special moulds (not in site)
=> small spans

* monolithic concrete
either in site (or) precast depending upon magnitude & span of loading
Ex:- suspended floors, bridge super structural
=> surface for large spans with 2-4 weeks of curing
=> It is basically a single large piece of concrete

Arches
structural elements constructed to span across the openings such as doors, windows & also gateways, entrance of church etc.
They convert all the tensile loads to compressive loads with the voussoirs placed side by side to support the arch & also each other.

purpose
=> supports load over the wall above openings just like lintels.
=> As they are made of wedges can transmits the load accurately.
=> provide appearance if curved precisely
=> suitable for large spans & heavy loads unlike lintels
=> Eliminates tensile stresses by resolving them

into compression stresses.

Timber arches

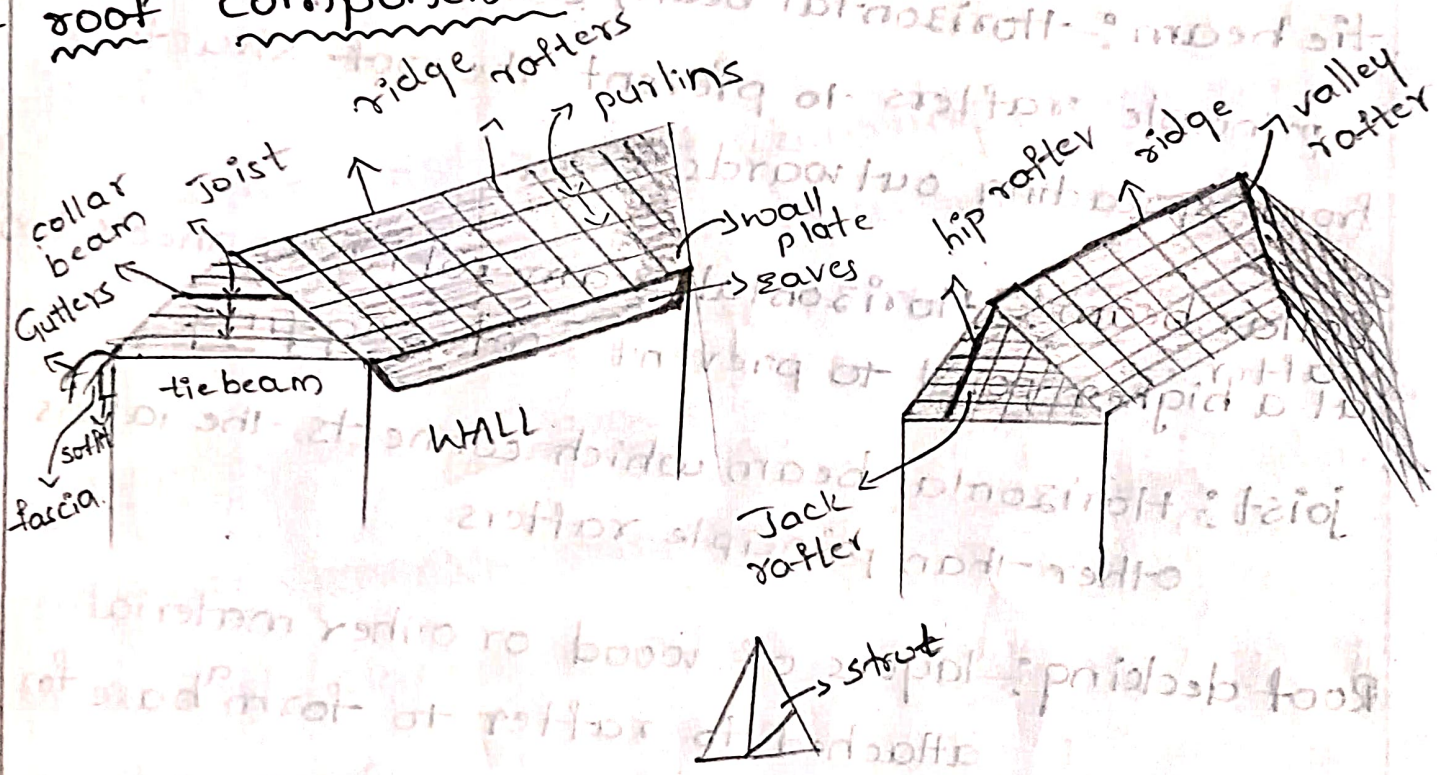
cladding purpose mostly used rather then for load bearing.

Steel arches

for bridges & high load bearing structures rolled steel sections are used. They differ high resistance to Ex:- loads unlike other arches.

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* roof components



ridge:- Horizontal intersection of two sloping surfaces inclining opposite direction metting at the apex.

wall plate:- Horizontal wooden or metal beam placed on the top of the wall providing a base to attach the roof components.

rafter :- Inclined beams which supports the roof and running from ridge-to Eaves.

Eaves :- lower edge of the roof that overhang over the wall is called "Eaves".

purlin :- Horizontal support running parallel to the ridge helping rafter for large roofs.

Gutter :- curved surface or trough like structure provided at the ends of eaves, for draining rain water.

tie beam :- Horizontal beam connecting two opposite principle rafters to prevent the roof structure from spreading outwards.

Collar beam :- Horizontal beam which connects two rafter at a higher point to prevent roof sagging.

joist :- Horizontal beam which connects the rafters other than principle rafters.

Root decking :- layers of wood or other material attached to rafter to form a base for roof covering.

underlaying :- water resistance layer provided over the deck to prevent the moisture Entry.

Batterns :- Strips of wood or metal placed over the underlayment for attaching roof tyles.

shingles cor) Roof coverings :- over laping pieces of tyles forming the ottermost roof (levelling) layer.

soffit :- these are provided under side of the roof Eaves covering the space blw eaves & wall.

fascia :- vertical edge board along side of the rafter it supports the Gutters.

strut :- sloping support beam which reinforces, rafters. By transforing the weight to beams and walls.

1/9/25

Mid-II

* Roof

Uppermost part of a building which encloses the space & protects from weathering agences like - rain, sun, wind etc.

Classification of roofs

roofs are generally classified into following types

1) pitched / sloped root

2) flat roof

3) curved roof.

pitched / sloped roofs :- These are known as sloping roof it is a basic and cheapest method for covering a structure. These are made up of materials like tiles, asbestos cement. These are further classified as 3 types of roofs

i) single roof

ii) Double / purlin roof

iii) triple / trussed roof

* Single roof :- In this types of roofs a common rafter is provided to each slope without any intermediate support

i) lean to roof

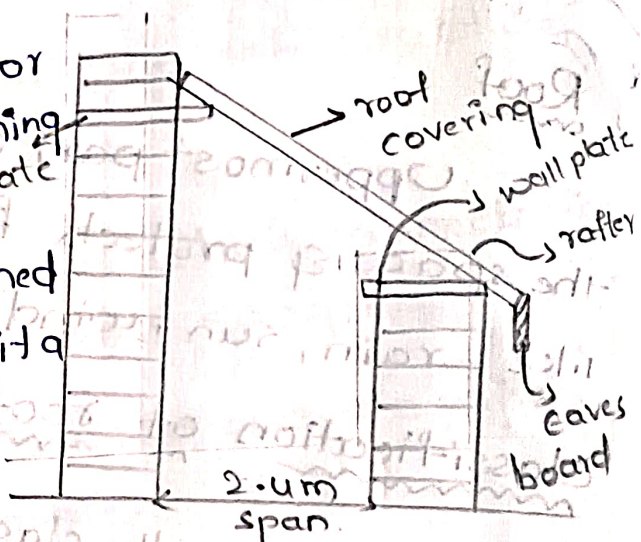
ii) couple roof

iii) couple closed roof

iv) collar roof

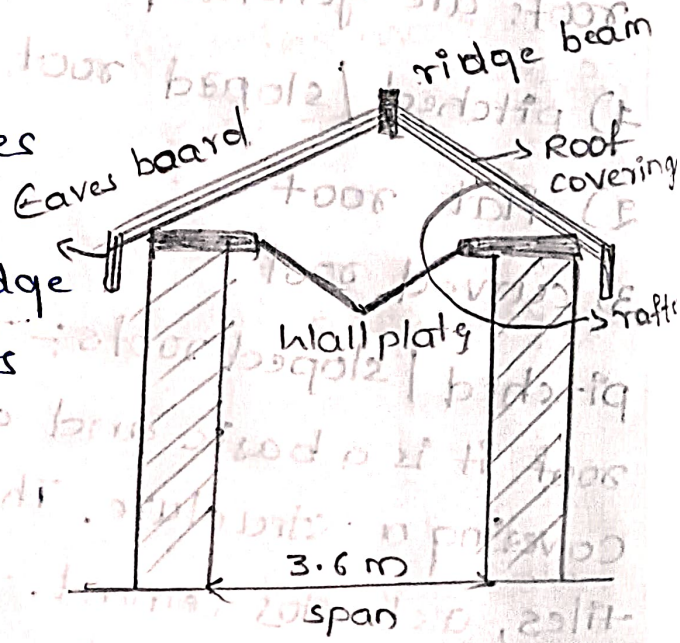
i) lean to roof

This type of roof is used for small shed or varanda opening. It has a single sloping surface with rafters inclined at angle of 30°c. It is suitable for span up to 2.4m.



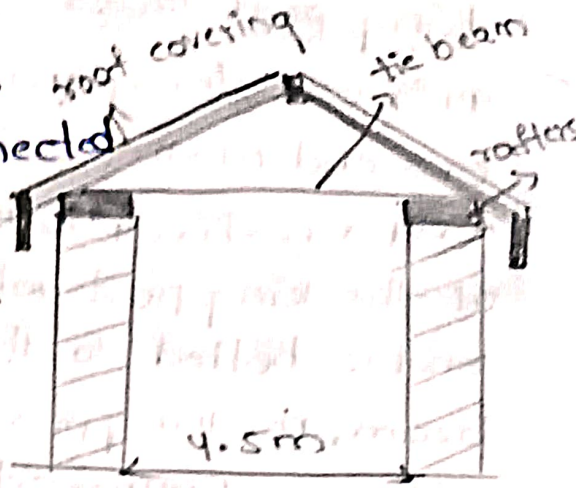
ii) couple roof

In this type of roof slopes are in two directions meeting at a common ridge beam. This types of roofs suitable for span up to 3.6m.



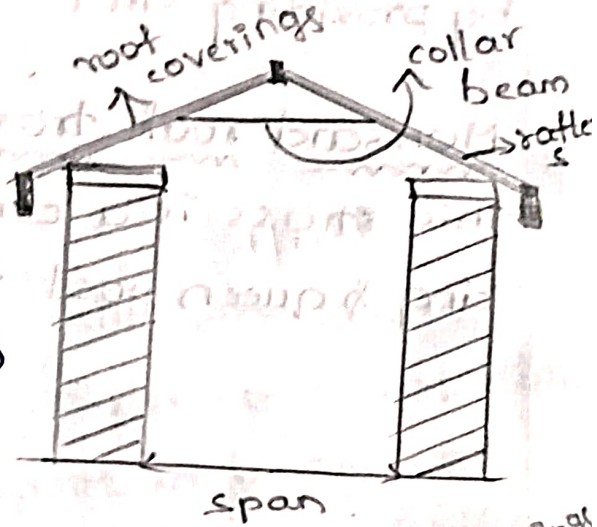
iii) couple close roof

In this type of roof the rafters of two sloping roofs are connected by horizontal beam (tie beam) suitable for span upto 4.5m.



iv) collar beam roof

This type of roof is similar to couple closed roof Expept that the horizontal beam fixed at $\frac{1}{2}$ or $\frac{2}{3}$ distance from the wall plate. This is suitable for span upto 4.8 m.

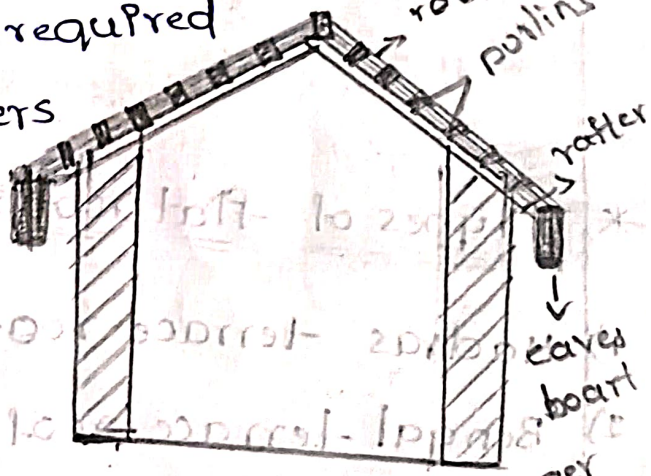


3/9/25

* Double / purlin roof

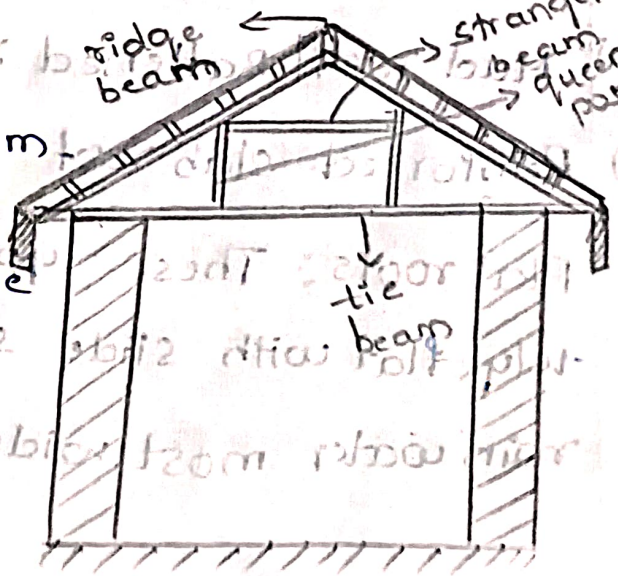
let us span Exceeds 2.4m the required The necessary size for the rafters become uneconomical.

Hence in order to reduce the size of rafters so that the provide intermediate supports called purlin's are provided.



* triple roofs (queen post).

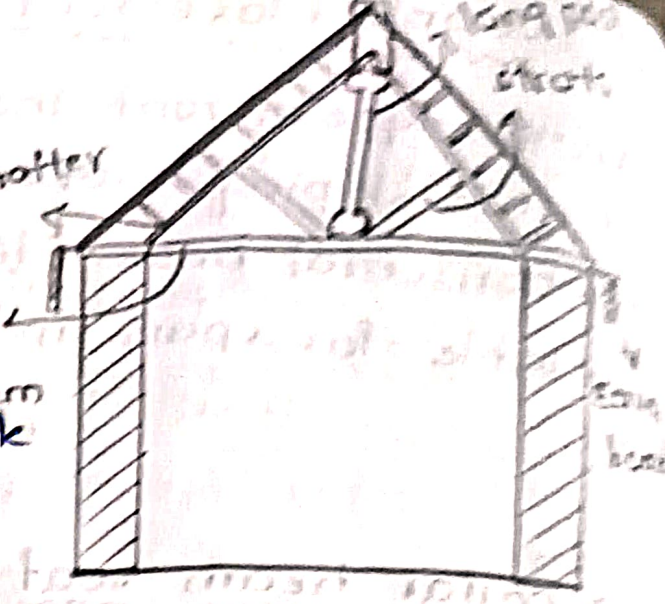
It can be used for span upto 13 m. 2 queen post are connected with the help of straining beam at the upper ends.



King post truss

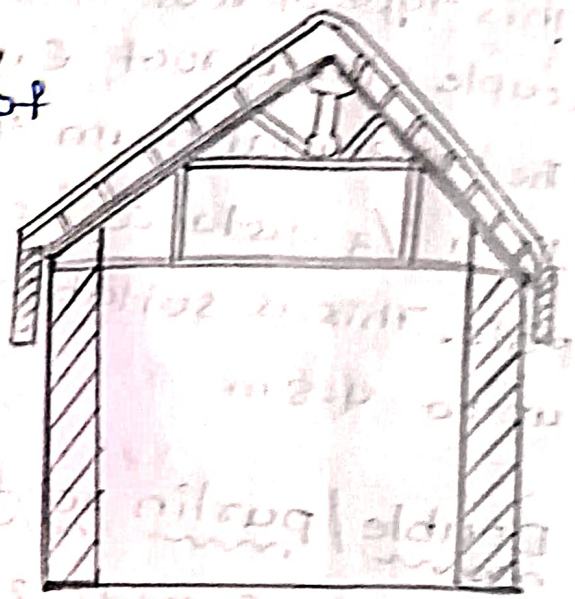
It is used for span up to 9.m

One end of the principle rafter is fixed to the head of the king post while other end is bolted to the tie beam. The king post & principle rafter are further strengthend by providing strut



Munsard roof truss

This truss is a combination of king & queen post truss.



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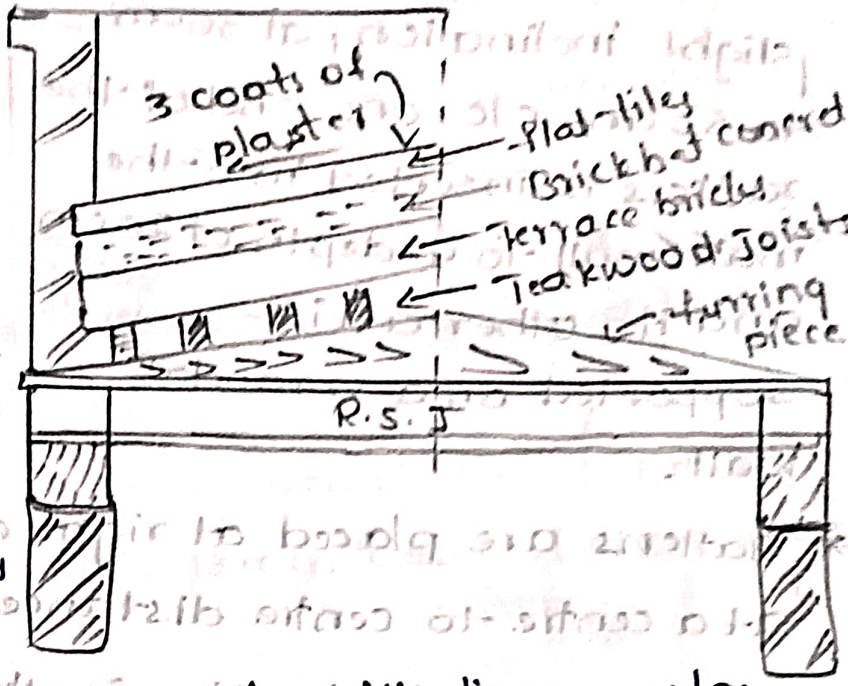
* Types of flat roofs

1) Madras terrace roof
2) Bengal terrace roof
3) Mud roof/ Battened roof
4) Reinforced slab roof

Flat roofs :- These types of roofs are laid approximately flat with slide sloping surface to drain of rain water most widely used flat roofs are

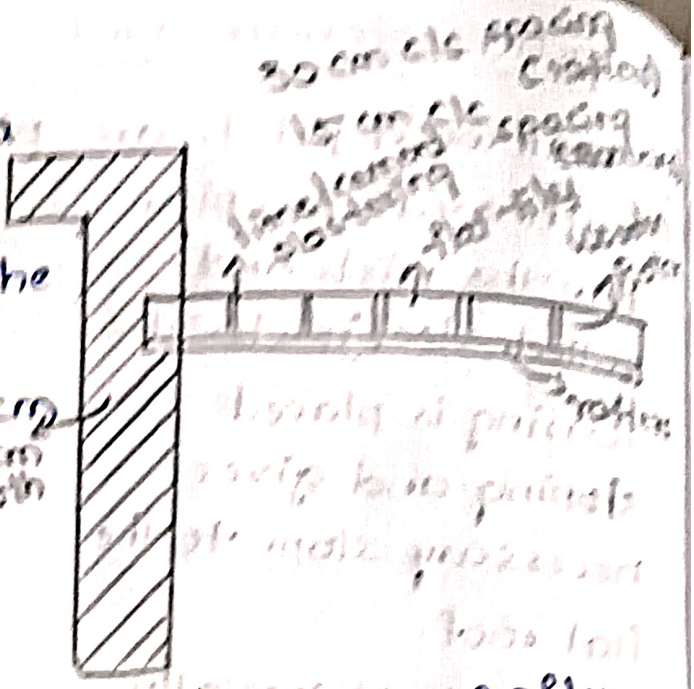
i) Madras terrace roof

* Teak wood joists are placed on rolled steel joists with a furring piece blw the joists and rolled steel joists. The furring is placed sloping and gives necessary slope to the flat roof.



* A course of specially prepared terrace bricks of 150 x 75 x 25 mm is laid diagonally across the joists with lime mortar.
* After the brick course, has set, a course of brick bat concrete of 75mm thick with 3 parts of brick bats, one part of gravel and sand and 50 percent of lime mortar by volume is laid.
* The concrete is well rammed for three days and allowed to set
* Flat tiles are laid over the layer of concrete of thickness 50 mm
* finally, the surface of roof is finished with three coats of plaster given a slope of 1 in 30
* As this type of flat roof is widely used in madras State, it is known as madras terrace roof as shown in fig.

iii) Bengal terrace roof



* Rafters are placed, with a slight inclination, at 30cm to 60cm c/c. one end of the rafters is inserted into the main wall to a depth of 20cm and its other end is supported on a verandah wall.
* Battens are placed at right angles to the rafters at a centre to centre distance of about 15cm.
* A course of flat tiles is then laid in mortar over the battens.
* Finally, the surface of the roof is finished in any one of the following methods
i) Two or more courses of flat tiles may be laid and the surface of roof is rubbed and polished with two or three coats of plaster.
ii) A layer of jelly concrete of 40mm thick may be laid over the first course of tiles. on this layer of concrete, another course of flat tiles is laid and the surface of roof is rubbed and polished with two or three coats of plaster.
* As this type of roof is mainly used in bengali state to cover verandahs, it is known as bengali Terrace roof as shown in fig.

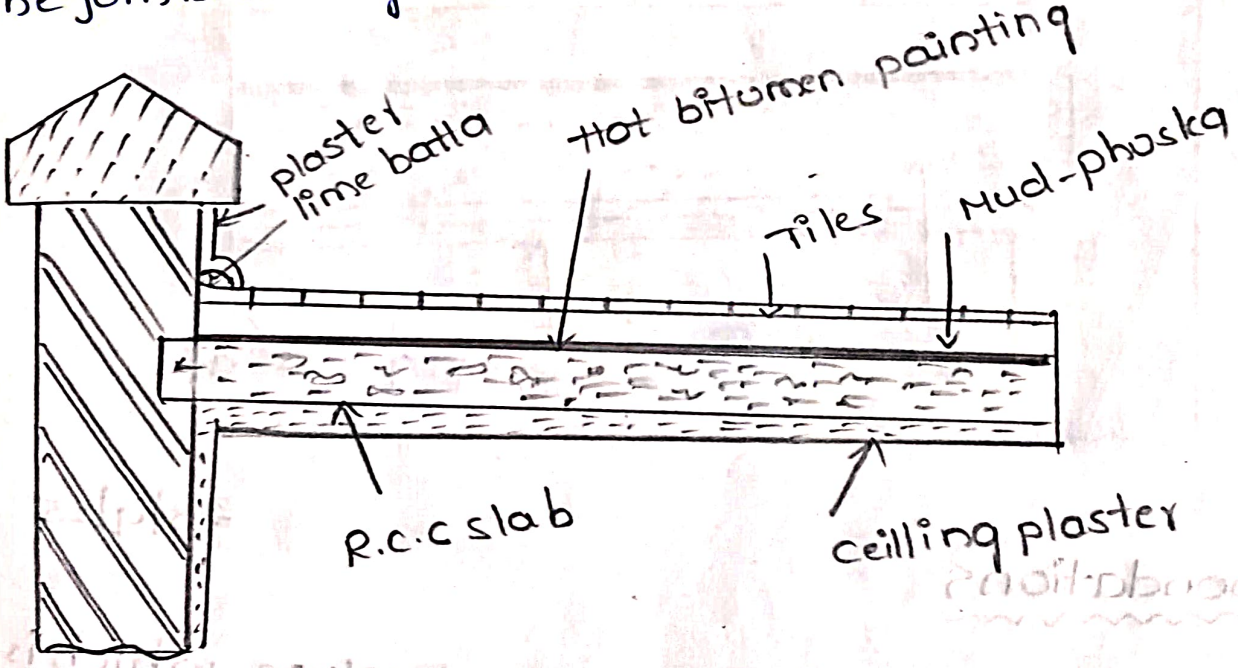
iii] MUD PHUSKA TERRACING (Mud roof/Battened roof)

This method is commonly used over R.C.C. roofing. A layer of hot bitumen is laid over Rcc roofing at the rate of 1·76 kg of bitumen per square metre of roofs.

A layer of coarse sand is immediately spread over it. Mud-phuska is prepared from puddled clay mixed with bhusa.

The mud-phuska layer is consolidated properly It is then plastered with 13mm coat of mud-cow-dung mortor (3:1).

Tile bricks are laid flat on plastered surface. The joints are grouted in 1:3 cement mortar.



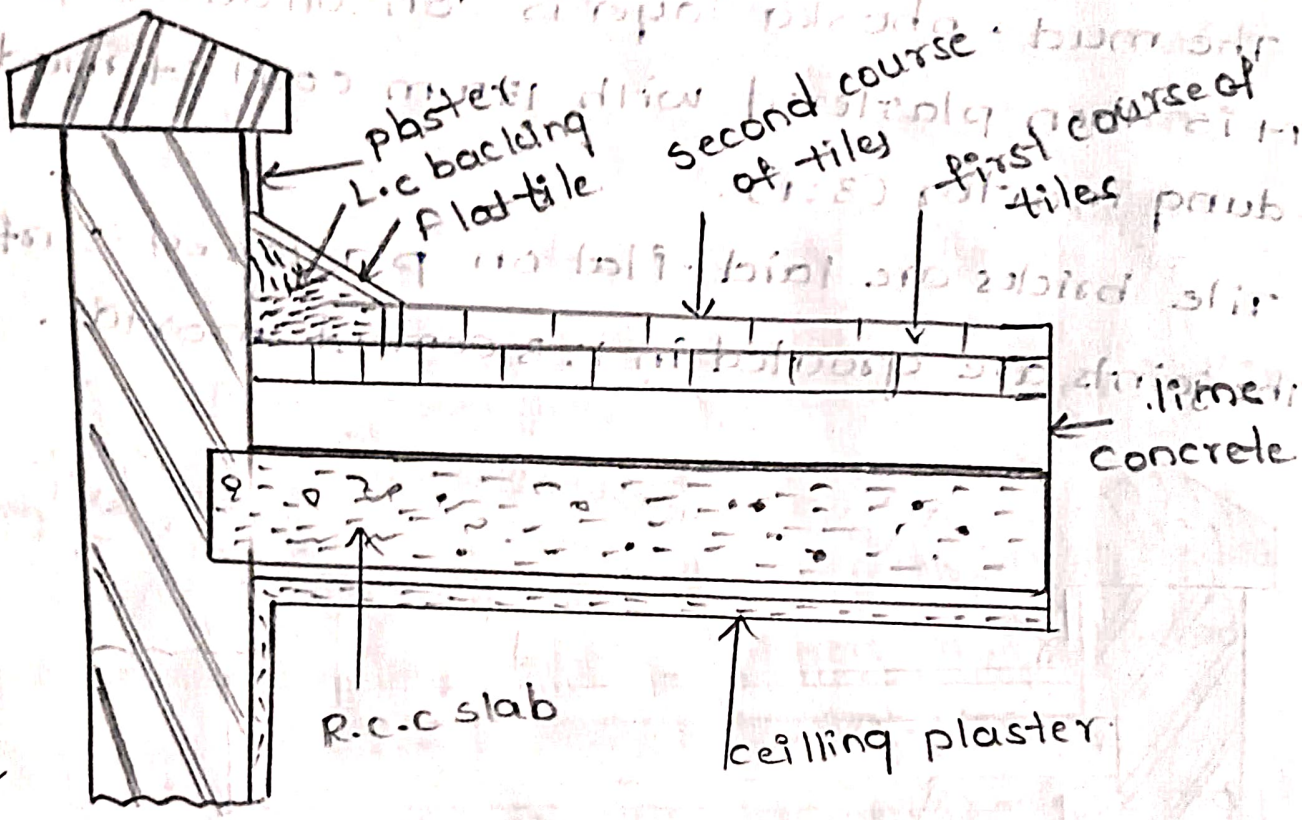
iv] lime concreting over Rc slab (Reinforced slab roof)

The R·C slab is cleaned off dust etc..., and layer of hot bitumen is applied roof surface. A layer of coarse sand is immediately spread over the hot layer of bitumen.

* A 10 cm thick layer of lime concrete is laid in proper slope. The entire slope is given in lime concrete itself.

The lime concrete may consist of 2 parts of lime, 2 parts of surkhi and 4 parts of brick ballast of 25mm.

Two courses of flat brick tiles are laid in 1:3 cement mortar.



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* Foondations

The lowest part of any structure which is Constructed to transfer all the dead/live loads to the subsoil without causing differencial settlements. Foondations are constructed sufficiently deep to safe guard the structure from swelling and shrinking of subsoil.

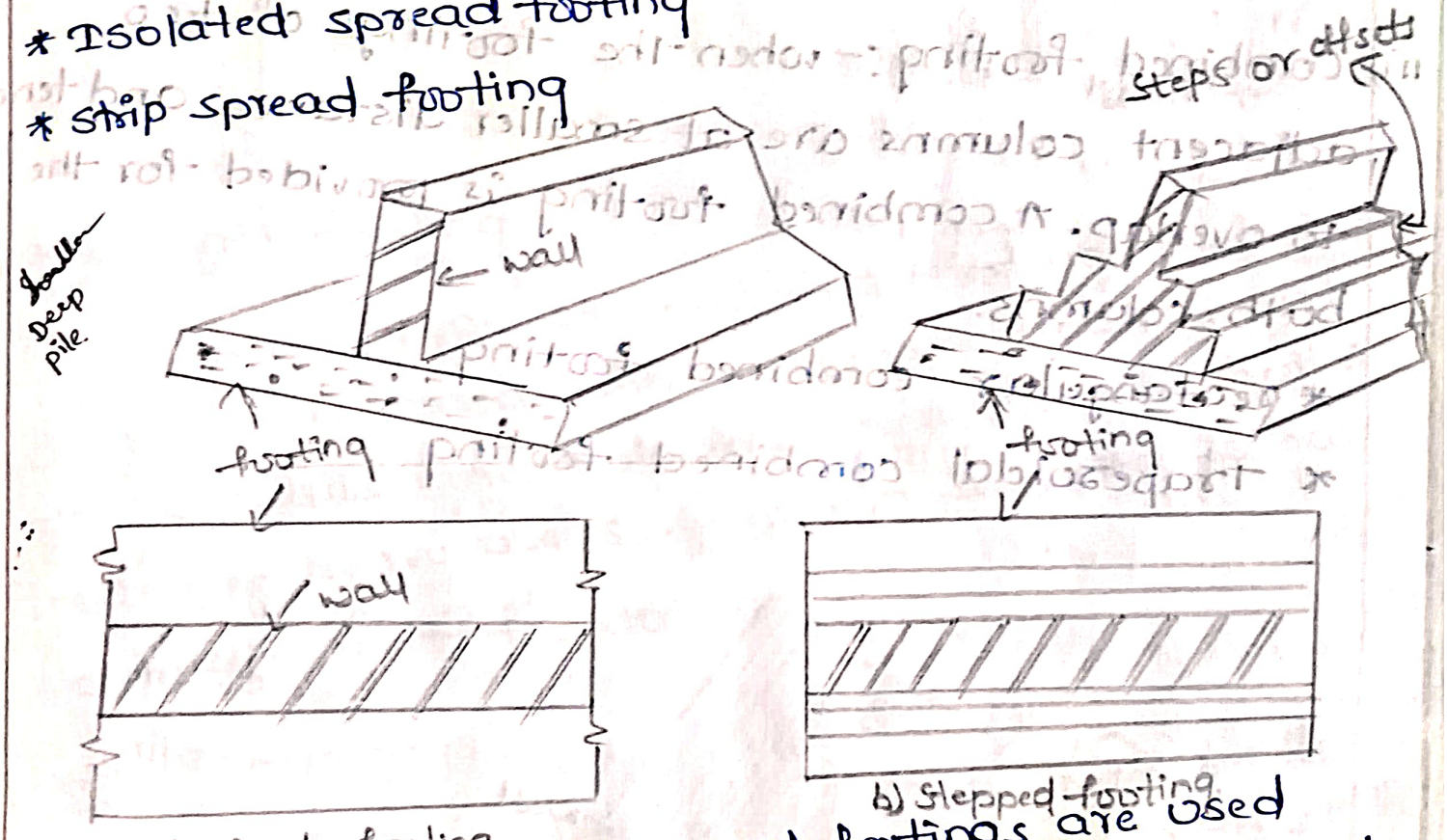
* According to the Terzaghi, A foundation is said to be shallow if the depth is ($D_f \leq B^{foot}$)

Types of shallow foundations

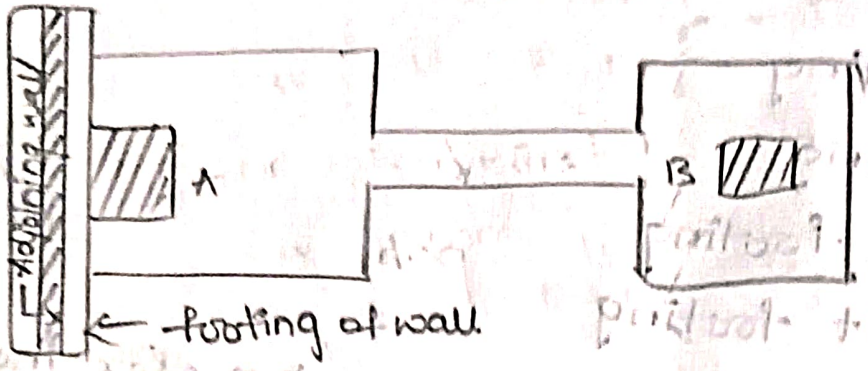
i. spread footing
ii. strap footing
iii. combined footing
iv. Matt / Raft footing

i. Spread footing :- Spread footing transfer the super imposed load of a wall or column over a larger area of the soil

* Isolated spread footing
* strip spread footing

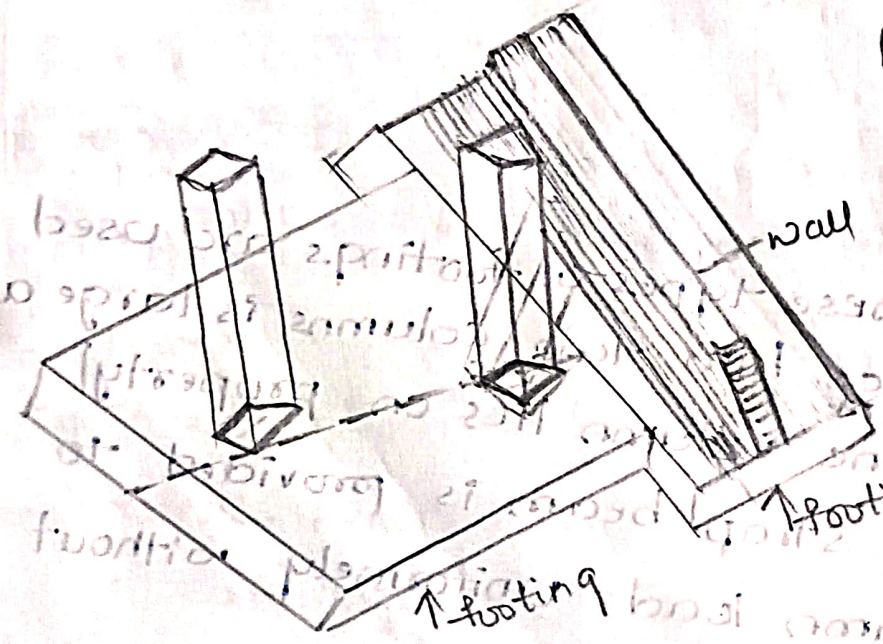


ii. Strap footing :- These types of footings are used when the distance blw two columns is large and the footing of one column lies on property boundary line. A strap beam is provided to transfer the column load uniformely without causing differencial settlement.

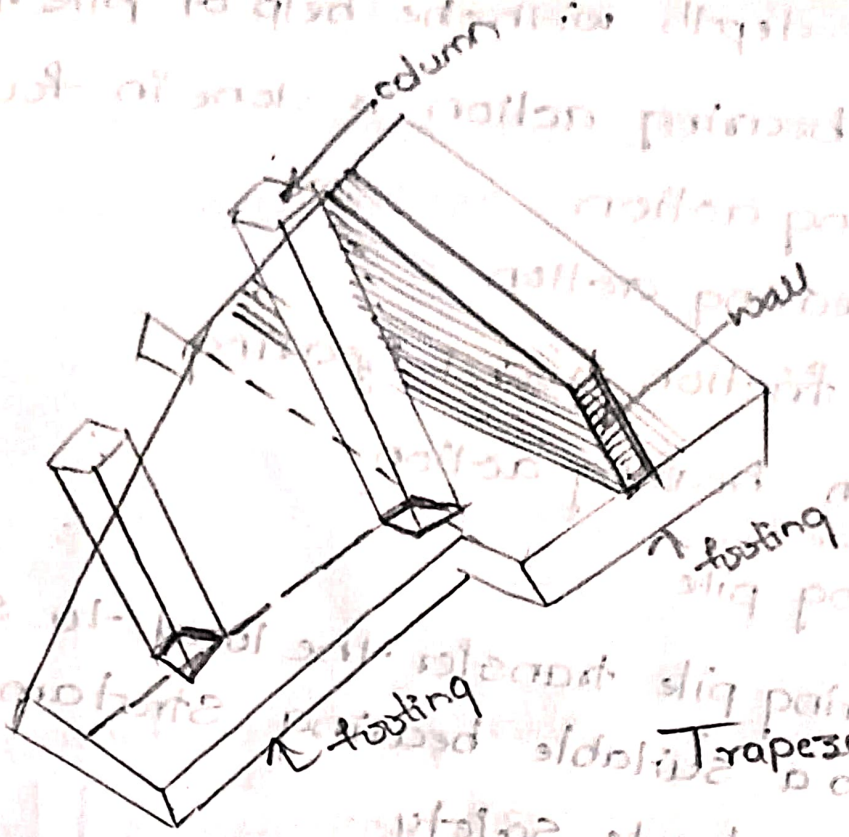


iii) Combined footing :- when the footings of two adjacent columns are at smaller distance and tend to overlap. A combined footing is provided for the both columns.

* rectangular combined footing
* trapezoidal combined footing



Rectangular combined footing



Trapezoidal combined footing

24/9/25

* Mat / raft footing

It is a type of combined footing that covers entire area with a structure and supports all the walls and columns. when ever the building loads are heavy are soil bearing capacity is low we prefer raft foundation.

Deep foundations

In case of deep foundation the depth of the foundation is greater than are equal to width.

pile foundations

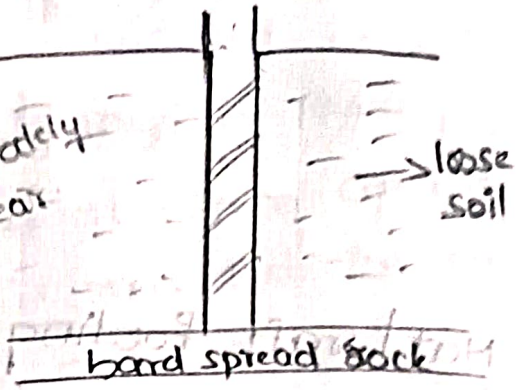
when there is no firm strength load bearing strata at lesser depth we transfer all the loads from the super structure.

At larger depth with the help of pile foundation,

* The load bearing action is done in four ways.
* End bearing action
* friction bearing action
* combined friction & end bearing
* compaction bearing action

i) End bearing pile

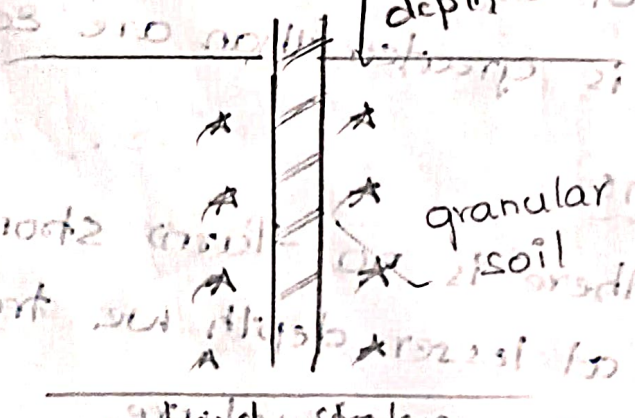
End bearing pile transfer the load to softer loose soil to a suitable bearing stratam. They carring beavy loads safety to a hard stratam. multi stored building invariably lay moderately or end bearing pile to avoid settlements. near



(end bearing action)

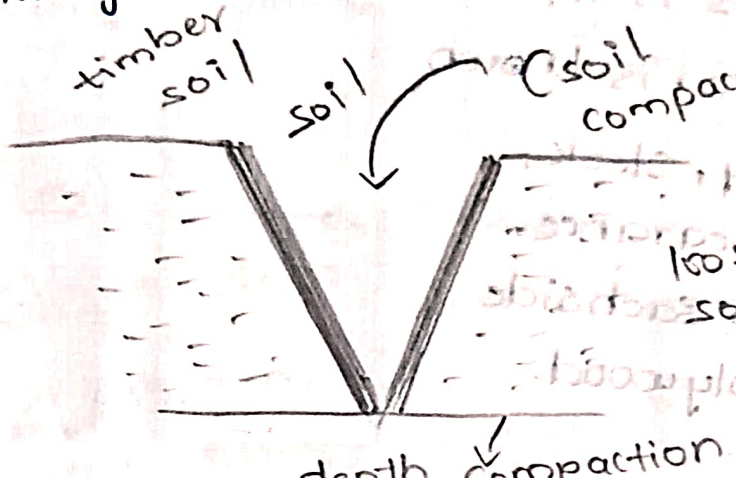
ii) friction bearing action

friction pile they transfer the loads to friction action known as skin friction along the length of the pipe. It is suitable for granula soil where the depth hard stratam is very high. beavy



iii) combined friction & End bearing

These pile transfer the superimposed load both through skin friction as well as End bearing action.



iv) compaction bearing pile

These piles do not carring any load. And are used to compact the loose granular soil. There by increasing bearing capacity of surrounding soil.

* Doors

An openable barrier secured in wall opening to provide access to inside of a room.

It consist of two parts

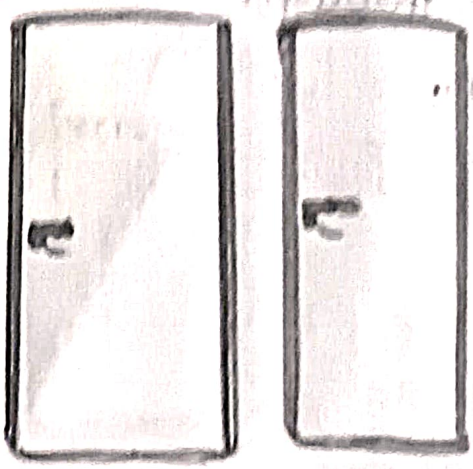
* Door frame
* Door shutter

Battened, legded And BRaced Doors

This is a ledged and battened door to which braces have been added to prevent sagging

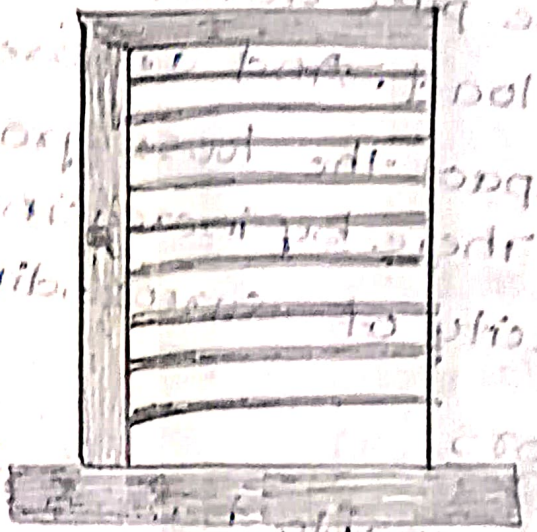
Flush Doors

One of the primary differences between flush and panel doors is in their design. Flush door is known for its simplicity, sleek and classic appearance. It is covered on each side by a sheet of plywood.



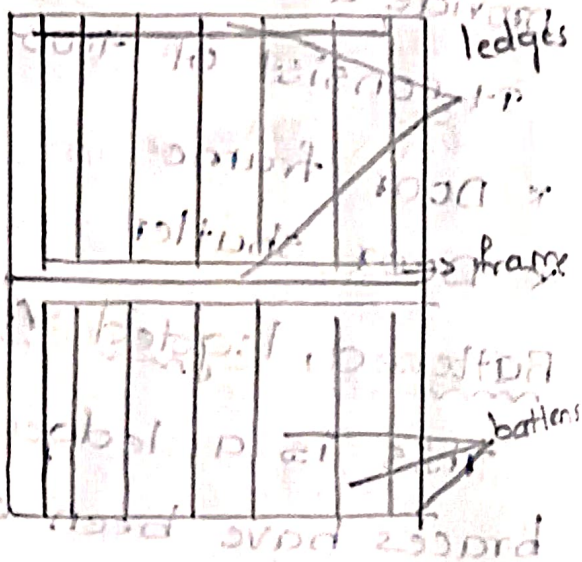
louvered Doors

These permit free ventilation through them and at the same time main the privacy of the room.



Battened, ledged and framed Doors

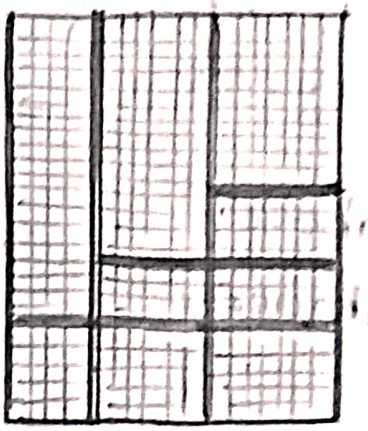
It is improved version of battened and ledged doors with provision of frame. Two vertical members known as style are provided.



wire-gauged Doors

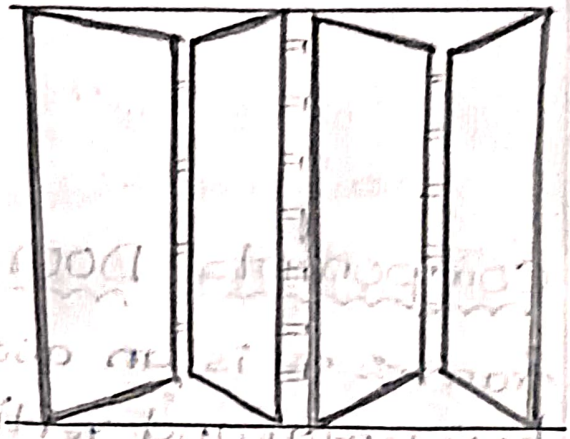
provide free air circulation and prevent mosquitoes flies, insects etc. from entering into the building





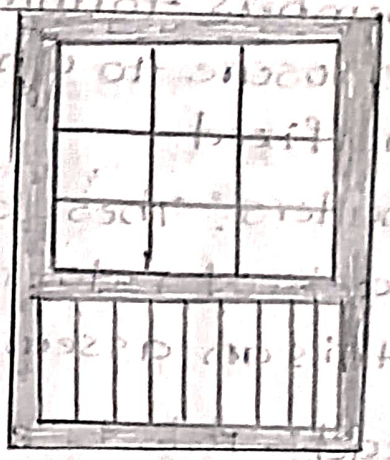
collapsibile door

The door system made of multiple panels hinged together that fold to one side or stack neatly, rather than swinging open



Glazed doors

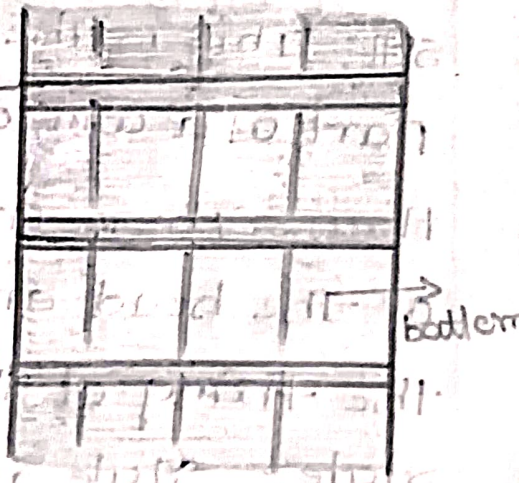
These are provided where the visibility / additional light of the interior of the room is required.



Battened and ledged doors

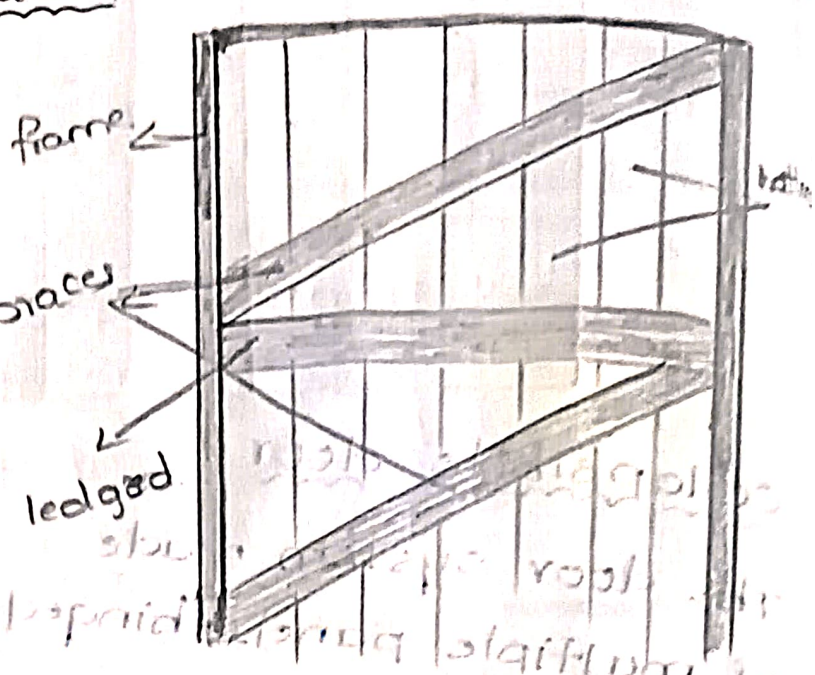
These doors consist of vertical boards called battens which are nailed or screwed to the horizontal members called ledges.

Often the battens are about 15 to 18cm wide and 2 to 3 cm.



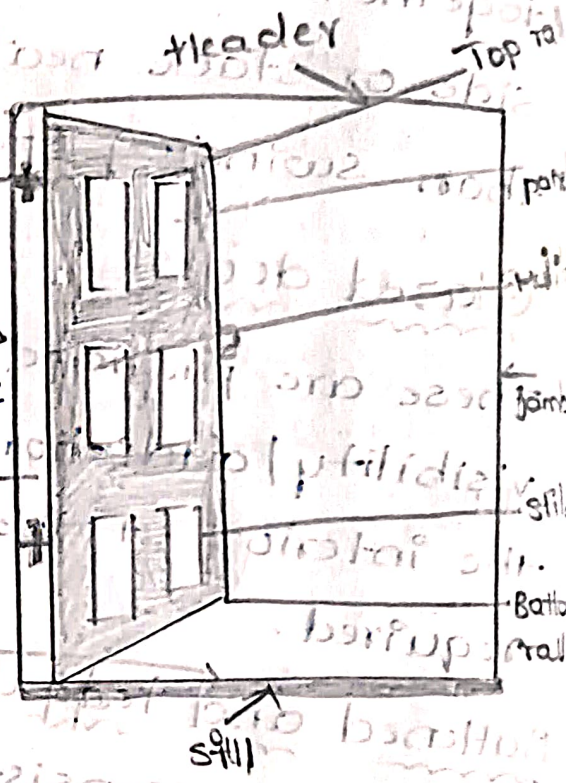
Battened, ledged, braced and framed doors

Same as above with Extrabraces



Components DOOR

frame:- It is an assembly of horizontal and vertical members forming an Enclosure to which the shutters are fixed.



Shutters:- These are the operable parts of a door or window It is an assembly of styles.

Head:- This is the top threshold or uppermost horizontal part of a frame.

Sill:- This is the lowermost or bottom horizontal part of a window frame.

Horn:- These are the horizontal projections of the head and sill of a frame to facilitate the fixing of the frame on the wall.

Style:- Style is the vertical outside member of the shutter of a door or window

Top
member of a shutter.
lock rail :- This is the middle horizontal member of a door shutter, to which locking arrangement is fixed.
Bottom rail :- This is the lowermost horizontal member of a door shutter.
panel :- This is the area of shutter enclosed blw the adjacent rails.
Mullion :- This is a vertical member of a frame, which is employed to sub-divide window or a door vertically.
Jamb :- This is the vertical wall face of an opening which supports the frame.
Transom :- This is a horizontal member of a frame, which is employed to sub-divide a window opening horizontally.

* Technical Terms

The technical terms associated with the design and construction of stairs are defined below

Step :- It is a portion of stair which permits ascent or descent. It is comprised it a tread and a riser.
A stair is composed of a set of steps.
Tread :- It is the upper horizontal portion of a step upon which the foot is placed while ascending or descending.

Riser:- It is the vertical portion of a step providing a support to the tread.

flight:- This is defined as an unbroken series of steps blw landings.

landing:- It is the level platform at the top or bottom of a flight blw the floors. A landing facilitates change of direction and provides an opportunity for taking rest during the use of the stair.

Rise:- It is the vertical distance blw two successive tread faces.

Going:- It is the horizontal distance blw two successive riser faces.

Nosing:- It is the projecting part of the tread beyond the face of the riser. It is usually rounded off from architectural considerations.

scotia:- It is a moulding provided under the nosing to improve the elevation of the step, and to provide strength to nosing

soffit:- It is the underside of a stair.

line of nosings:- It is an imaginary line parallel to the nosings. It is useful in the construction of hand rails, giving the line with which the under-surface of the hand rail should coincide.

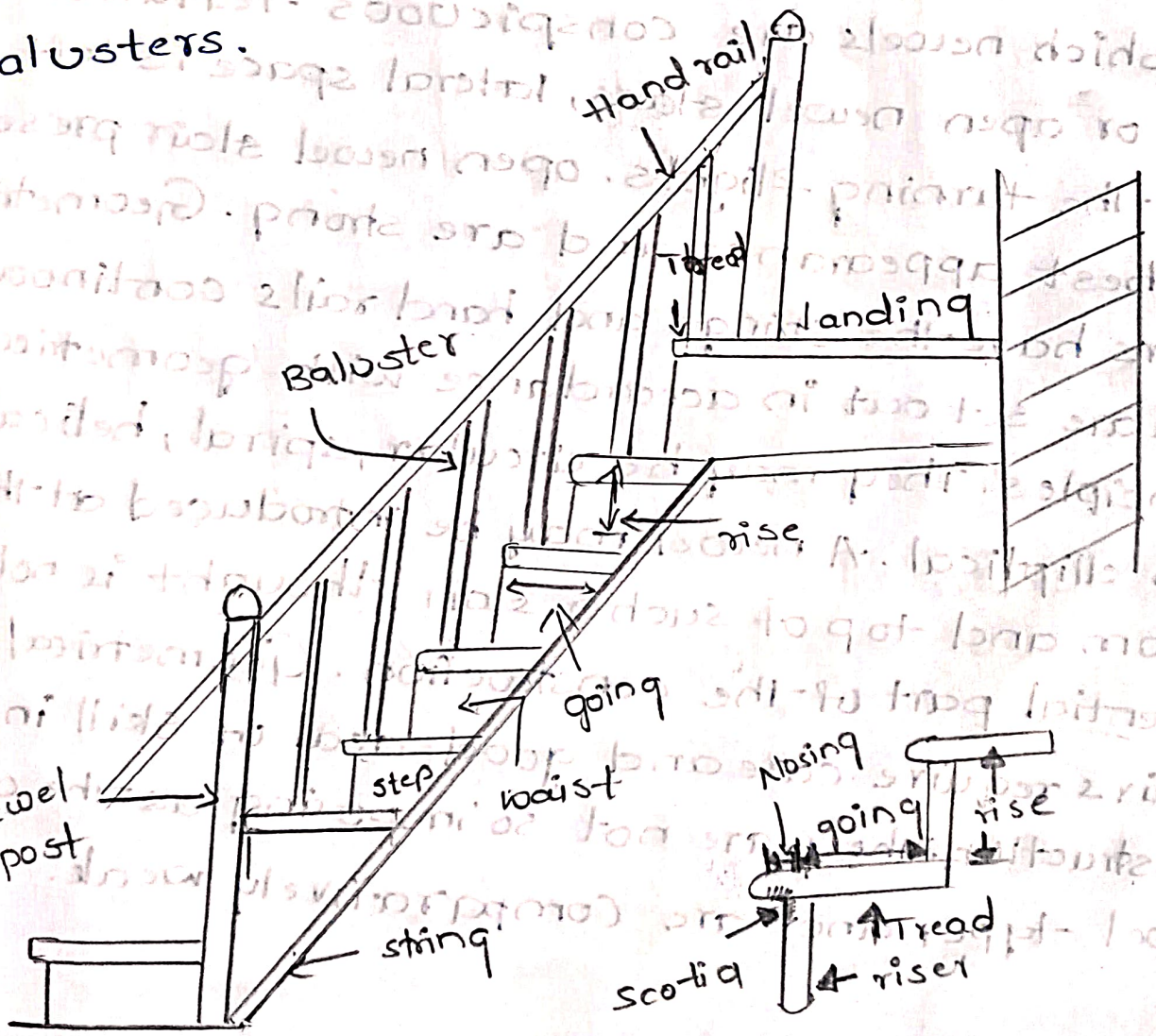
pitch or slope :- It is the angle which the line of nosing of the stair makes with the horizontal.

strings or stringers :- These are the sloping members which support the steps in a stair. They run along the slope of the stair.

Newel post :- Newel post is a vertical member which support the is placed at the ends of flights to connect the ends of strings and hand rail.

Baluster :- It is vertical member of wood or metal supporting the hand rail.

Hand Rail :- It is a rounded or moulded member of wood or metal following generally the contour of the nosing line, and fixed on the top of balusters.



* Classification of stairs

Stairs can be classified in two broad heads

* Straight stairs
* Turning stairs

i) quarter-turn stairs ii) Half-turn stairs (dog-legged and openwell stair

iii) Three quarter-turn stairs iv) Bifurcated stairs

Each of the turning stairs are of three types

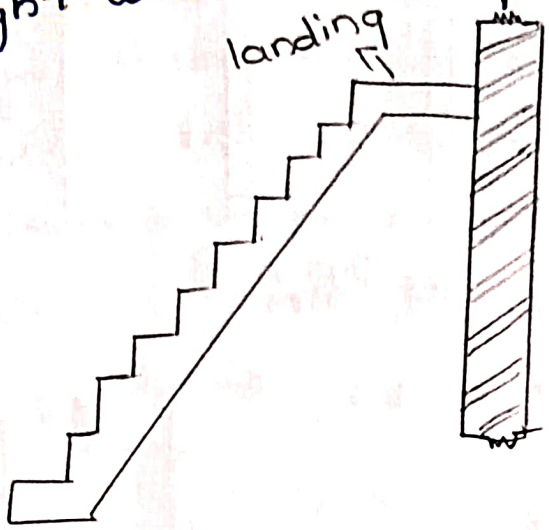
a) newel stairs b) well or open-newel stairs, and

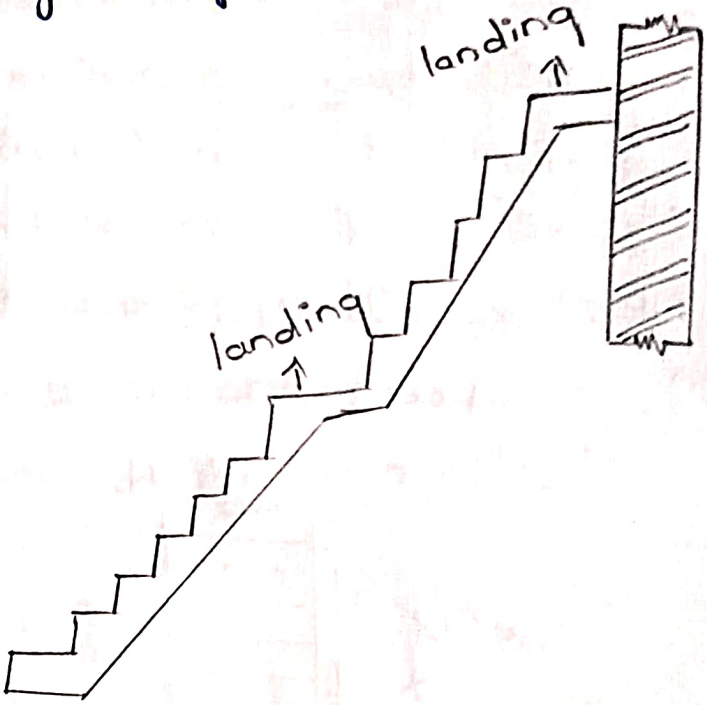
c) geometrical stairs.

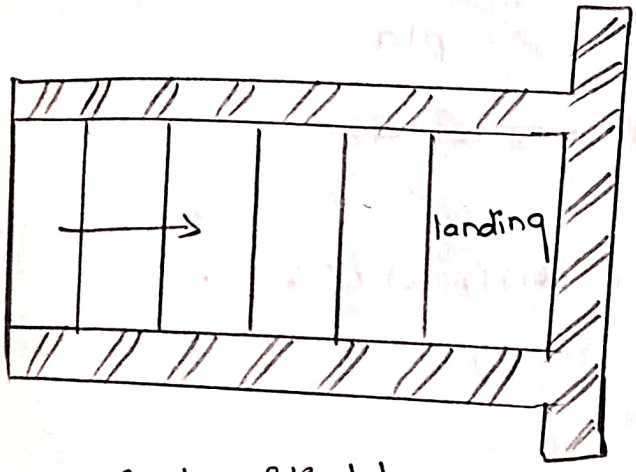
A newel stair is the one which has a newel at the foot and head of each flight of the stair, and in which newels are conspicuous features. In well or open newel stairs, lateral space is left blw the turning flights. open newel stair present at best appearance and are strong. Geometrical stairs have the strings and hand rails continuous and are set out in accordance with geometrical principles. They may be circular, spiral, helical or even elliptical. A newel may be introduced at the bottom and top of such a stair, thought is not an essential part of the construction. Geometrical stairs require care and good deal of skill in their construction. They are not so imposing as the open newel type, and are comparatively weak.

* Straight stairs

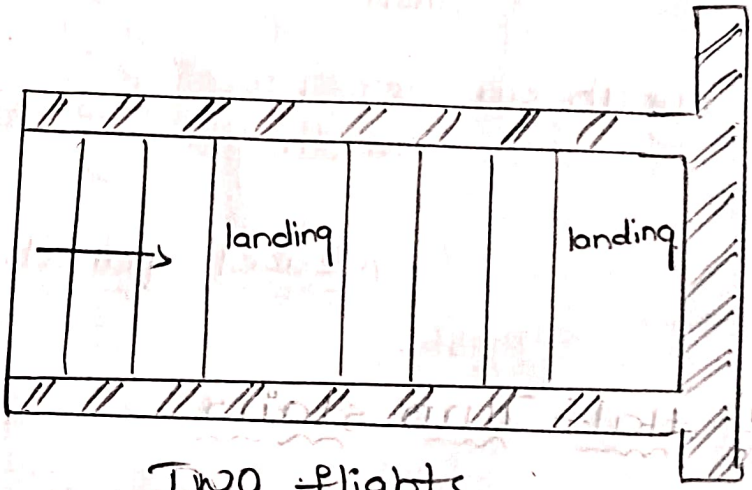
In this type, this stair runs straight blw the two floors. This used for small houses where there are restrictions in available width. The stair may consist of either one single flight or more than one flight with a landing.







single flight



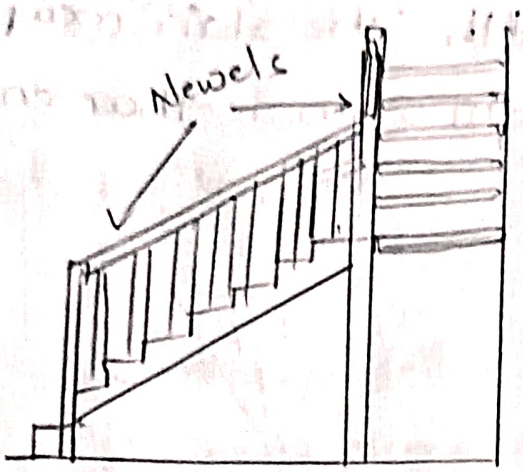
Two flights

Straight stairs

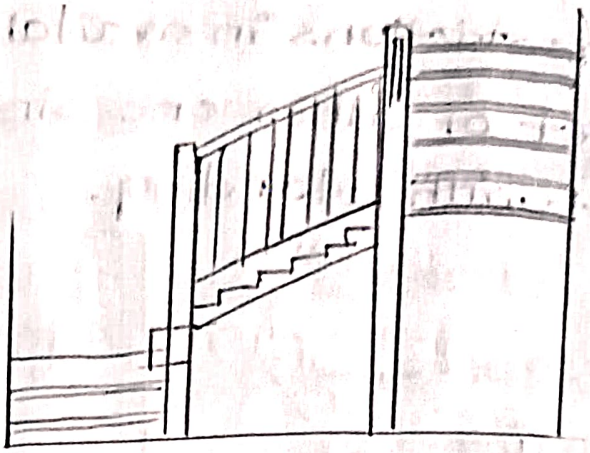
* Turning stairs
* Quarter Turn stairs

A quarter turn stair is the one which changes its direction either to the left or to the right.

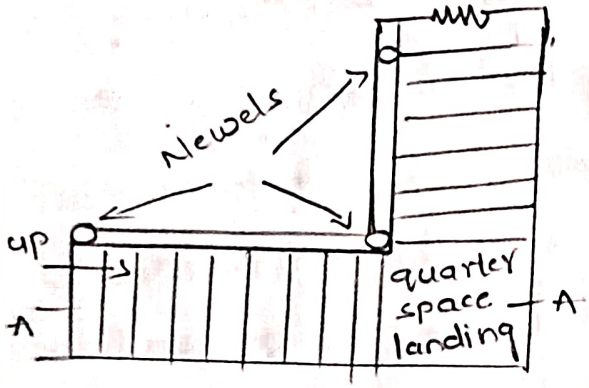
the turn being affected either by providing a quarter space landing or by providing winders



Section A - A

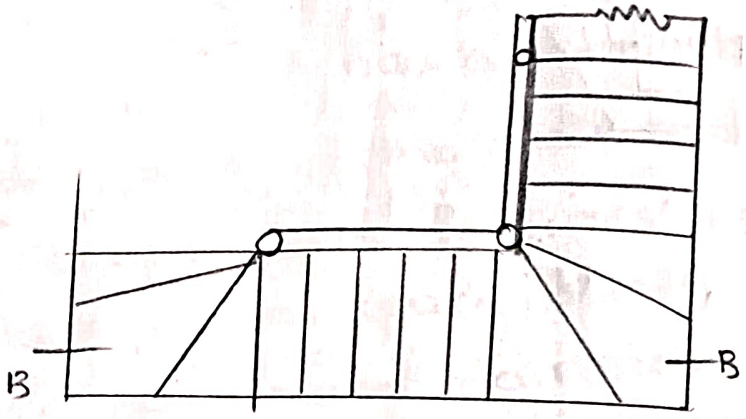


Section B - B



plan

a) with quarter space landing



plan

b) with winders

Newel quarter Turn stairs

ii) Half Turn stairs

Half-turn stair is the one which has its direction reversed, or changed for 180°. such stairs are quite common. These may be of three types.

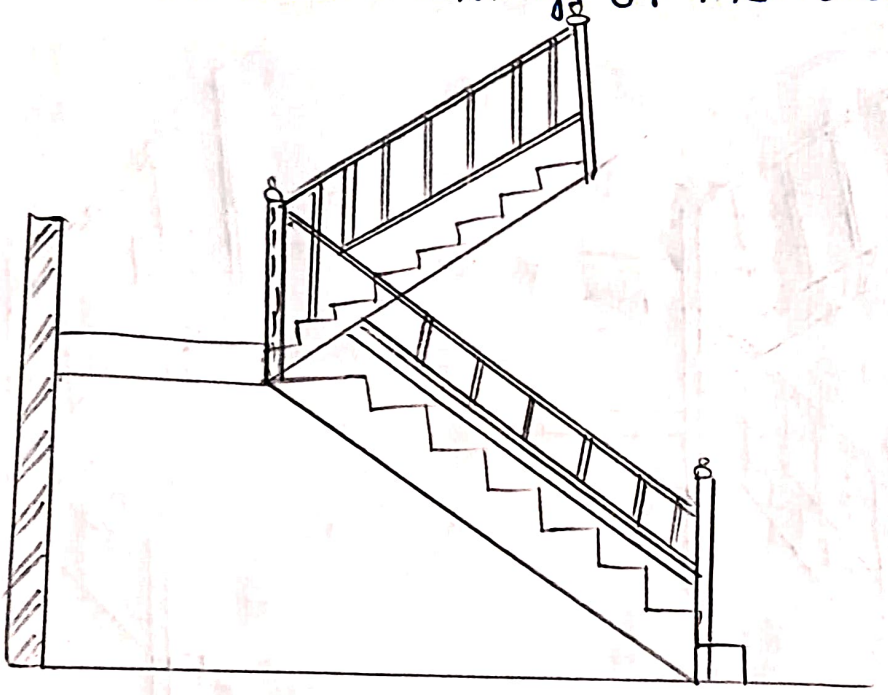
a) Dog-legged or newel half turn stairs

b) Open newel half turn stairs

c) Geometrical half turn stairs.

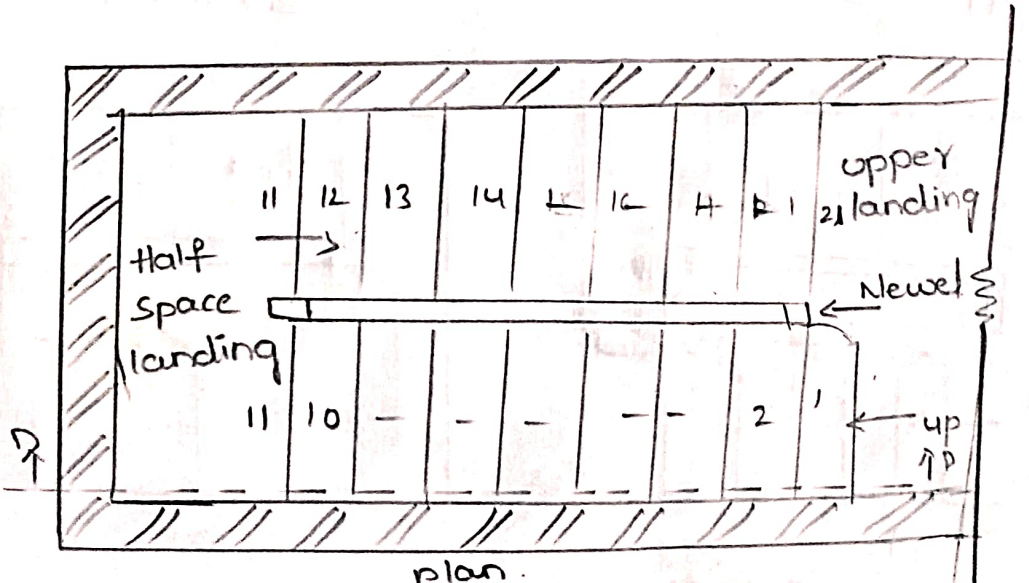
a) Dog-legged stairs

This name is given because of its appearance in sectional elevation. It comes under the category of newel (or solid newel) stairs in which newel posts are provided at the beginning and end of each flight. These may be of two forms: i) with half space landing and ii) with quarter space landing and winders. Generally, the former type (i.e without winders) is more common, as shown in fig. There is no space blw the outer strings of the two flights.



Section D-D

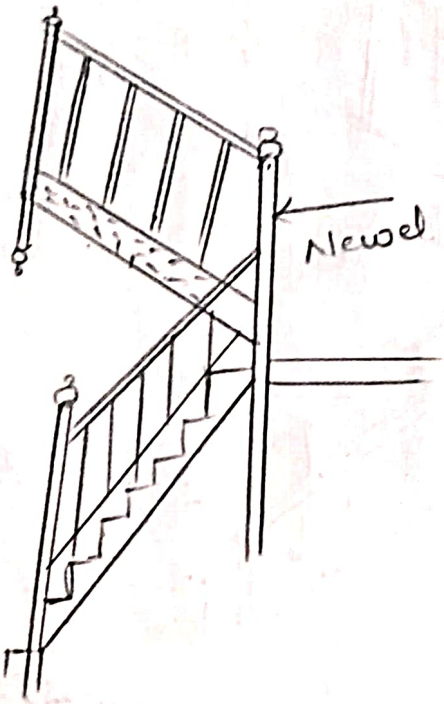
Dog-legged stair



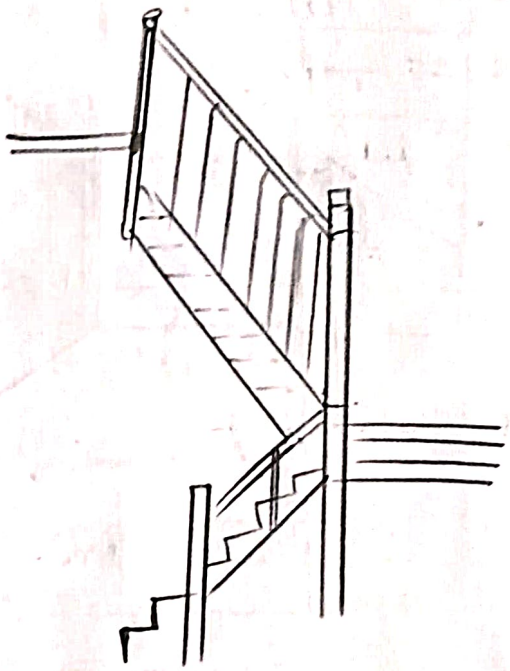
plan

b) open newel half-turn stairs.

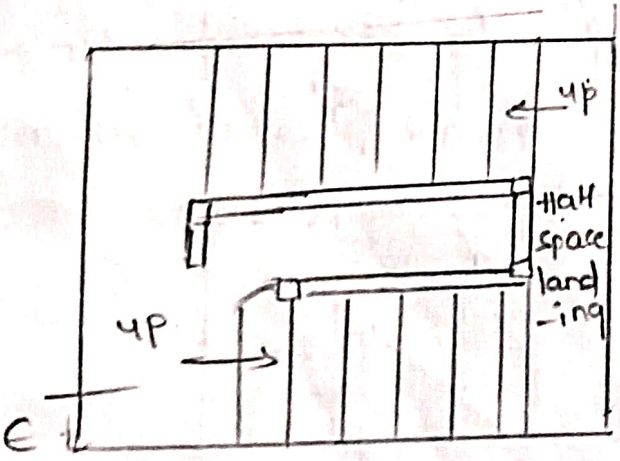
Open well or open newel half-turn stair has a space or well between the outer strings. This is the only aspect in which it differs from the dog-legged stair. The additional width is required blw the two flights: the space blw the two strings may vary from 15cm (min) to 100cm. when the spa left is more, a small flight containing two to four steps may be introduced at the turn, blw the two quarter space landing. otherwise for small width well, a half space landing may be provided.



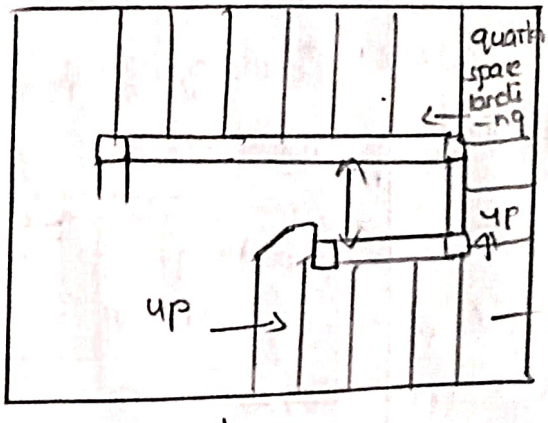
Section E-E



Section F-F



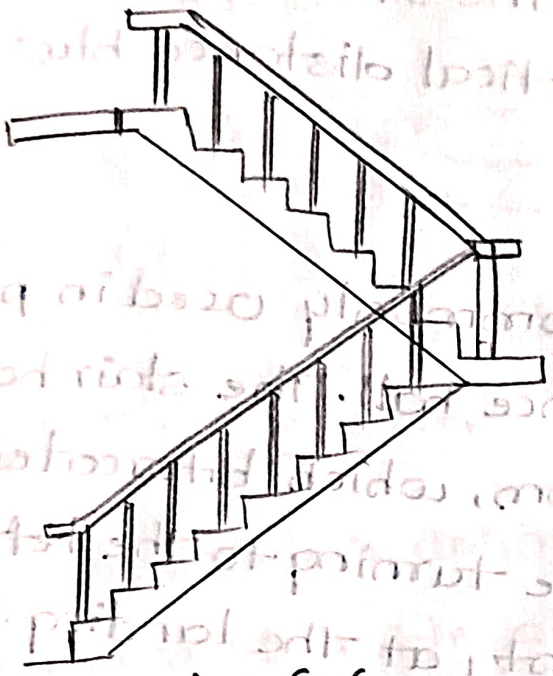
plan



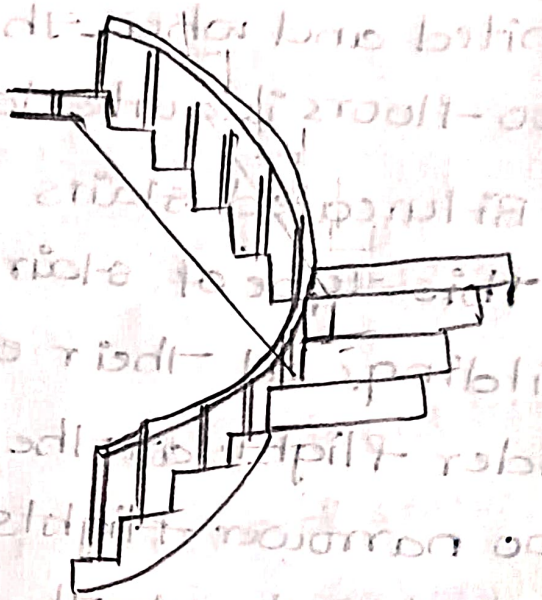
plan

c) Geometrical half-turn stairs.

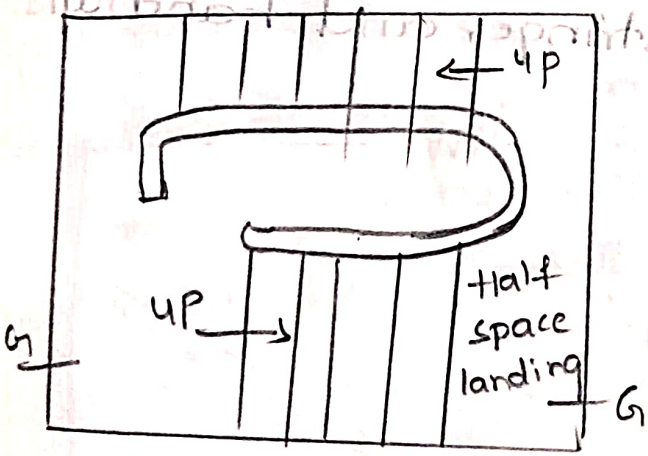
The essential features of such stairs are that the stringers and the hand rails are continous without any intervening newel post. These may be either with half space landing or without landing.



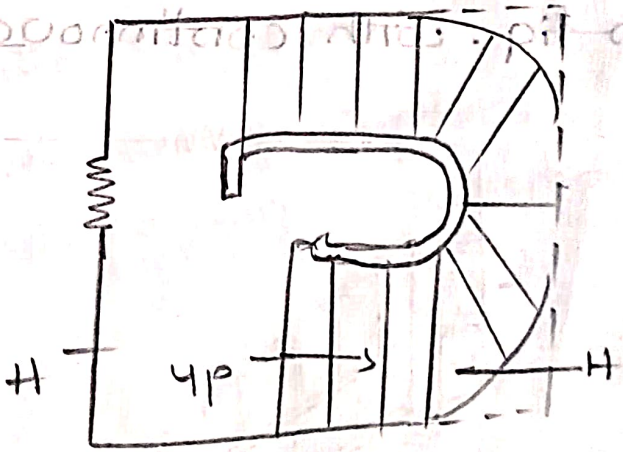
Section G-G



Section H-H



with landing



Continuous

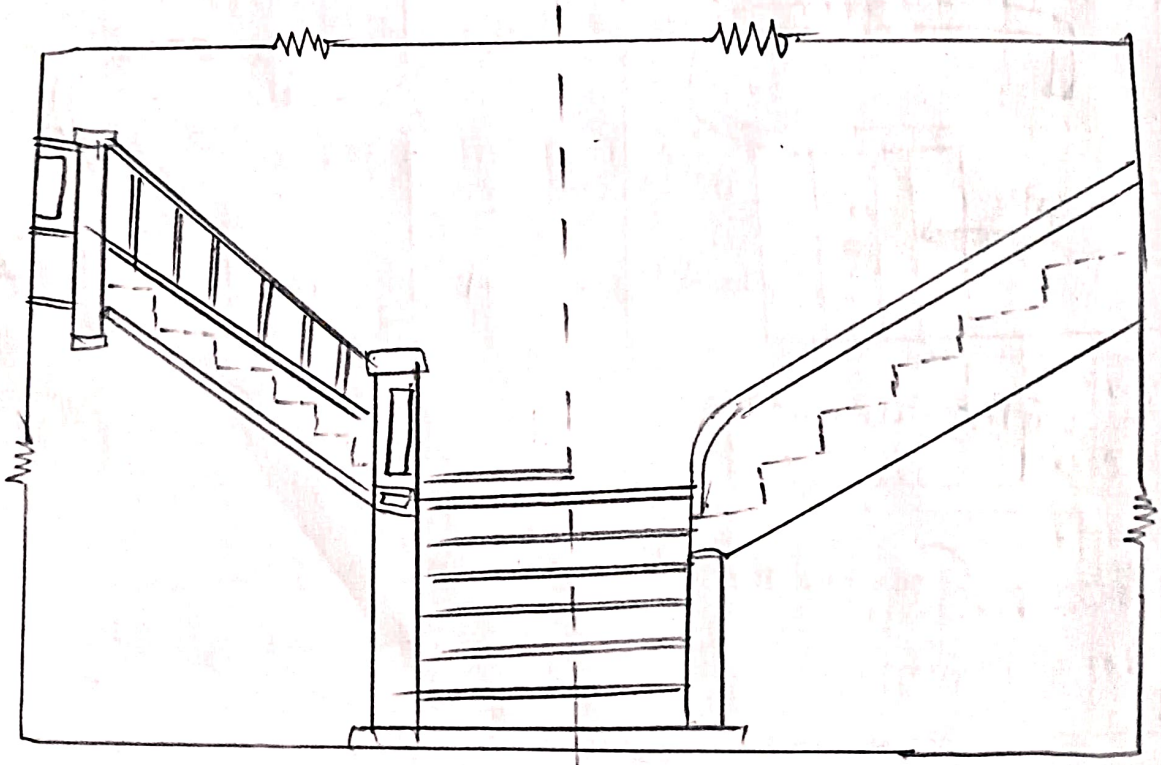
Geometrical Half turn stairs

iii) Three quarter Turn stairs

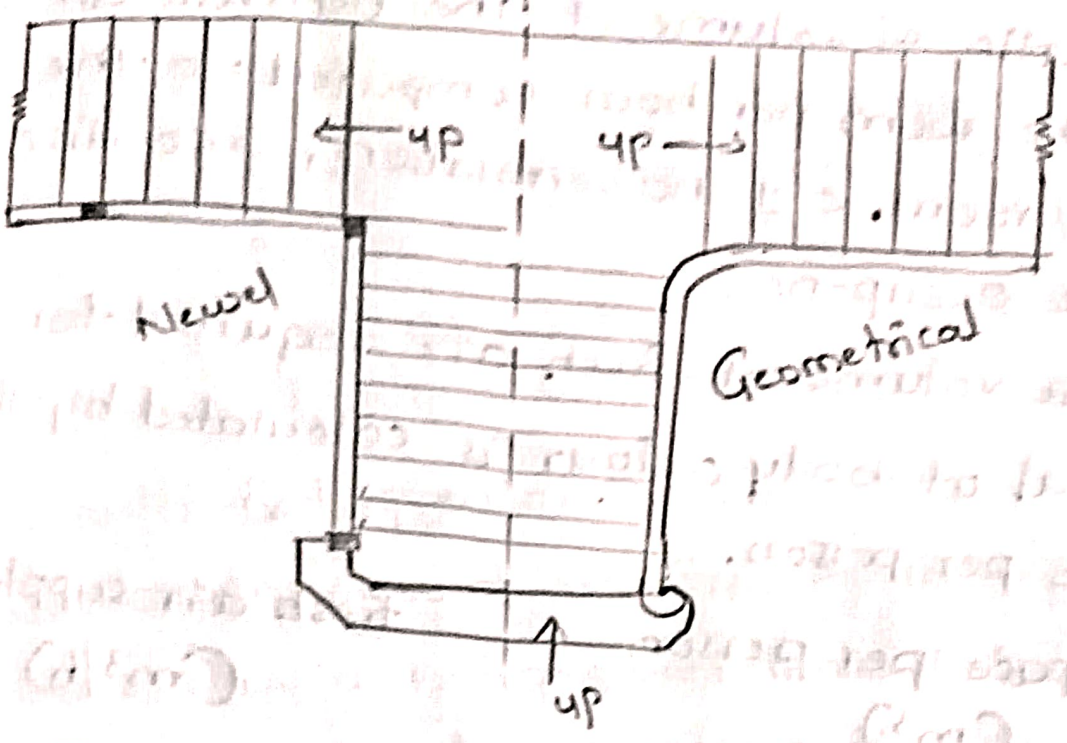
A three quarter-turn stairs has its direction changed three times with its upper flight crossing the bottom one. It may either either be newel type or open newel type. such type of stair is used when the length of the stair room is limited and when the vertical distance b/w the two floors is quite large.

iv) Bifurcated stairs

This type of stair is commonly used in public buildings at their entrance hall. The stair has a wider flight at the bottom, which bifurcates into two narrower flights, one turning to the left and the other to the right, at the landing. It may be either of newel type with a newel post as shown in fig. or of geometrical type, as show in fig. with continous stringer and handrails.



Elevation.



24-10-25

* Ventilation System

Ventilation is defined as supply of outside air or removal of inside air from enclosed space.

*Ventilation is necessary to remove carbondioxide water vapour, dust particles smoke and order generated by occupence of the room.

requirements of the ventilation system

From the point of view of human comfort ventilation should meet the following requirements.

1. Air changes
2. Humidity
3. Air quality
4. Temperature

*Air changes :- The minimum rate of air change should be 1 and maximum for hour.

*The ratio of volume of the outside air aloud into the room per hour compared to the value of the room. < 4 no ventilation, > 60 discomfort to the occupence.

The volume of fresh air required for the removal of body odour is calculated by the air space per person.

Air space per person (m^3)	Fresh air supply per (m^3/h)
5.5	28.5
8.5	20.5
11.0	17.0

Indian standard (IS) recommends the following values for residential building

* for living rooms
* bed rooms
* bath rooms & water closes (min air change of 3 m^3)
* for kitchens supporting 4-5 members (a min of 3 m^3 air change should be maintained

Humidity :- Air contains certain amount of water vapour in it relative humidity is the ratio of amount of water vapour present in the air to the amount of w.v if the air is saturated at the same temperature

* Relative humidity should be main 33-70%.

Air quality :- The ventilating air should be free from impurities organic matter & odour. It should also free from gases such as carbonmonoxide, carbondioxide & sulphur dioxide.

* CO_2 should not greater than 0.06%.
* sulphur dioxide should not greater than 0.5% ppm
* impurities should not greater than 0.5%. mg/m³

Temperature :- It is desirable that the incoming air should be cool is summer and warm in winter with regar to human comfort. The temperature diff between inside & outside should not exceed 8°C. This achieved by artifical or mechanical ventilation.

* Air conditioning

The process of treating air to control its temperature, humidity & purity 25-10-25

Inlet air → filtration → (Heating / cooling) → Humidification / Dehumidification → outlet for air distribution

(micro org - dust) (warm air furnace / chilled air / direct system)

filtration :- The Aim of this process is to exclude dust particles bacteria & other chemicals so, that clean air is obtained.

The filters used should be capable of holding a moderate amount of dust cleaned from the incoming air without effecting cleaning efficiency.

* It should offer low resistance to the flow of incoming air.

eg:- Electric precipitaters they remove the dust by subjecting the air to strong electric field where the dust get attached to the negative electrodes.

* spray washers The air is allowed to pass through water spray's where the dust & gases are removed by drops of water.

* viscous type filters these are made up of mator screens of split wires glass wool coated with non volatile viscous oil.

Heating:- The incoming air is passed through hot air furnace around which hot water or steam is circulating.

Cooling:- A volatile refriegerente is compressed cooled and aloud to expand and then it is passed through coils. In chilled water system a secondary medium like water is used to cool the air.

Humdification:- when the incoming air is have the low humidity we use spray humidefiers so that the air contains necessary humidity.

Dehumdification:- In this process surtain amount of water is extracted from the air it is done

either by condensation or by desiccation. In condensation method the air is first brough below the dew point and required quantity of moisture is removed from the surface.

* In desiccation method salt solution's of calcium or Amonia are used to extract excess moisture from the air.

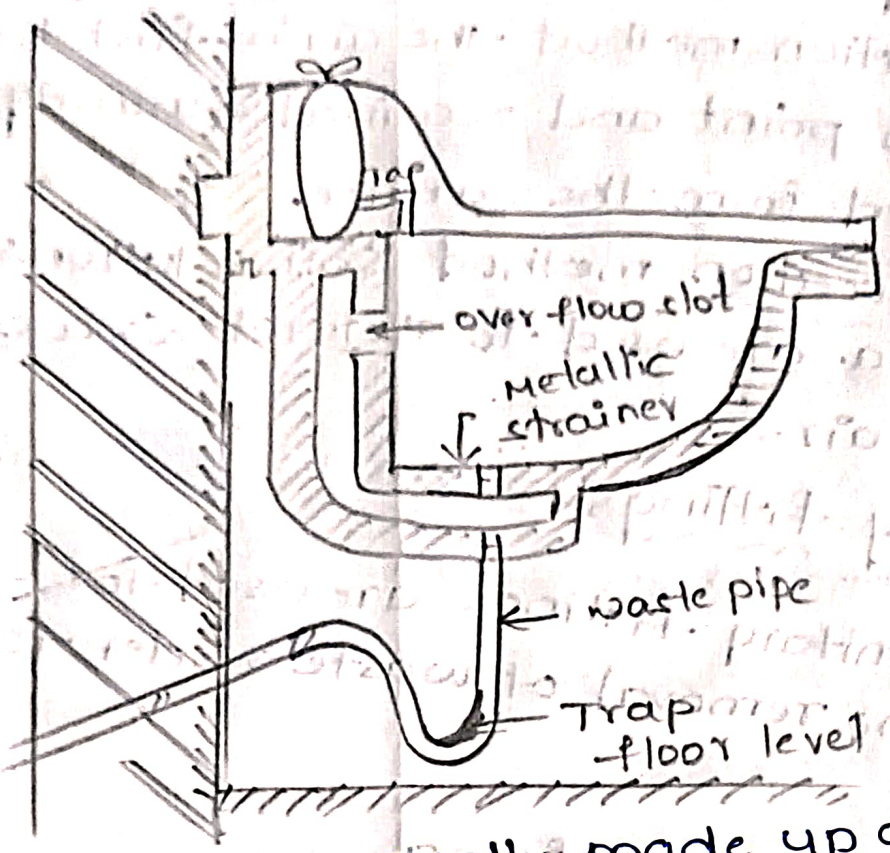
* sanitary fittings

Sanitary fittings are used for efficient collection & removal of waste water to the house drain.

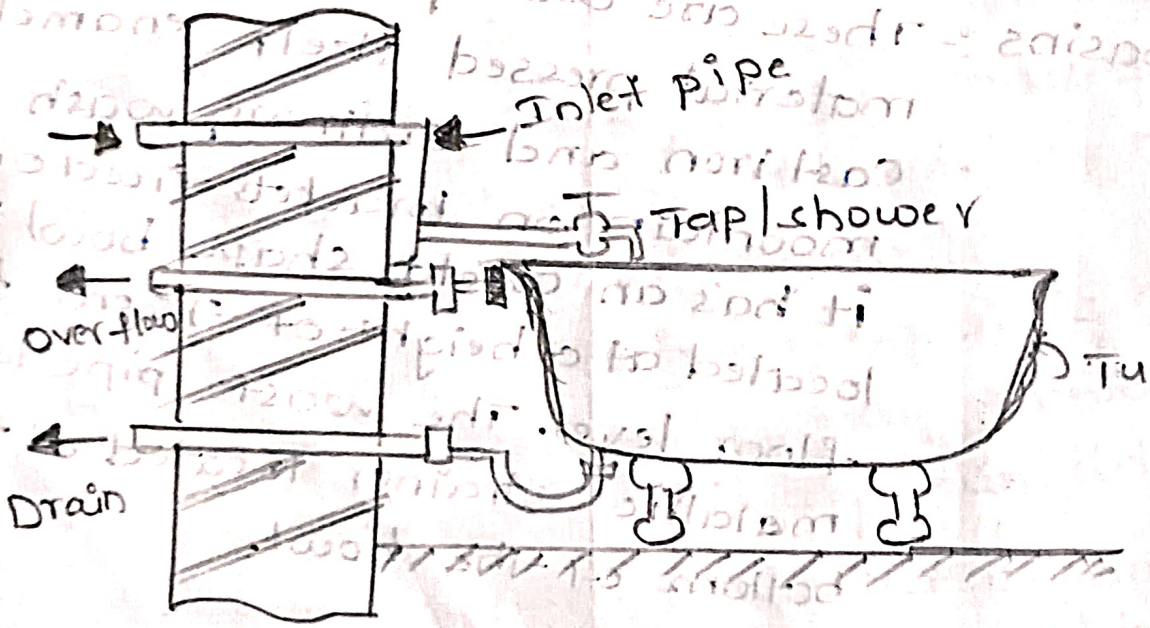
Types of sanitary fitting

* wash basins
* bath tubs
* water closets
* sink
* urinals
* flushing cisterns

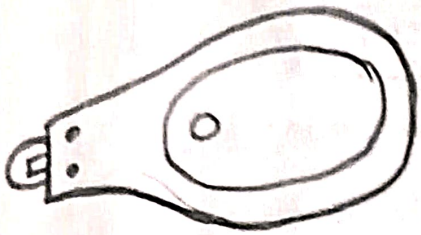
wash basins :- These are usually made up of procelain material pressed steel, enamelled cast iron and ordinary wash basin is mountain on brackets fixed on wall it has an oweld shape bowl it is located at a height of 75cm from the floor level. The waste pipe is a metallic strainer located at the bottom of the bowl.



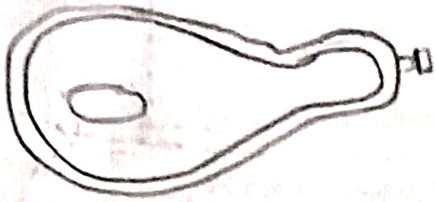
bath tubs :- They are usually made up of iron or steel coated with enamelled along with marble chips or terazo. It has a length of 1.7 to 1.8 m and width 0.7 to 0.75 m and a depth of 0.4 to 0.45 m It is provided with outlet & over flow pipes of 40mm dia



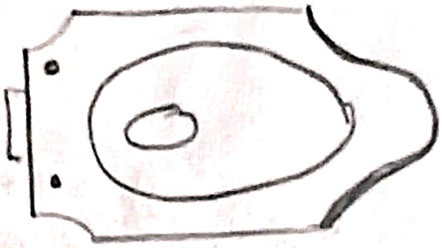
water closets:- They are designed to recieve and discharge human excreta it is connected to a soil pipe by means of a suitable trap.



plan



plan



plan

Sink :- While a wash basin is used for washing hands, face etc. a sink is used in kitchen or laboratory. These may be made of glazed fireclay, stainless steel, metal porcelain or enamelled pressed steel. They are manufactured in various sizes and shapes, though rectangular shape is quite common in kitchens. The out-let pipe, provided with a grating of brass or nickel, may discharge over a floor trap or nahni trap.

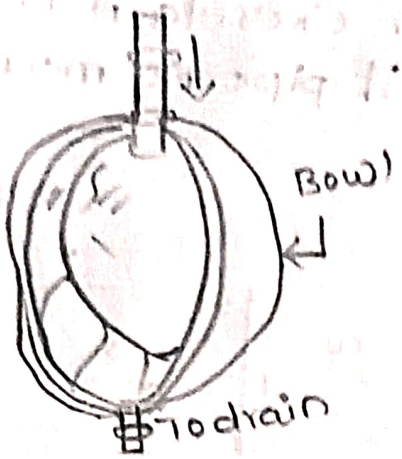
Urinals :-

bowl type / stall type → purlic places (close spacing) 0.6 - 0.7m

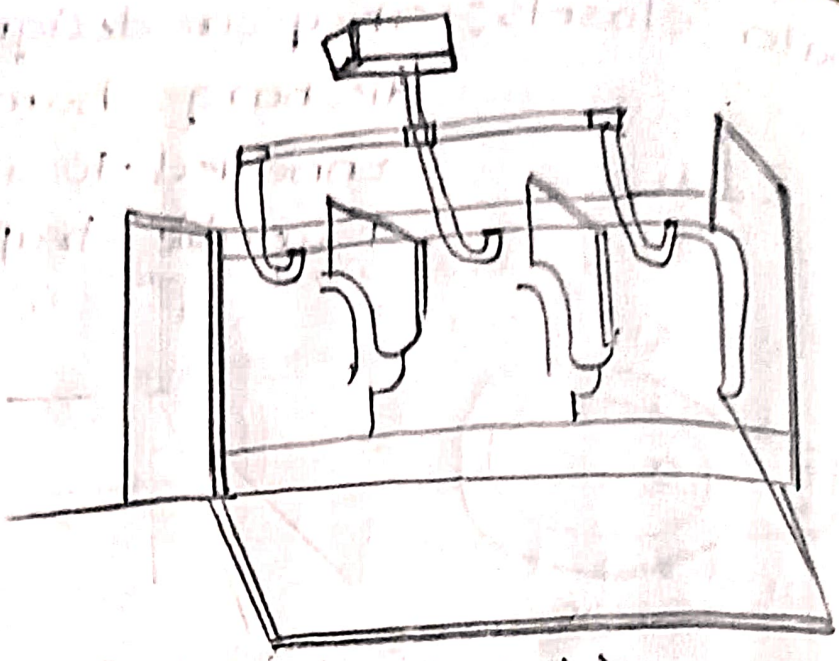
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residential buildings

* contents are collected & discharged through nahni trap
* flushing is done automatically at a regular interval of 10 - 15 minutes for stall urinals.



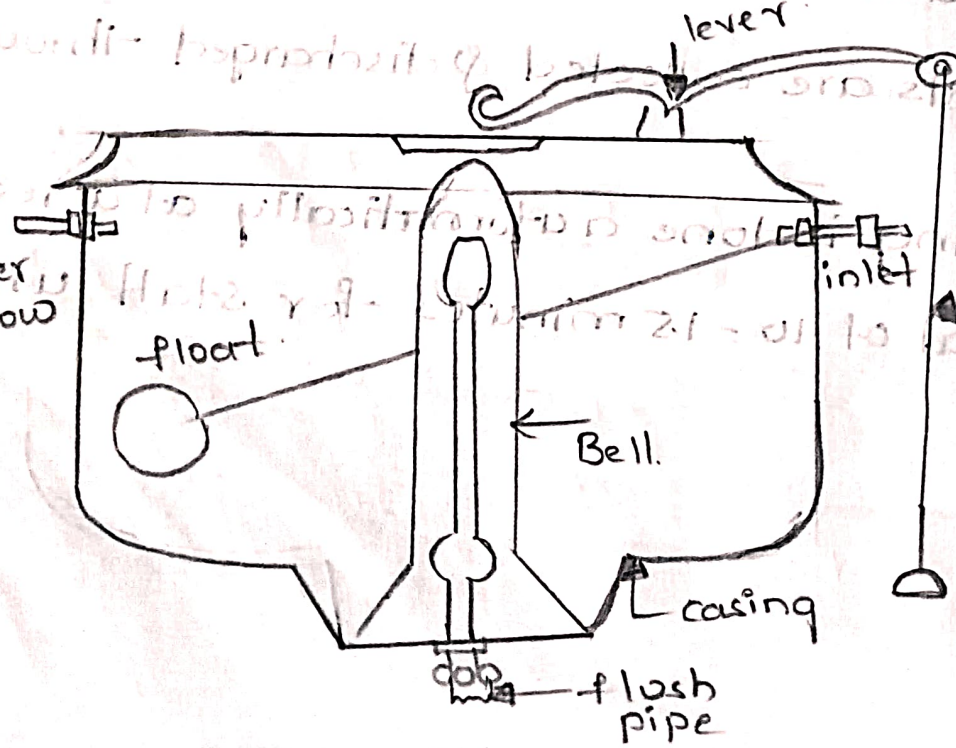
a) Bowl type



b) stall type

Flushing cisterns :-

They are used to flush out water closets & urinals, cistern is located at 2m above floor level.



Acoustics and Sound Insulation

Acoustics is the science of sound, which deals with origin, propagation and auditory sensation of sound, and also with design and construction of different building units to set optimum conditions for producing and listening speech, music etc.

Characteristics of audible sound

The velocity of sound depends upon the nature and temperature of the medium through which it travels. It travels much faster in solids and liquids than in air. The velocity of sound in air depends upon moisture in air and temperature of air. The velocity of sound in atmospheric air at 20°c is 343 m/s.

* There are three characteristics of sound

a] Intensity and loudness

b] frequency and pitch

c] quality or timbre

a) intensity of Sound

The intensity sound is the amount of sound energy passing per second through a unit area perpendicular to the direction of sound propagation.

Mathematically:

$$I = \frac{P}{A}$$

where,

I = intensity (in w/m^2)

P = power of the sound wave (in watts)

A = Area (in m^2)

* Intensity depends on the energy and distance from the source.
* It is an objective (measurable) quantity.

eg:- If a loudspeaker emits 2 watts of sound power equally in all directions, at a distance of 2m

$$I = \frac{2}{4\pi(2)^2} = 0.04 \ w/m^2$$

loudness of sound

The loudness of sound is how strong or soft a sound appears to our ears - it's the subjective perception of sound intensity.

$$L = 10 \log_{10}\left(\frac{I}{I_0}\right)$$

where,

L = loudness level (in dB)

I = intensity of the sound

$I_0 = 10^{-12}$ w/m² (reference intensity - threshold of hearing)

* loudness depends on:

=> sound intensity (greater intensity - louder sound)

=> sensitivity of the ear (varies with frequency)

=> Distance from the source

=> Duration and quality of sound

Difference Between intensity and loudness

feature	intensity	loudness
Nature	objective (can be measured)	subjective (depends on ear)
Unit	w/m²	Decibel (dB)
Depends on	power and area	intensity, frequency, ear sensitivity
Measurement	physical quality	psychological perception

Eg:-

* whisper - 30 dB
* Normal Conversation - 60 dB
* Traffic noise - 90 dB
* jet engine - 130 dB

* **Absorption**

when a sound wave strikes a surface, a part of its energy is absorbed by friction. The sound generated in an auditorium or hall is absorbed in four ways

i) In the air ii) by the audience
iii) in furniture and furnishing and
iv) at the boundary surfaces such as floors, ceilings, walls, etc.

i) Absorption in the air

The absorption of sound in the air is mainly due to the friction b/w the oscillating molecules when sound wave travels through it. However, this absorption is extremely small.

ii) Absorption by the audience

Sound energy absorbed by the clothing of the audience. Room acoustics change perceptibly by the number of audience present. Also, absorption is more in winter, than in summer, because of heavy clothings.

iii] Absorption in furniture and furnishings

furniture, curtains, carpets, etc. also absorb and sound energy to a fairly good extent

iv) Absorption by boundary surface

when sound waves strike the boundary surfaces such as walls, floors, ceilings (treated or otherwise), absorption takes place due to the following factors a) penetration of sound into porous materials, causing resonance within air pockets in the pores until energy is dissipated: b) Resonant vibration of panel materials c) Molecular damping in soft absorbing materials and d) Transmission through structures.

* Absorbants

Special materials used on boundary surfaces to increase absorption are known as absorbants.

* There are four types

a] porous materials

b] Resonant panels

c] cavity resonators

d] composite types

a] porous materials :- Absorption in porous materials is mainly due to the frictional losses which occur when the sound waves cause to and fro movement of the air contained in the material.

eg :- rock wool, glass silk, wood wool.

b] Resonant panels :- These panels absorb the sound by damping the sympathetic vibrations in the panels, caused by sound pressure waves of appropriate frequency.

* The narrow frequency band ranging from 50 to 200 cycles.
* The panels of frequency vibrate depend upon their weight & depth of air spaces behind them.

c] cavity resonators

* A cavity resonator is virtually a container with a small opening, and it function by the resonance of air in it.
* They can be designed to absorb sound of any frequency.

d] composite absorbers

These are a comparatively recent development, combining the functions of all the above three absorberts.

* The panel should form atleast 10% of the total area to allow the porous materials to absorb sound at higher frequencies.

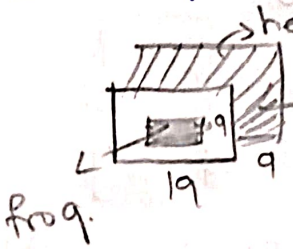
following are the sound absorbing materials

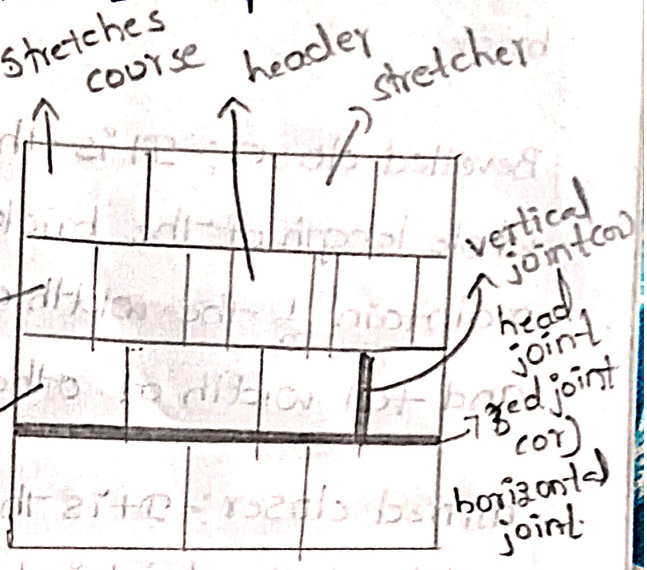
* compressed wood cool
* Mineral / glass wool quilts and mats
* Mineral / compressed glass wool tiles
* wood particle board

Brick Masonry

16/9/25

Header :- The brick laid with its longitudinal or larger phase of parallel to the phase of the wall.





Stretcher :- The brick laid with its longitudinal phase perpendicular to the phase of the wall.

Bed joint :- Thickend horizontal layer of cement motar which is laid before placing the brick.

head joint :- The motar joint which is placed normal to the phase of the wall.

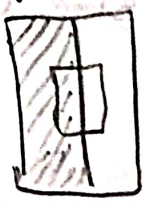
Course :- Horizontal layer of bricks either made up of all stretchers bricks or all header bricks

Cornice brick :- These types of bricks are cut into any designed shape. for architectural purpose

closers

These types of bricks are cut along the length

queen closer :- where a brick is cut into two parts along the length each part is known as queen closer.
It can be either half queen closer or quater queen closer.



(queen closer)

King closer :- A triangular portion containing Exactly half the width & half the length of two adjacent sides is removed from the brick.



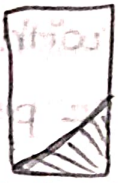
(King closer)

Bevelled closer :- It is the portion of the brick in which whole length of the brick is Bevelled to maintain $\frac{1}{2}$ the width at one end and full width at other end.



(Bevelled closer)

mitred closer :- It is the portion of brick where one width of the brick is bevelled to maintain half length at one side and full length at other side.



(mitred closer)

Bats

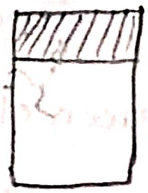
It is the portion of brick which is cut across the width of brick.

half brick bat :- The length of this brick bat is half the dimension of standered size of the brick



(half brick bat)

Three quarter brick bat :- The length of this brick bat is three quarter dimension of standered size of the brick



(three quarter brick bat)

Bevelled brick bat:- It is a type of half brick bat where the width is cut an angle or not making square edges



(Bevelled brick bat)

quoin:-



quoin

The brick which is placed at the meeting point of two adjacent walls or the brick which is placed at corner are exterior surface of the wall.

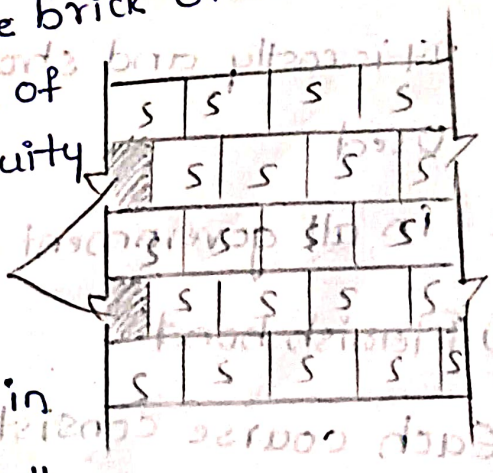
17/9/25

* Types of bonds

i) stretcher
ii) header
iii) English
iv) Flemish (or) Dutch
   - single flemish
   - Double flemish

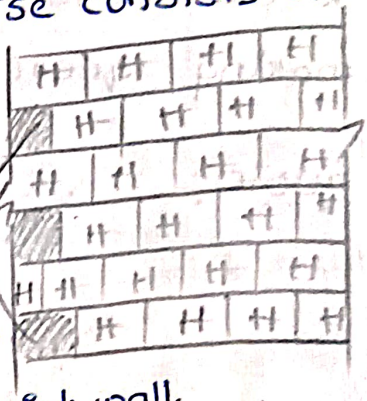
i) stretcher

In this type of bond all the brick or laid horizontally has stretcher along the phase of the wall. To break the continuity of vertical joint a half brick bat is placed in alternate courses. Used as in construction of half brick wall.



ii) header

In this type of bond each course consists of header. placed along the phase of the wall to break the continuity of vertical joint a queen closer is placed in alternate courses. It is used in the construction of one brick wall.

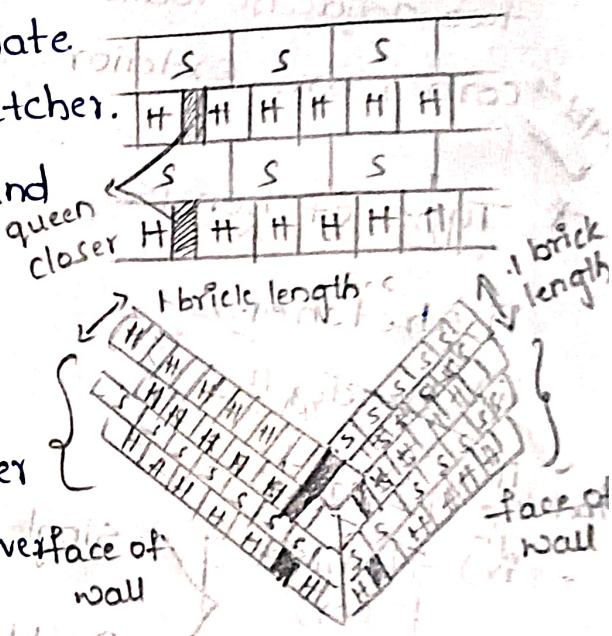


22/9/25

iii) English bond

This bond consists alternate course of headers and stretcher.

* It is the strongest bond and is used for wall thickness ≥ 20 cm
* A queen closer must be provided after quoin header
* Header course should never start with queen closer.



* Joint in a header course should be thinner than those in stretcher course.
* It is costly and stronger than flemish bond and used
* in all government works.

iv) Flemish bond

Each course consists of alternate stretcher and header.

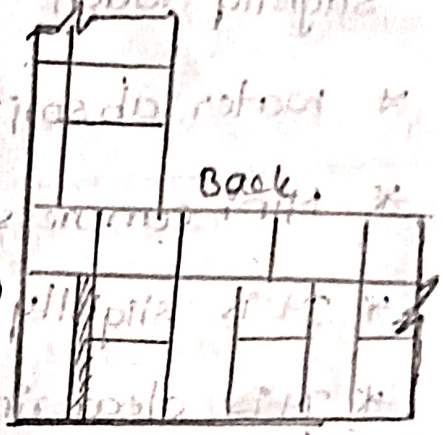
* It is Aesthetically pleasing than English bond but weaker compare to English bond.

i. Single flemish
ii. Double flemish

i. Single flemish

It is a combination of both English and flemish bond.

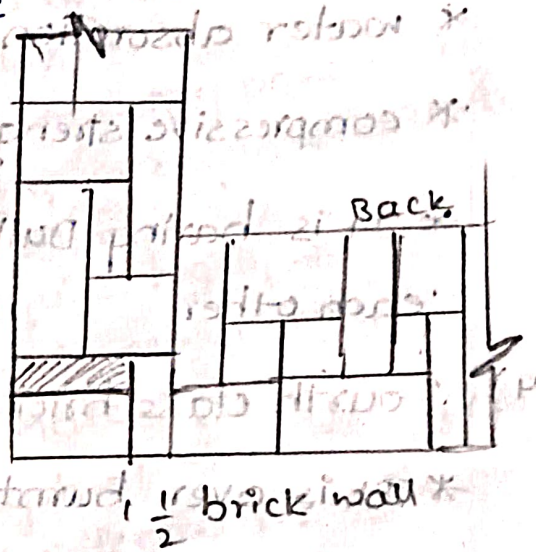
* It has flemish bond on facing side and English bond on other side



ii. Double flemish

There is same appearance in each course as front and back face of the wall.

* This bond have maximum used of half bat and 3/4 brick bat in wall thickness.



* Classes of bricks

1] first class brick

* water absorption should be *20% by dry weight of brick.
* Mini compressive strength = 10.5 Mpa / 10.5 N/mm²
* free from effluoresence
* It is hard - no impression is left when scratched.

2] Second class bricks

* The edges are sharp but brick surface is slightly rough.
* water absorption should be ≯ 22%.
* Mini compressive strength ≯ 7 MPa.
* It is slightly Effluorensence
* It is clear ringing sound

3] Third class bricks

* The edges are blunt (not sharp)
* water absorption ≯ 25%.
* compressive strength ≯ 3.5 MPa
* It is having Dull sound when struck against each other

4) Fourth class bricks

* It is over burnt (or) black (or) surkhi bricks
* It is consisting the mineral admixtures
* They are not used for directly in construction.

27-10-25

Masonry

It is an art of construction of a structure using stones or bricks which are arrange symmetrical layers and bonded with mortar.

Brick Masonry	Stone Masonry
* The strength of bricle Masonry depends upon the clay use & the motar which are used to bonding the bricks.	* The strength of stone Masonry depends upon the parent rock from which it is obtain
* They can be moulded into any desirable shape.	* Moulding of stone is very difficult hence different shapes of stone are not available.
* Brick masonry posses less crushing strength off 100 to 350 kN/m².	* Stone Masonry posses high crushing strength of 500 to 2000 kN/m².
* unskilled labours also can be performed in bricle Masonry.	* It requires highly skilled labour to performed in stone Masonry.
* The prefence off moisture contain will disintegrate the bricle masonry.	* strength of stone Masonry is not effected by moisture content
* They posses high resistance to fire & can be handled easily	* It has least resistance to fire and requires a lifting devicer.
* It is less Expansive and hence used in construction residential bricks.	* It is highly expansive hence used in building foundations, piers, lintels and railway ballast

Types of stone Masonry

i) Rubble Masonry

ii) Ashlar Masonry

i) Rubble Masonry :- This type of masonry has rough undressed stones with wider joins which are easily available and hence economical

ii) Ashlar Masonry :- The stones used in this masonry are dressed aqurately with uniform joints of 3mm thickness It gives a superior quality of Masonry and it is Expensive.

Mid-II

* Composite Masonry

When different types of materials are used for face work & back work it is called as composite Masonry. It is mainly done for minimizing the cost of Construction. For eg :- To obtain a good facing brick Masonry is used & to give good strength stone or concrete backing is used;

Composite Masonry of stone and brick

In this type of composite masonry, the stone are used for facing and bricks masonry is used as back work.

* either natural (or) artifical stones may be us for facing.
* Metal cramps (or) headers projecting in the fa work are used to secure the stones and the back work.
* The joints existing in the backing are more than tha of the joints present in the facing.
* The strength of the bond between the two faces should be strong enough to prevent any unequal settlement of any of the two surfaces.

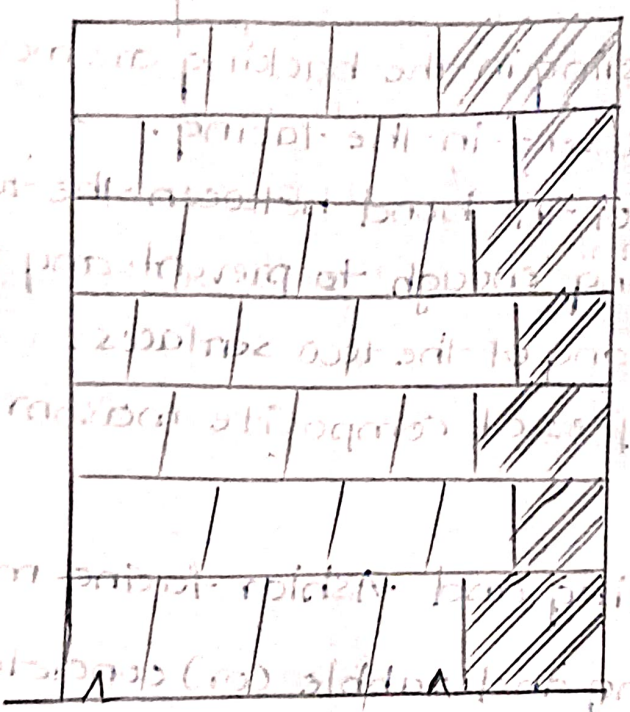
The various types of composite masonry are as follows

a] Brick backing and Ashlar facing masonry
b] Bricle facing and rubble (or) concrete backing
c] Brick, rubble (or) concrete masonry areas stone facing.

* Brick backing and Ashlar facing masonry.

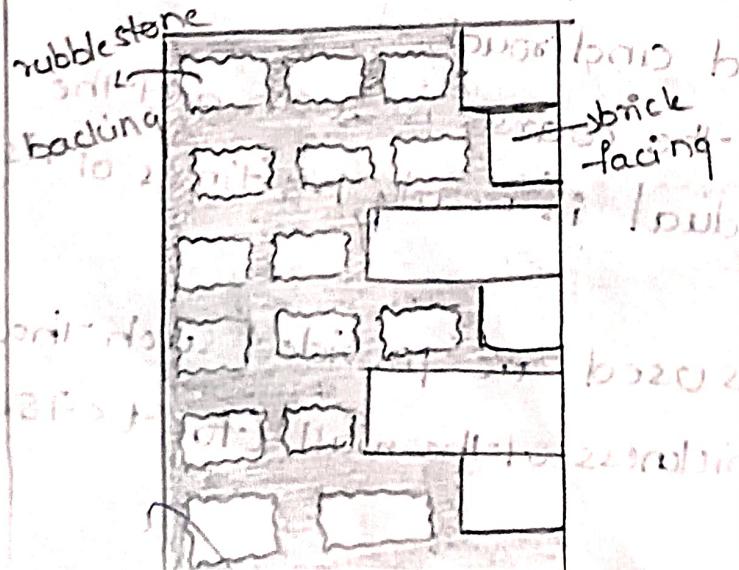
In this type of composite masonry, stone are used for facing and bricks are used for backing
* The backwork can also be carried out using concrete (or) rubble masonry.
* The faces of the stone provided in facing are generally chamfered and rough.
* the min height of the coarse is 20 cm and the width of an individual is nearly 1.5 times of its height
* The bond stones used are provided such that they cover full thickness of the wall (for t ≤ 750m)

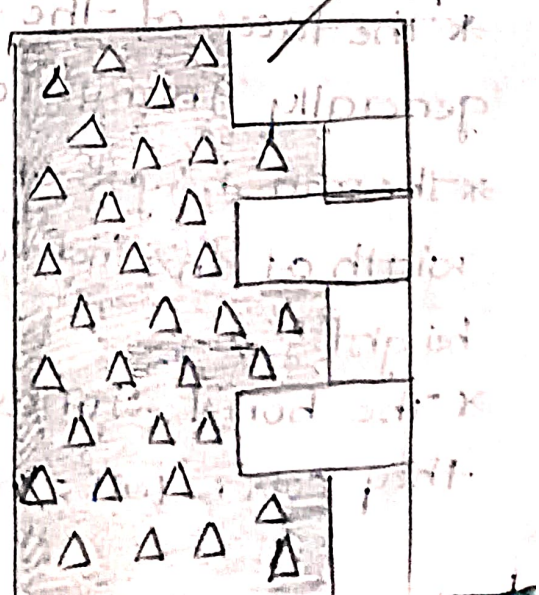
for walls having More than 45cm on overlapping thickness of 15cm is maintain blw each of the two stones.

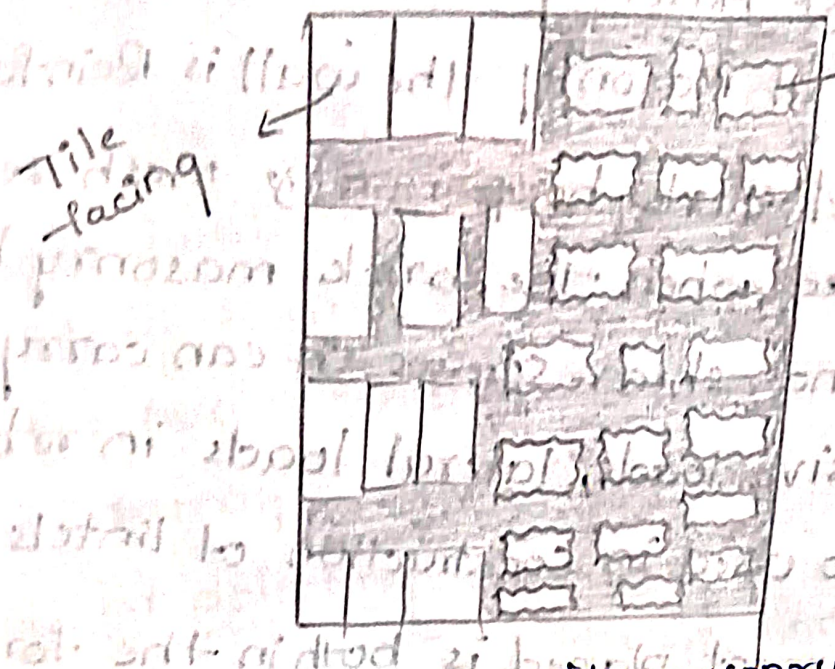


(Brick facing and Ashlar facing masonry).

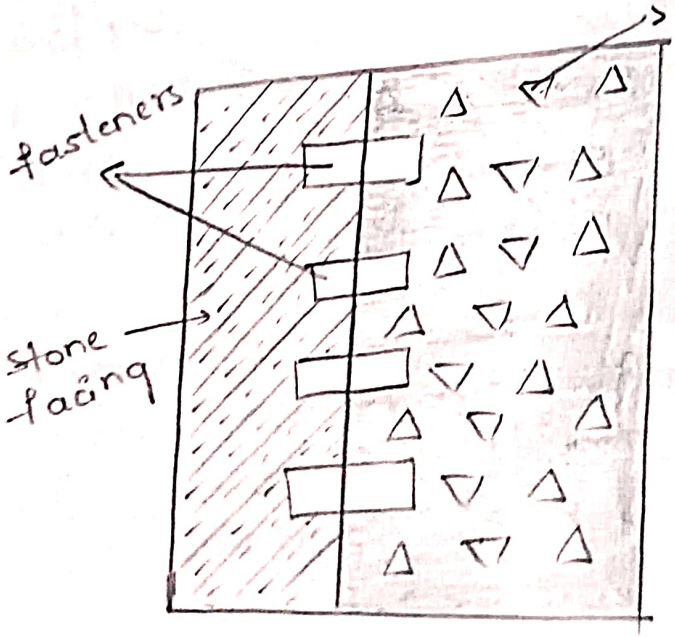
* This type of composite masonry construction uses bricks cor) glazed tiles as facing which are specially made for the purpose.
* The backing materials used may be brick, rubble cor) concrete
* In labatory blocks cor) other similar construction terra-cota tiles are commonly used
* This construction is preferred in to the areas, where rubble stones are available in abundance.







* In this type of composite masonry, the stone facing is provided such that even the backing as brick masonry appears to be constructed stone.
* This masonry instead being in expensive, gives the wall as aesthetic appearance.
* The thickness of the stone slabs used may Exceeds .5 to 10'c and the backing and facing properly secured to other. The stone blocks are finished well, fine dressed and can be made of marble.



1-11-25

* ## Reinforced brick Masonry

In this type of Masonry the wall is Reinforced with mild steel flats, hoop iron & mesh reinforcement. It is used when the brick masonry has to bear tensile and shear stresses it can carry heavy compressive loads, lateral loads in retaining walls and also used in construction of lintels

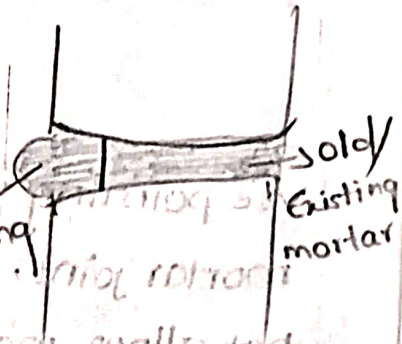
* The reinforcement placed is both in the form of horizontal & vertical reinforcement. In horizontal reinforcement the bond blw brick & mortar can be improved by using steel meshed strips called as "Exmet". vertical reinforcement is used for columns and the meshed reinforcement used heat is called as "bricklor". first cls bricks are used for optimum uses of all the materials like mortar & reinforcement.

* pointing

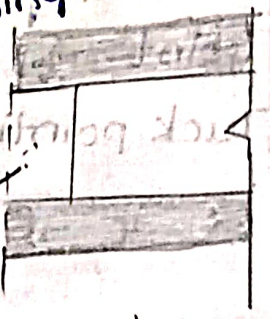
pointing is a process of finishing the mortar joints in brick Masonry or stone Masonry by filling it with fresh mortar. It prevents water from entering the Masonry and causing frost damage.

Types of pointing

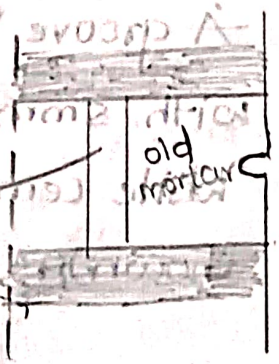
Beaded pointing :- Beaded pointing is obtained with the help of steel or iron rod with concave edge. It looks good in appearance but difficult to maintain.



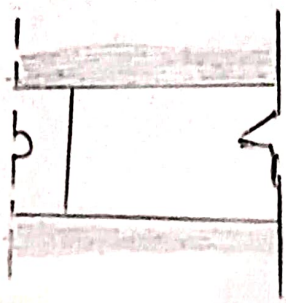
Flush pointing :- Flush pointing is achieved removing excess mortar from the joint & aligning with the face of the wall it is mostly common used because of its high durability & less maintainance.



Recessed pointing :- The vertical face of the pointing is pushed inside the wall at a depth ≥ 5mm it can be done with the help of any suitable tool.

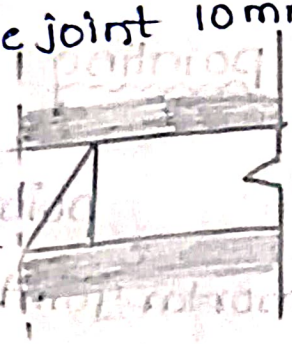


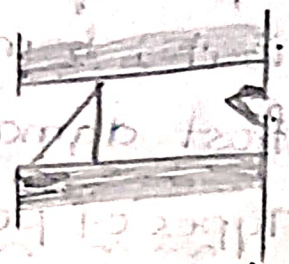
grooved pointing :- A groove is formed in the central portion at the mortar joint it is widely used pointing after flush pointing.



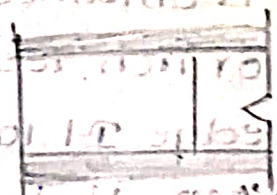
Struck pointing :- The upper edge of the joint 10mm inside widely the lower edge alinging the face of the wall.

* If the lower edge is also pressed in the the masonry edge wall it is called over hand struck point.



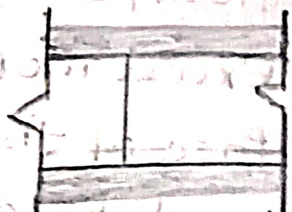


Vee pointing :- A 'V' shaped groove is made the mortar joint, It is also easy to maintain as it does not allow water to collect at the joint



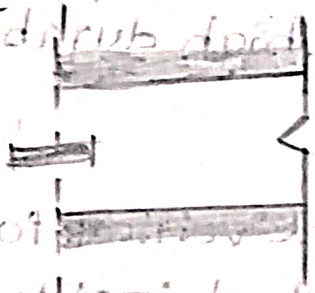
Vee pointing

Weathered pointing :- outward or inverted vee groove is made in the mortar joint



weathered pointing

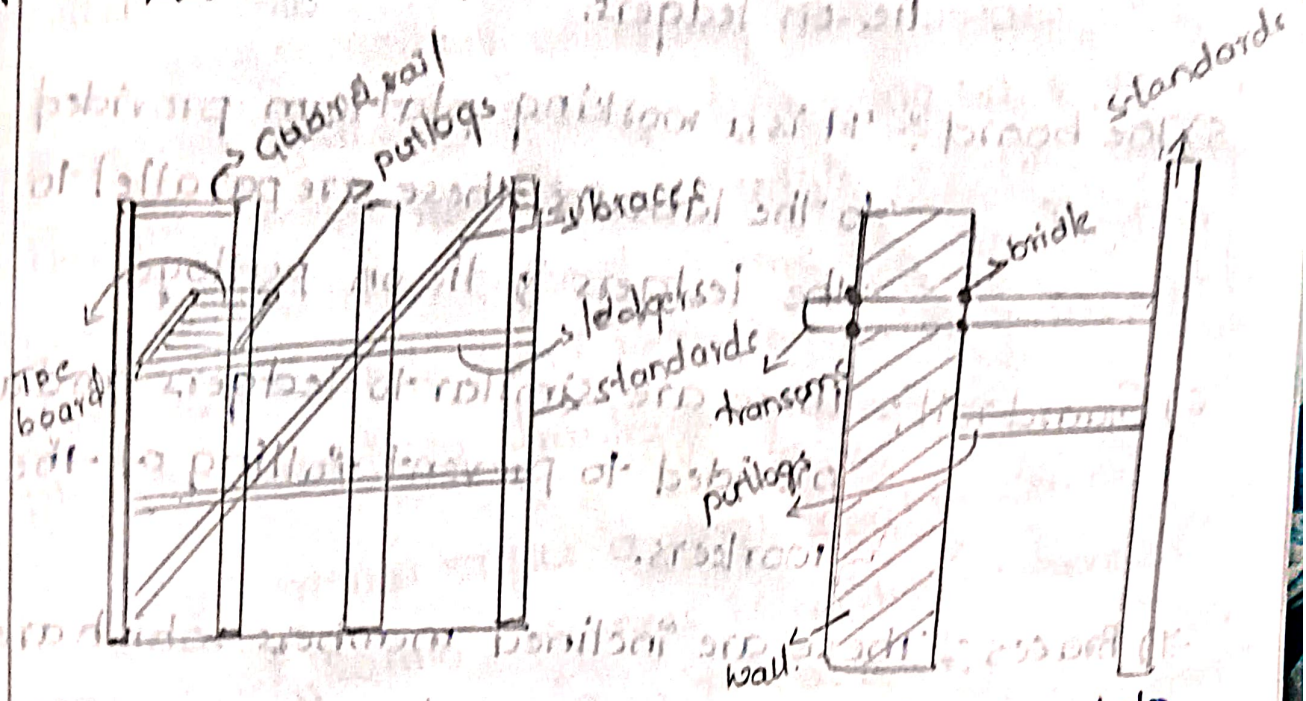
Tuck pointing :-



A groove is formed at the center of the joint with 5mm width & 3mm depth & filled with white cement putty with a projection of 3 mm as shown in fig.

Scaffolding - Components

29-10-25



A temporary frame work constructed to support concrete form work are work main and to store building materials like paints, and also repair of buildings. They are generally build around the perifary of building and goes upto sertain height in case of multi-stored building.

Components of Scaffolding

1) standards :- These are the vertical members parallel to the wall & perpendicular to ground.

2) ledger :- These are the horizontal members parallel to the wall & are fixed to standards and putlogs.

3) putlog :- putlogs are transoms members placed at right angles to the wall with one end fixed to ledger & other end fixed to the wall.

4) Transoms :- transoms are putlogs whose both ends lie on ledgers.

5) Toe board :- It is a working platform provided to the labours. these are parallel to the ledgers & lie on putlogs.

6) Guard rail :- These are similar to ledgers and are provided to prevent falling of the workers.

4) Braces :- These are inclined members which are secured on standards.

8) Bridle :- These are provided at the wall openings and this support one end of the putlog.

Timber Scaffolding

The timber members are placed in respective positions & frame work is made rigid with the help of ropes the joints have to be checked periodically for tightness throw the initial cost is less continous inspection is required for the safety of workers.

tubular | steel scaffolding

This similar to timbers scaffolding except the ropes are replaced by couplings. It possess high resistance to fire & can be Adected & dismantile. It is mostly used for heavy concrete structures & economically in the long run.

* plastering

It is a method of hiding the surface of external walls or seilings by mixing up, varies building materials like cement, lime, fine aggregate (sand) & water. Cement or lime act as binding materials while sand helps in proriding properties like resistant to shrinkage & porosity.

For interior works a single coat of cement mortar of 20mm thickness is applied whereas for external works 2 or 3 coats of mortar are applied. The first coat is called as "rendering coat" second coat is called as "floating coat" & the final coat is called "finishing coat". rendering is generally used as 12mm thickness coat of 1:4 (1 of cement 4 of sand) finishing or floating coat 8mm thickness and 1:1 (1 of cement, 1 of sand) cemet or lime mortar.

Applications of plastering

* It makes the surface smooth & durable
* It protects the surface of wall from rain water penetration
* It helps to hide intirior materials or defective works
* It provides resistance to dust & give decorative effect to interior or exterior walls.

* Types of plastering

The various types of plaster finishes are as follows,

i) Textured finish.
ii) sand faced finish
iii) scrapped finish
iv) smooth cast finish
v) Roughcast finish (spatter dash finish)
vi) pebble dash (dry dash) finish
vii) Depeter finish.

i) Textured finish :- Textured finishing done while carrying out stucco plastering. Textured surface are made by applying the final coat of stucco plastering with the help of suitable tools.

ii) sand faced finish :- Two coats of plastering is sand faced finish. The first coat is provided with 2cm-3cm and with the ratio 1:4 cement sand mortar applied for the thickness of 12mm. After curing the first coat for 7days the second coat is done and the ratio of 1:1 cement and mixed is applied for the thickness of 8mm.

iii) scrapped finish :- scrapped finish is applied with the thickness of final coat ranging from 6 to 12mm. After the stiffening of final coat for few hours, the surface is scrapped in patterns for a height of 3mm with the help of steel straight edge, old saw blade. The surface which is crapped is less liable to cracking.

iv) smooth cast finish :- smooth and levelled surface is obtained by smooth cast finish. Mortar is applied in the ratio 1:3 cement sand mix with the help of wooden float.

v) Rough cast finish (spatter Dash finish)

In rough cast finish mortar containing five sar and coarse aggregate is applied in the ratio 1:1.5: The size of coarse aggregate lies blw 3m to 12mm Mortar is dashed with the help of large trowel against the plastered surface and then the surface is finished roughly with the help of wooden float. Rough cast finish is water proof, durable and resistant to crazing and cracking. This type of finish is used for outer rendering.

* Form Work

It is a temporary reusable mould used in construction works to give a shape & support wet concrete until it hardens and gain sufficient strength on its own.

requirements of form work

* The design of form work should be accurate in order to achieve desider shape, size & finish of a structure.
* The inside surface of a form work is coated with crude oil or soap solution to provide smoothness such that the wet concrete does not stick & create a problem while stiping of the form work
* The strength of form work is also a important criteria as it has to bear loads such as dead weight of concrete, weight of the equipment used and weight of the workers.
* The form work should be rigid & should not deform under any loading conditions.

* The joints blw the adjacent sections should be fixed to remove the leakage through it.
* The form work material should be cheep & easily available at the siet for better economy.

* removal of form work.

	Slabs	Beams
with props, left under,	3 days	7
Removal of propes i) span upto 4.5m (6m)	7	14
ii) >4.5m (6m)	14	21

1-11-25

* Types of form Work

1) Timber formwork:- The timber formwork is generally used in places where less repetitions are required and the work is small. The timber form work are 10 to 12 times which is very much less when compared to steel formwork.
* It should be well seasoned, free from knots, light weight and workable.
* The timber used should possess a moisture content of about 20%.

* The timber sections sizes and dimensions are adopted with respect to the loads to be carried and the availability of the timber sections.
* Finally, the timber used in the formwork for exposed concrete works should posses levelled and smooth surfaces on all the faces, to provide an even and well dressed surface.

2] Steel form work :- The steel formwork is used at places where the shuttering is desired to be used repeatedly. The reusability of steel formwork is nearly 10 to 12 times more than the timber formwork. Type of shuttering is used for heavy works where great efficiency is required.

advantages of steel form work.

i) steel formwork is more strong and durable compared to timber formwork and hence can bear larger loads

ii) It greately saves the labour cost because of its simple installation and dismantling processes.

The other formworks such as plywood formwork precast concrete formwork, fiber glass formwork and aluminium formwork are also excessively used now-a-days, besides the timber and steel forworks.

* Shoring

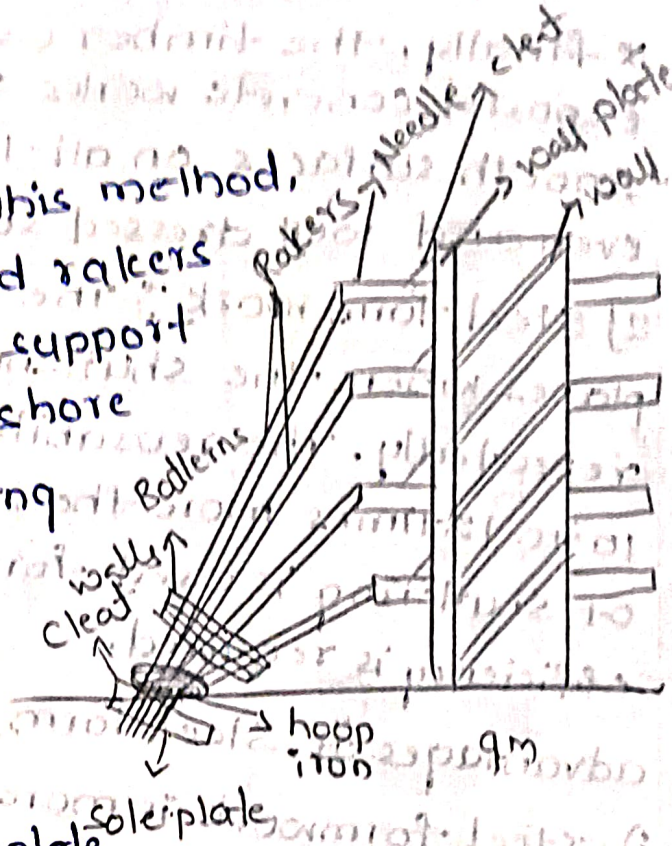
Shoring is the construction of a temporary structure to support temporarily an unsafe structure. These are under lateral support of the walls.

Types of shorings

* Raking shores
* Flying shores
* Dead shores

i) Raking shores :- In this method, inclined members, called rakers are used to give lateral support to the wall. A raking shore consists of the following components:

i) rakers or inclined members ii) wall plate iii) needles iv) cleats v) bracing and vi) sole plate.

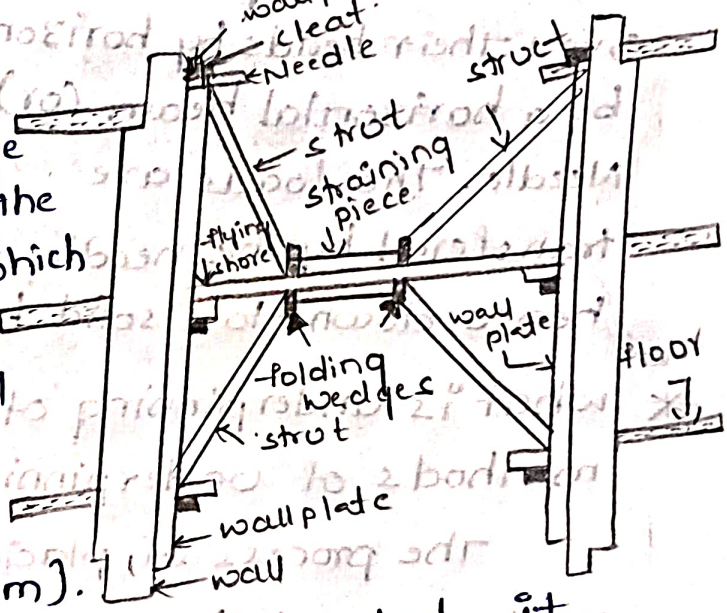


* The wall plate, about 20 to 25 cm wide and 5 to 5cm thick placed vertically along the face of wall is secured in the needle of 10cm x 7.5cm section. The needle penetrate 10cm.
* Rakers abut against the needles in such a way that the centre line of the raker and wall meet at the floor level.
* Rakers are interconnected by struts, to prevent their buckling.
* The feet of rakers are connected to an inclined sole plate, embedded into the ground of iron dogs.
* The wall plate distribute the pressure to the wall uniformly.

* Rakers should be inclined to the ground by 45 to make them more effective.
* The top raker should not be inclined steeper than 75°
* the centre line of a raker and the wall should meet at floor level.
* The longer length of the wall needs support, shoring may be spaced at 3 to 4.5 m.

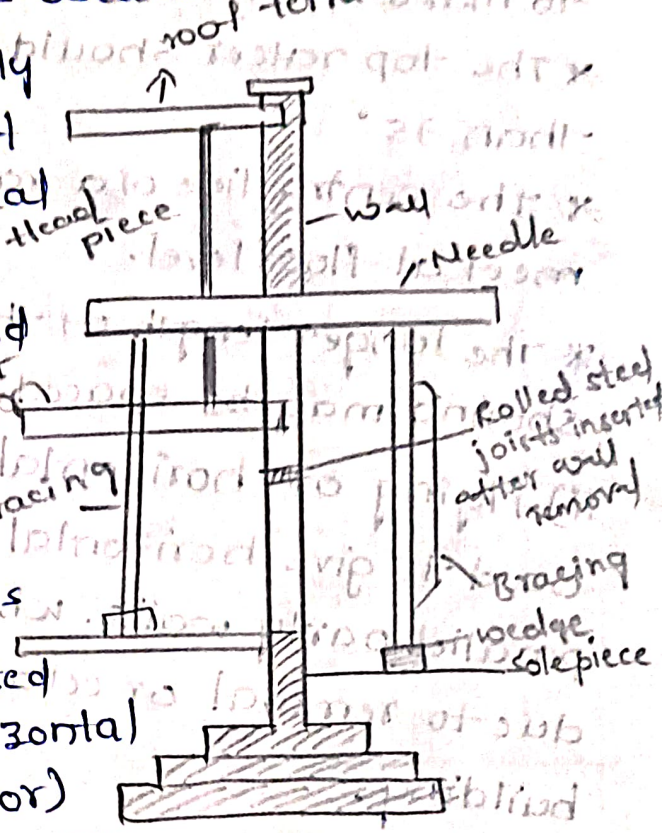
ii) flying or horizontal shores :- such shores are used to give horizontal support to two adjacent parallel party walls. which have become unsafe due to removal or collapse of the intermediate building.

* All types of arrangements of supporting the unsafe structure in which the shores do not reach the ground fall under this category.
* wall are near to each other (distance up to 9m).
* single flying shore can be constructed, it consists of wall plates, needles, cleats, struts, horizontal shore, straining pieces and folding edges.



iii) Dead Storage shores:-

This type of shoring is used to dead loads that vertically downwards. In its simplest form it consist of a vertical prop (or) shore leg with a head plate, sole plate, and some means of adjustment for tightening and easing the shore. The usual arrangement is Use two more legs connected over their heads by horizontal by a horizontal beam (or) Needle. The loads are transfered by the needle to the shore legs and hence down to a solid bearing surface.



what is underpinning of structure? Explain the methods of underpinning?

The process of placing a new foundation under an existing one (or) strengthening and Existing foundation.

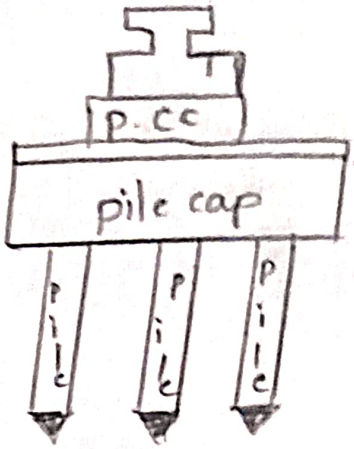
* The underpinning is done by two methods.

i) pile method. ii) pit method.

i) pile method

* piles are driven at regular interval
* piles are connected by concrete (or) steel.

* These beam incidentally act as pile cap.
* Used in clay soil & water logged areas.



pit method

* Old wall is supported by a bearing plate, steel beam and jerks.
* Excavation upto new depth is carried out
* foundation is provided
* pcc (1:2:4) is provided for new foundation.
* For proper joint blw old & new work strengthening vertical steel bars may be added.

