2021

BUILDING MATERIAL

Brick

Composition of good brick earth: ASLOM

1) Alumina:

- Chief constituent of every kind of clay. It is a combination of silt and clay.
- Good brick earth and contain about 20 to 30% of alumina.
- It imparts plasticity to the earth it can be molded.
- If alumina present in excess with inadequate quantity of sand, the raw brick shrink and warp during drying and burning.

2) Silica:

- It exist in clay either as free or combined.
- It is mechanically mixed with clay and in combined form, it exists in chemical composition with alumina.
- 50 to 60% of silica
- Presence of this constituent prevents cracking, warping, shrinking and warping of raw bricks.
- It imparts uniform shape to the brick.
- Excess of silica destroys cohesion between particles and the brick become brittle material.

3) Lime:

- Small quantity of lime and not exceeding 5% is desirable.
- It should present in very finely powdered state.
- Lime prevents shrinkage of bricks.
- Excess of lime cause the brick to melt and hence its shape is loss.

4) Oxide of iron:

- 5 to 6% is desirable in good brick earth.
- It also imparts red colour to the bricks.
- Excess of iron make the brick dark blue or blackish.
- If quantity is less, bricks will be yellowish in colour.

5) Magnesia:

- Small quantity of magnesia in brick earth imparts yellow tint to bricks and decreases shrinkage.

But excess of mg lead to decay of bricks.

Harmful ingredients in Brick earth:

i) Lime:

ii) Iron pyrites:

- Bricks are crystallized and disintegrated during burning.

iii) Alkalies:

- potash and soda.
- Act as flux, helps to fuse. If excess- twist, warp and bricks are melted and loose their shape.
- It causes efflorescence.

iv) Pebbles/ grit:

- It will not allow the clay to mix uniformly. - weak or porous bricks.

v) Vegetation and organic matter:

- This material is not completely burnt, the bricks becomes porous.

Manufacturing of Brick:

1) Preparation of clay:

a) Unsoling: Top layer of soil, about 200mm in depth is taken out and thrown away. This soil is rejected because top soil is full of impurities.

b) Digging: Clay is then dug out from the ground. Height of clays is about 600mm to 1200mm.

c) Cleaning: Should be cleaned of pebbles, stones, vegetable, matter etc. Lump are converted into the powder.

d) Weathering: Clay heaps is exposed to atmosphere for softening or mellowing. Period of expansive many varies from few weeks to full season.

e) Blending: Clay is made loose and any ingredient to be added to it is spread out at its top. Blending indicates intimate or harmonious mixing.

f) Tempering: To make soil mass plastic & to get maximum dry density with less voids, the operation to mix certain amount of water & mixing the soil to a homogeneous mass.

I. By kneading
II. In pug mill

Note:

For manufacture good brick on large scale, tempering is done in pug mill. A typical pug mill capable of tempering sufficient earth for a daily output of about 15000 – 20000 bricks. Process of grinding clay with water and making it plastic is known as pugging. Whereas kneading is done by feet.

2) Moulding: It is of two types (I) Hand Moulding (II) Machine Moulding Further hand moulding sub divided into ground moulding and table moulding.

Moulds are rectangular boxes of steel and wood which are open at top and bottom.

Brick shrink during drying and burning. Hence mould are to be made larger than size of fully burnt brick. Moulds are made longer by about 8 to 12%, in all directions. 10 mm thick wooden moulds of shisham wood are generally used whereas 5mm thick steel moulds are used.

Ground moulded bricks:

Ground is made level and fine sand is sprinkled over it. The mould is dipped in water and placed over ground clay is taken and pressed or force in the mould in such a ways that it fills all the corner of mould extra material is removed by the wooden strike, metal strike and wire.

- In 8 hour, brick molder can mould about 750 brick/day.

3) Drying:

- Brick are dried before they are taken for next operation of burning.
- Stack consists of 8 to 10 tiers. Brick are laid along or across the stock in alternate layers. Brick placed on edge. Brick should be allowed to dry till they become hard to moisture content of about 2% or so.

a) Artificial drying: Brick are generally dried by natural process. But in this case, Bricks are allowed to pass through special dryers, which are in the form of tunnel or hot channels or floors temperature < 120^0C. Time required 1 to 3 days.

b) Circulation of air: Brick in stack should be arrange in such a way that sufficient air space is left between them for free circulation of air.

c) Drying yard: An arrangement would prevent the accumulation of rain water & protected from direct sunlight .

d) Period of drying: 3 to 10 days for dry.

e) Screens: Not directly exposed to the wind or sun for drying. Suitable screen may be provided to avoid such situations.

4) Burning:

Imparts strength and hardness to the bricks and make them dense and durable. Brick should be burnt properly. If over burnt, they will be brittle and hence can break easily. If they are Underburnt, they will be forts and cannot carry loads.

If temperature exceeds 1100˚C, Bricks are to be vitrified. Bricks are begin to loss their shape beyond a certain limit of vitrification.

Clamps	Kiln burning
1) 20000 to 100000 bricks can be prepared at a time. **2)** Cow dung used as fuel **3)** Initial cost is low **4)** % of good quality brick is small as 60% or so. **5)** Not possible to control or regulate fire. **6)** Require 2 to 6 months for burning and washing of bricks. **7)** Wastage of heat is more.	**1)** Average bricks 25000 can be prepared per day. **2)** Coal dust is to be used **3)** Cost is high as permanent structure is to be constructed **4)** % of good quality brick is more about 90% so. **5)** Fire is under control throughout the process of burning. **6)** 24Hours and 12days for cooling of bricks. **7)** Wastage of heat is loss.

Bull's trench kiln	Hoffman kiln
1) 3 lakh in 12 days	**1)** 40 lakh in 1season.
2) It is under grounded circular, rectangular or oval shaped chamber so Stop functioning during monsoon.	**2)** It is circular shaped, Function all year round as it is provided with a permanent roof.
3) Cost of fuel is high as consumption is more.	**3)** Low of consumption of sand is less
4) Require more space for drying	**4)** Less space
5) Initial wet low	**5)** High
6) More popular due to less wet.	**6)** Less popular because of high initial cost.
7) % of Good quality brick is small.	**7)** More

Tunnel kiln:

In the form of tunnel which may be straight, circular, oval in plan.

5) Unloading - 12 days after burning

Qualities of good bricks:

1) Should be table moulded, well burnt, copper coloured, free from cracks with sharp and square edges. The colour should be uniform and bright.
2) Standard size, give clear metallic ringing sound, when stuck each other.
3) Should not absorb water more than 20% by weight for 1st class brick. 22% for 2nd class bricks. When soaked in cold water for a period of 24hours.
4) Brick should be sufficiently hard. No impression should be left on brick, when scratched with finger nail.
5) Should not break, into pieces when dropped flat on hard ground from a height of about one meter.
6) When soaked in water for 24H, doesn't show deposits of white salts.
7) Brick should have low thermal conductivity and should be sound proof.

***Note**

1) **Shape and size:**

- Shape should be truly rectangular.
- For thin 20 bricks of standard size (190mm X 90mm X 90mm) are selected random.

  Length → 3680mm to 3920mm

  Width → 1740mm to 1860mm

  Weight → 1740 to 1860mm

2) Presence of soluble salts:

- If soluble salt present cause efflorescence on the surface of bricks.
- For finding out, brick immersed in water for 24H. then dry the brick in shade. Absence of grey of white deposits indicate absence of soluble salts.
- If white deposits cover 10% the efflorescence is to be slight. If cover about 50% of surface, considered as moderate. If cover more than 50%, Considerd as serious, efflorescence becomes easily.

Classification of bricks:

i) Burnt bricks

ii) Unburnt on sundried bricks.

First class brick:

Bricks are table moulded and of standard size. Burnt in kilns surface and edges of bricks are sharp, square, smooth and used for superior work of permanent nature i.e. load bearing wall. Crushing strength 100 to 105 kg/cm^2. Water absorption not more than 20% & desirable 15% of its dry weight.

Second class brick:

- Ground moulded and burnt in kilns.
- Surface is somewhat rough and shape is slightly irregular.
- Brick may have hair cracks and edge not sharp or may not be uniform.

- Used where brick work is to be provided with a coat of plaster i.e. internal surface, shurki.
- Crushing strength is about 75kg/cm^2 & water absorption 22 to 23% off its dry weight.

Third class brick:

- Ground moulded and burnt in clamps.
- Bricks are not hard and have rough surface with irregular and distorted edges.
- Give dull sound when stuck each other. Used for unimportant and temporary structure at places where rainfall is not heavy.
- Crushing strength is about 50kg/cm^2 & water absorption 25 to 27% off its dry weight.

Fourth class brick:

- Over burnt bricks, with irregular shape and dark blueish colour.
- These bricks are used as aggregate for concrete in foundations, floors, roads etc.
- Sometimes these bricks are found to be stronger than even the first class brick. Crushing strength for picked jhama – 240 kg/cm^2

  Over burnt - 350 kg/cm^2

Size and weight of brick: As per **IS 1077 – 1970**

Standard size → 190mm X 90mm X 90mm

Nominal size of modular brick → 200mm X 100mm X 100mm

Nominal size of brick includes the mortar thickness of 10mm .

Average weight of brick will be about 30 to 35N and weight of $1m^3$ of brick earth is about 18KN.

Frog - Depression on top of brick to make a key for mortar.

Size → 100mm X 40mm X 18mm

Shape of bricks:

Ordinary bricks are of rectangular shape.

i) **Bullnose bricks:**

Brick moulded with a rounded angle is termed as bullnose. It is used for rounded quoin.

ii) Channel bricks:

Bricks are moulded to the shape of gutter or a channel and they are often glazed.

Brick are used to function as drains.

iii) Cownose brick:

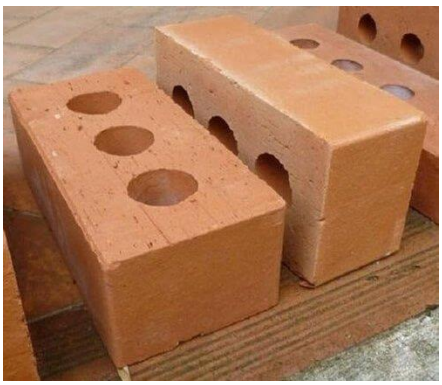
A brick moulded with double bullnose on end is known as a Cownose.

iv) Curved sector bricks:

In the form of curved sector and are used in the construction of circular brick masonry pillars, bricks chimneys.

v) Hollow bricks:

- Known as cellular or cavity bricks.
- Such brick have wall thickness of about 20mm to 25mm.
- Prepared from spiral homogenous clay.
- Less in weight about 1/3rd of ordinary brick of the same size.
- Lead to speedy construction.
- Used in construction of brick partitioning.



vi) Paving brick:

- Prepared from clay containing a higher % of iron it resist wear & tear.
- Resist better the abrasive action of traffic.
- Used for garden walks, street pavements, stable floors etc.

vii) Perforated Bricks:

- Contains cylindrical holes throughout their thickness.
- Used in the construction of brick panels for light weight structures and multistoreyed framed structures.
- Perforation may be circular, square, rectangular etc.

- Water absorption should not exceed by 15% of weight.
- Compressive strength should not be less than 7N/mm^2 .

Fire clay:

- Is refractory clay which is capable of resisting of high temperature without being melted or softened.
- Two main constituent are alumina or silica.
- Alumina → 25 to 35%
- Silica → 75 to 35%

1) High duty fire clay → 1483^{0}C to 1648^{0}C

2) Medium duty fire → 1315^{0}C to 1483^{0}C

3) Low duty fire clays → Upto 870^{0}C only

Fire bricks:

- Made from fire clay.
- Burning and cooling is done gradually.
- Used for livings of interior surface of furnace chimneys, kilns, ovens, fire places etc.
- Compressive strength → 200 to 220N/mm^2 and percentage of absorption for these varies from 5 to 10%.

Three varieties of fire bricks:

A) Acidic bricks: **Acid brick** or **acid resistant brick** is a specially made form of masonry brick that is chemically resistant and thermally durable**.**

It is of two types-

1) Ordinary fire bricks:

2) Silica bricks

B) Basic Bricks: Magnesite (or Basic Bricks) is based on magnesium oxide (MgO) and calcium oxide (CaO). Generally, basic materials offers very great high-temperature properties, along with good resistance to basic slags, making the material very useful as refractory for the steel, iron and cement industry.

C) Neutral bricks: These bricks are used for neutral lining. They offer resistance to corrosive action of slags and acid fumes. As compared to the basic bricks, the neutral brick are more inert to the slags.

i) Chromite bricks:

Prepared from a mixture of chrome, iron ore, ferrous oxide, bauxite and silica. Unaffected by the acidic or basic actions.

ii) High alumina bricks:

These bricks contain more amount of alumina and found to be more inert to the slags.

Substitute bricks:

Our country needs 60billion and lead to erosion of fertile soil, degradation of soil and disturbance in ecology.

i) Concrete blocks

ii) Fly ash bricks – Fly ash is a waste from thermal power plant, Brick made with mixing lime + cement + magnesia + fly ash and cured known as fly ash brick.

iii) Sand lime/Calcium silicate bricks

Lime

1) **Calcination:** Heating to redness in contact with air.

2) **Hydraulicity:** It is the property of lime by which sets in damp places, water or thick masonry works where there is no circulation of air.
3) **Milk of lime :** A thin fluid from suspension of select lime.

4) **Lime:** $CaCO_3 \xrightarrow{\text{Calcination}} CaO + CO_2$
(Limestone) (Lime)

5) **Quick lime:**

- Lime obtained by calcination of pure lime over 900°C temperature
- Have great affinity for water.
- Amorphous in nature
- Have no affinity for carbonic acid
- Also called caustic lime
- Quick lime as it comes out from kilns is known as lump lime.

6) **Slaking:**
Process of addition of water to quick lime is known as slaking.

7) **Hydrated/Slaked lime:**
$CaO + H_2O \xrightarrow{\text{Slaking}} Ca(OH)_2 + \text{Heat}$
Quick lime Slaked lime

- Rise of temperature accelerates the slaking process.
- Can be carried out speedily by steam under pressure in closed drums.
- Slaked lime shouldn't be stored in damp places.

Classification of limes:

1) Fat lime/High calcium lime/Pure lime/Rich lime/White lime:

- It slakes vigorously and its volume is increased to about 2 to 2.5 times the volume that of Quick lime.
- Prepared from pure lime stone (impurities < 5%)
- Hardens very slowly, have high degree of plasticity, sets slowly in presence of air (CO_2).
- Used in white washing and plastering walls.
- White in colour and soluble in water.

2) Hydraulic lime/Water lime:

- It sets under water use in masonry wall below G.L & foundation of flooring.
- Consist of impurities like clay and some amount of ferrous oxide.
- On the basis of %age of clay it is divided into three types
  a) Feebly hydraulic lime → Clay 5 – 10%
  b) Moderately hydraulic lime → Clay 11 – 20%
  c) Eminently hydraulic lime → Clay 21 – 30%
- With increase of clay content slaking time also increases.
- With increase of clay content setting time and solubility in water decreases.
- Strength is more than fat lime due to clay content.

3) Poor lime/Lean lime:

- Contains clay > 30%
- It sets very slowly
- It has poor binding properties and its colour is muddy white.
- Use for interior work

Physical properties:

- Pure lime stone is indicated by white colour (SP. gr - 1.6 & size 0.25mm - 0.50mm).
- Hydraulic lime stones are indicated by bluish grey, brown or some dark colour.
- Taste of hydraulic lime is clayey with earthy smell.
- Presence of glistering particles on surface of lime stones indicates the presence of free sand.
- Presence of lumps gives indication of quick lime or unburnt limestone.

Note:

As per BIS: 712 – 1984 (Third revision) building limes are categorized into 6 categories.

1) Class A → Eminently hydraulic lime
2) Class B → Semi – hydraulic lime
3) Class C → Fat lime
4) Class D → Magnesium or dolomitic lime
5) Class E → Kankar lime
6) Class F → Siliceous dolomitic lime

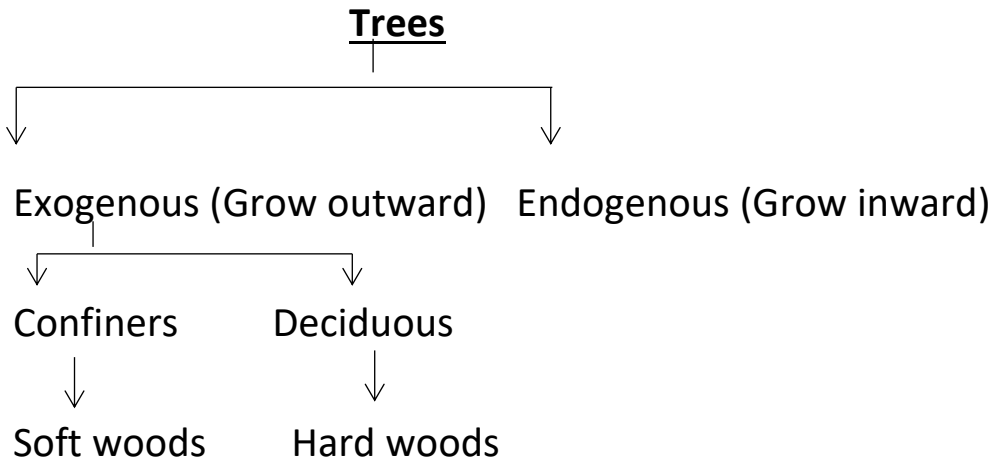
Note:

The presence of magnesium carbonate in lime allows lime to slake and set slowly but impart strength to lime.

- **Shell lime -** More than 95% purity after calcining of sea shells. It is the best lime used for white washing and lime punning .

Timber

1) Classification of trees:



Endogenous trees: These trees grow inwards and fibrous mass is seen in their longitudinal sections. The timber having this type, has very limited engineering applications e.g. Bamboo, cane, palm etc.

Exogenous: These trees increases in bulk by growing outwards and distinct consecutive rings are formed in the horizontal section of such a tree.
These are known as annular rings and one such ring is added every year and these rings are useful in predicting the age of tree.
Further subdivided

i) Confiners (Deoder)

ii) Deciduous (Teak, shishum, sal)

Confiners: are known as ever green trees and leaves of this tress do not fall till new ones are grown. These tree yield very soft woods, which are generally light coloured, resinous, light in weight and weak.

Deciduous: known as the broad leaf trees and leaves of these tress falls in he autumn and new one appear in spring season. Tree yield hard woods, which are usually close grained, strong, heavy, dark coloured and non resinous. They do not show annular rings.

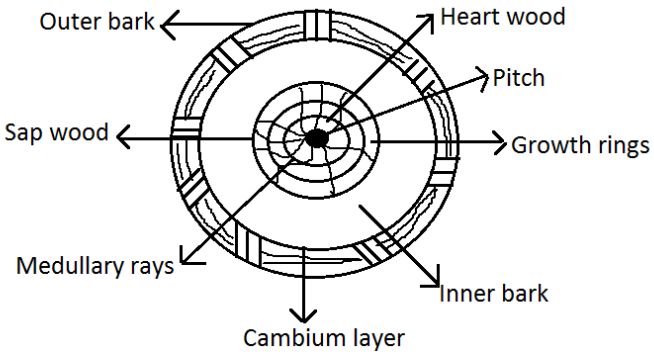
Soft woods: e.g. Chir, deodar, tar, kais, pine sprue etc.

Hard wood: Babul, oak, Sal, teak, maloong etc

Structure of tree:

Tree basically consist of three parts i.e. trunk, crown, and roots. Function of trunk is to support the crown and to supply water and nutrients from the roots to the devices through branches and from leaves to the roots. Further subdivided in two arts.

1) **Macrostructure:** The structure of wood, visible to naked eye or at a small magnification is called the macrostructure.



a) Pith:

- Inner most, central position or core of the tree is called the pitch or medullar.
- Vary in size and change for different trees.
- Plant becomes old, the pitch dries leads to decays.

b) Heart wood:

- Inner annual rings surrounding the pitch constitute heart wood.
- Dark in colour and imparts rigidity to the tree.

c) Sap wood:

- Outer annular rings between heart wood and cambium layer is known as sap wood.
- It is light in weight and colour also known laburnum.

d) Cambium layer: Thin layer of sap between sap wood and inner bark is known as cambium layer.

If the bark is removed for any reason, then the surface of exposed and cells cease to be active resulting in the death of tree.

e) **Inner Bark:** Inner skin or layer covering the cambium layer is known as the I.B. Give protection to C.L from any injury.

f) **Outer Bark:** Outer skin or cover of tree is known as the outer bark, it is the outermost protective layer and contains cracks and failures.

Medullary rays: The thin radial fibres extending from pitch to cambium layer is known as the medullary rays.

Seasoning of timber:

- When new tree is felled it contains 50% or more of its own dry weight as water. The process of drying timber is known as seasoning of timber.
- Wood is hygroscopic material capacity of wood to absorb water vapor from air is called hygroscopicity of wood.

i) Objects of seasoning:

a) To allow timber to bun readily.
b) Decrease the wt. of timber and lower the coil of handling and transport.
c) Impart strength, hardness, stiffness and better electrical resistance to timber.
d) To make safe from attack of fungi and insects
e) To reduce tendency of timber to crack, shrink and warp.

Method of Seasoning

Natural of seasoning : Timber are cut and stacked in layers, Seasoning is carried out by natural air. Moisture content of would brought down to 10-20%, method is cheap, used for section having thickness up to 100mm i.e thin section. Process is slow, it usually take 60 to 90 days to make timber fit for the work of carpenter.

Artificial seasoning : Various methods are:

i) Boiling
ii) Chemical seasoning
iii) Electrical
iv) Kiln
v) Water

Natural seasoning	Artificial seasoning
1) Difficult to decrease the moisture the content below 12 to 15% **2)** Simple and economical. **3)** More liable to attacks of fungi and insets. **4)** Require more space for stacking. **5)** Slow process 60 to 90 days **6)** Gives stronger timber	**1)** Reduce at any desired level. **2)** Expensive and quite technical. **3)** Less timber to attack of fungi and insects **4)** Less space **5)** Quick process 4 to 5 days **6)** Give little weaker timber up to 10% strength losses.

Preservation of timber:

Carried out to achieve the following objects:

i) To increase the life of timber structure.

ii) To make timber structural durable.

iii) To protect the timber from the attack of destroying agency such or fungi or insects etc.

Types of preservatives:

1) ASCU treatment

i) ($AS_2O_5.2H_2O$) Arsenic pent oxide

ii) ($CuSO_4.5H_2O$) Copper sulphate

iii) ($K_2Cr_2O_4$) Potassium dichromate

2) Chemical salts

3) Coal tar

4) Creosote oil

5) Oil paints

6) Solignum paints

*Fire resistance of timber is done by sir ABEL'S process.

Market product of timber

Fibre boards:

Rigid board and allow known as pressed wood or reconstructed wood.

Thickness $\rightarrow$ 3mm to 12mm

Length $\rightarrow$ 3m to 4.50m, Width $\rightarrow$ 1.20m to 1.50m

Hard board:

Made from wood pulp which is compressed to make sheet of usually of 3mm thick. Width is usually 1.2m and length varies from 1.2m to 5.5m

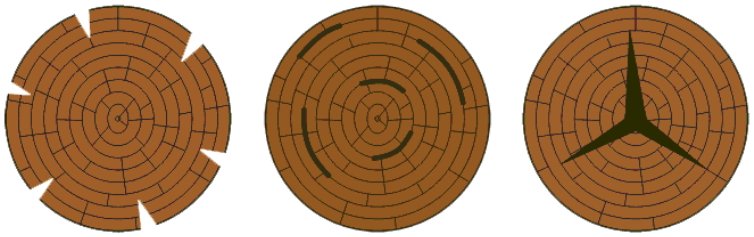
- **Ply wood:** Ply is a thin layer. Plywood is boards, which are prepared from thin layers of wood or teak veneers. The three or more veneer are placed in odd numbers are above each other, with direction of grains of successive layer at right angle to each other. They are held in position by suitable adhesives. The placing of veneers normal to each other increases the longitudinal and transverse strength of plywood.
- While during giving, pressure may be applied on veneers. The pressure may either be applied cold or hot. Temperature $\rightarrow$ 150°C to 260^0C. For cold temperature $\rightarrow$ room temperature. The pressure applied on plywood varies from 0.70 to 1.40N/mm^2

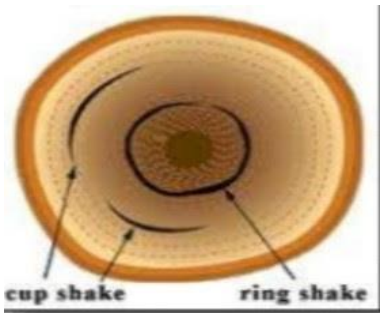
Defects in Timber

A. **Due to fungi** – When moisture content in timber is above 20% & there is a presence of air then it may attacked by fungi
   I. Dry rot – insufficient circulation of air timber attacked by fungi & solid converted to powder
   II. Wet rot – Decay of timber cost by alternate drying & wetting thus leads to defect in the size of timber.

   Bule strain, sap strain, brown rot, are also defects caused by fungi.

B. Due to natural forces –
   I. Check - Longitudinal crack normal to annular ring
   II. Shake - Longitudinal cracks at the C/S causes separation between annular rings

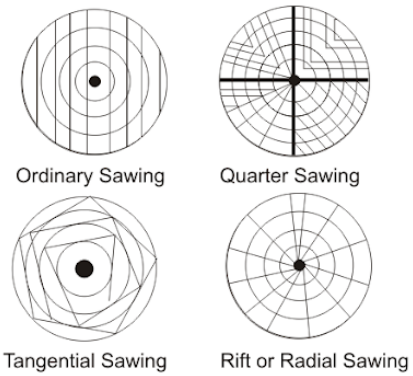




   III. Rind galls – curved swelling caused by growth of layers of shape wood over wounds after cutting of branch.
   IV. Knots – Formation of dark circular rings (Lumps) right angle to the stem & the junction between branch & stem
   V. Twisted fiber – Due to storm fiber became parallel
   VI. Foxiness – due to over maturity & poor ventilation decay of timber.
   VII. Druxiness – Defect indicated by white spot .
   VIII. Upset – Crushing of fiber due to storm wind.

C. Miscellaneous & artificial defects -
   I. Honey Combing – Due to improper seasoning
   & Bow , collapse, twist, warp, are some artificial defect in timber

Sawing of timber



types of sawing
(iamcivilengineer.com)

- Ordinary or flat or slab sawing – quick, economical, widely used,
- Quarter sawing – Wood wears batter & shrink more evenly
- Tangential sawing – Unsuitable for flooring
- Radial sawing – produce strongest timber

STONE

Studies

- Lithology – Study of physical characteristic of rock .
- Mineralogy - Study of chemical, physical, minerals of rock.
- Rockology – Geology of rock at basic .
- Petrology – Study of condition under which rock forms.

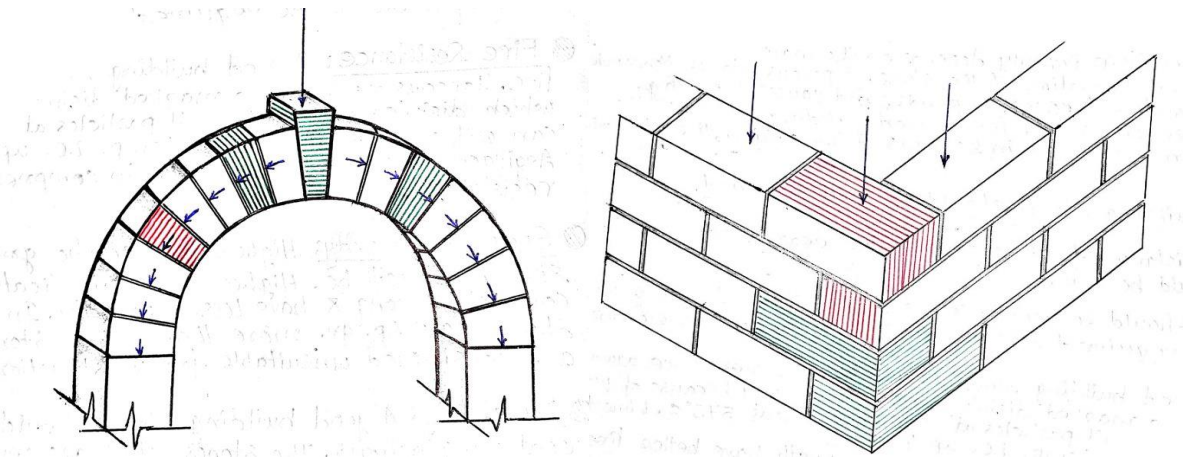
Rock

- It is the portion of earth crust having no shape, also an aggregate of one or more minerals.

Stone

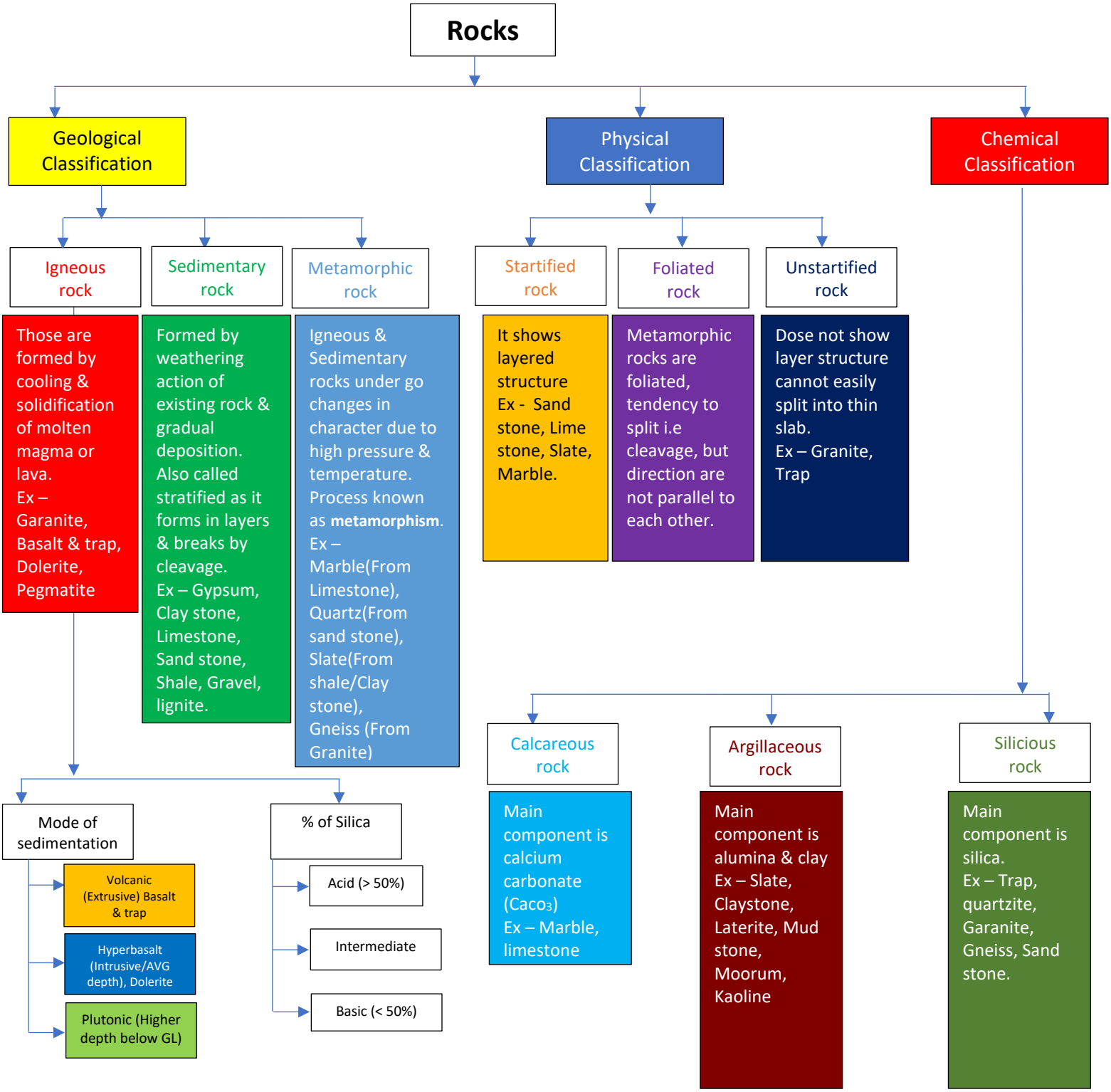
- It is obtained from rocks, have distinct planes (Natural bed)
- In stone masonry, stone are placed such that the natural bedding plane is normal to the direction of pressure.

Types of work	Direction of natural bed
Masonry work	Horizontal
Arch	Radial
Cornice / string course	Vertical



Terms & notes

- Cleavage – Ability to split, parallel to crystal faces
- Lustre – It is the sign on the surface of the mineral
- Streak – It is the colour of mineral in powder from.
- Sp.Gr of most of stones lies between 2.5-3.0



Stone	Type Of rock	Use
Granite SP.GR (2.6 - 2.9) Comp Strength (1000-1200 kg/cm^2)	Igneous (Geologically) Silicious (Chemically) Unstratified (Physically)	Exterior facing of building, Window sill, Piers, Steps, decorative Use In kitchen & dining
Basalt or trap SP.GR (3.0)	Igneous (Geologically) Silicious (Chemically)	Road material, aggregate in concrete, Railway ballast, Paving
Marble SP.GR (2.7)	Metamorphic (Geologically)	Flooring, Decoration, Steps, Ornamental, carving
Gneiss	Metamorphic (Geologically)	Street paving
Limestone SP.GR (2.6)	Sedimentary (Geologically) Calcareous (Chemically) Aqueous Rock	Stone Masonry in Blast Furnace, Lime obtained from it
Sandstone SP.GR (2.6-2.95)	Sedimentary (Geologically) of silicious variety	Road kerb, Channel, pitching, Rubble masonry, Moulding
Quartzite	Metamorphic (Geologically) Silicious (Chemically)	Protective work for embankment, Road metal, Retaining wall, Rubble masonry.
Slate SP.GR (2.8)	Metamorphic (Geologically) Argillacious (Chemically)	Roofing, DPC, Shink, urinals, Electric Switch Board
laterite	Sedimentary (Geologically) Argillacious (Chemically)	Road metal, Building Stone,

Quarrying of Stone

- Process of extracting stone from natural rock bed.
- Jumper/Dipper (Drill hole), Scraping spoon, Primary Needle, tamping bar are used
- Cross cut saw used for cutting hard stone
- Spalling hammer used for rough dressing (Dressing is done to obtain appearance, durability, strength of stone).
- Wedging for sedimentary, stratified, costly, soft rock like lime stone, sand stone, Marble etc.
- Heating for small thin block like granite & Gneiss
- Blasting for large hard rock like Igneous & metamorphic.
- Gun/Blasting powder – Large block explosion
- Gun/Blasting cotton (Saturated with HNO_3) - Demolition
- Dynamite – Small excavation.
- Gelignite – Underwater Explosion.
- Lithofactor – In tunnel Explosion.

Some Points On stone

- ✓ Good building stone crushing strength more than 1000kg/cm^2.
- ✓ Coefficient of hardness >17 (Very hard used in road work)
- ✓ Wear < 3%
- ✓ Toughness 13-19 for moderately tough
- ✓ Building stone – Water absorption-5% desirable & not more than 10% if above it then rejected.
- ✓ Seasoning of stone – Sap must be removed by evaporation before use – period of seasoning is 6-12 months
- ✓ Smith test – presence of soluble matter
  Acid test – Weather resistance
  Mohs scale – Hardness
  Brad test – Forst resistance
- ✓ Weight test - Is done on stone used in dock harbour
- ✓ Sandstone – Best for ashlar masonry, Highest fire resistance
- ✓ Marble & granite – Polished easily
- ✓ Bearing capacity of - Igneous rock > Metamorphic rock > sedimentary rock
- ✓ Dressing of stone is done immediately after quarring & before seasoning for less weight & weather resistance.

Paint

White Washing

- ✓ Process of giving Wash covering to plaster surface.
- ✓ Base of white wash – Fat lime or shell lime
- ✓ In fat lime, water is added & stirred in a tub , after it fully slaked it is screened & used.
- ✓ For new surface at least 3 coats & for old surface at least 2 coats white wash should be applied last coat should always be horizontally stroked.
- ✓ Moonj brush is used.

Distempering

- ✓ More superior than white wash, but chipper than paints
- ✓ 1kg of distemper requires 0.6 liters of water.
- ✓ Distemper has a base of powered chalk ($caco_3$), water as a carrier/thinner, colouring agent as pigment
- ✓ For water as a carrier, distemper also known as 'water paint'
- ✓ Used in interior walls of moderately cost building

Varnish

- ✓ A non transparent or transparent solution of Resinous substance (copal, amber, shellac, lac) & solvent like linseed oil, turpentine oil, alcohol.
- ✓ Sprit varnish – Shellac + methylated sprit & wax, used in wooden surface, interior surface
- ✓ Water varnish – shellac + hot water, used to varnishing maps & pictures
- ✓ Oil varnish – Linseed oil + amber, copal, interior & exterior use, most durable
- ✓ Spar varnish – Use in spars & parts of ship
- ✓ Asphalt varnish – Asphalt class linseed oil + petroleum, used in steel work.
- ✓ French polish – one type of sprit varnish where mixture of 1kg shellac + 8L alcohol + gala, used for superior transparent finish on timber surface.

Composition of oil paint

Base

- Solid substance in fine state, it is metallic oxide, principle constituent of paint, provided for opaque film on the applied surface. It reduce shrinkage & crack. Ex – White lead (For timber painting), Red lead (For steel painting), Zinc white, Iron oxide, titanium white.

Vehicle or carrier or binder

- It is an oil where base is mixed.
- It holds solid ingredient like base & pigment & helps to spread it.
- It gives durability, toughness, waterproofness.
- Ex – Linseed oil, tung oil, poppy oil, nut oil.

Solvent or thinner

- It is an oil to thin the mixture of (Base + Vehicle), So that can be easily applied
- Solvent evaporate after the application of paint
- For exterior work it should be minimum. EX – Turpentine oil commonly used, petroleum, sprit, naphtha.

Drier

- Act as a catalyst & accelerate the process of drying of paint
- Absorb o_2 from nature & transfer to vehicle
- Drier is not used at all in the final coating & should not be more than 10% by volume
- Ex – Litharge, Lead acetate, cobalt, Manganese, Red lead.

Filler or inert extender

- Added to paint to reduce the cost. Also known as 'adulterants'.
- Ex – Silica, Charcoal, Alumina, Gypsum, Barium Sulphate.

Colouring pigment

- When different colour is needed, pigment is used as an alternative to its base.
- Ex – Red lead, Indigo, Chrome green.

Name of paint / Primer / Base	Use
Oil paint	Wooden or steel surface
Aluminum Paint	Hot water pipe, Piers of bridge *visible in dark, cover large area, water proof
Enamel Paint	Doors & windows of wooden or metal
Emulsion Paint	Use in wood & steel frame work, plastered surface
Asbestos Paint	Stopping leakage of metal roof, used as a DPC in basement wall, fire proof
Bituminous Paint	Panting of iron works under water
Cellulose Paint	Painting motor car & airplanes body
Cement paint (snowcem, snowcrete, weathershild, durocem)	External surface of building
Plastic Paint	Internal surface of costly building
Zink oxide & red oxide	used as a primer on metal on a wooden surface
Bronze paint	High reflective property

***Notes**

- ✓ 1st coat – priming coat, last coat – finishing coat, intermediate coat – under coat,
- ✓ Blistering – defects caused in painting due to formation of bubble under fill
- ✓ Bloom – Formation of dull patches occurs due to bad ventilation.
- ✓ Fading - Loss of colour of paint due to sunlight
- ✓ Flashing – Formation of glossy patch due to poor paint or workmanship.
- ✓ Flaking – loosening of part of painted surface due to poor adhesion

Miscellaneous Materials

Glass

- Glass is a transparent or translucent non-crystalline material made from silica, soda and lime.
- When heated glass does not melt & when cooled glass does not crystallize.
- Foam glass- For air conditioned building
- Laminated Glass – Display windows of Jewellery shop
- Wired Glass – Outside window to resist fire and breakage, Strengthened glass.
- Ground Glass – Where light is to be admitted but vision restricted
- Float Glass – Superior to ordinary glass, used in commercial building
- Fibre Glass – consist of small glass fibre, soft and flexible and used for thermal insulation.
- Safety Glass – Shatter proof glass used in cars, it does not breaks but cracks.
- Bullet proof glass – Layers of glass with high strength plastic & fibre in between.

Plastic

- FRP (Fibre Reinforced Polymer) – Consist (Fibres + Matrix), Fibres like carbon, glass gives strength & matrix like polyester, epoxy transfer load.
- FRP is anisotropic materials, high strength in the direction of fibres.
- FRP does not yield, it is linear elastic material
- Tensile strength is greater than steel but $1/4^{th}$ weight of steel.
- FRP is electrically & thermally non-conductive, it can use in RCC member where non-ferrous reinforcement is required.
- As an Alternative to FRP, Epoxy & stainless or galvanized steel bars are used.

Ceramic Product

- Ceramic – In organic, non-metallic solid, made by heating and cooling, it may be crystalline or amorphous (i.e. glass), resist high temperature, having more compressive strength but weak in shear & tension.
  Ex - Teracotta, porcelain, glass ect.

→ Porcelain

- **Treacotta** – Type of earthenware, clay based, porous. Use in ornamental work, vessel, waste water pipe etc.

- **stoneware** – It is a vitreous or semi-vitreous ceramic product made from stoneware clay or non-refractory clay.

- **Tiles** – It is a manufactured piece of ceramic, stone or glass. Use in roofing, flooring, table tops etc.

Fly Ash – Residue resulting from combustion of powdered coal & collected from Thermal power plant or electro static precipitator, a pozzolanic & ceramic material, it consist SIO2,Al2O3 & Fe_2O_3. Use in – Portland cement, Soil stabilization, fly ash brick.

Steel

- Metal used for construction purpose known as ferrous metal with iron as main component i.e. wrought iron, cast iron, stainless steel etc.

- **Pig iron –** Obtain from blast furnace, carbon content – 3 to 4%, it is hard & brittle, high comp. strength, weak in tension. Use in making base plate, columns, door bracket.

- **Cast iron –** It is the molten metal of (pig iron + coke + lime) is poured into moulds of desired size. Carbon content 2-4%, use in making of lamp post , bathroom fittings, swear pipe, wall brackets.

- **Wrought iron** – Purest from of iron, obtained by removing impurities from cast iron, carbon content 0.10-0.15% , use in making roof covering, rivets, chimney gates etc.
  *Note: More carbon content increases the brittleness & comp. strength of steel/iron & decreases its ductility.

- **Mild steel –** Low carbon steel or soft steel, malleable & ductile & more elastic than wrought iron. Carbon content 0.15-0.30%, use in rolled steel section, sheet pile, roof covering, rails, reinforcing bars.

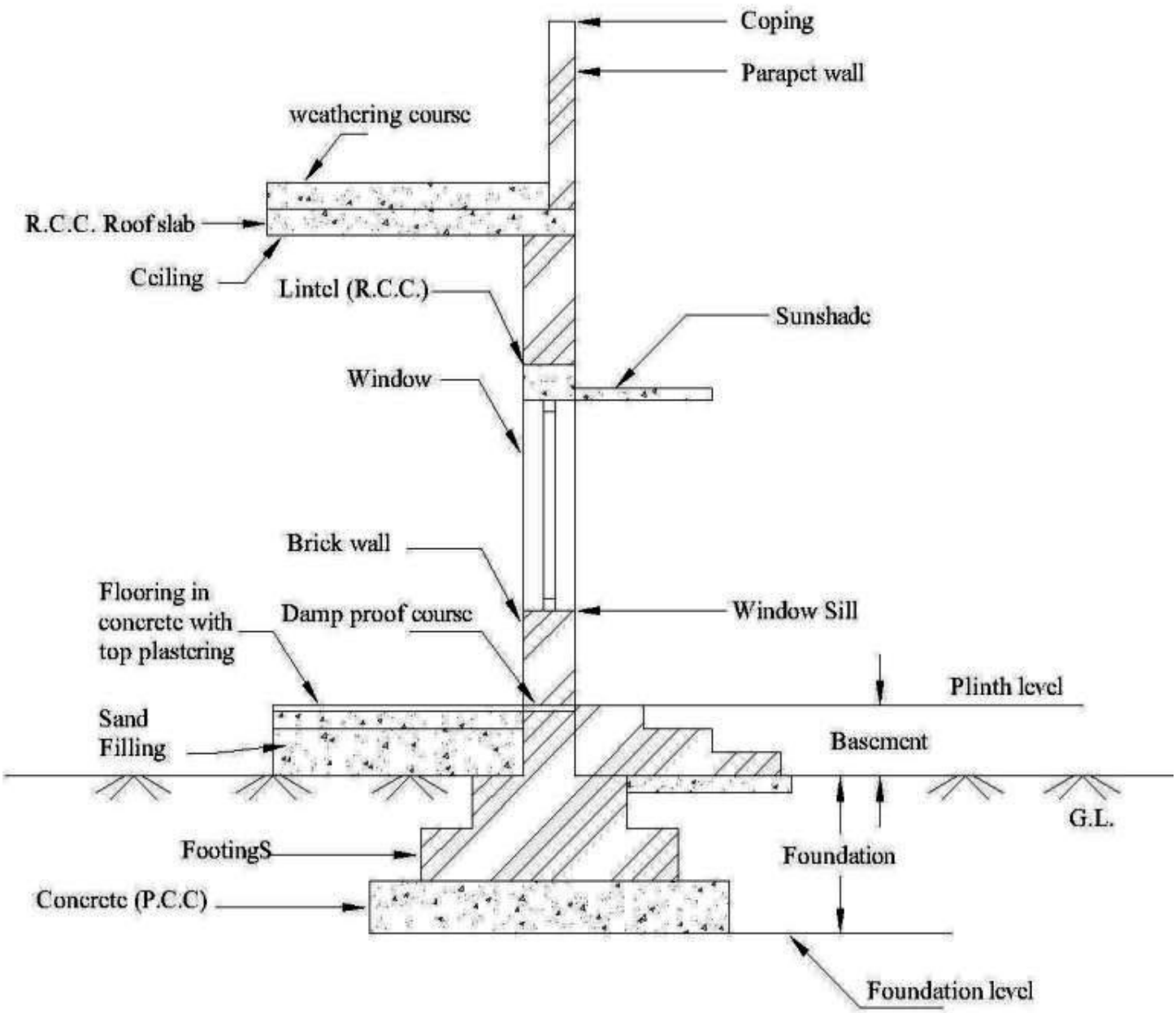
- **High carbon steel –** Hard steel, tougher & more elastic than mild steel. Carbon content – 0.55-1.0%. Use in making machine parts & tendon in prestressed concrete.

- **High tensile steel –** Medium carbon steel, carbon content - 0.6-0.8%, Use in prestressed concrete.
  - ✓ **Drawing –** Process of reduction of C/S of steel & increment of length of steel, Drawn it through dies.
  - ✓ **Rolling –** Angles, channels, joists, rails, prepare in rolling mill.
  - ✓ **Forging –** To improve strength of steel the process of repeated blowing of steel by power hammer.
  - ✓ **Annealing –** Process of making the steel more ductile & soft.
  - ✓ Melting point of steel – 1300 to 1400°C, poisson ratio = 0.3, γ = 7850 kg/m^3, E = 2 X 10^5 mpa, G = 0.77 x 10^5 mpa, α = 12 x 10^{-6}/°C
  - ✓ Corrosion resistance element in steel are – chromium, Phosphorus, Copper.

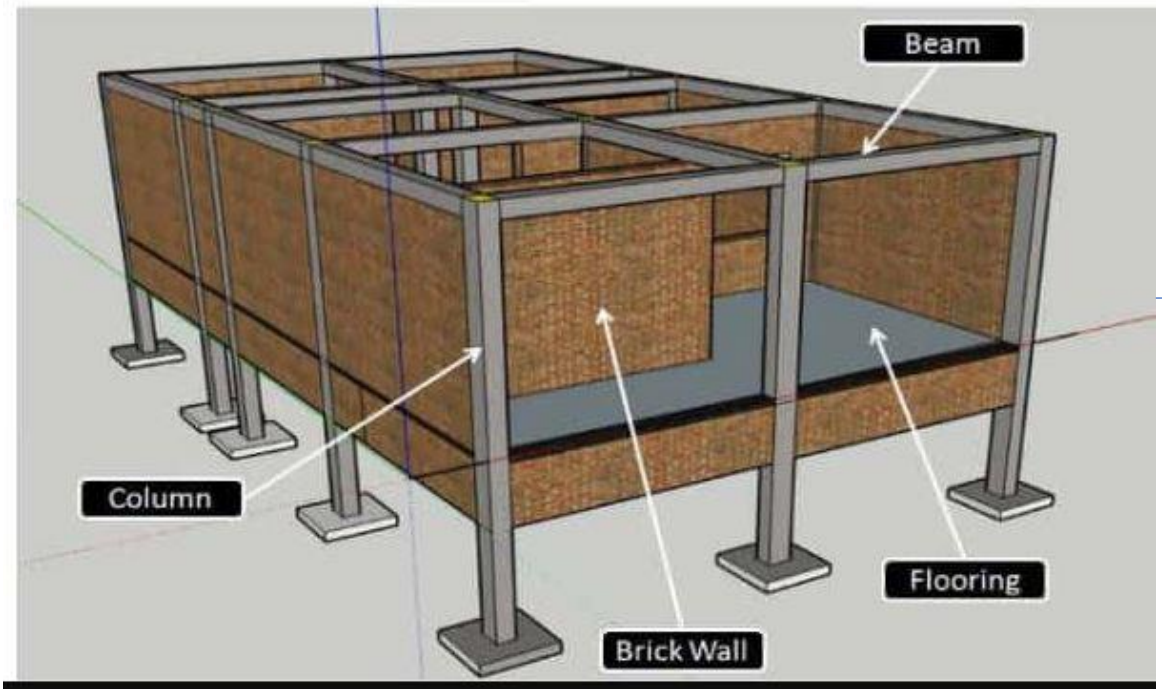
2021

Building Construction

MAIN COMPONENTS OF A BULDING



Load bearing wall



Framed structure

- As per NBC India (Part iii, 1983) a Building is a relative permanent enclosed construction over a plot of land having a roof. Tent, shamiana, shelter not considered as building.

- There are 9 types of building based on occupancy.

- Residential – Where sleeping accommodation is provided

- Institutional – Hospital, homes, jails, sanatoria etc.

- Business building – Includes shops, store, market, area upto 500m^2.

- Assembly – part of a building where group of 50 people gather i.e. cinema hall, restaurant, theater.

- Hazardous – Storage of highly explosive & positional materials.

Foundation

- Building has two main components i.e. substructure & superstructure

- **Substructure** – Lower most part, Below GL, transmit load to subsoil.

- **Superstructure –** Part of structure above GL.

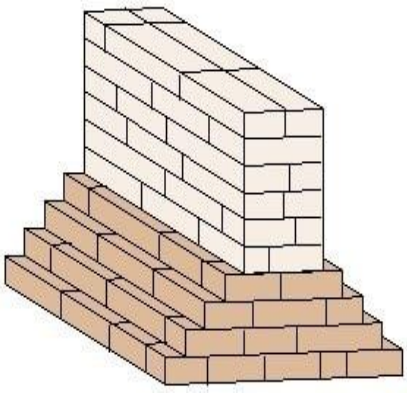
- **Footing** – Lower most part of foundation direct contact with subsoil.

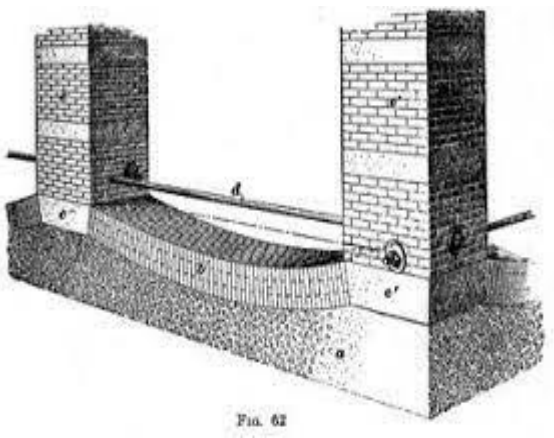
- **Object of foundation**
  - ✓ To distribute the load of structure on a large area evenly.
  - ✓ Prevent over turning & sliding.
  - ✓ Prevent unequal settlement & to give a flat & hard base for the superstructure.

- **Causes for failure of foundation**
  - ✓ Unequal settlement of subsoil
  - ✓ Lateral force on superstructure causing sliding & over turning
  - ✓ Atmospheric agent.
  - ✓ Escape of subsoil.

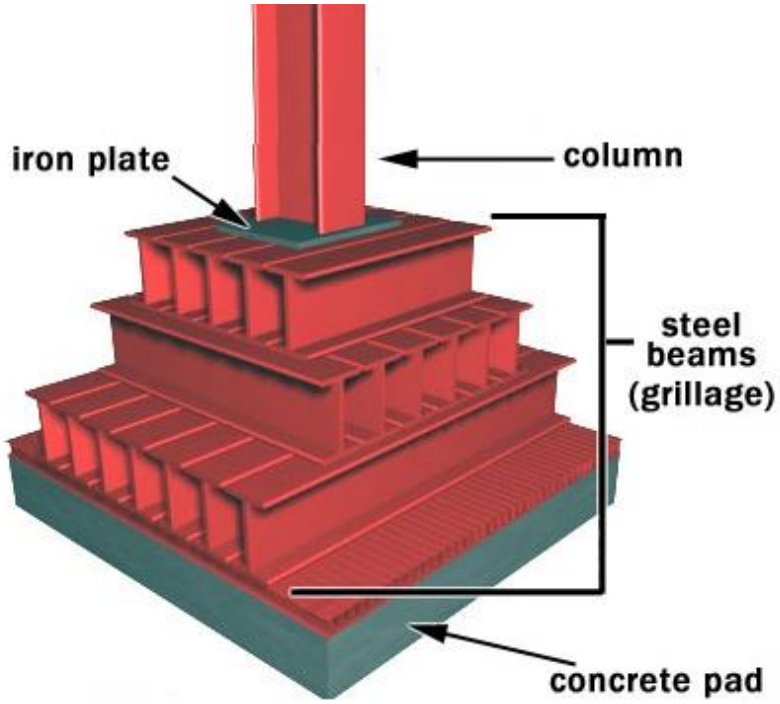
- **Rankine's Formula**
  - ✓ Depth of foundation (D) = $\frac{p}{\gamma}\left(\frac{1-sin\emptyset}{1+sin\emptyset}\right)^2$
  - ✓ Generally D = 900mm (Minimum for clayey soil) & 1600mm (Maximum for clayey soil)
  - ✓ According to K.Terzaghi , for shallow foundation : D $\leq$ B
    for deep foundation : D > B

- **<u>Classification of shallow foundation</u>**
  - Spread footing – Wall footing, RCC isolated foundation, Inverted arch foundation etc.

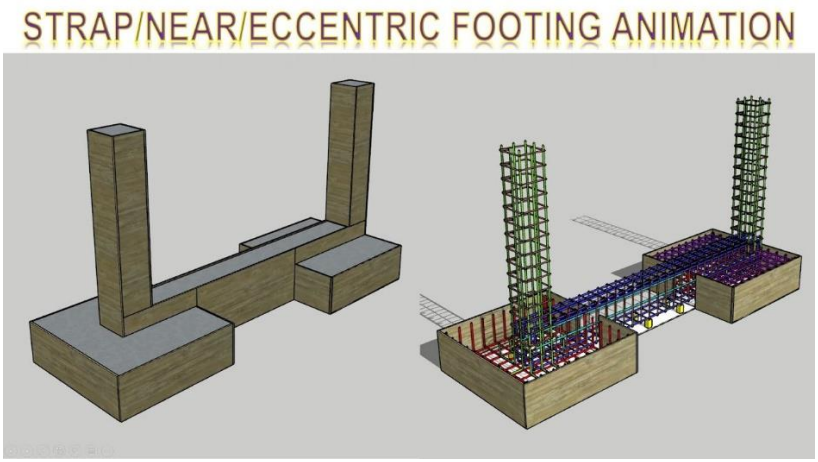


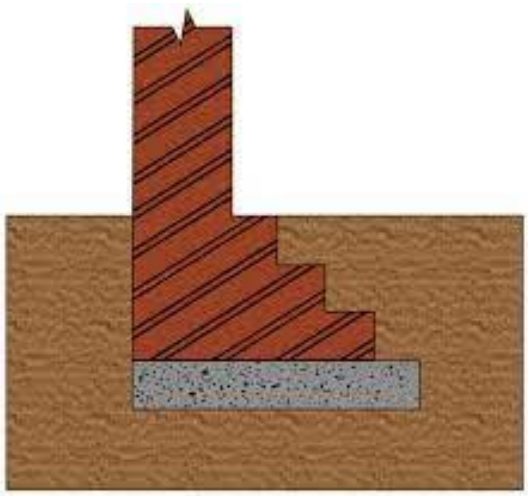


- **Grillage foundation** – When structural load is heavy & to be transferred on a soil through steel column, soil has low bearing capacity then it is used. It consist concrete block of 1.6m depth with RSJ beam in two tires.

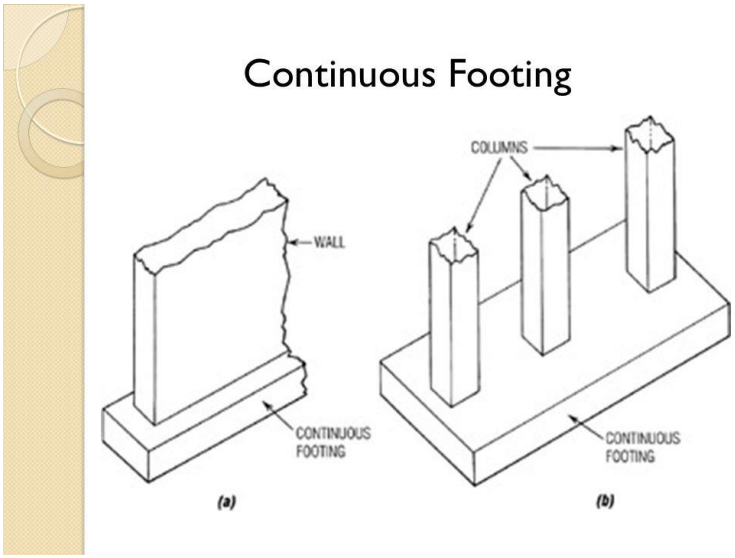


- **Eccentrically loaded footing** –
  - ✓ When wall or column situated at property line & foundation can't be extended beyond it then cantilever type footing is used.
  - ✓ "Strap footing" is a Eccentrically loaded footing where foundation of exterior column is connected by a grade beam.



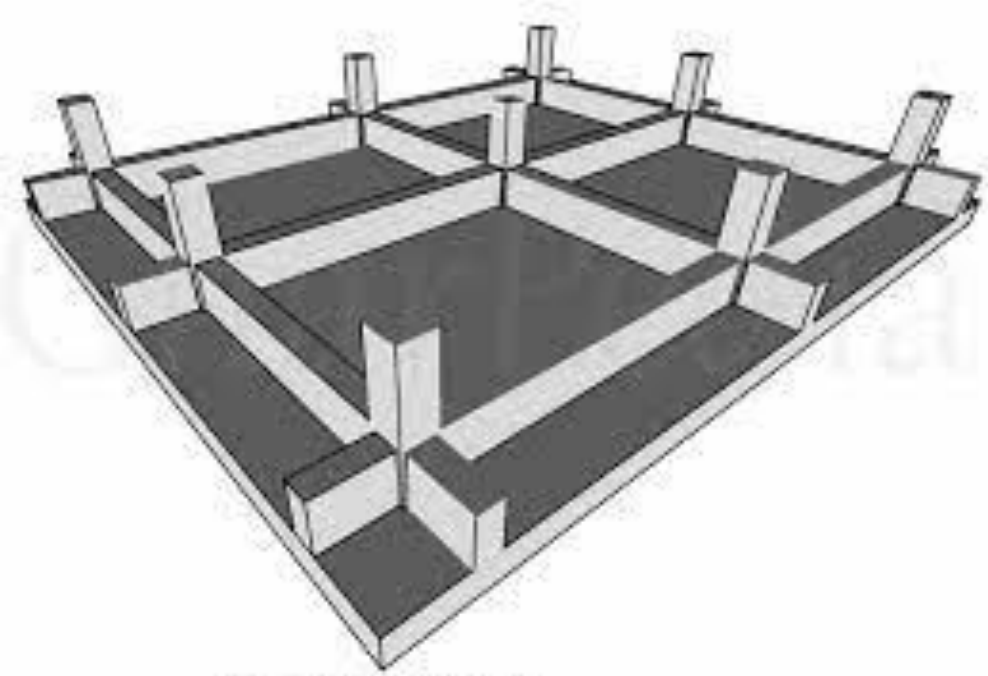


- **Strip footing** – A continuous strip of concrete whose length is bigger than its width, connects the column in a row.



- **Combined footing -**The common footing on which more than one column is constructed to eliminate the overlapping of isolated footing. It may be rectangular or trapezoidal (Most effective). If isolated footing's area cover more than 50% of trench area then also combined footing is done. C.G. of loads on the columns should coincide with the C.G. of combined footing.

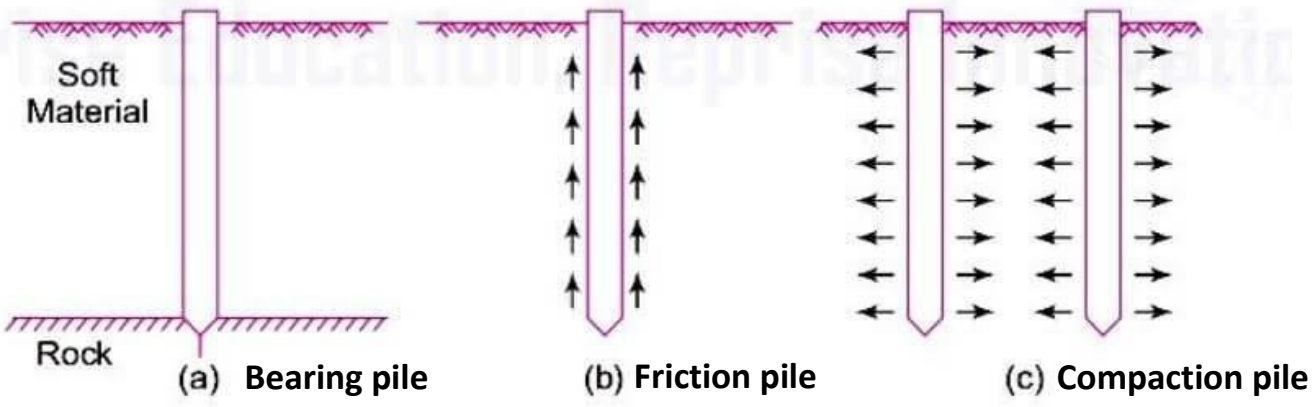
- **Raft Foundation –** For soft, Marshy , low bearing capacity land, the entire area covered by a RCC slab. It is a combination of slab at bottom & beam above it. Settlement of raft slab is very low. Also when all isolated footing's area is more than 50% of trench area then also raft or mat foundation is used.

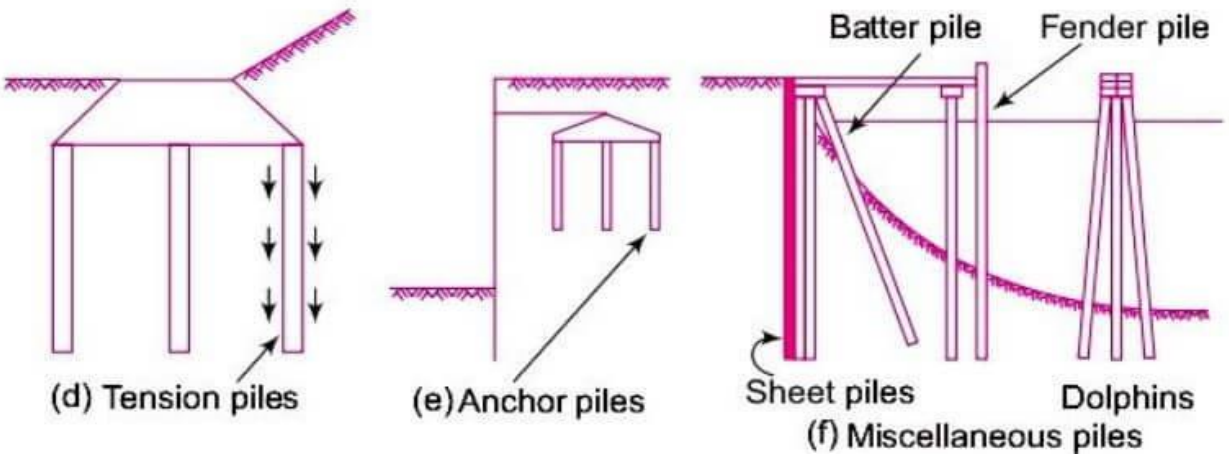


Slab-beam type raft foundation

➢ Classification of deep foundation

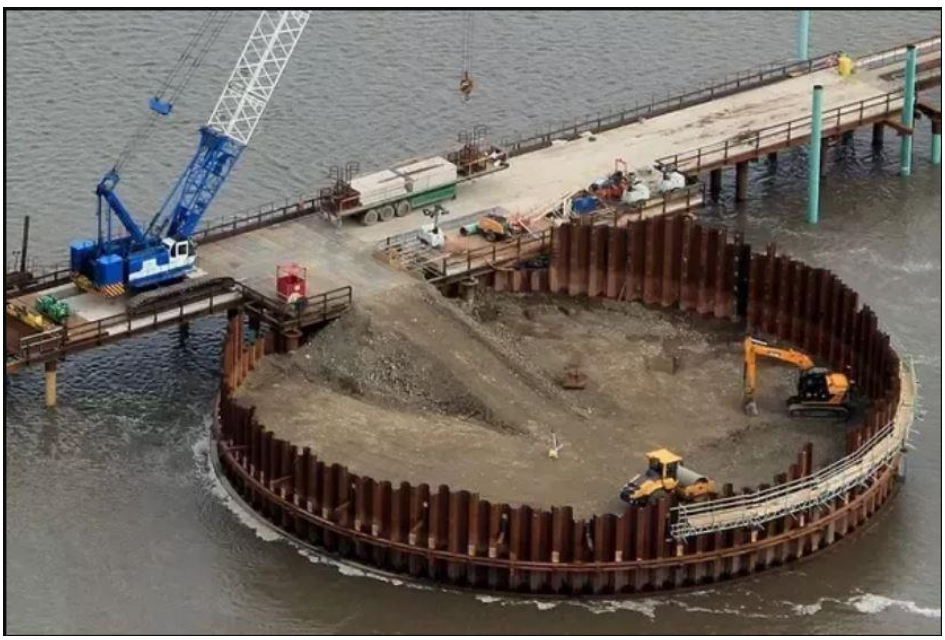
- **Pile foundation –** When compressible, water logged, marshy land is available & construction of multistorey, heavy, non uniform loaded construction is to be made upon it then pile is preferred. Pile is a long vertical load transferring member, transfer load on rocky stratum or hard ground. For foundation located at sea shore, river bed , bridge, marine structure pile foundation is used.
  - ✓ **Friction pile –** When soil is poor after excavating large depth , then it is economical to develop friction between surface of pile & soil i.e. skin friction.
  - ✓ **Sheet pile –** It does not take vertical load but used as a retaining wall in river bank or foundation trenches.
  - ✓ **Fender pile -** Constructed to protect docks from impact of ships.
  - ✓ **Compaction pile –** To improve the bearing capacity of poor soil, granular material inserted into hole as a pile.
  - ✓ **Batter pile -** Driven inclinedly to resist horizontal & inclined force safely.





- **Caisson –** It is water tight box sunk through ground or sea, for maintenance & construction of bridge pier. 3 Types of caisson – box caisson , open caisson , pneumatic caisson.

- **Cofferdams –** Temporary structure to exclude water from working place .



Flooring

- Floors divide the building into different levels. The floor at P.L is known as ground floor, while floors above it are called upper floors & below it are called basement floors.

Types of Floor:

- **Mud & Muram Floor –** Cheap, used in rural area, hard, easy to construct, good thermal insulation property, need washing by cowdung or oxalic acid.

- **Terrazzo Floor –** (Concrete flooring + marble chips of 3 to 6mm), Decorative, good wearing property, used in both residential & public building.

- **Mosaic Floor –** (Concrete flooring + marble chips / glazed china + coloured cement),
  Usually 40mm thick, for cleaning of mosaic floor muriatic acid is used, precast conc. Tiles with marble chips known as mosaic tiles.

- **Natural stone Floor** – Natural laminated stone i.e. kota stone, cuddappa stone, shahabud, i.e. flag stone or granite, marble etc used. It is durable,

easily repaired, may be polished or rough. Granite floor is a expensive, minimum thickness of marble slab is 20mm.

- **Cork Flooring –** It is Fully noiseless & used in libraries, theatre etc. Cork is the outer bark of oak tree. Rubber & linoleum floor also used in libraries.

- **Timber Flooring –** It is costly used in halls & auditorium.

- **Granolithic Flooring –** It is used where hard wearing course is needed such as godowns floor. (M15 conc. 25mm thick + Granite / Quartz). As an alternative brick flooring are used in godowns, ware house.

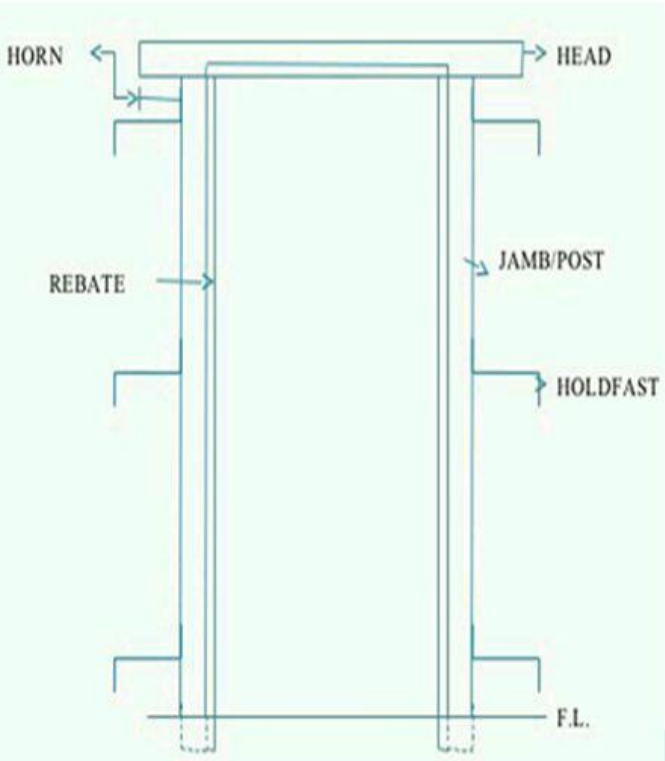
- **Asphalt Flooring –** Acid proof, water proof, jointless, dust free. Used in swimming pools, dairies, hospitals, terrace etc.

***Notes:** Clay tiles are used now a days for flooring, ceramic tiles with glaze known as glaze tiles & tiles from terracotta with glass like finish known as vitrified tiles.

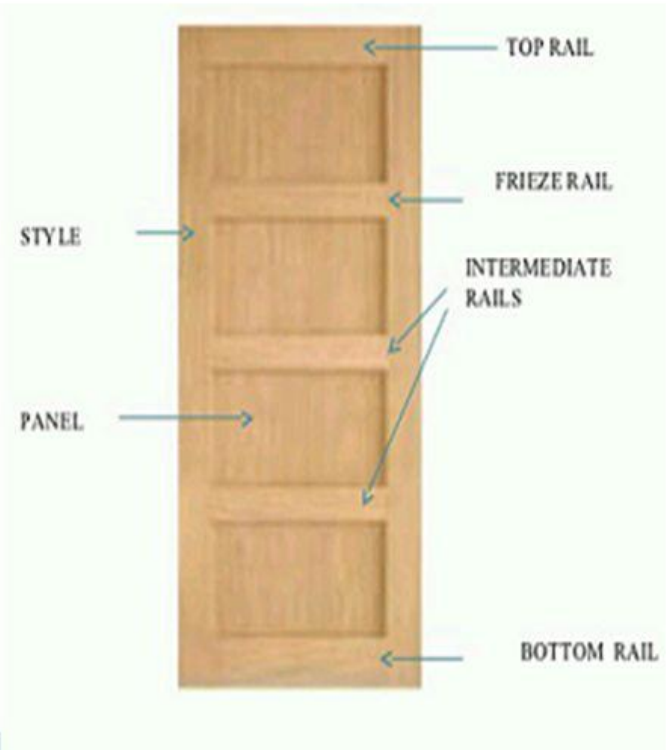
Doors & Windows

COMPONENTS OF DOOR

- A) Door Frame

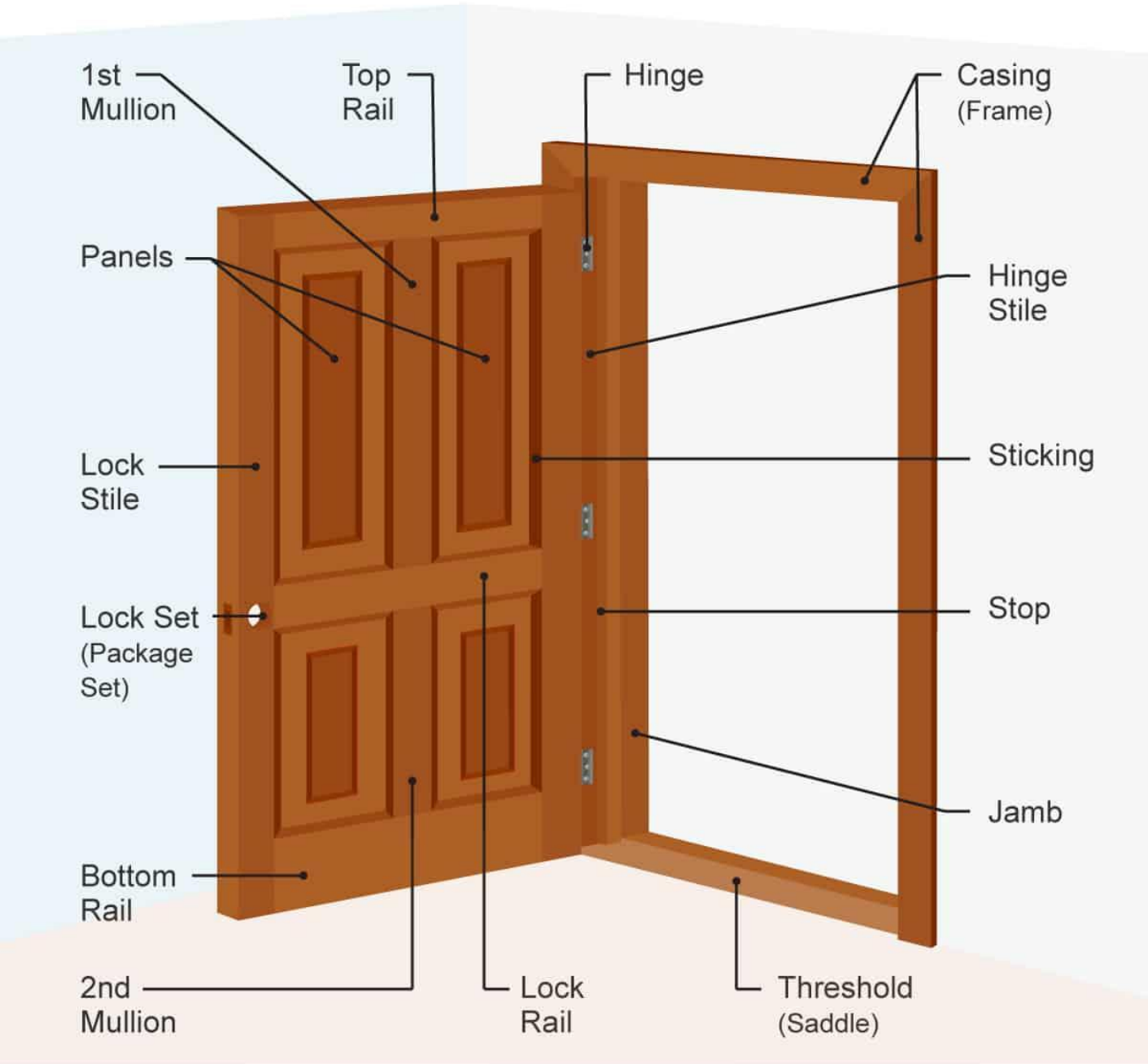


B) Door Shutter



Anatomy of a Door

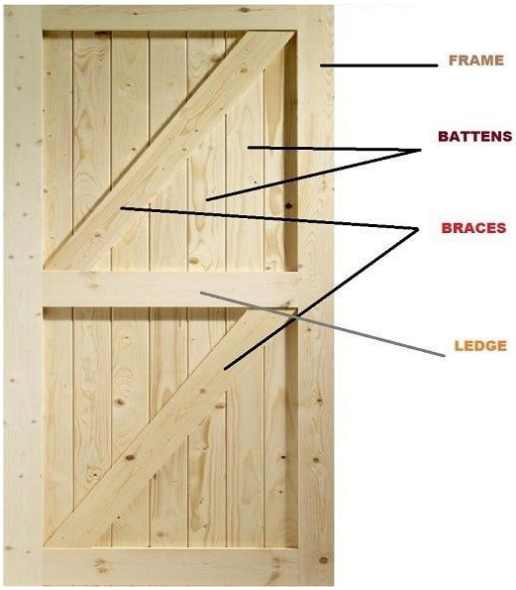
Door



- Sill of window should located about 700-900mm above floor level.
- Width of door (B) = [0.4-0.6 X H] and Height of door (H) = [B + 1.2]m.
- Generally height of door should not less than 1.8m – 2m.
- **Reveal** – external portion of a jamb of a door or window opening.
- **Rebate** – Depression made inside door frame to receive the shutter.
- **Horn** – Horizontal projection of the head & sill of a frame for fixing the frame into wall.
- **Transom** – Horizontal member of a frame, subdivide a window opening horizontally.
- **Mullion** – Vertical member of a frame, subdivide a window opening vertically.
- **Hold fasts** – Steel flats provided to fix the frame into wall, Embedded in masonry, (size 200mm x 30mm x 6mm). Door need at least 3 hold fasts on each side, whereas window require 2 on each side.
- **Sash bar** – Frame made of light section which hold the glass within the door or window frame.
- **Threshold** – Cross wooden member of door at floor level to provide lateral stability of frame, some times it is not provided.
- Location of door – Near the corner of a room for residential building.

Types of door & windows

- **Battened and ledged & Braced door –** Generally Used in w.c, kitchen & bathroom. Unimportant places.



- **Sliding doors –** For air conditioned building, Offices or banks.

- **Swinging Doors –** It can open on both side, double action spring is used. Use in hotel & bank.

- **Revolving doors –** Used in public buildings (libraries, banks etc) also suitable for continuous heavy rush of traffic, and also for air conditioned building.

- **Flushed door – S**hutters are made of plywood. Suitable for interior portions of residential or office buildings.

- **Louvered Doors –** Used where both privacy & ventilation are required such as bathrooms & water closet.

- **Rolling shutter –** Used for addition safety in shops, office, garage, godowns, factories etc. Width of this door 2-3m.

- **Collapsible door -** Consist still channels of 16-20mm with rollers at top & bottom, used for additional safety & front part of stair case, shops, schools, banks etc.

- **Bay window –** Provided on the projected portion of the external wall.

- **Dormer window –** Vertical window on sloping roof.
- **Sky light window –** Projected above the slopping roof.
- **Gable Window –** Provided at the gable end of a building.

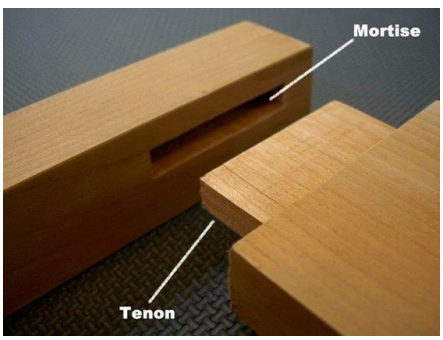
- **Lantern window –** Provided on roof slab for direct sunlight & ventilation.

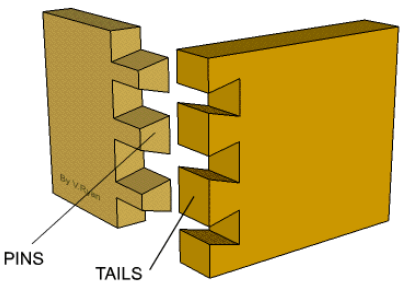
- **Clear storey window –** Provided when hide of a room is much more than adjacent room.

***Notes:**

- ✓ **D –** Stands for door, **S – F**or single shutter, **T –** For double shutter.
- ✓ **8 DS 20 –** Door opening of width 800mm, height 2000mm, single shutter.
- ✓ **10HS 12 –** Window with horizontal glazing sash bar width = 1000mm, height = 1200mm.

- ✓ **Between style & rail –** Tenon & mortis joint.
- ✓ **Between post & head** – Dovetail joint.
- ✓ **In roof truss –** Oblique tenon & mortis joint.





Temporary Works in Building Construction

➢ Form Work

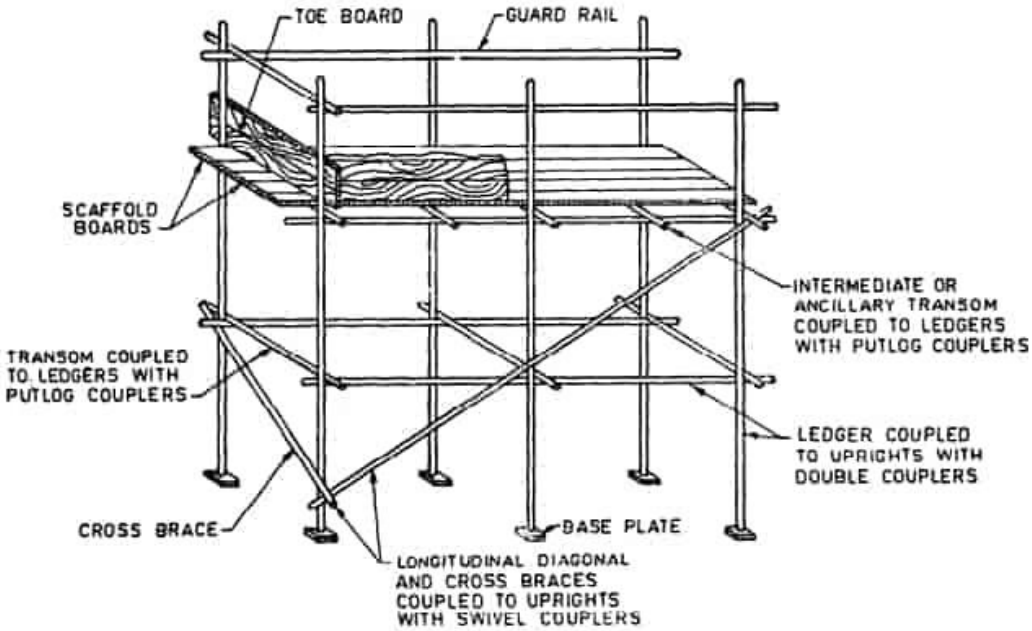
- Failure of structure during casting is due to failure of form work.
- Deflection of form work should be minimum of span/150 or 25mm.
- Live load on form work – 3.7- 4.0 kN/m^2 .
- Form work should be smooth, dust free, leakage proofed.
- Form work should rest on nonyielding props of maximum spacing 1m between them, should connected by bracing, should placed on hard ground.
- Stripping of form work should be to its natural load canning capacity i.e. for cantilever form work should striped from free end towards fixed end.
- Timber form work (like gammer or local woods) used for small work & as it absorb water & get swelled, so it can only be used for maximum 10 times.
- Now a days teak wood i.e. ply as a form work to give superior finish to concrete surface.
- Steel form work are used for large project as easy to remove & join, initially costly, no swelling, no change of size, smooth surface to concrete can be used more than 100 times.
- Slip form work used for construction of shaft, chimney, tower it has no joint & can be extended vertically, suitable for speedy and homogeneous construction.

➢ Scaffolding

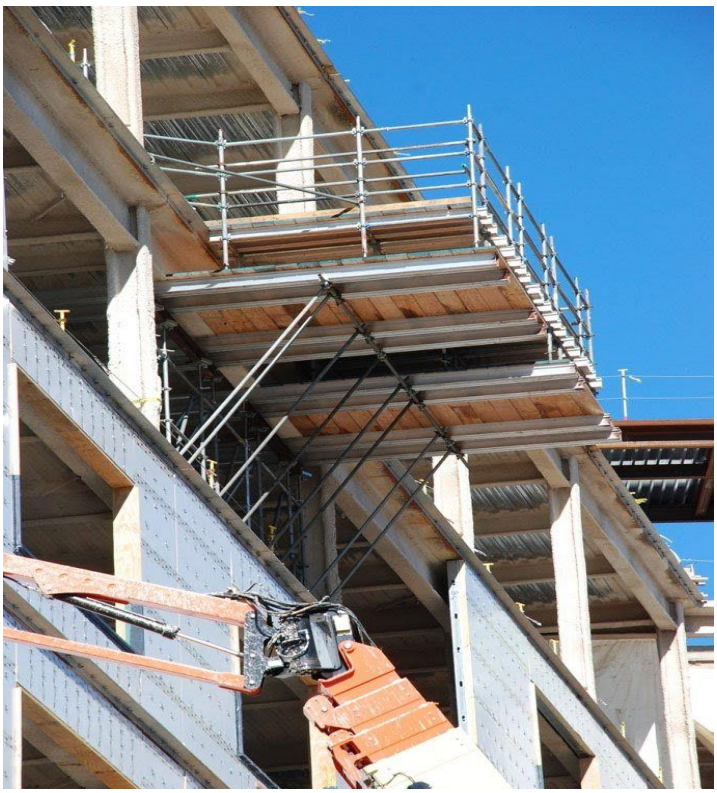
- Temporary structure needed for labour and materials for work carried out over 1.5m height.

- **Single or brick layers scaffolding –** It has only one row used for construction of brick wall.

- **Double or mason scaffolding –** It has two rows, doesn't support on brick wall so independent scaffolding, used for carrying heavy loads like stone masonry work.



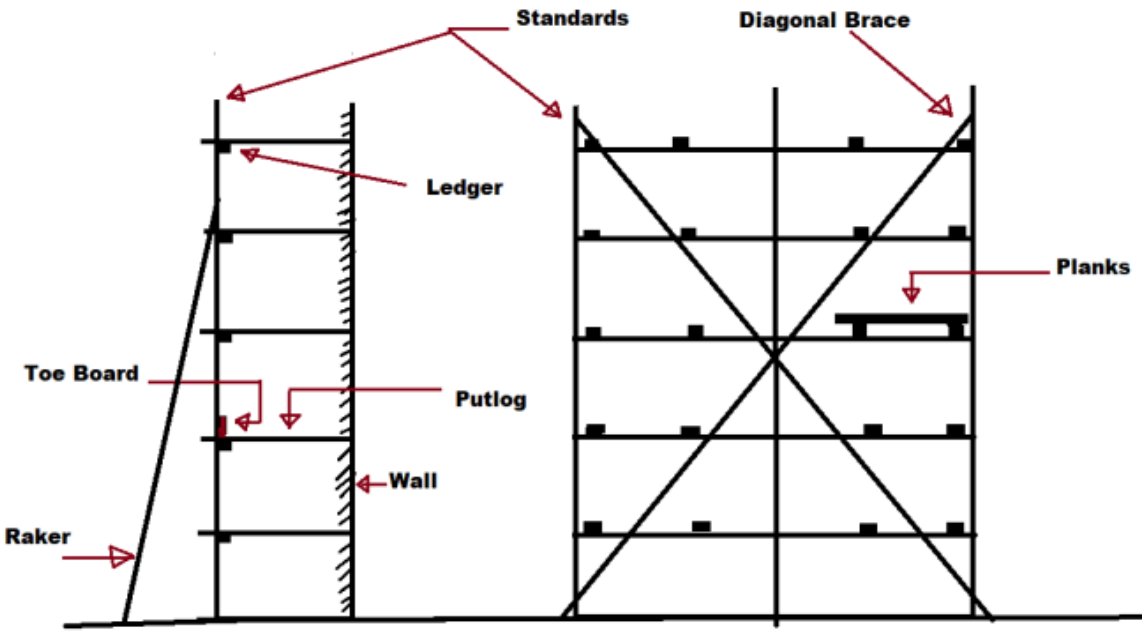
- **Needle or cantilever scaffolding –** When hard ground is not available to rest scaffolding or in case of a busy road or when construction works going on is at very large height then it is used.



- **Trestle scaffolding –** Used for maintenance work inside of the building, height 5-15 m, consist a moveable platform on tripod stand & roller.

- **Suspended scaffolding -** Used for painting on outside wall of building, cheapest, suspended platforms hung from roof by means of rope.

- **Gauntries scaffolding –** Used for lifting of heavy stone block.



Standard - Vertical post, **Ledger –** Horizontal member parallel to wall,
Put log – Horizontal member 90° to wall, if both end of put log supported on ledger than it is termed as transom.
Guard Rail – 1m high protected rail for working platform.
Bracing - Inclined member connects standard.

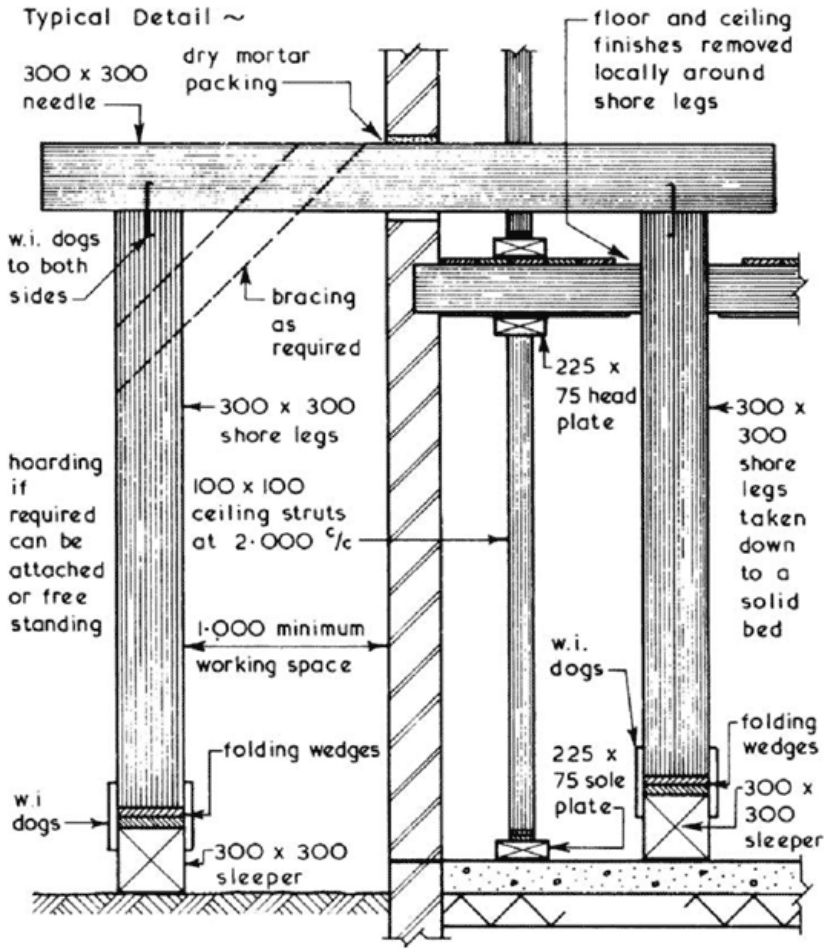
➢ Shoring

- Temporary support given to improve the lateral strength of wall during repair, alteration etc.

- **Raking or inclined shore –** Inclined rakers support the wall, angle with the horizontal 45° - 75°, spacing 3-5 m c/c.

- **Flying or horizontal shore –** Used to support two parallel walls which are in danger. It should be at mid depth, single flying shore for span up to 9m & double flying shore for span exceeds 9m.

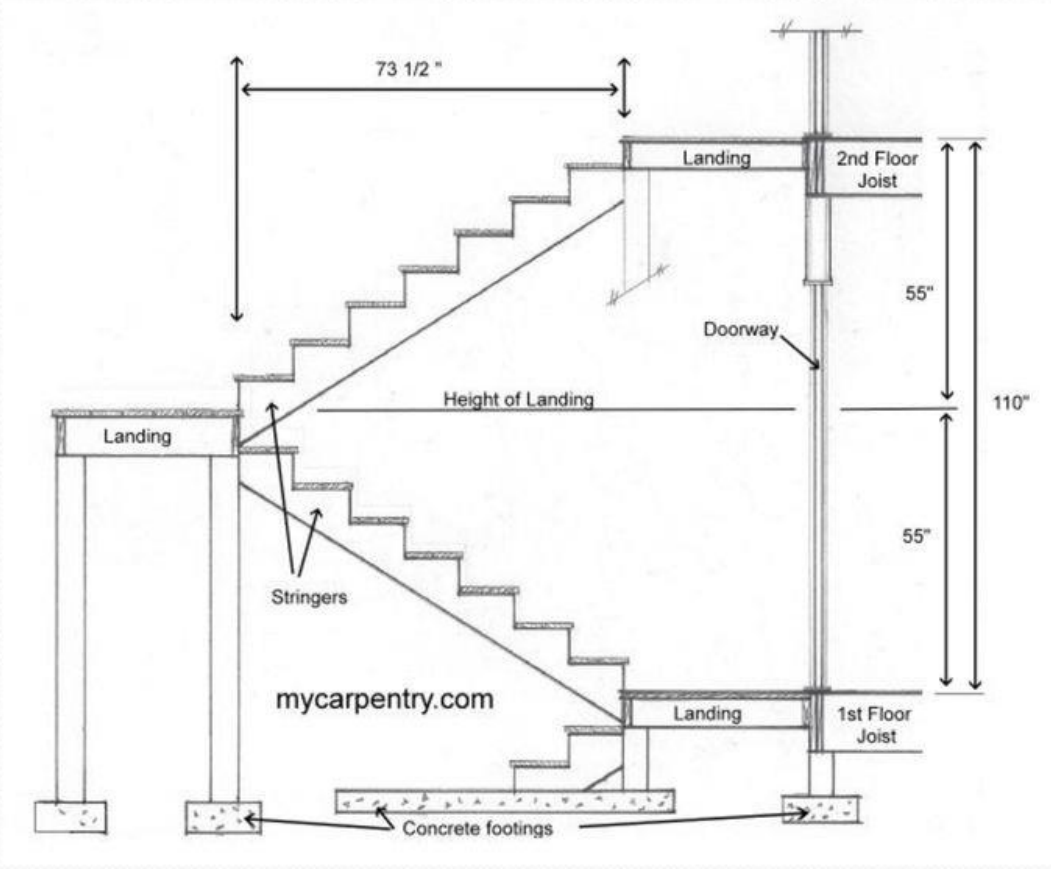
- **Dead or vertical shore –** Needle is provided through the wall, which is supported on dead shore. When opening have to enlarge, bottom part of opening have to dismantled without affecting the top part then it is used.



- **Under Pinning –** Process of strengthening & existing foundation or two construct a new foundation below existing foundation or to repair cracks on lower most part of building or two construct basement it is used.

StairCase

Staircase Cross-section



- Location of stair - Near the main entrance (For public building)
  Centrally (For residential building)
- Stair way - space occupied by stair.

- Head room – Minimum clear vertical height between tread & overhead roof covering. Minimum head room should be at least 2.00-2.05 m.

- Tread – Horizontal upper part of step, where foot is placed.
  Normally T = 200mm – 250mm.

- Riser – Vertical Portion of step provides support to tread. Normally R = 150mm.

  ***Note** : T + R = 40cm – 45cm, T + 2R = 60cm – 64cm,
  T x R = 400 – 450cm^2, Nos of trade = (Nos of riser – 1)

- Flight – Unbroken series of steps between floor to landing.

- Landing – Horizontal platform between two flights for change the direction.

- Balustrade – Vertical members support the hand rail & provide protection for the user. Height of hand rail above tread is 750mm -800mm.

- Newel post – Balustrade at the end of flight to connect the ends of hand rails.

- Soffit – Under side of stair.

- Pitch angle (Inclination) - 25° - 40° for stair case, but maximum pitch for public building is restricted to 33°.

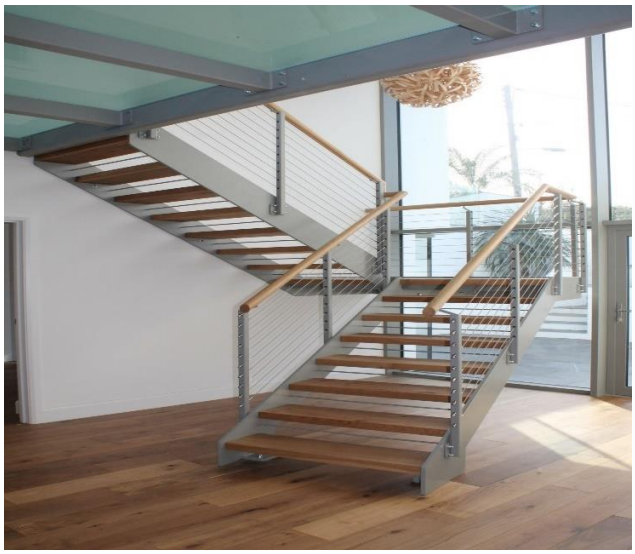
- Scotia – Moulding / ornamental work under the nosing, to provide strength to nosing.

- Number of steps should not be more than 12 & not less than 3 in a flight.

- Stringer – Inclined beam, which supports the steps of a stair.

- Width of stair –
  - 900mm (Minimum for residential building)
  - 900mm -1200mm (Generally for residential building)
  - 1500mm -1800mm (Generally for public building)
  - 1000mm (Minimum for commercial building)
  - Width of landing should not be less than width of stair.

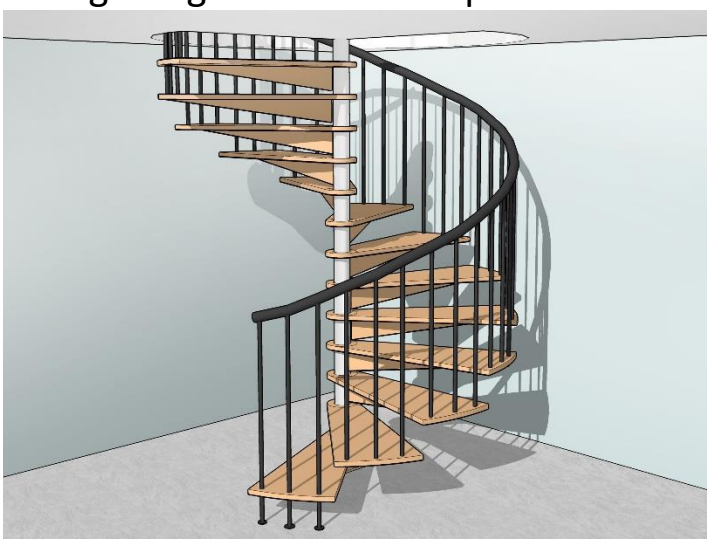
- **Types of stair** –
  - ✓ Half turn stair (Dog legged & open well stair) - two symmetrical flights with two 90° turns.

  - ✓ Straight stair – For narrow and long space.
  - ✓ Bifurcated stair – Two flights from one common flight

- ✓ Quarter turn stair - A quarter-turn staircase consists of two straight rows of stairs and a one quarter turn of 90°

- ✓ Spiral staircases - Also known as a screw, helical, corkscrew, or cockle staircase, in which the treads go around a central pillar or shaft, following a circular or polygonal plan. Often found in industrial contexts, secondary purposes or small interior spaces. Its space-saving advantage also comes with some major inconveniences: its reduced width is a unsuitable for moving furniture, and the risk of falling is higher due to the pronounced tapering of the treads.



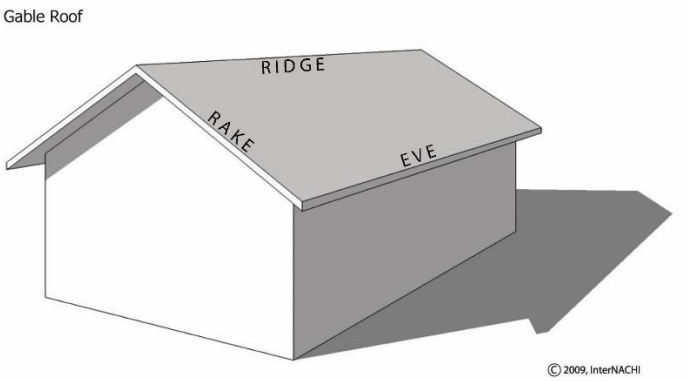
Roofs

- Types of roofs –
  - Pitched or slope roof – Large span > 6m. For heavy rainfall, snowfall, hilly area. Angle of inclination > 10°, generally 30 ° - 40°, rise = L/2 to L/3, Bay distance = L/3 to L/5.

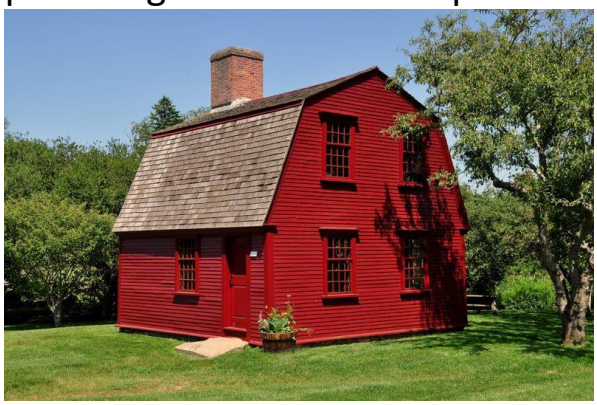
  - Flat or terraced roof - Span ≤ 6m, angle of inclination ≤ 10°.

  - Curved roof – Hemispherical type shelled roof, used in planetarium & laboratory.
    Circular type domed roof, used in religious structure.


  - Gable roof – Slope in two directions, looks like inverted V , Not suitable for high wind pressure.



- Gambrel roof – Slope in two directions but break in each slope, provide good amount of space in the attic. Use on barns.



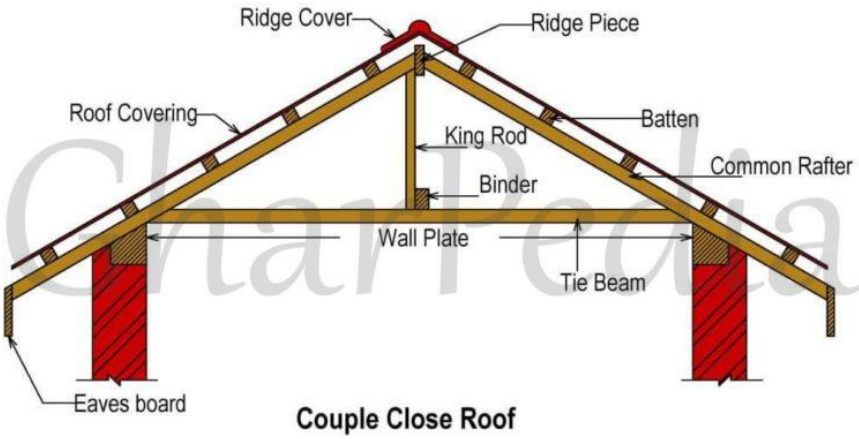
- Hip Roof - Four side slope

- Single roof - One side slope, also known as verandah, lean, pent, aisle roof. Span 2.4m.

- Couple roof – Slope on both side span upto 3.5m.

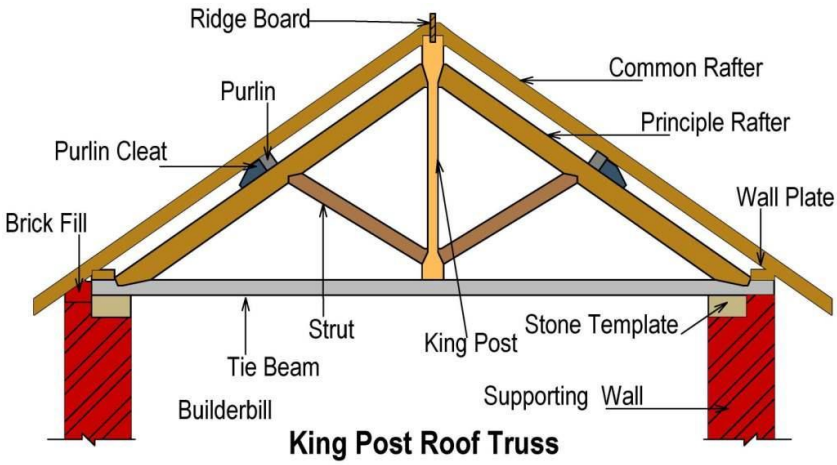
Couple Roof

- Couple close roof - Span 5m, rafter connected by tie beam.



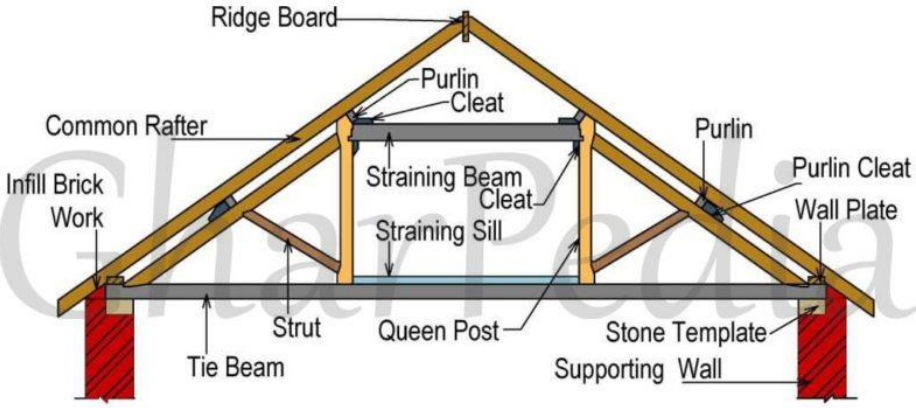
Couple Close Roof

- King post trussed roof – Central vertical post, Support the tie beam, small span 6-9m.



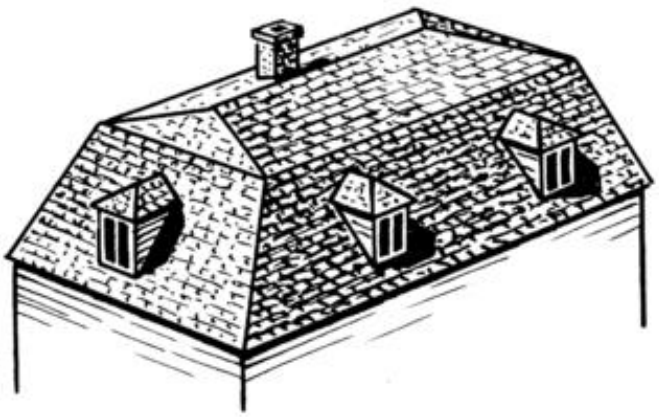
King Post Roof Truss

- Queen post truss roof - The Queen posts are the tension members which are used to prevent the sagging of tie beam. Queen post truss is used when there is a need to cover large areas & span of 9-12m.



Queen Post Truss

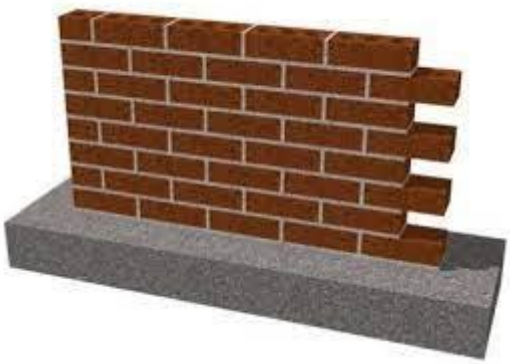
- Mansard roof – French architect F.Mansard invented the combination of two storied (king + Queen) post trussed roof, which slops in four directions with each slope has a break.



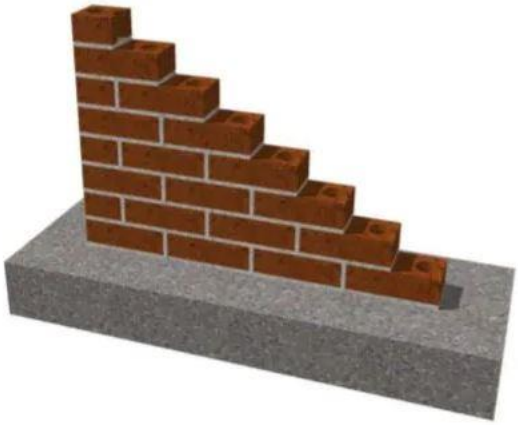
***Note :** Bel fast roof truss/latticed roof truss can be used for long span about 30m & steel roof trusses are more economical for larger span (Greater 12m).

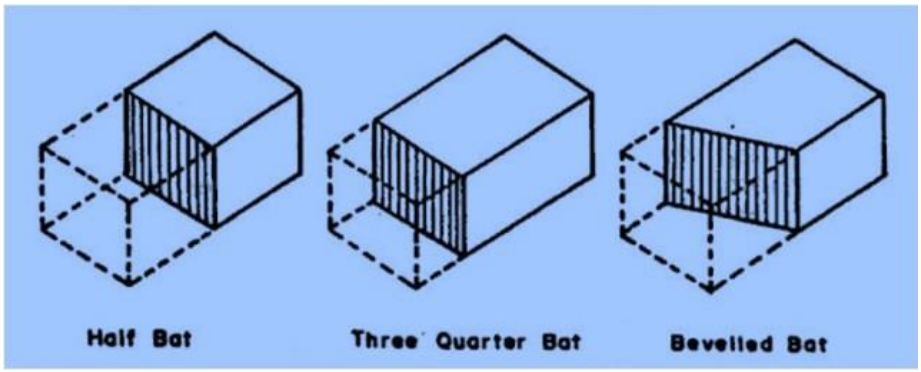
Brick masonry

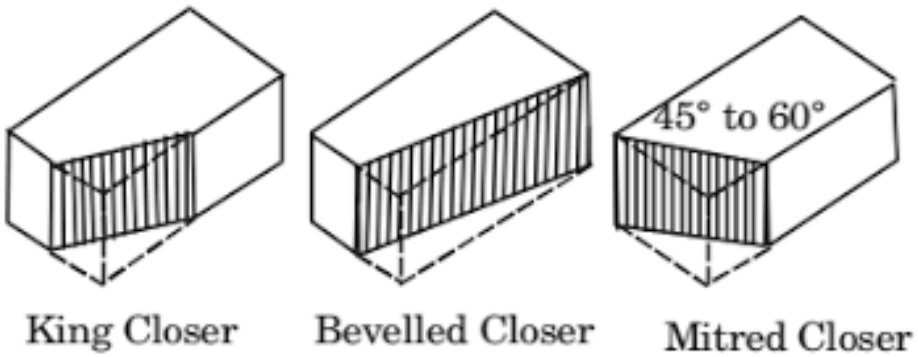
- **Stretcher –** Longer face of brick showing (190mm X 90mm), parallel to direction of wall
- **Header –** Shorter face of brick showing (90mm X 90mm).
- **Bed** – Lower surface of brick when laid flat.
- **Arises** – Edges of brick.
- **Perpend** – Imaginary line passing through the vertical joint in alternate course.
- **Lap** – Horizontal distance between vertical joints in successive course.
- **Quoin** - It is the angle at a corner on the face side of the wall.
- **Bat –** Portion of brick cut across the width.
- **Closer –** Portion of brick cut along its length.
- **Toothing** – Method of terminating a wall with projecting alternate course for proper bond.

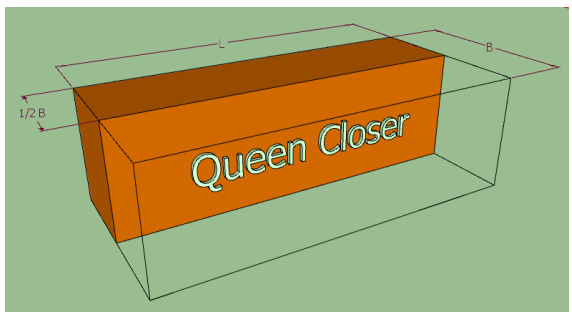


- **Racking back** – At the end of days work wall is left in a steeped manner.









- **Use of queen closer** - a brick of full length and thickness but half width that is used at the end of a course next to the quoin header.

- **Brick bonding –** Method of arranging brick in a course to avoid formation of continuous vertical joint. It is done to provide vertical & lateral stability, reduce settlement as brick work act as a whole unit by bonding.

- **Stretcher bond –** All the bricks are arranged in stretcher course, user for half brick thick wall.

- **Header Bond** - All the bricks are arranged in header course, user for one brick thick wall.

- **English Bond –** Alternate course consist (Headers) & (Stretchers). Strongest bond.

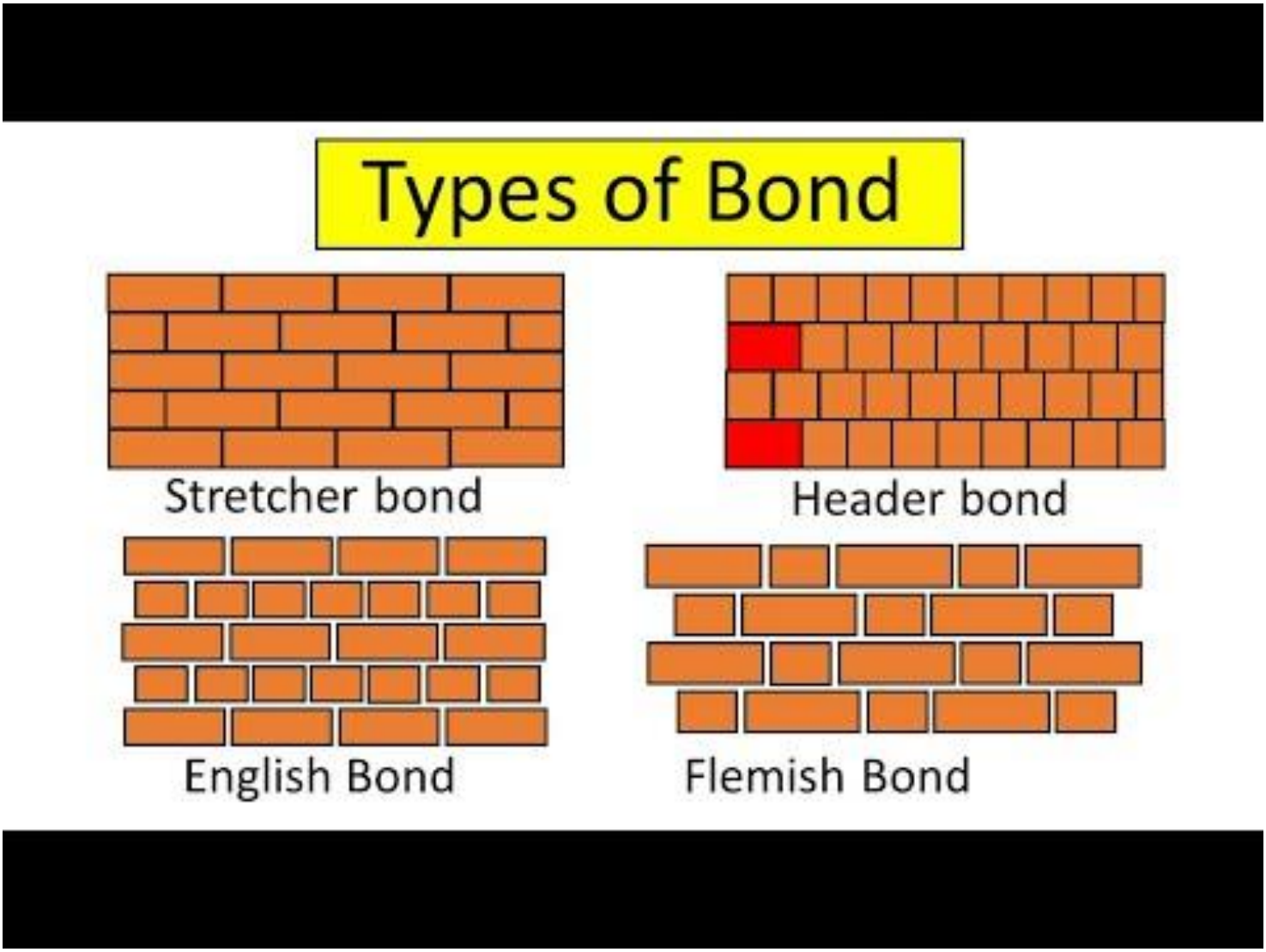
- **Flemish Bond** – Each course consist alternate (Header & Stretcher). For double Flemish bond both faces of wall have a same appearance. But for single Flemish bond – inner face like English bond & outer face like Flemish look. Single Flemish can't be used for wall thickness < $1\frac{1}{2}$ brick but good appearance than English bond.

- **Raking Bond –** Bonding bricks are lade at any angle other than 0 or 90°.

- **Diagonal bond –** Bricks are lead diagonally.

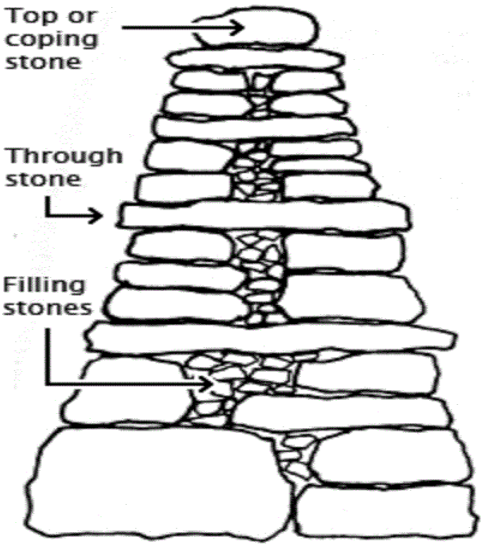
- **Herring Bone bond -** Bricks are lead 45° angle from the center in both direction.

- **Dutch bond –** modified form of english bond.


Types of Bond
Stretcher bond
Header bond
English Bond
Flemish Bond

Stone Masonry

- **Facing –** Stone used in the face of the wall.
- **Backing -** Stone used in the back portion of the wall.
- **Hearting** - Stone used in the portion between facing & backing of the wall.
- **Through stone –** Stone provided right across the wall. Generally it covers the full thickness of the wall.



- **Rubble masonry -** Here stones of irregular size & shape are used. They may be hammered to removed sharp edge. In case of dry rubble masonry mortar isn't used (In compound wall).

Uncoursed rubble masonry

- **Ashlar masonry –** Here stones are cut in regular shapes of same height 250-300mm.

- **Corbel –** Projecting stone provided to support for joist, roof truss, weather shed, corbel extend at least 2L/3 into the wall.

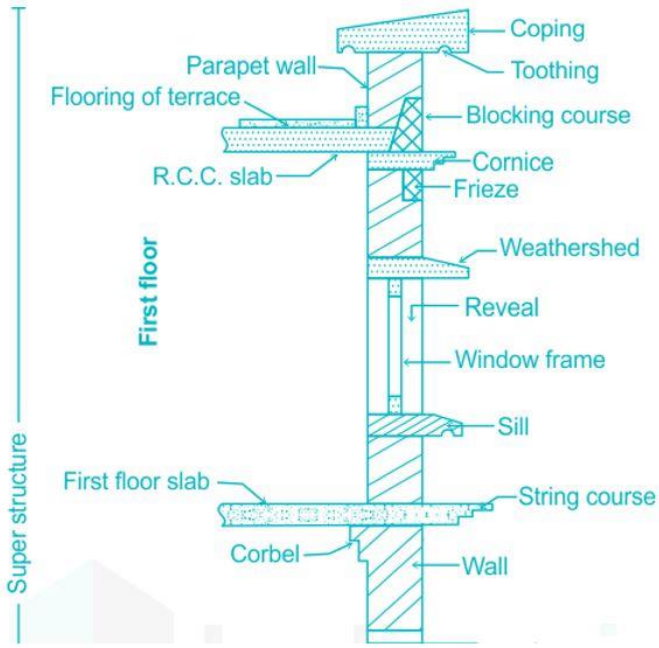
- **Cornice –** Course of stone/ horizontally moulded projection near the top of a building. To dispose of rain water off.

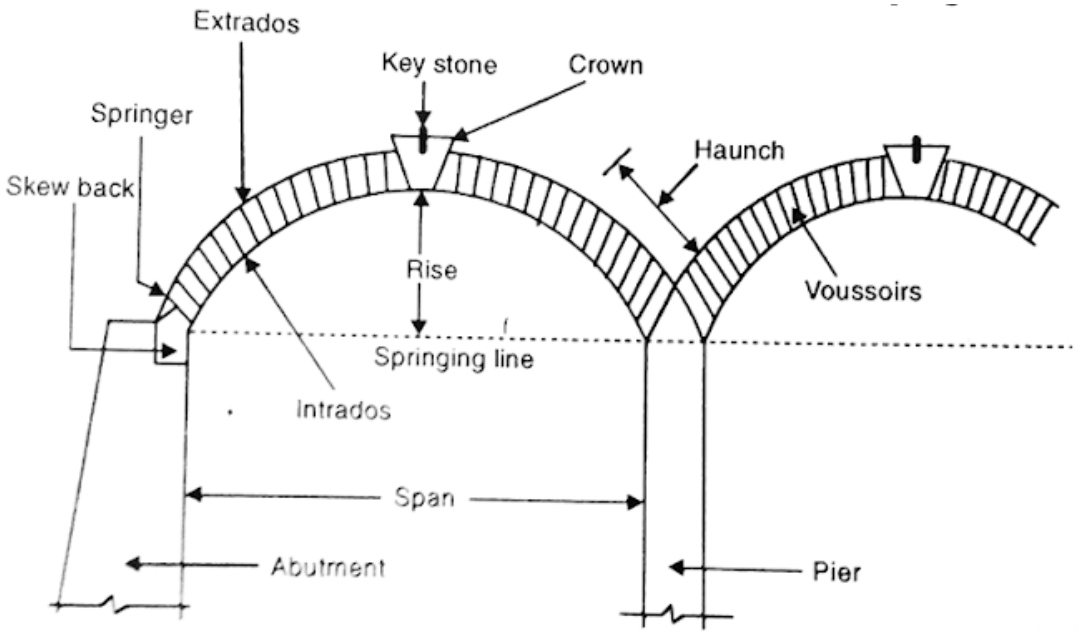
- **Coping –** Covering of stone, concrete, brick on the expose stock on the external wall.

- **Blocking course -** Course of stone immediately above Cornice.

- **Frieze -** Course of stone immediately below Cornice.

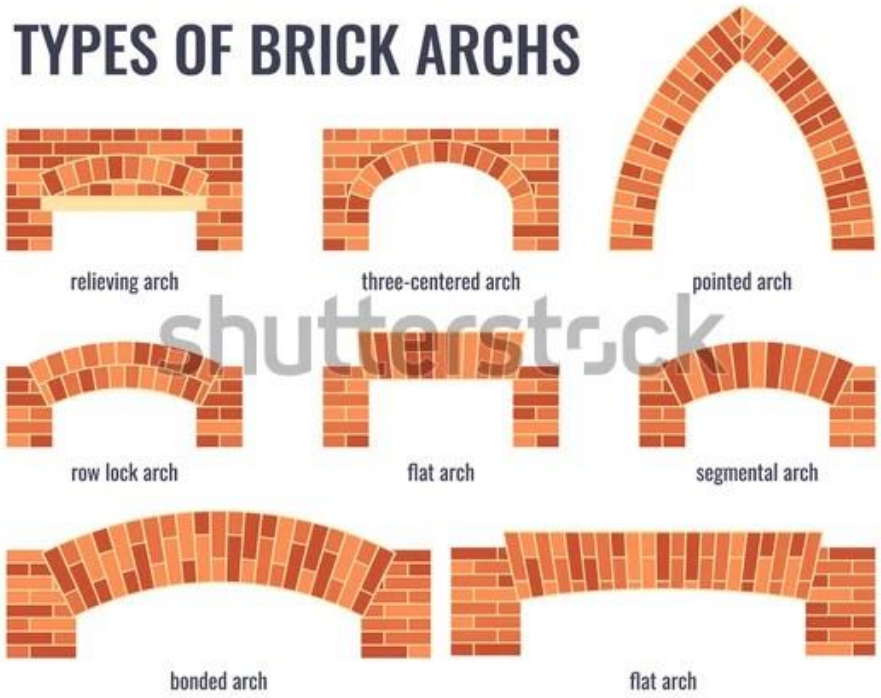
- **Spalls –** Small pieces of stones obtained from reducing big block stones into regular stones.





- **Type of arch** –
  - Flat arch – Extrados is kept horaizontal and flat, skew back is arranged in and inclined position so that angle of 60° with springing line.

  - Segmental arch – Center of arch below the springing line.


TYPES OF BRICK ARCHS
relieving arch
three-centered arch
pointed arch
row lock arch
flat arch
segmental arch
bonded arch
flat arch