Building Materials

Chapter-1: Rock

Rock minerals

Quartz, Mica, Gypsum, Dolomite, Amphibole, Calcite, Feldspar etc.

Hardness of stone based on Moh's scale

Talc Gypsum	1 Scratched 2 by the finger nail
Calcite Fluorite Apatite	3 Scratched 4 by 5 knife
Feldspar Quartz	6 Scarcely scratched 7 by knife
Topaz Corundum Diamond	8 Not scratched 9 by 10 knife

Properties of Minerals

Cleavage	Measurement of the capability of some minerals to split along certain planes parallel to the crystal faces
Streak	Colour of the mineral in powder form
Lustre	Shine on the surface due to reflection of light of a mineral
Texture	It is defined as shape, arrangement, distribution and coarseness of grains of a mineral.

Classification of Rocks

1. Geological

- **Igneous** — Ex.- Basalt, Trap, Dolerite, Granite, Syenite Gabbro etc.
- **Sedimentary** — Ex.-Sand Stone, Lime Stone, Laterite, Dolomite, Gypsum, Shale, Chalk, Magnesite etc
- **Metamorphic** — Ex. Gneiss, Quartzite, Marble, Slate, Schist etc

Igneous

- **Extrusive/Voleanic/Effusive** (Extremely fine) **Ex.** Basalt, Trap, Pumice etc.
- **Intrusive**
  - Plutonic (Deep Depth) (Coarse Grained) **Ex.** Granite, Syenite
  - Hypabyssal (Shallow depth) (Fine Grained) Ex. Dolerite, Diorite

2. Physical

- **Unstratified Rock** **Ex.**-Granite Basalt, Trap Diorite, Dolerite Dolomite, Syenite Gabbro etc.
- **Stratified Rock** **Ex.**-Lime Stone Sand Stone, Shale, Gypsum Laterite etc
- **Foliated Rock** **Ex.**-All stratified Rocks except marble and quartzite

3. Chemical

- **Silicious Rock** **Ex.**-Granite Basalt, Trap Syenite, Gneiss, Sand Stone, Quartzite etc.
- **Calcareous Rock** **Ex.**-Gypsum, Dolomite, Lime Stone, Marble etc.
- **Argillaceous Rock** **Ex.**-Laterite, Shale, Kaoline, Slate, Schist etc

Metamorphism of Rocks

Original Rock	Metamorphic form
Granite	Gneiss
Syenite	Gneiss
Sand Stone	Quartzite
Lime Stone	Marble
Marl	Marble
Dolomite	Marble
Shale	Slate
Mud Stone	Slate

Dolerite/Basalt	Schist

Use of various types of stone

Name of Rock	Use
Granite	Railway ballast, Roofing, Abutment, Pier and Sea walls
Marble	Ornamental work
Lime Stone	Manufacture of cement
Slate	Flooring, Roofing
Quartzite	Retaining wall
Basalt	Marine work, Rubble masonry
Kankar	Manufacture of Hydraulic lime

Tools Used in Quarrying of Stone

Jumper	To make hole
Scraping spoon	For Cleaning hole
Dipper	For making deep hole
Priming Needle	To make space for fuse
Tamping Rod	For tamping of explosive **Length** - 600 mm **Dia** ϕ - 16 mm
Crow bar	To removed the wedge
Wedge	For split the rock slab

Methods of Quarrying

Method	Suitability	Example
Wedging	Costly, Soft and Stratified rock.	Sand stone, Lime stone, Laterite, Marble and Slate etc.
Heating	Those rock whose thermal expansion is very low.	Granite, Gneiss etc.
Digging	To get stone at a small scale.	Serpentine, Gypsum, Aterite.
Channeling	Obtaining stone in the form of block.	
Blasting	To obtain stone at a large scale.	

Steps for Blasting

Boring → Cleaning → Charging → Tamping → Firing

Explosive Material Used in blasting

Name of Explosive	Chemical Composition
Blasting Gelatine	Nitroglycerine (93%) + Gun – cotton (7%) **Use-** In deep wells, underground works, in wet conditions.
Gund Cotton (Most powerful)	Cotton with the solution of (HNO_3+H_2SO_4) **Use-** where demolitions are required
Dynamite	Nitroglycerine (75%) + Fine sand (25%) **Use-** Both under water and surface blasting
Blasting/Gun powder	Potassium nitrate (65%) + Sulphur (25%) + Charcoal powder 20% **Use-** In quarrying large blocks
Rock-a-Rock	Potassium Chlorate (79%) + Nitro benzol (21%) **Use-** Under water and damp situation blasting

Types of Stones Finishing

Boasted finishing	For making non-continuous parallel marks on the surface of stone. It is done by a tools called boaster.
Furrowed finishing	Sides are sunk up to 20 mm width and the middle portion is projected by 15 mm.
Polished finish	Provided for marbles, granite which are mostly used for floor tiles.
Reticulated finish	A margin of 20 mm wide is marked on the sides of surface and irregular sinking type finish is made in the middle area.
Tooled finish	It is a classic finish which consists parallel continuous marks.
Scrabbling finish	Rough surface finish achieved after removing irregular projections on the stone surface by the scrabbling hammer.
Vermiculated finish	Sinking in this type of finish is more curved and like worm eaten appearance.

Note:

- Time required for perfect seasoning of stone is 6 to 12 month.

Stone crusher and equipment

Crusher Type	Equipment
Primary	Jaw, Impact and Gyratory crusher and Hammer mill
Secondary	Roll crusher, Cone crusher
Tertiary	Ball mill, Roll mill and Rod mill

Specific Gravity of Various Types of Stone

Name of Stone	Specific gravity
Sand Stone	2.65 – 2.95
Marble	2.7 – 2.85
Granite	2.65 – 2.79
Basalt	2.6 – 3
Slate	2.72 – 2.89
Laterite	2 – 2.2
Lime Stone	2 – 2.75
Gniess	2.5 – 2.7

Various types of test and purpose for stone

Type of Test	Determine for
Abrasion Test (By Dorry Testing machine)	wearing resistance
Attrision Test (By Deval Testing Machine)	Hardness, Toughness and rate of wearing resistance
Crushing Strength Test (By C.T.M) (IS : 1121-1974)	Compressive strength
Smith's Test	Soluble minerals/Muddy matter
Brard's Test	Frost resistance
Acid Test	Frost resistance
Acid Test	Weather resistance
Crystallization Test (IS : 1126-1974)	Durability
Hardness Test (Moh's Scale)	Hardness
Impact Test (By Page Impact Machine)	Toughness
Water Absorption Test (IS 1124-1974)	% Voids ($\nless$ 5% for good stone)

Dorry Testing Machine Test

$$\text{Friction Factor} = 20 - \frac{\text{Loss in weight}}{3}$$

Friction Factor	Type of Rock
0-14	Soft rock
14-17	Medium hard
> 17	Hard rock

Impact Test

Toughness coefficient	Toughness
19 or More	Very tough
16 to 17	Moderate tough
16 or below	Poor tough

Attrision Test

Friction Co-efficient	Quality of Stones
2%	Good
3%	Medium
5% or More	Useless

Chapter-2 : Brick

Common Brick Size

Brick	Usual size	Nominal size
Conventional / Traditional/ user size	$9" \times 4\frac{3"}{8} \times 2\frac{3"}{4}$ (23 × 11.2 × 7.0) cm	$9" \times 4\frac{1"}{2} \times 3"$ (23 × 11.4 × 7.6) cm
Standard/ Modular/ Normal size	(19 × 9 × 9) cm	(20 × 10 × 10) cm

Ingredients of Good Brick Earth

Ingredients	% in brick
Silica (SiO_2)	50 – 60
Alumina (Al_2O_3)	20 – 30
Lime (CaO)	2 – 5
Iron Oxide (Fe_2O_3)	3 – 5
Magnesia (MgO)	<1
Alkalies	<1

Functions of Various Brick Ingredients

Ingredients	Function
Silica	Imparts Strength **Excess-** Brittle (Due to loss of cohesion)
Alumina	Impart plasticity **Excess-** Cracks developed, corner deformed
Lime	Used as flux (Reduce melting point) **Excess-** Brick over burnt and shape changed
Iron Oxide	Red colour, Used as flux **Excess-** Provide dark blue or blackish colour
Magnesia	Yellow colour and its prevent to shrinkage, **Excess-** Give yellowish colour

Note:

- Steel moulded bricks are good compared to wooeden moulded bricks.
- Steel moulded bricks are used in facing work.
- Mould are made by steel or timber of Shisham.

Frog	10 cm × 4 cm × 1 or 2 cm
Stock Board (To make frog)	21 cm × 10 cm × 6 cm
Pallet Board (To dry the brick	30 cm × 12 cm × 1 cm

Sequence for the Preparation of Brick Earth

Unsoiling → Digging → Weathering → Blending → Tempering / Kneeding

Burning Zone of Bricks

Burning Temperature- 900 – 1200°C		
Dehydration Zone	Oxidation Zone	Vitrification Zone
400-650°C	650-900°C	900-1200°C

Types of kiln	1st Class Brick outcome	Remark
Pazawah	50-60%	—
Allahabad kiln	60-70%	Intermittent
Bull's Trench kiln	70-80%	Semicontinuous
Hoffman's kiln	80-90%	Continuous

Clas of Brick on the Basis of Strength

IS : 10719557-1970

Class	Comp. Strength
Grade AA	$\nless 140$ kg/cm^2
Grade A	$\nless 105$ kg/cm^2
Grade B	$\nless 70$ kg/cm^2
Grade C	$\nless 35$ kg/cm^2

Types of Refractory Bricks and its composition

Bricks	Composition
Acid Refractory	**Silica- 95-97%, Lime-** 1-2%
Basic Refractory	**Magnesia** - 85% (max), **CaO** - 25% (max), **Silica** - 5.5% (max)
Neutral Refractory	Chrome + Iron ore + Bauxite ore+ Silica + Magnesia

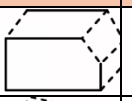
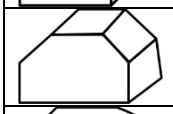
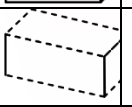
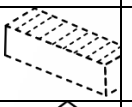
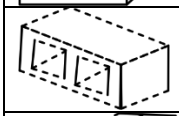
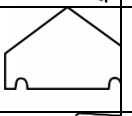
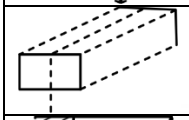
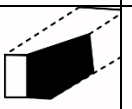
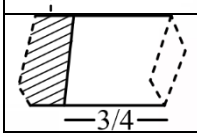
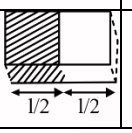
Efflorescence Test- According to IS 3495 (part-III) : 1992

Whtie	Composition
Up to 10%	Slight
10 – 50%	Moderate
>50%	Severe
Presence in large amount	Serious

Tolrance in brick dimension test

For 20 brick	Dimension (cm)	Tolerance (mm)
Length	380	± 80
Width	180	± 40
Height- (i) 9 cm (ii) 4 cm	180 80	± 40 ± 20

Special Forms of brick

Figure	Brick Name	Figure	Brick Name
	Rounded		Cant
	Double cant		Compass
	Bull nosed		Perforated
	Hollow		Coping
	Queen closer		King Closer
	$\frac{3}{4}$ Brick		Bat

General Data about bricks

Types of bricks	Water absorption (%)	Compressive Strength (Kg/cm^2)	Use
1st Class	≤ 20	>105	Facing work R.B. Slab
2nd Class	≤ 22	>70	Hidden Structure
3rd Class	> 25	>35	Temporary brick masonry
4th Class (Jhamma or over burnt bricks	10-12	350	Bricks ballast, lime concrete foundation, road metals
Perforated Bricks (IS 2222)	15	70	Partition Wall
Hollow Bricks (IS 3952)	20	35	For making heat proof, sound proof, damp proof walls

Paving Bricks (IS 3583)	<5	350	Road pavement
Soling Bricks (IS 5779)	< 20	50	Soling of road
Refractory Bricks (IS 6902)	4-10	350	Kiln lining, furnace boiler combustion
Engineering Brick Class-A	4-5	>125	D.P.C
Class-B	7	75	Multistorey building
Sundry bricks	-	15-25 ≃ 21	-

Defects of Bricks	Causes
Under brunt	Caused due to insufficient heat.
Over burnt	Occurs due to extremely high heat.
Lime bursting problem	Caused by the hydration of quick lime particles.
Efflorescence	Due to present of alkalis in bricks.
Chuffs	Caused by the rain water falling on hot brick.
Blister	Due to air imprisoned during their molding
Lamination	It produce thin lamina on brick faces. **Cause-** Entrapped air in clay voids.
Bloating	Defect observed as spongy swollen mass over the surface of burnt brick. Occurs due to excess of carbonaceous matter and sulphur in brick clay.
Checks or Cracks	Occurs due to presence of lumps of lime or excess of water.
Black core	Prime cause of brick black core is improper burning.
Spots	Due to presence of iron sulphide in brick earth.

Chapter-3 : Lime

Types of Lime Obtained After Calcination of	Type of lime
Pure lime stone	Pure lime
Dolomite	Magnesia lime
Kankar	Hydraulic lime
Chalk	Pure lime
Gypsum	Pure lime
Calcined lime stone	Quick lime
Calcined dolomite stone	Non-hydraulic lime
Shale	Pure lime

Chemical Formula	Name of lime
Calcium carbonate [$CaCO_3$]	Lime Stone
Calcium oxide [CaO]	Quick lime, Lump lime, White lime, Rich lime, Pure lime
Calcium Hydroxide [$Ca(OH)_2$]	Slaked lime, Fat lime
Calcium Sulphate [$CaSO_4.\frac{1}{2}H_2O$]	Plaster of Paris
Calcium Sulphate [$CaSO_4.2H_2O$]	Gypsum

Chemical Reaction of Lime

1. $CaCO_3 \xrightarrow[\text{Calcination}]{816^\circ C} \underset{\text{Pure lime}}{CaO} + CO_2 \uparrow$
2. $CaO + H_2O \rightarrow Ca(OH)_2$
3. $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O + \text{Heat}$

Slaking of lime

Type of lime	Slaking time
Lump lime, Quick lime, Rich lime, Pure lime, Fat lime. White lime	2 to 3 hrs.
Hydraulic lime, Poor lime, Lean lime	12 to 48 hrs.

Item description	Feebly Hydraulic lime	Moderate Hydraulic lime	Eminently Hydraulic Lime
% impurities	05 to 10%	11 to 20%	21 to 30%
Slacking action	Few minutes	1 or 2 hours	1 day or more
Setting action	3 week or more	1 week or more	1 days or more
Hydraulicity	Feebly	Moderate	Eminently
Use	For ordinary masonry work	For superior type of masonry work	Use in very damp places

Classification of lime as Per B.I.S. (IS : 712)

1. Class A
- Eminently Hydraulic lime
- Used in Hydraulic Structure
- Compressive strength of 28 day-28 kg/cm^2
- Initial setting time 2 hours and final setting time 48 hours

2. Class B
- Semi-hydraulic lime
- Use in masonry work and lime-concrete
- Compressive strength of 28 day-17.5 kg/cm^2

3. Class C
- Fat lime
- Use in Plaster work

4. Class D
- Magnesium Lime or Dolomite lime
- Use in white washing and Finishing or Plastering

5. Class E
- Kankar lime
- Use in masonry mortar and lime-concrete

Chapter-4 : Cement

Chemical Components of Portland Cement

Oxide/Composition /Average composition	Function
Lime (CaO) 60-65% ≈ 63%	Strength & soundness control
Silica (SiO_2) 17-25% ≈ 20%	Due to excess reduces strength
Alumina (AL_2O_3) 3-8% ≈ 6%	Responsible for quick setting excess of its lowers strength
Iron oxide (Fe_2O_3) 0.5-6% ≈ 3%	Used as flux
Magnesia (MgO) 0.1-4% ≈ 2%	Imparts colour & hardness
Gypsum 3-6% ≈ 3%	Used as retarder

Sulphur (SO_3) 1-3% ≈ 1%	Impart soundness
Alkalies 0.2-1% ≈ < 1%	Used as flux & Imparts efflorescence

Chemical Compositions or Bogue's compound of cement

Chemical/Bogue's Compound	Composition /Avg. composition	Function
C_3S (Alite)	25-50% ≈ 42%	7 days hardness & strength
C_2S (Belite)	20-45% ≈32%	Ultimate strength
C_3A (Celite)	8-12% ≈ 11.5%	Flash set
C_4AF (Felite)	6-10% ≈ 9%	Poorest cementing value

Decreasing order of Bogue's compound based on the following properties;

Strength Reaction with water Heat of hydration Rate of hydration	$C_3S > C_2S > C_3A > C_4AF$ $C_3A > C_4AF > C_3S > C_2S$ $C_3A > C_3S > C_4AF > C_2S$ $C_4AF > C_3A > C_3S > C_2S$

If quantity of C_3S is increase and C_2S is decrease then-

- Increase the rate of hardening, rate of heat of hydration and increase 28 day's strength.
- Decrease the ultimate strength, capability to resist the chemical and Sulphur attack.

If fineness of cement is increases then-

- Strength of cement, rate of hydration and rate of heat of hydration is increases.
- No effect on total heat of hydration.
- No effect on setting time.
- Rate of gain of strength increases.
- Value of shrinkage/contraction increases.

% Value of C_3A is increases then-

- Initial setting time is decrease.
- Rate of hydration is increase.
- The value of total heat of hydration is increase.
- There is no effect on strength.

If % value of C_2S is increases and C_3S is decreases then-

- Increase the ultimate strength.
- The value of 28 day's strength is decreases.
- Increase the capacity to resist chemical attack.
- Value of total heat of hydration is decreases.
- Prefer in the construction of hydraulic structure.

Note-

- Surkhi is added to lime mortar to impart hydraulicity.
- Lime is mixed with brick earth to prevent shrinkage.
- Chemical reaction of cement with water is an exothermic.

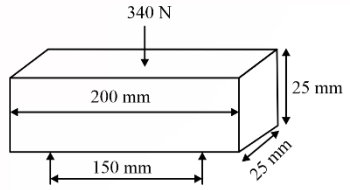
Water required for hydration-

- Bound water = 23% by weight of cement
- Gel water = 15% by weight of cement
- Total minimum water for Complete hydration = 38%

Note- Cement reaction is an exothermic.

Field Test of Cement-

Colour test	Colour of OPC should be greenish grey.
Lump Test	Cement should be free from presence of any lumps.
Float test	Cement particle should sink in water it should not float over the water surface.
Temperature test	Thrust your hand into the cement bag. It must give you a cool Feeling.

Rubbing test	When cement is rubbed between fingers, there should be smooth feeling.
Smell test	A thin paste of cement with water should feel sticky between the fingers.
Strength test	Cement block given below should not fail while loading (340N) is applied in that manner. 

Lab Test/Physical Test

Required Consistency for Various Cement test at (27 ± 2°C)

Initial & final setting time test	0.85P
Soundness test	0.78P
Compressive strength test After 3 days - 16 N/mm^2 After 7 days - 22 N/mm^2	$\left(\frac{P}{4}+3.5\right)\%$
Tensile strength test After 3 days - 2 N/mm^2 After 7 days - 2.5 N/mm^2	$\left(\frac{P}{5}+2.5\right)\%$

Reduction in comp. strength of cement due to aging

3 months	20%
6 months	30%
12 months	40%
24 months	50%

Setting Time & use of various types of cement

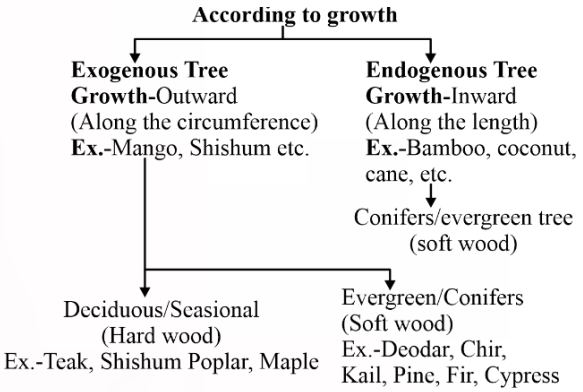
Cement Type	Setting time		Use
	Initial	Final	
Rapid Hardening (IS:8041)	30 Min.	10 Hrs.	Bridge, Road maintenance or Repairing work
High Alumina Cement (IS: 6452)	30 Min - 3.30 Hrs.	5 Hrs.	Precast structure, refractory bricks, used where chemical attacks are more
Quick Setting Cement	5 Min.	30 Min.	Foundation basement, under water structure, mass concrete raft foundation
Low Heat Cement (IS: 12600)	60 Min.	600 Min.	Mass cone, work such as Dam
Portland Pozzolana Cement (IS:1489 P-I)	30 Min.	600 Min.	Running water structure foundation, basement
Super Sulphate Portland Cement (IS: 6909)	30 Min.	600 Min.	Rcc pipes, where sulphate attack is more, Hydraulic structure
Sulphate Resisting	30 Min.	600 Min.	Sea water works, sewers,

Cement (IS: 12330)			lining of canals
Portland Slag Cement	30 Min.	600 Min.	Mass concreting

Effect while adding Pozzolana in OPC

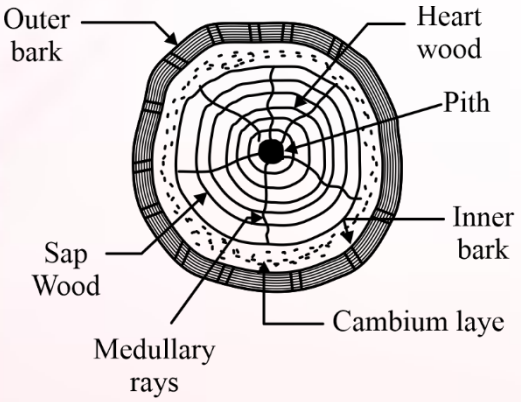
Shrinkage	↑
Initial Strength	↓
Heat of hydration	↓
Workability	↑
Curing period	↑
Capacity of sulphate attack resistance	↑
No effect on overall strength.	

Chapter-5 : Timber



Conifers Tree

These trees having pointed needle like leaves. Most Conifer tree are evergreen tree but not all of them. (**Ex.-** Larch tree (larix Laricina) or Tamarack)



Macro Structure of Exogenous Tree

Medulla (Pith)	The innermost part or core of the stem of a tree
Heart wood	Death portion of the tree
Sap wood	Outer layers of a log of wood
Cambium	To growth wood cells
Bark	Protect the wood against mechanical damage
Transverse septa (Medullary rays)	The vascular tissue which Encloses the pith
Annual rings	A cellular tissue and woody fibre arranged in distinct concentric circle
Log	Trunk of tree obtained after the removal of branches.
Lumber	It is a log pieces of timber sawn into pieces of desired shape.

Properties of a Good Timber

Density	540 kg/m^3
Specific gravity	1.54
Moisture content	10-12%
Shrinkage	0.1-0.3% along fibers
Swelling	0.1-0.8% along length
Sound Conductivity	2-17 time more than air

Seasoning of Timber (IS : 1141)-

Purpose of Seasoning-

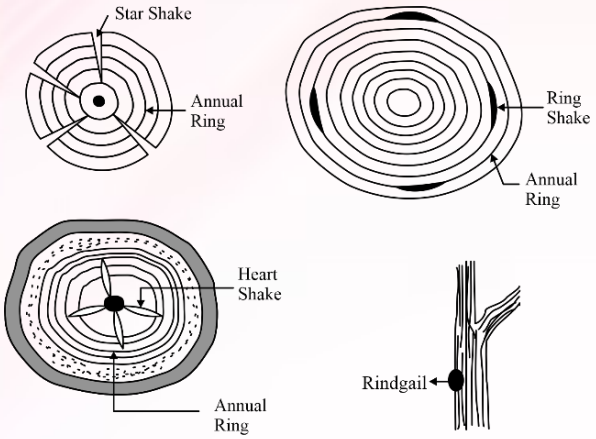
1. Reduce the weight of timber.
2. Reduce the shrinkage and warping after placement in structure.
3. Increase strength, durability and workability.
4. Make it suitable for painting.
5. Reduce its tendency to split and decay.

Method of Seasoning and its property-

Method	Property
(A). Natural or Air Seasoning- (6 month to 1 Year)	It take long time but best quality of seasoned wood are obtain. • Easy and most economical method. • Reduce moisture up to 12- 15%
(B). Artificial Seasoning-	
1. Water Seasoning (2-4 weeks)	It is quick process but elastic property and strength are reduced.
2. Boiling (3 - 4 Hour)	This process is very quick but expensive.
3. Kiln Seasoning (3-5 days) Kiln dried Air dried	Most effective and economical method. • Loss in strength < 10% • Used for rapid seasoning on large scale. • Kiln seasoning causes case hardening.
4. Charring or Scorching	• It is used for lower part of wood pole which is below the ground level.
5. Me. Neil's Process (15-60 days)	• Best but most expensive method.
6. Electric Seasoning	• Timber losses their strength and may split. • Most expensive method.

Sawing Method of Timber

Method	Property
Ordinary Sawing	Best method of sawing and most commonly used. • Easiest and economical method. • Wastage of timber is very less. **Disadvantage-** • Strong possibility of twisting and warping
Tangential Sawing	• Suitable for timber whose annual rings are clearly visible. • Sawing is done tangentially to the annual rings. • Economical due to very less wastage. Disadvantage • Low strength due to less annual ring and medulary rays. • Possibility of warping and twisting also occurs.
Quarter Sawing	• Each log is sawed at a radial angle into four quarters. • This method is popular for Oak and Maple.
Radial Sawing	• Sawing is done perpendicular to the annual ring and parallel to medullary rays. • Durable and strong timber pieces are obtained. • Wastage of timber is more. • Time and labor is more. • Useful for best class of timber.



Defects of Timber

Checks	**Longitudinal cracks which is normal to the annual rings**
Shakes	**Longitudinal separation b/w the Annual rings.**
Star shake	**Wide at outside and diminish inside**
Heart shake	**Wide at center and diminish out side**
Cup shake	**Caused due to rupture of tissue in circular direction. It is developed due to non uniform growth**
Ring shake	When cup shake cover the entire ring.
Radial shake	When timber is exposed to sun for seasoning after being felled down
Knots	These are the base of branches which are broken or cut-off from the trees.
Rind Galls	Abnormal growth or curved swellings on the body of tree.
Foxiness	It is a sign of decay appearing in the form of yellow or red tinge. Cause-Over maturity lack of ventilation.
Burl	It is a deformed growth occurs when the tree receives shock or injury in its young age.
Callus	It is the soft tissue or skin which cover the wound of a tree.
Druxiness	White spots are formed on the top surface of wood.
Twisted fiber	It is caused by wind turning the trunk of young tree in one direction. • Reaction wood is the wood with twisted fiber.
Upsets	In this case wood fibers damaged by compression or crushing.
Rupture	It is due to injury or impact.

Defect Due to Conversion of Timber

Defect	Description
Chip Mark	A mark or sign placed by planer on finished surface of timber.
Wane	It is the original rounded surface on the manufactured part of timber.
Torn Grain	Small depression occurs on the finished surface (along the fiber of timber) due to falling of tool.
Diagonal Grain	It is formed because of improper timber sawing indicate by diagonal mark on the straight-grained surface of the timber.

Defect due to seasoning

Warp	Duc to unequal shrinkage the curved deformation formed along the length of board.
Bow	Curve along the face of board caused by the wood on one face shrinking more than face.
Cup	This is the hollowing of the board throughout its length on its bark side face
Twist	In this defect the end of timber is rotate in opposite direction.

Preservation of Timer (IS: 401)

Tarring	It is a process of heating the coal tar to make it in workable condition.
Charring	It is a old method of preservation of timber. It is not suitable for exterior wood works.
Oil Paint	It is suitable for well seasoned wood and generally applied 2-3 coats.
Creosote Oil	It is derived from wood or coal tar and best antiseptic material. >It is applied at 50°C and pressure of 0.7- 1.0 N/mm^2
Solignum Treatment	This treatment well suitable for preserving timber from white ants.
AsCu Treatment	It is developed at forest research institute Dehradun.
Dipping	In this method timber is dipped directly in the preservative solution. The solution penetrates the timber better than the case of brushing or spraying.
Abie's Process	It is used to make wood Fire resistance. Chloride, Borex, Boric Acid, Sodium arsenate and Ammonium sulphate is used in Abie's Process of Preservation of timber.
Bethel Process	It is used when max. absorption of the preservative is desired.
Boucherie Process	It is used to treatment of green wood.
Empty cell /pressure process	It's aimed at a maximum penetration of the preservative with a minimum net retention.
Diffusion process	It is the method of treatment of timber (poles and planks) and other plant material like in green condition.

Chapter-6 : Paint

Ingredients of Paint

Ingredient	Properties
Base	It provide opaque layer and possesses binding properties and prevent the shrinkage and cracks in the film on drying.
	Ex.- White lead, Red lead, Zinc oxide, Aluminium oxide, Iron oxide, Lithophone etc.
Vehicle/ Binder	• Holds the constituent of paint and spread over surface • It forms the body of the paint • Most widely used vehicle Linseed oil. **Ex.-** Linseed oil, Nut oil, Poppy oil and Tung oil

Solvent/ Thinners	•Used to thin the paints and increase the covering properties
	• Turpentine is used extensively **Ex.**-Petroleum, Spirit, Naptha, benzene, Turpentine oil etc.
Driers/ Plasticizers	• Accelerate drying of the vehicle • Quantity limited to 8% • Red lead is best for prime coat over steel. **Ex.**- Letharge (Oxidized lead), Lead acetate [Red lead (Pb_3O_4)]
Adultrants/ Extenders	• Reduce weight, increase durability.
	• Best Adultrant is Barium Sulphate. **Ex.**-Barium Sulphate, Calcium Carbonate, Magnesium Silicate and Silica.

Colouring Pigments

Lamp black, Ivory black	Black
Prussian blue, Indigo	Blue
Chrome yellow, Yellow orchre	Yellow
Burnt umber, Burnt Sienna	Brown
Vermillion, Red lead	Red
Copper sulphate, Chromium oxide	Green
White lead Lithophonc	White

Ingredient for Different Types of Paint

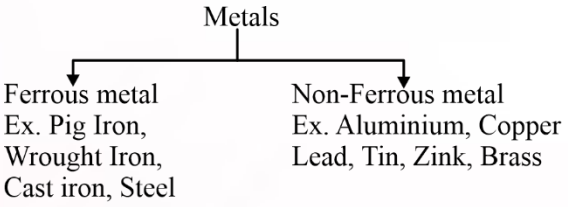
Types of paints	Base	Vehicle	Use
Aluminium Paint	Aluminium powder	Sprit /oil Vamish	Painting in Poles, Tower, Metal roofs
Asbestos/ Fire proof paint	Asbestos minerals		Stopping leakage in sloppy roof, painting of gutters etc.
Bitumcnous Paint	Natural Asphalt or residual bitumen	Mineral spirit or Ncptha	High water Resistance
Plastic Paint	Plastic powder	Water	Interior of offices auditorium and Showrooms.
Cellulose Paint	Methyl or Ethyl Cellulose	Petrolium	Painting cars, ships and aeroplanes.
Cement Paint [IS :5410]	White or Coloured cement	Water	Exterior surface of building
Enamel paint	White Zinc, White Lead	Varnish	Acid resistance, alkalis & water proof
Luminous paint	Calcium Sulphide	Vamish	Metal surface & sign board

Defects of Paint

Blistering	Swelling occurs is due to oil or grease on the surface.
Peeling	Swelling is caused by moisture.
Cracking	It is caused due to - • Excess quantity of drier in Paint. • Paint applied on glossy surface and painting on improperly seasoned wood.
Flaking	Detachment of paint film from the surface.
Checking	It is similar to alligatoring but hair cracks are limited to a small area, unlike alligatoring cracks.
Crazing.	These defects cracking area is small.
Crocodiling	• These defects have small cracking area is large.
Chalking	Formation of powder due to insufficient oil in primer, is called chalking.
Bloom	It is the dull patches formed on the finished, surface due to defect in the quality of paint or poor ventilation.
Mildew	It is a form of fungus which grows in warm, moist and dark places.
Grinning	The background and its defects can be seen clearly.
Sagging	Thick paint film run downward.
Running	Thin paint film run downward.
Curtaining	Long distance of sagging
Wrinkling or Crawling	It occurs when the top coat dries before the bottom layers and paint film shrinks due to drying in course of time.
Loss of Gloss	Due to application of old paint or excess quantity of drier it loss the shining.
Popping	It is the formation of Pin holes in the surface of a coating as it dries.
Fading	Discoloration of the paint surface due to atmospheric agencies like sunlight, moisture and thermal difference.
Flashing	It is characterized by the appearance of certain glossy patches on the painted surface.
Saponification	It is due to chemical action of alkalies and formation of soap patches on the painted surface.
Alligatoring	One layer of paint film sliding over the another layer, when a hard paint is applied over a soft one or vice versa.

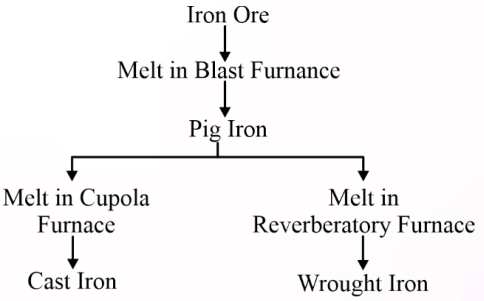
Type of Varnish	Resin or Base	Solven	Remark
Oil varnish	Copal, Amber (Hard resin)	Boiled linseed oil	It is most durable. Suitable for both Interior & exterior work
Spirit varnish Ex.- French polish, lacquer and Shellac varnish	Lac, Shellac (soft resin)	Methylated spirit	It dries very quickly but not durable. Easily affected by weathering action.
Turpentine varnish	Gum dammar, Mastic Raw Copal	Turpentine oil, Naphtha	Dry quickly but not so durable. It is cheaper than oil varnishes.
Asphalt varnish	Melted hard asphalt	Linseed oil	With a thinner such as turpentine or petroleum sprit. It is used over shop fabricated steel work.
Water varnish	Shellac	Hot water	Either ammonia or borax or soda or potash is added. It is used for varnishing map and pictures.
Flat varnish or Wax varnish	Was, metallic soap or finely divided silica.	Turpentine Oil	For highlighting grain over wooden surface.

Chapter-7 : Metals



Iron Ore	Quantity
Magnetite [Fe_3O_4]	72%
Hematite [Fe_2O_3]	70%
Limonite [$2Fe_3O_3.3H_2O$]	60%
Iron Pyrite [FeS_3]	47%
Siderite [$FcCO_3$]	40%

Production process of iron



Types of Iron	Manufacturing process
Pig Iron	Blast furnace or electric reduction furnace.
Cast Iron	Cupola furnace
Wrought Iron	Reverberatory or puddling furnace by Astor's process
Steel	Bessemer process

Pig iron is classified as following type -

1. Bessemer pig
2. Foundry pig/grey pig
3. Forge pig/White pig
4. Mottled pig

Heat treatment process and related steel property-

Process	Steel property
Tempering	Toughness
Annealing	Malleability, ductility softness
Normalizing	Grain refinement
Hardening	Brittleness

Chapter-8 : Glass

Constituent of glass and their function

Constituent	Function
Silica/Sand	It is the major constituent of glass.
Lime	It makes the glass fluid and suitable for blowing, drawing, rolling, pressing or spinning.
Soda	Impart durability and toughness. Acts as an accelerator for the fusion of glass.
Potash	It renders glass infusible and makes fire resistance.
Lead oxide	Imparts colour, brightness and shine.

Various manufacturing Process of Glass

Process	Used for
Blowing	Glass bottle and Jar
Drawing	Tube, Rod, window glass
Rolling	Glass sheet
Pressing	Open pot
Casting	Lens, mirror
Spinning	Heat, sound and electric insulator glass.

Commercial Forms of glass

Type of Glass	Remark
Pyrex glass	It is fire resistance and use for making laboratory apparatus and insulator.
Optical Glass	• It contain phosphorus, lead silicate and cerium oxide. • It is absorb UV ray and use for making lenses.
Opal glass or milk glass	It is used where high thermal shock resistance & chemical durability is desired.
Ground glass	Used for bedroom, toilets and for making black board.
Obscured glass or Patterned glass	It is used in doors and window of bedroom and bathroom.
Bullet Proof or Laminated glass	It produced by placing vinyl plastic and glass in several alternate layers and pressing them with outer layer of glass • Used in banks, Jewelry stores and display window.
Sheet glass	It is used for glazing door, window and partition. made by blowing, available with in 2 - 6 mm thickness.
Plate Glass	It is used for all engineering purpose and is superior than sheet glass.