Timber

Wood suitable for use as an engineering purpose is called timber.

❖According to various stages of which timber is found, it is named as:

- ❖Standing timber – part of living tree
- ❖Rough timber – when the tree felt.
- ❖Converted timber – rough timber is further sown & converted to market forms such as beams, planks etc.

❖**Types of wood:**

❖Depending upon the mode of growth; trees are:

❖Endogenous

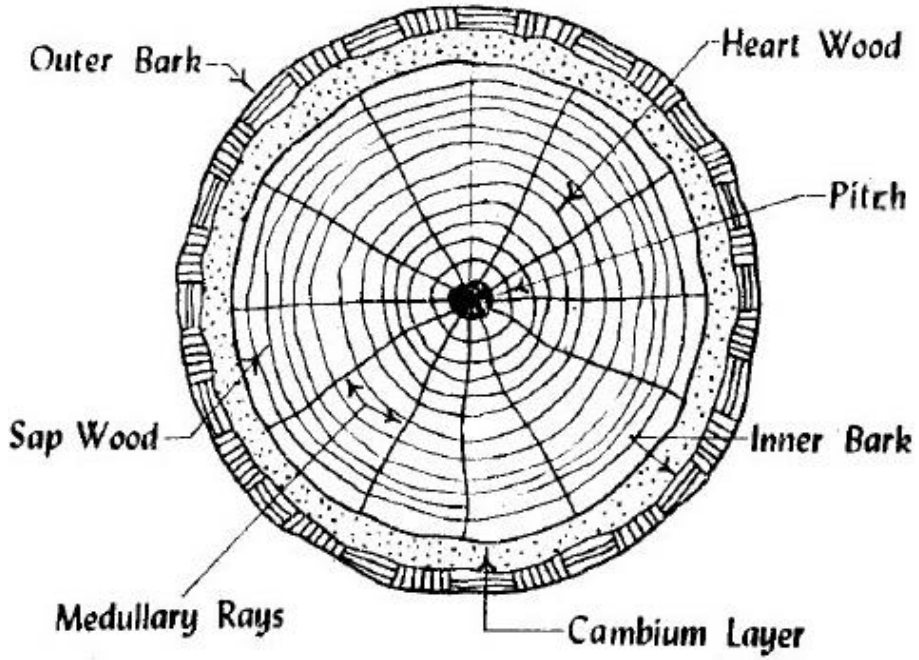
- ❖Endogenous trees grow inward in a longitudinal fibrous mass such as banana, bamboo, cane.
- ❖**It is not suitable for engineering purposes with exceptional bamboo.**

❖Exogenous

- ❖Exogenous trees are those that grow outwards with the addition of the ring every year known as annual ring.
- ❖Thus number of annual ring show the age of the tree.
- ❖**The timber obtained from this class of trees is extensively used in engineering works.**

❖**Conifer or evergreen yielding soft wood:**E.g. Deodar, pine, chir etc.

❖**Deciduous yielding hard wood:**



Characteristics of good timber

- It should have straight and close fibres.
- Uniform colour.
- **Give clear ringing sound when struck.** Dulls heavy sound is the sign of internal decay.
- It should have regular annual rings.
- Timbers with narrow annual rings are generally strongest.
- **Teeth of saw shouldn’t get clogged while sawing.**
- It should have bright & smooth surface when planned, dull appearance is a sign of defective timber.
- Darker & heavier pieces are strong.
- **It should be free from knots, shakes for other defects.**
- It should have compact medullary rays.

Metal and alloys

Classification:

- Ferrous metal:
  - The metal where iron is main constituent.
- Non-ferrous metal:
  - The metal where iron is not main constituent.

- **Occurrence of iron:**
  - **Magnetite (70-75% iron)**
  - **Haematite (70% iron)**
  - **Iron pyrite (47% iron)**
  - **Siderite (40% iron)**
- Pig iron is the crudest form of iron. All the various forms of iron & steel are then obtained by suitably purifying & adjusting the composition of pig iron.

Type, properties and uses of iron

- **Pig iron:**
  - In order to remove impurities from the iron ore, carbon & flux are added while melting it. The refined product so obtained is the crudest form of iron & is called pig iron. Then it is cast into raw parts called pigs.
- **Cast iron:**
  - Pig iron is remelted with limestone & coke in a furnace & poured into moulds of desired shapes & sizes to get pure product known as cast iron. Carbon contain in cast iron vary from 2-4.5%. It contains impurities like manganese, phosphorous, silicon etc.
- **Wrought iron:**
- In wrought iron, nearly all the carbon & other elements in pig iron are oxidized & left with 0.25% of carbon obtained wrought iron. It is the purest form of iron in which the total impurities don't exceed 0.5%.

Characteristics:

- It is hard, brittle & easily fusible with 1250ºC of melting temperature.
- It doesn't burst& can't be magnetized.
- It can be harden by heating & sudden cooling.
- It can't be tempered.
- It shrinks on cooling.
- It is strong in compression but weak in tension.
- It can't be riveted or welded.
- It is used for rainwater pipes, sewer pipe, gutters etc.

Composition and properties of steel

Carbon steel types:

- Dead carbon steel (Carbon < 0.15%)
- Mild carbon steel (Carbon 0.15 – 0.25%)
- Medium carbon steel (Carbon 0.25 – 0.70%)
- High carbon steel (Carbon 0.70 – 1.5%)

Heat Treatment Process

Annealing: (Cool in sand, ash, lime)

- Annealing may be defined as heating the steel to austenite phase & then cooling slowly through the transformation range

Quenching/Hardening:

- Quenching may be defined as rapid cooling of steel from the austenite phase. The rapid cooling is obtained by immersion of steel in a liquid bath such as water or oil & sometimes forced air can also be used.

Normalizing: (become brittle & crack)

- Normalizing may be defined as heating the steel to austenite phase & cooling it in air. It is done to achieve machinability.

Case hardening/Surface hardening:

- Surface hardening may be defined as a process of hardening a ferrous material in such a manner that the surface layer (case) is substantially harder than the remaining material (core).

Properties:

- It is a mid way between cast iron & wrought iron.
- It has a granular structure.
- Its MP is between 1300 – 1400ºC
- It can be hardened & tempered.
- It absorbs socks.
- It rusts easily.
- It is tough, malleable & ductile.
- It is strong in compression as well as tension.
- It can be magnetite.
- It can be rapidly forged & welded.
- Used as reinforcement in RCC works, drill, bridges, steel column & beams, machine tools etc.

Bitumen:

- **It is defined as non crystalline solid or viscous hydrocarbon material having adhesive properties & derived from petroleum either by natural or refining process.**

Properties:

- It is solid or semi-solid, black in colour & is sticky.
- It melts or softens as application of heat.
- It is completely soluble in carbon-disulphide.
- It is binder in all types of asphalt.

Uses:

- Used as road making materials.
- Used in damp proof coarse (DPC).
- Since it forms good expansion joint, it is used for filling up the joints in leaky roof.
- It is employed in manufacture of water proofing materials, paints etc.

Cut-back bitumen:

- Cut back is defined as a bitumen **whose viscosity is maintained by addition of volatile diluents such as gasoline, kerosene etc.** Cut backs are manufactured in three groups from rapid curing, medium curing, and slow curing.

Emulsion:

- **Emulsion is combination of water, bitumen & emulsifying agent. To prevent bitumen spheres from coagulation, an emulsifying agent is added. Mostly soap is used as an emulsifying agent.**

Emulsion may be classified as rapid setting, medium setting & slow setting.

- Rapid setting (10-30 mins)
- Medium setting (30-60 mins)
- Slow setting (2-24 hrs.)

Tar:

- Tar is one of the bituminous material obtained during the destructive distillation of coal, peat, wood or other organic material.

Paint and Varnishes

- **Paint** is any liquid, liquefiable, or mastic composition(resin) that, after application to a substrate in a thin layer, converts to a solid film.
- It is most commonly used to protect, **color, or provide textur**e to objects.

Components of Paint

1. Binder (or film former)

- The binder, commonly called the vehicle, is the film-forming component of paint.
- It is the only component that **must be present.** Other components are included optionally, depending on the desired properties of the cured film.
- The binder imparts **adhesion** and strongly influences properties such as gloss, durability, flexibility, and toughness.

2. Diluent or Solvent

- The main purposes of the diluent are to dissolve the polymer and adjust the viscosity of the paint.
- **It is volatile and does not become part of the paint film**. It also controls flow and application properties, and in some cases can affect the stability of the paint while in liquid state.
- Its main function is as the carrier for the non volatile components.

3. Pigment and Filler

- Pigments are granular solids incorporated in the paint to contribute **color**.

4. Additives

- Besides the three main categories of ingredients, paint can have a wide variety of miscellaneous additives, which are usually added in small amounts, yet provide a significant effect on the product.

Types of Paint

1. Whitewash:low-cost paint made from mixture of slaked lime or powdered chalk, size and water used for whitening walls

2. Oil Paint:slow drying paints which consist of particles of pigment suspended in a drying oil or oil varnish.

3. Emulsion Paint:

- Emulsions are defined as a mix of two liquids that don't mix well.

4. Cement Based Paint:

- Cement-based paints are water based paint in which cement forms the base.

5. Enamel Paint:

- Enamel paints are oil based paints and with a considerably glossy finish. Enamel Paints consists of white lead, zinc white, resinous matter and petroleum spirit. Enamel paints are more durable and have hard strong finish.

6. Bituminous paint 7. Lead Paint 8: Rubber paint 8.Metallic Paint

Varnishes

- **Varnish** is a transparent, hard, protective finish or film primarily used in wood finishing but also for other materials.
- Varnish is traditionally a combination of a drying oil, a resin, and a thinner or solvent.
- Varnish finishes are usually glossy but may be designed to produce satin or semi-gloss sheens by the addition of "flatting" agents.
- Varnish has little or no color, is transparent, and has no added pigment, as opposed to paints or wood stains, which contain pigment and generally range from opaque to translucent.

Components of Varnish

1. Drying oil

- There are many different types of drying oils, including linseed oil, tung oil, and walnut oil.

2. Resin

3. Solvent (traditionally turpentine)

Distemper

- **Distemper** is a term with a variety of meanings for paints used in decorating and as a historical medium for painting pictures, and contrasted with tempera. The binding element may be some form of glue or oil; these are known in decorating respectively as
  - soft distemper and
  - oil bound distemper.

- 1. Bitumen is obtained from _____
  a) Wood
  b) Petroleum
  c) Coal
  d) Kerosene

- The distance between two samples in penetration test should be _____
  a) 10mm
  b) 15mm
  c) 20mm
  d) 25mm

- The bitumen is completely soluble in _____(IMP)
  a) Carbon monoxide
  b) Carbon dioxide
  c) Carbon sulfide
  d) Carbon disulfide

- Which bitumen does not need heating?
  a) Paving grade
  b) Cut back
  c) Modified
  d) Bitumen emulsion

- Which of the following grade of bitumen is harder?
  a) 30/40
  b) 60/70
  c) 80/100
  d) All are equal

STANDARD TESTS ON BRICKS

Compressive strength test on brick

Step 1: brick specimen immersed in water for 24 hrs
Step 2: frog of brick is filled with 1:3 mortar and is stored under damp jute bags for 24 hrs followed by immersion in clean water for three days.
Step 3: place the specimen between the plates of the compression testing machine
Step 4: apply load axially at a uniform rate (14 N/mm^2) and maximum load at the specimen fails is noted

Compressive strength = $\frac{maximum\ load\ at\ failure}{loaded\ area\ of\ brick}$

Crushing or compressive strength of common building brick should not be less than 3.5 N/mm^2

Efflorescence test

- Step 1: Immerse the brick specimen for 24 hrs.
- Step 2: Take out and allow the specimen to dry in shade.
- Step 3: Check the availability of grey or white deposit on its surface which indicate the presence of soluble salt
- Presence of white deposit about 10% of surface -> said to be slight & consider as moderate
- Presence of white deposit about 50% of surface -> said to be heavy & considered as serious

- In absorption test on brick, how many hours it has to be soaked in cold water?
  a) 19 hours
  b) 5 hours
  c) 6 hours
  d) 24 hours

- What is the loading rate used in compressive strength test?
  a) 14 N/mm^2 per hour
  b) 14 N/mm^2 per minute
  c) 20 N/mm^2 per minute
  d) 40 N/mm^2 per hour

- When observed efflorescence is more than 10% but less than 50% of the exposed area, it is:
  a) Moderate efflorescence
  b) Serious efflorescence
  c) Heavy efflorescence
  d) Light efflorescence

- _____ is used for skirting around bathtubs and mosaics?
  a) Sandstone
  b) Travertine
  c) Granite
  d) Onyx

- How is the hardness of brick tested?
  a) Using finger nail
  b) Using hardness apparatus
  c) Using hammer
  d) Using chisel

- What is the maximum permissible tolerance for length and width respectively?
  a) ± 3mm and ± 6mm
  b) ± 6mm and ± 3mm
  c) ± 3cm and ± 6cm
  d) ± 6cm and ± 3cm

- Which of the following is not a feature of second class bricks?
  a) Have small irregularities
  b) Water absorption is between 20-25%
  c) Rectangular in shape
  d) Free from cracks

- The compressive strength of the brick should be:
  a) Minimum 3.5 kN/m^2
  b) Maximum 3.5 kN/m^2
  c) Minimum 3.5 N/mm^2
  d) Maximum 3.5 N/mm^2

- What does M_1 indicate in the formula:
  % water absorption = $M_2 - M_1 / M2$ x 100
  a) Oven dried mass of brick
  b) Oven dried and cooled mass of brick
  c) Mass of water absorbed brick
  d) Mass of water absorbed and dried brick

- Quarry tile is also called:
  a) Granite tile
  b) Unglazed ceramic tile
  c) Stone tile
  d) Workshop tiles

- Type of tile commonly used in roofs
  a) Porcelain
  b) Shale
  c) Slate
  d) Granite

Tests on Aggregate,Bulking of Sand

Bulking of sand refers to an increase in the volume of sand due to the presence of moisture. When dry sand absorbs water, the water coats the sand particles and fills the voids between them, causing the sand to expand. This phenomenon is important to consider in construction, especially in applications where accurate volume measurements are crucial, such as concrete mixtures.

Causes of Bulking:

1.Surface Tension: Water adheres to the surface of sand particles due to surface tension, causing the sand particles to repel each other and increase the volume.

2.Capillary Action: Water is drawn into the spaces between sand particles through capillary action, leading to an increase in volume.

3.Film of Water: A film of water forms around each sand particle, separating them and causing expansion.

Effects of Bulking:

1.Reduced Yield: Bulking of sand results in an apparent increase in volume, which can lead to a decrease in the amount of sand available for a given weight or volume.

2.Inaccurate Measurements: Bulking can cause inaccuracies in volume measurements, affecting the proportioning of materials in concrete mixtures and other applications.

Procedure:

Selection of Sand Sample:

Obtain a representative sample of the sand to be tested. Ensure that the sample is free from contaminants and large particles.

Initial Volume Measurement:

Fill the graduated cylinder or container with a known volume of dry sand, ensuring that it is compacted and leveled off to eliminate any voids or air pockets. Record the initial volume (V1) of sand.

Wetting of Sand:

Slowly add a measured quantity of water to the sand sample in the mixing bowl, ensuring thorough mixing to achieve uniform moisture distribution. The amount of water added should be sufficient to fully wet the sand but avoid excessive saturation.

Final Volume Measurement:

Transfer the wetted sand back into the graduated cylinder or container, filling it to the same level as before. Tap the container gently to settle the sand and remove any trapped air bubbles. Record the final volume (V2) of sand.

Calculation:

Calculate the bulking factor using the formula:

Bulking Factor=$V2/V1 \times 100\%$

Results Analysis:

Analyze the bulking factor obtained and compare it with known values or specifications for the sand type. Bulking factors can vary depending on factors such as sand particle shape, gradation, and moisture content.

1.For the manufacture of Portland cement, the proportions of raw materials used, are

a) lime 63% ; silica 22% ; other ingredients 15%

b) lime 22% ; silica 63% ; other ingredients 15%

c) silica 40% ; lime 40% ; other ingredients 20%

d) silica 70% ; lime 20% ; other ingredients 10%.

- The attachment used in consistency test of cement is:

a) Vicats needle

b) Vicats plunger

c) Vicats needle with annular collar

d) Le Chatliers apparatus

- Initial setting time for OPC cement should not be less than:

a) 45 mins

b) 600 mins

c) 40 mins

d) 30 mins

Area of plunger used in consistency test of cement is:

a) 1.8 cm2
b) 1 cm2
c) 1.5 cm2
d) 2 cm2

Two consecutive readings for initial setting time of cement mustnot be less than

a) 1 cm
b) 1.9 cm
c) 1.5 cm
d) 1.8 cm

Standards for Cement

NS Code

1. NS 49:2041 Ordinary Portland Cement
2. NS 384:2054 Portland Slag Cement
3. NS 385:2054 Portland Pozzolana Cement

IS Code:

1. IS 269: Ordinary Portland Cement
2. IS 8112: High Strength Portland Cement
3. IS 12269: Portland Slag Cement
4. IS 1489: Portland Pozzolana Cement

NS 572:2076 Specification for 43 grade and 53 Grade OPC

- The **minimum amount of clinker** shall be **95%** by mass of OPC
- No materials shall be added to clinker other than gypsum (natural, mineral or chemical), water and not more than (a total of 1.0% of air entraining agents or other agents including coloring agents, which have proved not to be harmful. Such additions shall be made before grinding.
- The net quantity of OPC per bag shall be 50 kg or 25 kg or 10 kg or 5 kg. the quantity of OPC in any of bags shall be ±1% of the market net quantity.
- The cement can be packed in
  - Jute Sacking bag
  - Multi-Wall paper sacks
  - Light weight jute
  - HDPE/PP Woven Sacks
  - Jute Synthetic Union Bags
  - Any approved composite bag
- Marking of each bag of cement should contain:
  - Manufacturer's Name and his registered trade mark
  - The name and designated grade of the ordinary Portland cement
  - Net quantity in kg
  - Batch No/Code number in terms of week, month and year of packing
  - Best before date (that is, not more than 3 months from the date of packing)
  - Need for testing of cement more than 3 months old to check conformity beforfe its use
  - Nepal standard certification mark with applicabe number and year.
  - Address of the manufacturer

Standards for Cement

- **Physical Requirements for OPC 43 Grade:**
- **Fineness**: The cement should have a specific surface area (Blaine) not less than 225 m^2/kg.
- **Setting Time**: The initial setting time of cement should not be less than 30 minutes, and the final setting time should not be more than 600 minutes.
- **Soundness**: The ***autoclave expansion*** of the cement should not exceed 0.8%. And when measure with ***Le-Chatliers Appratus*** the cement should not go expansion more than 10mm.
- **Compressive Strength**: The compressive strength of OPC 43 Grade at various ages should meet the following requirements:
  - 3 Days: Not less than 23 MPa
  - 7 Days: Not less than 33 MPa
  - 28 Days: Not less than 43 MPa
- **Loss on Ignition (LOI)**: The loss on ignition of the cement should not exceed 5%.
- **Specific Gravity**: The specific gravity of cement should be between 3.10 to 3.20.

- **Physical Requirements for OPC 43 Grade:**
- **Fineness**: The cement should have a specific surface area (Blaine) typically not less than 325 m^2/kg.
- **Setting Time**:
  - Initial setting time: Not less than 30 minutes.
  - Final setting time: Not more than 600 minutes.
- **Soundness**: The ***autoclave*** expansion of the cement should not exceed 0.8% and the expansion measure using ***Le-Chatliers*** should not exceed 5mm.
- **Compressive Strength**:
  - 3 Days: Not less than 27 MPa
  - 7 Days: Not less than 37 MPa
  - 28 Days: Not less than 53 MPa
- **Loss on Ignition (LOI)**: The loss on ignition of the cement should not exceed 3%.
- **Specific Gravity**: The specific gravity of cement should typically be between 3.10 to 3.20.

Note: The aeration shall be done by spreading out the sample to a depth of 75mm at a relative humidity of 50 to 80% for a Total period of 7 days. The expansion of OPC so aerated shall be not more than 5mm and 0.6% when tested Le-Chatelier Method and autoclave test respectively

Standards for Cement

S.No	Characteristics	Requirements	
		OPC 43	OPC 53
1	Lime saturation factor(ratio of percentage of lime to percentage of silica, alumina and iron oxide	0.66-1.02	0.8-1.08
2	Ratio of percentage of alumina to that of iron oxide	0.66 minimum	0.66 minimum
3	Insoluble residue, percent by mass,	2 max	2max
4	Magnesia, percent by mass,	5.0 max	5.0 max
5	Total sulphur content calculated as sulphuric anhydrid present by mass		
	case a. content of C3A <5%	2.5 max	2.5max
	case b. content of C3A >5%	3.0 max	3.0 max
6	Loss on ignition, percentage by mass	4 max	4 max

Standards of Rebar

- NS 84:2042 Mild Steel Rod
- NS 191:2046 Deformed steel bars and wires for concrete reinforcement
- IS 1786: High Strength Deformed steel bars and wires for concrete Reinforcement Specimen

Note: mild steel: Fe 250

Tor(Toristeg Steel Corporation)***Steel: Fe 415***

TMT: Fe 500

- Nominal Size of bars: 4,5, 6,8,10,12,16,20,25,28,32,36,40,45,50 mm

Types of Rebar:

1.Mild Steel Rebar (MSR): Also known as "black bar," mild steel rebar is the traditional type of rebar used in construction projects. It is primarily composed of carbon steel and is easily weldable.

2.High-Strength Reinforcement Steel (HSRS): This includes rebar with higher yield strength than traditional mild steel rebar. Examples include Fe 415, Fe 500, Fe 550, and Fe 600 grades.

3.Corrosion-Resistant Rebar: Rebar coated with epoxy or other corrosion-resistant coatings to protect against rust and corrosion in aggressive environments, such as coastal areas or structures exposed to chemicals.

4.Stainless Steel Rebar: Stainless steel rebar offers excellent corrosion resistance and durability, making it suitable for use in corrosive environments or where aesthetic considerations are important.

5.Galvanized Rebar: Rebar coated with a layer of zinc to provide corrosion protection. Galvanized rebar is commonly used in projects where exposure to moisture and chemicals is a concern.

Tensile Test on Rebar

- To determine yield stress, strain and ultimate tensile strength
- Apparatus: UTM, Extensometer, Vernier Calipers, Punching tool

Notes:

- The Stress upto the point where the material loses its elasticity and goes into plastic deformation is called a yield point/yield stress
- At this very point, we can experience that the specimen is getting narrow and thin. We can even experience a sudden drop in the curve
- After this, the bar goes into plastic deformation where specimen starts getting thin from center point and the metal specimen goes upto ultimate tensile stress which is the highest point.
- When the specimen reaches maximum stress it experiences “necking "process which is known as Ultimate tensile stress
- After this , the bar goes into more deformation and finally arrives at a fracture point where the metal breaks.
- Stiffness= Young’s modulus (Slope of stress-strain curve)
- Strength= Yield Stress
- Young's modulus can be calculated using the following formula:

  E= Stress/Strain

  Where:

  E = Young's modulus of elasticity (in Pascals, Pa)

  Stress = Force (in Newtons, N) applied to the material divided by the original cross-sectional area (in square meters, m^2) of the material

  Strain = Change in length of the material (in meters, m) divided by the original length (in meters, m) of the material

Standards for Aggregate

- Ns 297: 2050 Aggregate
- NS 298: 2050 Sampling Method for aggregates
- NS 305:2050 Methods of test for aggregates for Concrete
- IS 383:1970 Specifications for fine and Coarse aggregate

Class A	Consist of Igneous or quartzite rock from an approved source
Class B	Consist of Crushed quarry rock other than Class A from an approved source
Class C	consist of natural or partly crushed gravel, pebbles obtained from approved gravel deposit
Class D	consist of crushed gravel
Class E	consist of an artificial mixture of any of the above classes

Types of Aggregates:

1.Natural Aggregates:

1. **Sand**: Fine granular material, typically composed of particles ranging from 0.075mm to 4.75mm in size.
2. **Gravel**: Coarse granular material consisting of particles larger than sand, typically ranging from 4.75mm to 75mm in size.
3. **Crushed Stone**: Stone aggregates produced by crushing larger rocks, available in various sizes.

2.Manufactured Aggregates:

1. **Recycled Concrete Aggregate (RCA)**: Produced from demolished concrete, used as a sustainable alternative to natural aggregates.
2. **Slag Aggregates**: Byproducts of industrial processes, such as blast furnace slag or steel slag, used in construction.

Characteristics of Aggregates:

- **Shape**: Influences workability, strength, and durability of concrete. Angular and rough-textured aggregates provide better interlocking, while rounded aggregates reduce water demand.
- **Size Gradation**: Refers to the distribution of particle sizes within an aggregate sample, affecting the workability and strength of concrete.
- **Cleanliness**: Presence of contaminants like clay, silt, or organic matter can affect the performance and durability of concrete.
- **Specific Gravity**: Indicates the density of aggregates relative to water and influences the density and strength of concrete.
- **Absorption**: Measures the porosity of aggregates and affects the water-cement ratio in concrete mixtures.

Standards for aggregate

Composition of Aggregates:

1.Minerals: Aggregates primarily consist of mineral materials such as **quartz, feldspar, limestone, granite, or basalt.**

2.Particle Size Distribution: Aggregates are classified based on particle sizes, including coarse aggregates (gravel and crushed stone) and fine aggregates (sand).

Selection Criteria:

Application: Consider the intended use of aggregates, whether for concrete, asphalt, base course, or drainage.

Gradation: Ensure proper particle size distribution for optimal concrete workability, strength, and durability.

Quality: Assess cleanliness, grading, and absence of deleterious materials to meet project specifications and performance requirements.

Availability: Consider local availability and sourcing of aggregates to minimize transportation costs and environmental impact.

Cost: Balance quality requirements with budget constraints when selecting aggregates for construction projects.

Usage of Aggregates:

Concrete Production: Aggregates constitute the bulk of concrete mixtures, providing strength, durability, and volume stability.

Asphalt Mixtures: Aggregates are used as the main component in asphalt concrete for road construction and pavement.

Base Course Material: Aggregates serve as the foundation material for roads, railway tracks, and airport runways.

Drainage Systems: Coarse aggregates are used in drainage systems to facilitate water flow and prevent soil erosion.

Landscaping: Decorative aggregates are used in landscaping projects for pathways, gardens, and decorative features.

Testing Methods for Aggregates:

Gradation Analysis: Determines the particle size distribution of aggregates using sieving techniques.

Specific Gravity and Absorption: Measures the density and porosity of aggregates relative to water.

Particle Shape Analysis: Assesses the shape characteristics of aggregates using visual or mechanical methods.

Cleanliness Test: Determines the presence of contaminants such as clay, silt, or organic matter in aggregates.

Aggregate Crushing Value (ACV): Measures the resistance of aggregates to crushing under compressive loads.

Bulking of Sand

Bulking of sand refers to an increase in the volume of sand due to the presence of moisture. When dry sand absorbs water, the water coats the sand particles and fills the voids between them, causing the sand to expand. This phenomenon is important to consider in construction, especially in applications where accurate volume measurements are crucial, such as concrete mixtures.

Causes of Bulking:

1.Surface Tension: Water adheres to the surface of sand particles due to surface tension, causing the sand particles to repel each other and increase the volume.

2.Capillary Action: Water is drawn into the spaces between sand particles through capillary action, leading to an increase in volume.

3.Film of Water: A film of water forms around each sand particle, separating them and causing expansion.

Effects of Bulking:

1.Reduced Yield: Bulking of sand results in an apparent increase in volume, which can lead to a decrease in the amount of sand available for a given weight or volume.

2.Inaccurate Measurements: Bulking can cause inaccuracies in volume measurements, affecting the proportioning of materials in concrete mixtures and other applications.

Procedure:

Selection of Sand Sample:

Obtain a representative sample of the sand to be tested. Ensure that the sample is free from contaminants and large particles.

Initial Volume Measurement:

Fill the graduated cylinder or container with a known volume of dry sand, ensuring that it is compacted and leveled off to eliminate any voids or air pockets. Record the initial volume (V1) of sand.

Wetting of Sand:

Slowly add a measured quantity of water to the sand sample in the mixing bowl, ensuring thorough mixing to achieve uniform moisture distribution. The amount of water added should be sufficient to fully wet the sand but avoid excessive saturation.

Final Volume Measurement:

Transfer the wetted sand back into the graduated cylinder or container, filling it to the same level as before. Tap the container gently to settle the sand and remove any trapped air bubbles. Record the final volume (V2) of sand.

Calculation:

Calculate the bulking factor using the formula:

Bulking Factor=$V2/V1 \times 100\%$

Results Analysis:

Analyze the bulking factor obtained and compare it with known values or specifications for the sand type. Bulking factors can vary depending on factors such as sand particle shape, gradation, and moisture content.

1.3 Building technology:

A. Building construction technology :brick and stone masonry, carpentry, painting, plastering, concrete roofing, flooring, damp proof course;

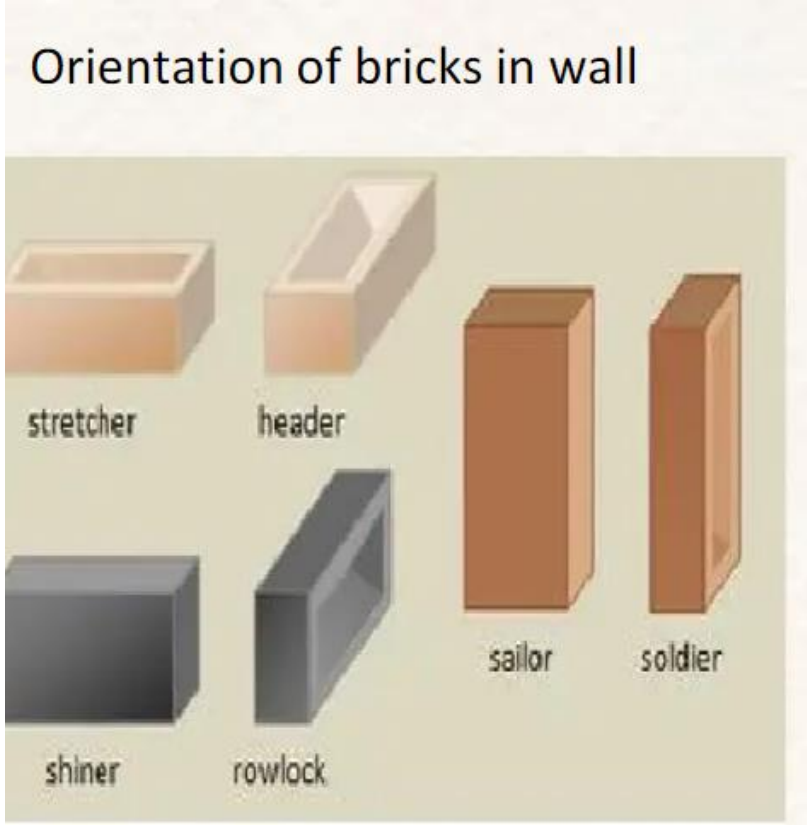
B. Building by laws

Brick Masonry

Brick units bonded together with mortar to form different structure.

Strength of brick masonry depends upon:

- Quality of bricks
- Mortar used
- Bonding of bricks

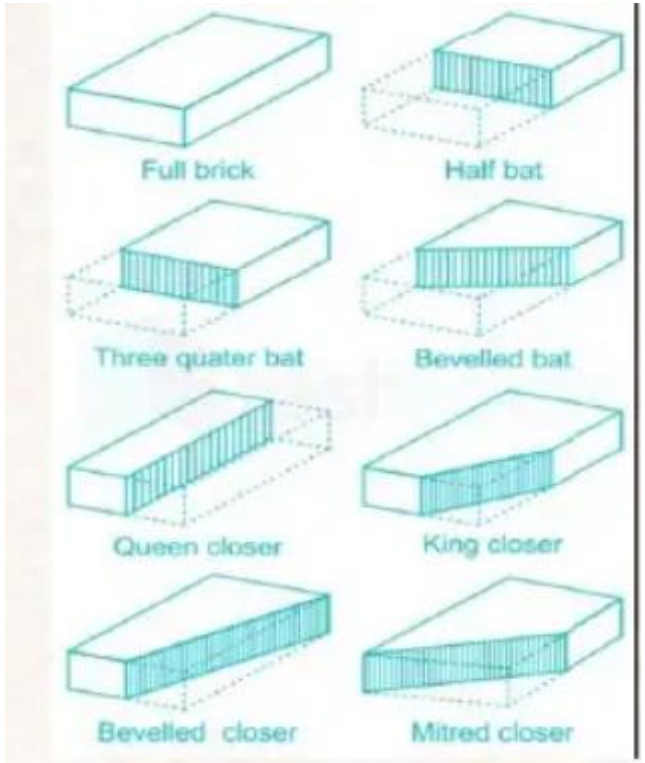


Masonry Wall can be divided into:

- **Load Bearing Wall,**
- **Non Load Bearing Wall**
- **Retaining wall**

Terminologies

- **Header: Full brick or stone which is laid with its length perpendicular to the face of the wall**
- **Stretcher' Full brick or stone which is laid with its length parallel to the face of the wall**
- **Bond: term applied to overlapping of bricks or stones in wall in alternate courses**
- **Bed- Lower surface of brick or stone in each course**
- **Hearting- Portion of wall between facing and backing is hearting**
- **Toothing; Brick left projecting in alternate courses**
- **Bat-Portion of brick cut across width**

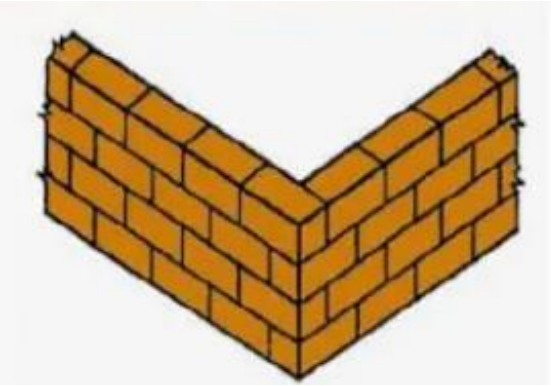


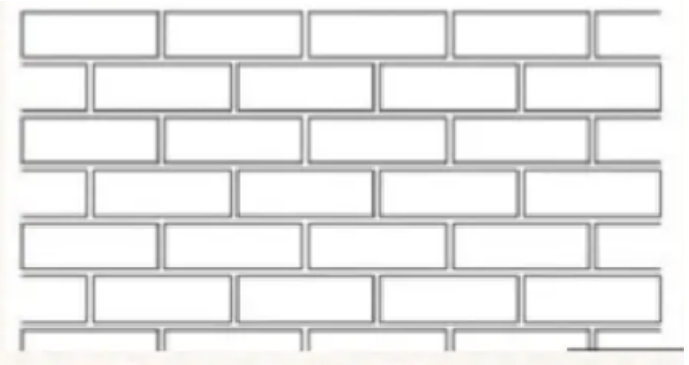
Types of bond in brick masonry

Types of bond in brick masonry

Stretcher Bond

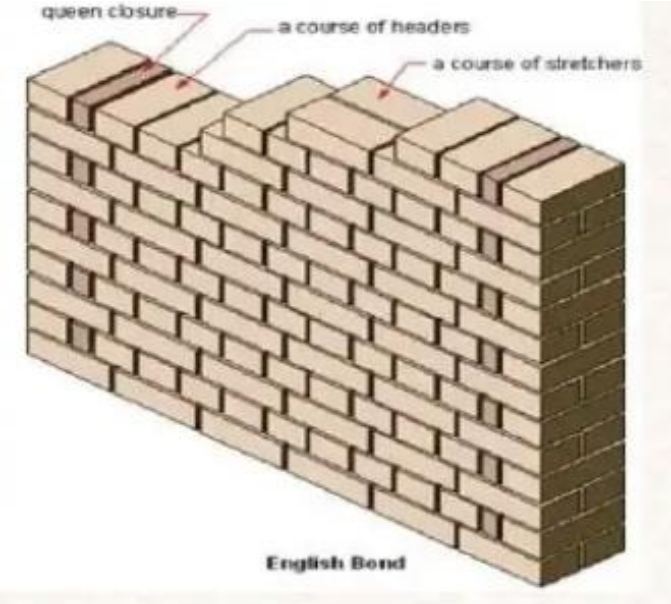
- Simple
- Useful for half brick walls, partition walls, cavity walls
- No header in walls
- Weak bond is developed
- Should not be used for walls with thickness more than half brick thick

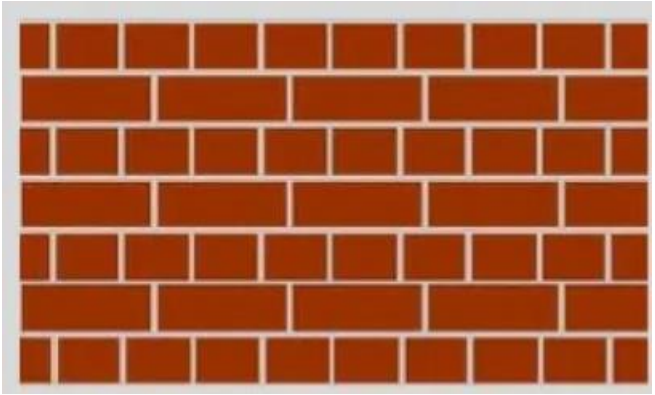




English Bond

- Consist of header and stretcher in alternative courses
- **Strongest of all bonds**
- **Noticable continuous vertical joints are not seen**
- Work progress is faster
- Minimum thickness of wall is one brick thick

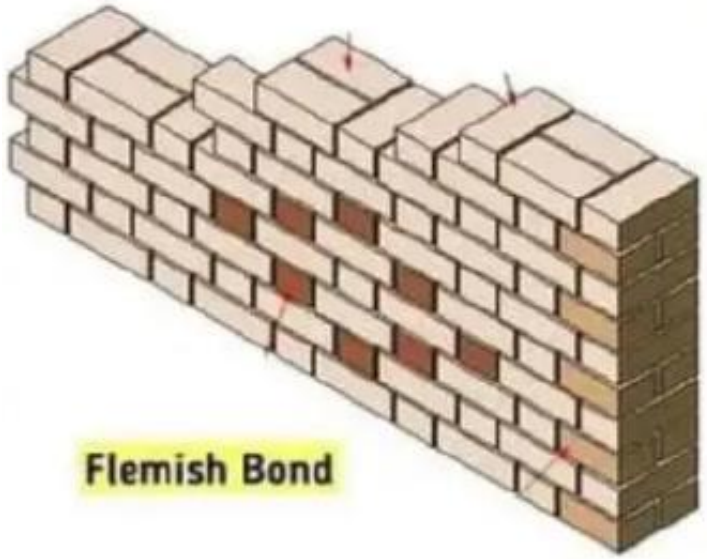


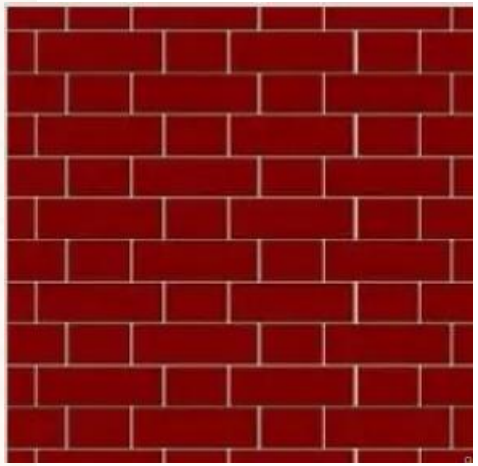


Types of bond in brick masonry

Flemish Bond

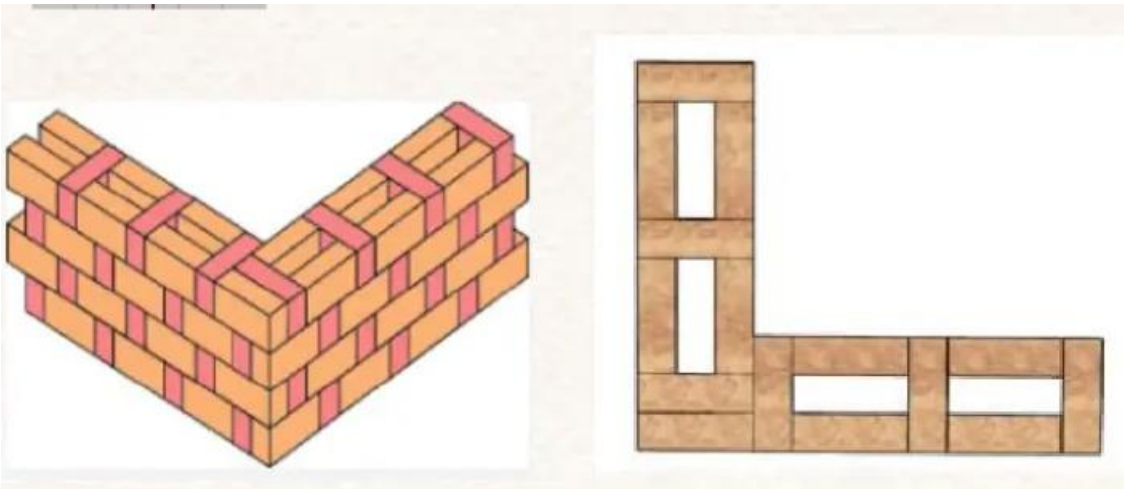
- Consists header and stretcher alternatively in each course
- Partly **continuous vertical joints in the structure is seen**
- Slow progress of work
- Provides good appearance
- Minimum thickness of wall is one brick thick





Rat Trap Bond

- The shiner and row lock are placed alternatively in each course
- Cavity is formed in between the bricks
- 20-35% saving in bricks and30-50% saving in mortar can be made
- Walls have approximately 20 % less dead weight
- For 1 cu. m of **masonry,470 bricks** are required in comparison to conventional walls that require **550-560 bricks**
- Reinforcement bars can be inserted that increases the ductility of wall
- Proper heat and sound insulation because of cavity
- Good workmanship is required



- **1.What is a brick called when it is split into two halves along longitudinal direction ?**
- a.King closer b.Queen closer c.Half bat d.Squint
- **2. Which of the following is the most strongest bond?**
- a.Flemish bond b.Rat trap bond c.English bond d.Stretcher bond
- **3. What is the bond called when the alternative courses have header and stretcher?**
- a.Flemish bond b.Rat trap bond c.English bond d.Stretcher bond

Stone Masonry

- Stones used as building units is called stone masonry
- Stones are cheap, durable and easily available
- Stones help to maintain thermal comfort
- Stone masonry has longer span
- Attractive in appearance

Requirements of stones in stone masonry

- Hard
- Durable
- Tough
- Sound
- Free from cracks
- Free form loose and soft material

Rubble masonry	Ashlar masonry
Random rubble masonry	Ashlar fine masonry
Square rubble masonry	Ashlar rough tooled masonry
Dry rubble masonry	Ashlar rock or quarry faced masonry
Polygonal rubble masonry	Ashlar chamfered masonry
	Ashlar block in course masonry
	Ashlar facing masonry

Rubble Masonry: Masonry in which undressed or roughly dressed stones are used

A. Random rubble masonry :

- Undressed or hammer dressed stones

B. Squared rubble masonry:

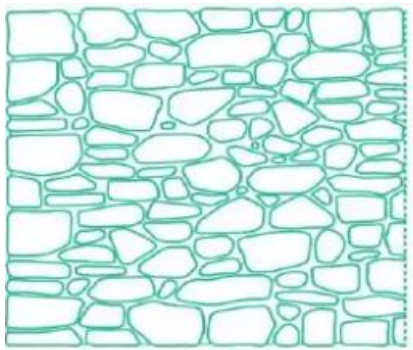
- Rubble masonry in which the face stones are squared on all joints and beds by hammer dressing or chisel dressing

C. Dry rubble masonry :

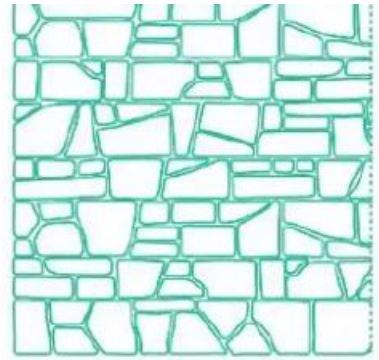
- Rubble masonry in which stones are laid without use of the mortar
- Mostly used in retaining works of less height and in boundary walls
- Height **should not exceed 6 m**

D. Polygonal rubble masonry

- Stones are dressed at joints to form a polygonal shape



Uncoursed random rubble masonry



coursed random rubble masonry

Uncoursed square rubble masonry

Coursed square rubble masonry

Ashlar masonry

Stone masonry in which finely dressed stones are laid in cement/lime mortar (or even without a mortar)

- Joints are regular and have uniform thickness
- Dressing increases the cost of masonry

Coursed and uncoursed fine ashlar masonry

A. Ashlar fine masonry

- The stones are fine tooled on all sides
- Heavy wastage and high labour requirement

B. Rough tooled ashlar masonry

- All sides of stone are rough tooled and dressed with chisels

C. Rock or Quarry faced ashlar masonry

- similar to rough tooled ashlar masonry except that the face contain chisel marks

D. Chamfered ashlar masonry

- The edges of the stones are chamfered at an angle of 45 degrees.

E. Ashlar facing

- Masonry in which the facing is made of ashlar masonry and the back of the wall contain rubble masonry or brick masonry
- Used to economize the cost of construction

Carpentry

- Carpentry is the activity of making and repairing the things out of woods

Methods of sawing timber

A. Ordinary or flat sawn

- Parallel cuts made throughout the length of log
- Easiest and economical methods
- Causes warping and twisting of planks
- Most common type of sawing

B. Quarter sawing

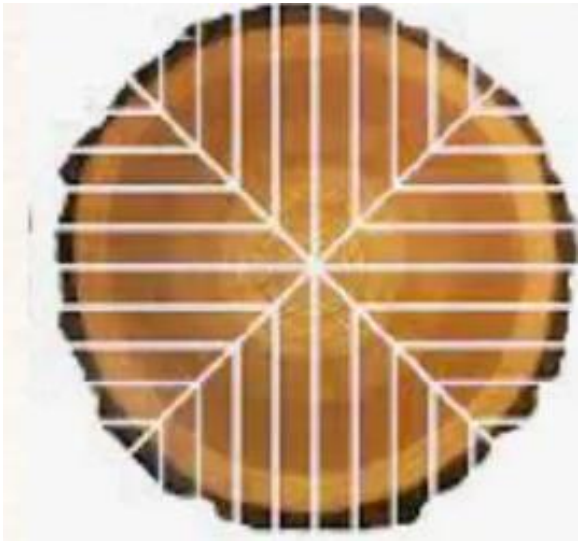
- Log divided into four quarters and flats are cut out of each quarter with decreasing lengths
- Useful for timbers not having distinct medullary rays

Carpentry

Methods of sawing timber

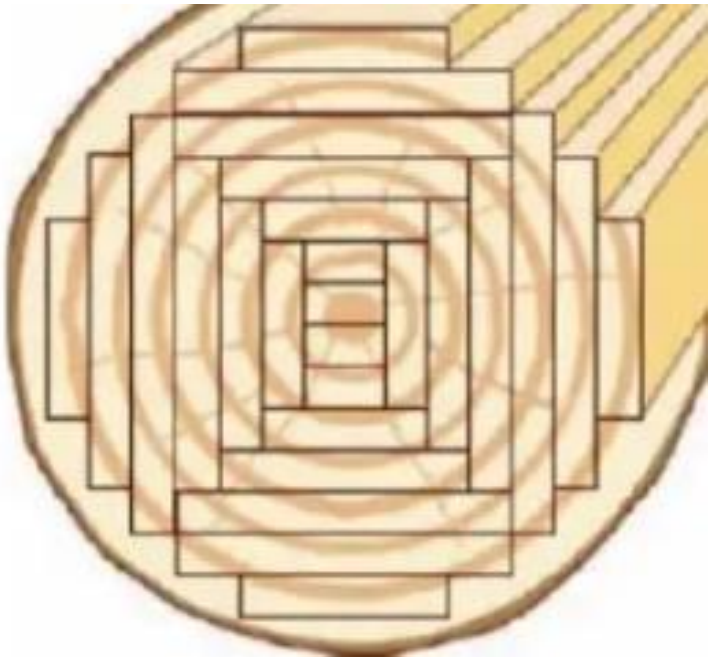
c. Rift or radial sawing

- Timber cut parallel to medullary rays and perpendicular to annual rings
- Have greater decorative effect

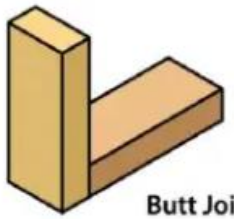


D. Tangential sawing

- Boards or planks sawn tangentially to annual rings
- Useful for joists and beams
- Not suitable for flooring to be used as planks

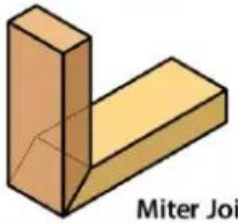


Types of Wood Joints



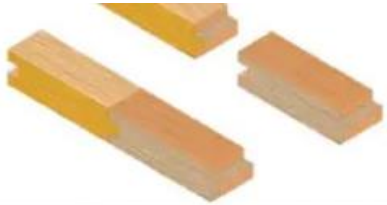
Butt Joint

(most common; less important works)



Miter Joint

(doors, windows, photo frame)

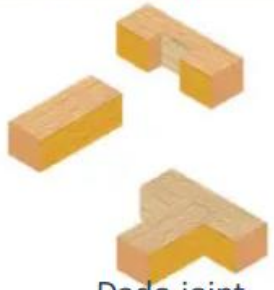


Tongue and groove joint

(flooring panels)

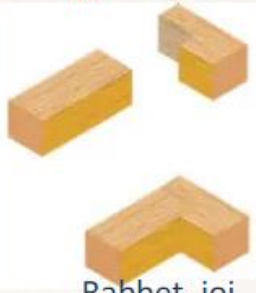
Lap joint

(frame structure, furnitures)



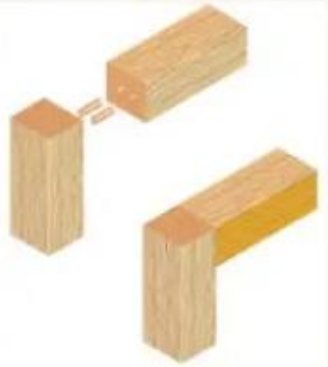
Dado joint

(cabinets , book shelves)



Rabbet joi

(cabinets)



Dowel joint

(strongest joint; mostly furniture)

Dovetail joint

(Drawers; moving items)

Mortise joint

(stronger alternative to butt joint)

1. What is the most strongest type of sawing timber ?

- a.Flat sawing
- b.Quarter sawing
- c. Radial sawing
- d.Tangential sawing

2. What is the wooden member called which is used as a beam in the floor?

- a.Floor plank
- b.Floor panel
- c.Floor timber
- d. Floor joist

3. The wood mostly used for the boat construction is

- a.Shisham wood
- b.Sal wood
- c. Teak wood
- d.Willow

Plastering

- Process of covering rough surface of walls, column, ceiling and other components of building with mortar.

Types of plaster

a.Lime plaster (lime, sand, water)

b.Cement plaster (cement, sand,water)

c.Mud plaster (earth, sand, straw,water)

d.Surkhi plaster (surkhi , sand , water)

e.Bajra plaster (dal, lime, earth,water)

- **Cement mortar generally used for masonry = 1: 6**
- **Cement mortar generally used for internal plaster = 1: 5**
- **Cement mortar generally used for external plaster = 1: 4**
- **Cement mortar generally used for plastering of ceiling = 1: 3**

Concrete Roofing

- Roof constructed of cement concrete
- Reinforced with cold deformed rebars
- Maximum spacing of rebars: minimum of

  a.300 mm

  b.3 x effective depth
- Size of bars usually used in roofing =10 mm
- Maximum size of aggregates used in slab and lintel =15 mm
- Time of removal of fromwork for slabs

a. span less than 4.5 m =7 days

b. span from 4.5 to 6 m =14 days

c. span greater than 6 m =21 days

Flooring

Floors are horizontal elements of a building dividing building into different levels.

Types of flooring

- Mud flooring
- Muram flooring (Disintegrated rock with binding materials)
- Brick flooring
- Stone flooring
- Cement concrete flooring
- Tiles flooring
- Marble flooring
- Terrazzo flooring (composite material made up of cement and marble chips)
- Mosaic flooring (made of small pieces of broken tiles or marble arranged indefinite patterns)
- Timber flooring
- Planks
- Rubber flooring
- Cork flooring (made of corks of wood, used in libraries for sound insulation)

Ratio of cement : sand in mortar used for plastering of ceiling is

a.1:6

b.1:5

c.1:4

d.1:3

Which of the following is not a type of Inorganic building materials?

a) Mud

b) Gypsum

c) Wood

d) Lime

Damp Proof Course

- Dampness is the penetration of moisture content inside the building through walls, floors, roofs, etc.

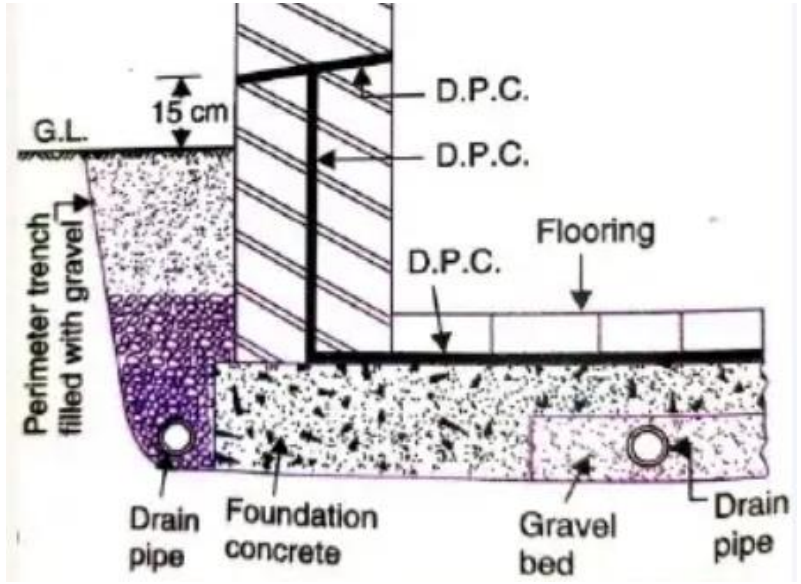
Sources of dampness

- Damp arising from soil through soil below the floor or adjacent to wall
- Moisture penetrating walls through rain
- Moisture penetrating into building through defective civil engineering construction (leaking pipes, leaking roofs, etc.)

Water proofing	Damp proofing
• It is the treatment of surface to prevent the passage of liquid water in presence of hydrostatic pressure • Water flows on account of the piezometric head • Higher the water table, higher will be the amount of water percolation • Two types of water proofing : A. Positive side water proofing : water proofing provided on same side (interior) of structure B. Negative side water proofing: water proofing provided on opposite side (exterior) of structure	• It is the treatment of surface to prevent the passage of liquid water in absence of hydrostatic pressure • Water flows does not depend on the piezometric head • Water flows through capillary action

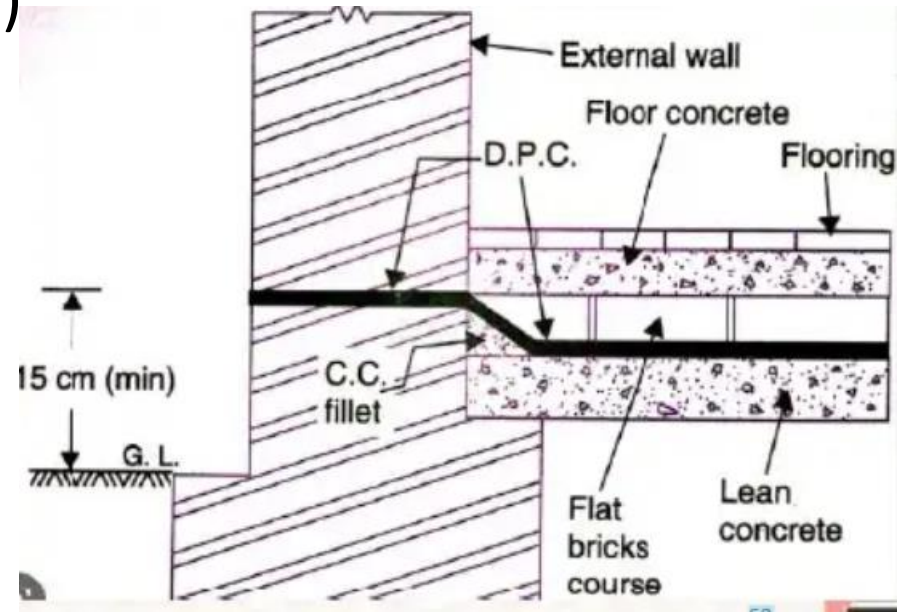
Damp Proof Course in Basements

- Prevention of water from below the basement of the building
- DPC layer is provided on the foundation level along with drain pipes
- RCC slab is provided at the bottom
- Asphalt tanking is provided (vertical asphalt layers provide on the walls along with the horizontal DPC)



Damp Proof Course in ground floor

- Compaction of subsoil
- Concreting of floor
- Provision of plinth beams all around the masonry
- Provision of mastic asphalt in case of high water table



Building By Laws

National building codes

- National building codes are the norms that provide regulations and guide lines for construction of buildings in all areas of Nepal.
- There are **23 volumes** of National Building codes in Nepal

Building by laws:

- Building by laws are the rules set forth by the government authorities to regulate the architectural and construction aspects of buildings and the elements around the building
- Prepared by the local authorities
- Building by laws should be in accordance with the national building codes.

Purpose of building by laws:

- Ensure uniform development
- Affirm public safety against noise, fire, health hazards, etc.
- Prevent haphazard development of towns
- Ensure optimum utilization of spaces

Categories of buildings as per NBC

Category	Features	Approval of map and design
A	• Buildings built with international state-of-art technology	• Concerned engineer appointed by GoN • Structural design is necessary
B	• Plinth area more than 1000 sq. feet • More than 3 floors including ground floors • Structural span . 4.5 m	• Civil engineer or architect • Structural design is necessary
C	• Plinth area less than 1000 sq. feet • Up to 3 floors including ground floors • Structural span . 4.5 m	• A person who has passed certificate level in civil engineering or architect from recognized institution
D	• Small houses , shades made of baked or unbaked brick, stone, clay, bamboo	

Terms related to building by laws

A. Ground coverage : Plinth Area of building/ Area of plot * 100

B. Floor area ratio : Total area of all floors / Area of plot

C. Setback: Minimum distance from the property boundary, public property or the road boundary to be left for building construction.

D. Right of way : The width of the road as designated by the existing rules and the guidelines of the government.

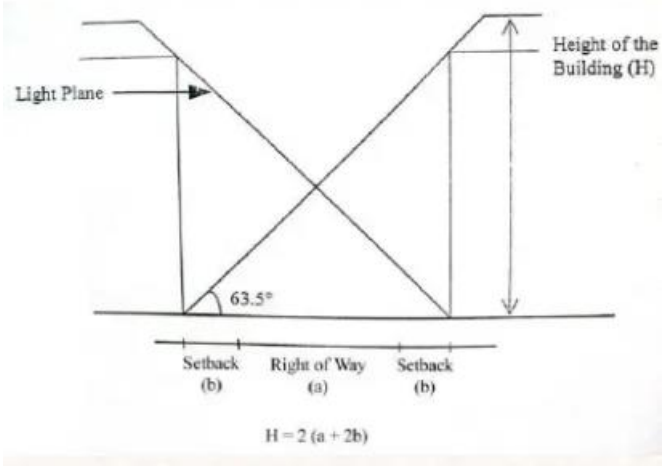
E. Building line: The line beyond which the building is to be constructed is called building line

F. Built up area : The sum of all floor areas in the building

G. Permissible height of Building: Maximum two times the spacing between the buildings

Terms related to building by laws:

S. N.	Building type	Land Area	Maximum ground coverage	Floor Area Ratio (FAR)	Maximum permitted building Area	Maximum Height
1	residential	2 anna 2 paisa to 1 ropani	70 %	1.25	Plot Area x 1.25	Not blocking the light plane as shown below
2	residential	More than 1 ropani	50 %	1.25	Plot Area x 1.25	
3	School, college, etc.	-	40 %	1.50	Plot Area x 1.50	
4	Star Hotel	-	40 %	3.00	Plot Area x 3.00	
5	Cinema Hall	-	40 %	2.00	Plot Area x 2.00	
6	nursing home, polyclinic, etc. and works related to agricultural purposes and cottage and small industries	-	40 %	1.50	Plot Area x 1.50	



Some key points in building by laws

- Distance to be left from boundary wall to the building wall containing windows in Kathmandu valley =**5 feet**
- Maximum ground coverage for hospital building =**35%**
- Maximum ground coverage for University building =**30%**
- Floor height to be maintained in terai region =**3.6 m**
- Floor height to be maintained in hilly region =**3.2 m**
- Width of road for national highway =**50 m (ROW)**

1. Which of the following line is usually parallel to the plot boundaries and laid down in each case by the Authority, beyond which nothing can be constructed towards the site boundaries?

- a) Property line
- b) Building line
- c) Plot line
- d) Control line

2. Which of the following building material have high Seismic resistance and flexibility of nailed joints.

- a) Husk
- b) Bamboo
- c) Timber
- d)Ply

3. The temporary framework is known as _____ and it is useful in construction demolition, maintenance or repair works.

- a) Grouting
- b) Scaffolding
- c) Shoring
- d) Underpinning

4. In which of the following type of construction, the square or rectangular blocks of stones are used?

- a) Rubble masonry
- b) Rock Masonry
- c) Ashlar masonry
- d) Brick masonry

A wall may be defined as that component of a building, whose width is _____ times its thickness.

- a) 2
- b) 4
- c) 6
- d) 8

Which roofs are preferred in areas having heavy rainfall?

- a) Pitched roofs
- b) Flat roofs
- c) Terraced roofs
- d) Curved roofs

The apex line of a pitched roof is known as _____

- a) Purlin
- b) Ridge
- c) Hip
- d) Valley

The flooring in which the small pieces of broken tiles or marble are arranged in definite pattern is called

- a.Terrazzo flooring
- b.Muram flooring
- c.Mosaic flooring
- d.Cork flooring

If the water proofing is provided in the interior of the structure, then it is called :

- a.Positive side water proofing
- b.Negative side water proofing
- c.Neutral side water proofing
- d.Interior side water proofing

Total no. of volumes of building codes available in Nepal are

- a.15
- b.23
- c.20
- d.17

The rules set forth by the government authorities to regulate the architectural and construction aspect of building is called

- a. Building codes
- b. Building guidelines
- c. Building regulations
- d. Building by laws

- **The FAR of building is the ratio of total floor area of the building with**
- a.Area of ground floor
- b.Plot area
- c.Ground coverage of building
- d.Half of the ground floor area
- **NBC has categorized the buildings in Nepal in …… categories**
- a.1
- b.2
- c.3
- d.4