

BUILDING MATERIALS

Rock Minerals

Quartz, Mica, Amphibole, calcite, feldspar etc.

* **Hardness based on Moh's scale :**

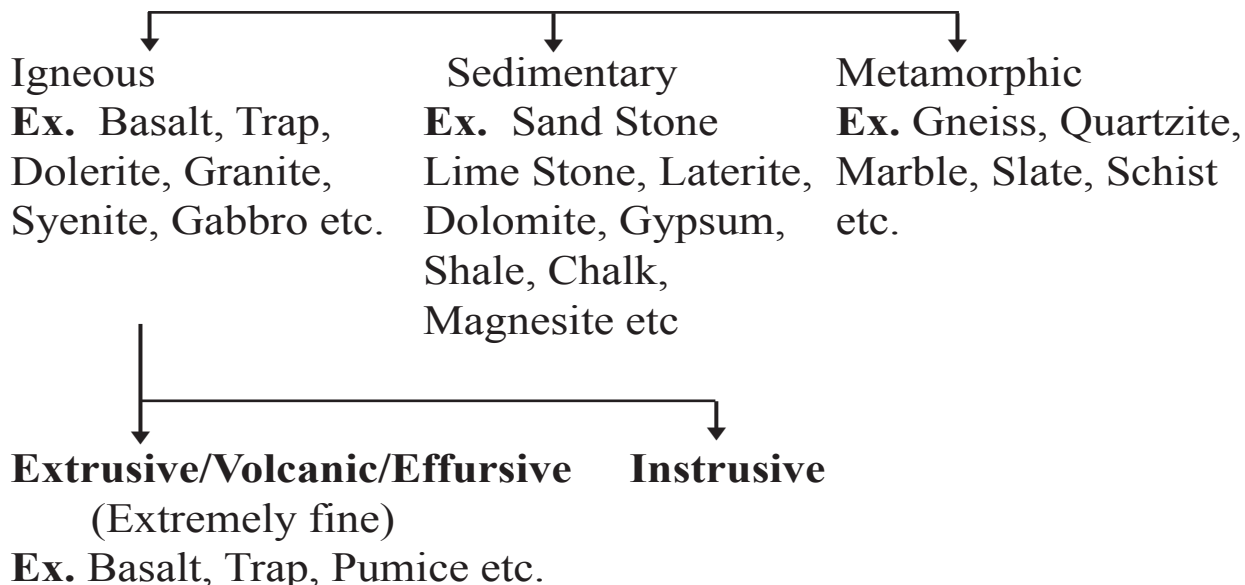
Rock's Mineral Hardness		
Talc	1	Scratched by the finger nail
Gypsum	2	
Calcite	3	Scratched by Knife
Flourite	4	
Apatite	5	
Feldspar	6	Scarcely scratched by knife
Quartz	7	
Topaz	8	Not scratched by knife
Corundum	9	
Diamond	10	

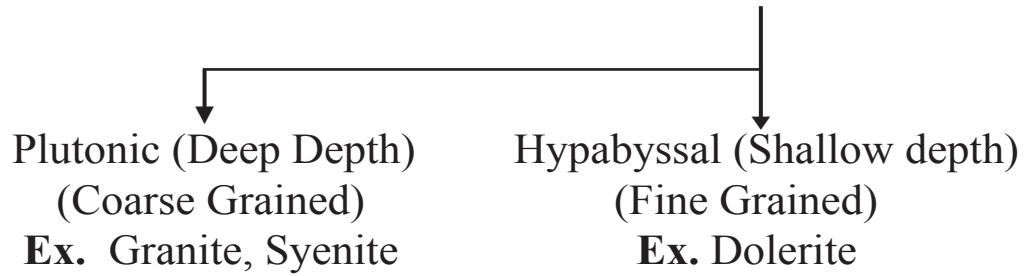
* **Propterties of Minerals :**

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.

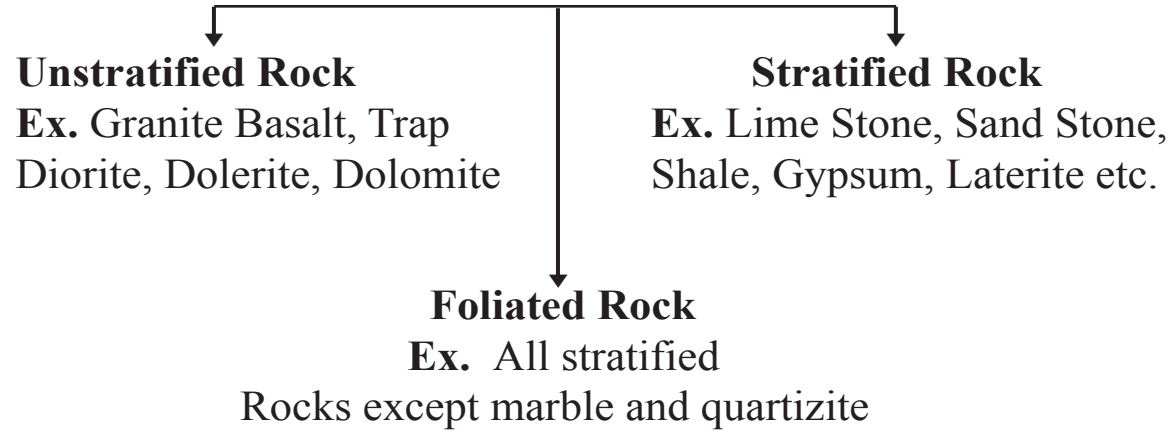
* **Classification of Rocks :**

1. Geological

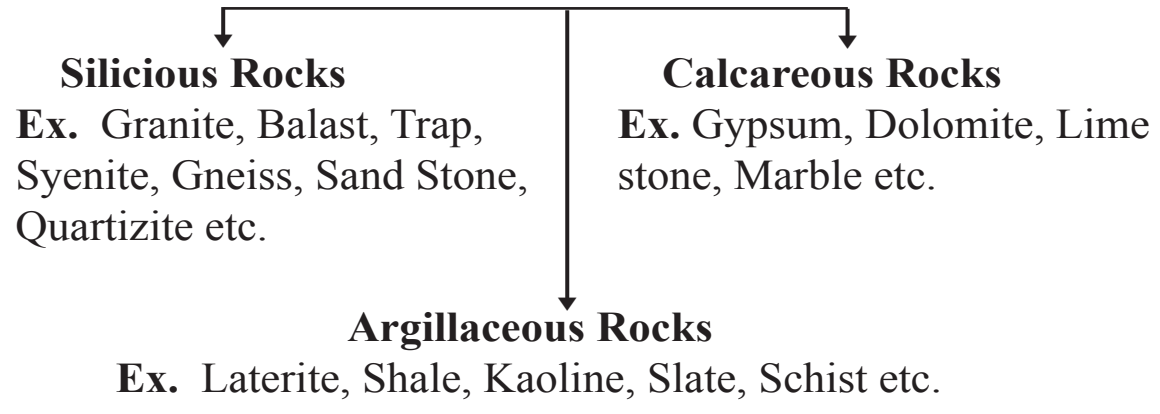




2. Physical



3. Chemical



*** Classification of Rocks on the Basis of Mineral Available :**

Name of Rock	Example
Mono-mineralic Rocks	Quartzite, Marble & Gypsum
Polymineralic Rocks	Granite, Trap, Basalt, Shale, Sand Stone, Shale, Slate.

*** Metamorphism of Rocks :**

Original Rock	Metamorphic Form
Granite	Gneiss
Syenite	Gneiss
Conglomerate	Gneiss

Sand Stone	Quartzite
Lime Stone	Marble
Marl	Marble
Dolomite	Marble
Shale	Slate
Mud Stone	Slate
Dolerite/Basalt	Schist

* **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

* **Steps for Blasting :**

Boring → Cleaning → Charging → Tamping → Firing

* **Quantity of Explosive :**

$$N = [L.L.R \text{ (in m)}]^2 \times 1.5$$

$$\text{(in gm)} = \frac{[L.L.R \text{ (in m)}]^2}{0.08} = \frac{[L.L.R \text{ (in cm)}]^2}{61}$$

* **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.
Gun Cotton (Most powerful)	Cotton with the solution of (HNO ₃ + H ₂ SO ₄) Use : Where demolitions are required.
Dynamite	Nitroglycerine 75% + Fine sand 25%. Use : Both Under water and surface blasting.

Blasting/Gun powder	Pottasium nitrate 65% + Sulphur 15% + Charcoal powder 20%. Use : In quarrying large blocks
Rock-a-Rock	Potassium Chlorate 79% + Nitro benzol 21%. Use : Under water and damp situation blasting.

* **Stone crusher and equipment :**

Crusher Type	Equipment
Primary	Jaw, Impact and Gyrotory crusher and Hammer mill.
Secondary Tertiary	Roll Crusher, Cone crusher 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)	Hardness and 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
Brad's 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 (\neq 5%)

* **Dorry Testing Machine Test :**

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

* **Attrition Test :**

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

* **Common Brick Size :**

Brick Classification	Usual Size	Nominal Size
Conventional/Traditional/ user Size	$9'' \times 4 \frac{3^{\circ}}{8} \times 2 \frac{3^{\circ}}{4}$	$9'' \times 4 \frac{1^{\circ}}{2} \times 3^{\circ}$ or (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 ₂ O ₃)	20 - 30
Lime (CaO)	2 - 5
Iron Oxide (Fe ₂ O ₃)	3 - 5
Magnesia	<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
Lime	Used as flux (Reduce melting point) Excess - over burnt and shape changed
Iron Oxide	Red Colour, Used as Flux Excess - Provide dark blur or blackish colour.
Magnesia	Yellow colour & prevent shrinkage. Excess - Give yellowish colour.

*** Preparation of Brick Earth Sequence :**

Unsoiling → Digging → Weathering → Blending → Tempering/Kneeding.

*** Burning Zone of Bricks :**

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

*** Efficiency of Kiln :**

Types of kiln	First 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

* **Class of Brick on the Basis of Strength :**

Class	Strength
Grade AA	≥ 140 kg/cm ²
Grade A	≥ 105 kg/cm ²
Grade B	≥ 70 kg/cm ²
Grade C	≥ 35 kg/cm ²

* **Types of Refractory Bricks-**

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-**

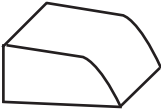

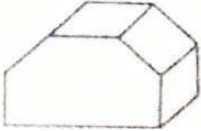
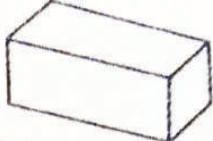

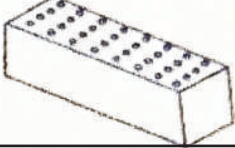
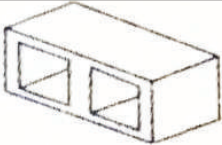

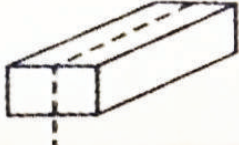


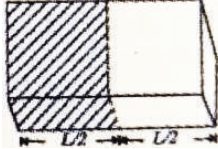
According to IS 3495 (Part-III) : 1992

White Patches	Alkalies
up to 10%	Slight
10 - 50%	Moderate
> 50%	Severe
Presence in large amount	Serious

* **Sample Required for Various Brick Test-**

Bricks Test	I.S. Code	No. of Sample
Compressive strength test	3495-Part I	6
Water absorption test	3495-Part II	5
Efflorescence test	3495-Part III	-
Warpage test	3495-Part IV	10
Dimension test	1077	20

*** Special Forms of Bricks**

Figure	Brick Name	Figure	Brick Name
	Round ended		Cant
	Double cant		Compass
	Bull nosed		Perforated
	Hollow		Coping
	Queen closer		King closer
	Brick		Bat

*** General Data about Bricks-**

Types of Bricks	Water absorption (%)	Compressive Strength (Kg/cm ²)	Use
1 st Class	≤ 20	> 105	Facing work R.B. slab
2 nd Class	≤ 22	> 70	Hidden Structure
3 rd Class	> 25	> 35	Temporary brick masonry
4 th Class (Jhamma or overburnt 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

* **Lime Obtained After Calcination-**

Pure lime stone	Pure lime
Dolomite	Magnesia lime
Kankar	Hydraulic lime
Chalk	Pure lime
Gypsum	Pure lime
Calcined lime stone	Quick lime
Calcinated dolomite stone	Non-hydraulic lime

* **The compositions of Bogue's compound in different type of cements-**

Chemical/Bogue's Component	Composition/Average Composition	Function
C ₃ S (Alite)	25-50% ≈ 42%	7 days hardness & strength
C ₂ S (Belite)	20-40% ≈ 32%	Ultimate strength
C ₃ A (Celite)	5-11% ≈ 10.5%	Flash set
C ₄ AF (Felite)	8-14% ≈ 9%	Poorest cementing value

- Cement reaction is an exothermic reaction

*** Classification of lime as per B.I.S. (I.S. 712)**

- | | | | | |
|--|--|---|--|---|
| <p>1. Class A</p> <ul style="list-style-type: none"> - Eminently hydraulic lime - Uses in hydraulic structure - Compressive strength of 28 days-28 kg/cm² - Initial setting time 2 hours and final setting time 48 hours | <p>2. Class B</p> <ul style="list-style-type: none"> - Semi-hydraulic lime - In masonry work and lime-concrete - Compressive strength of 28 days-17.5kg/cm² | <p>3. Class C</p> <ul style="list-style-type: none"> - Fat lime - In plaster | <p>4. Class D</p> <ul style="list-style-type: none"> - Magnesium - In white washing and finishing of plastering | <p>5. Class E</p> <ul style="list-style-type: none"> - Kankar lime - In masonry mortar and lime-concrete |
|--|--|---|--|---|

*** 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 ₂ O ₃) 3-8% ≈ 6%	Responsible for quick setting excess of its lowers strength
Iron oxide (Fe ₂ O ₃) 0.5-6% ≈ 3%	Used as flux
Magnesia (MgO) 0.1-4% ≈ 1%	Imparts colour & hardness
Gypsum 2-5% ≈ 4%	Used as retarder
Sulphur (SO ₃) 1-3% ≈ 1%	Impart soundness
Alkalies 0.2-1% ≈ <1%	Used as flux & imparts efflorescence

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

Properties	Order
Strength	C ₃ S > C ₂ S > C ₃ A > C ₄ AF
Reaction with water	C ₃ A > C ₄ AF > C ₃ S > C ₂ S
Heat of hydration	C ₃ A > C ₃ S > C ₄ AF > C ₂ S
Rate of hydration	C ₄ AF > C ₃ A > C ₃ S > C ₂ S

*** Water required for hydration-**

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

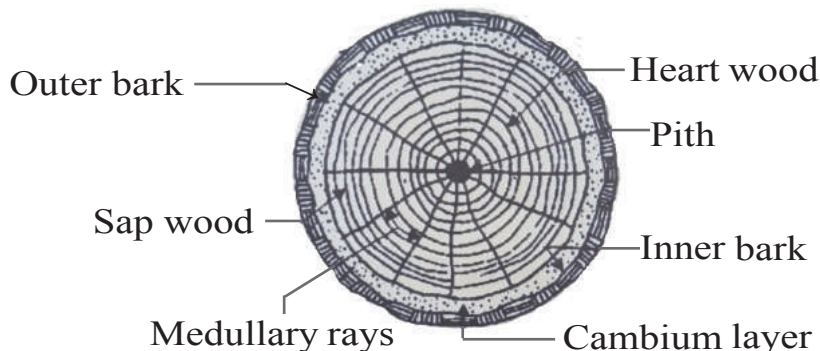
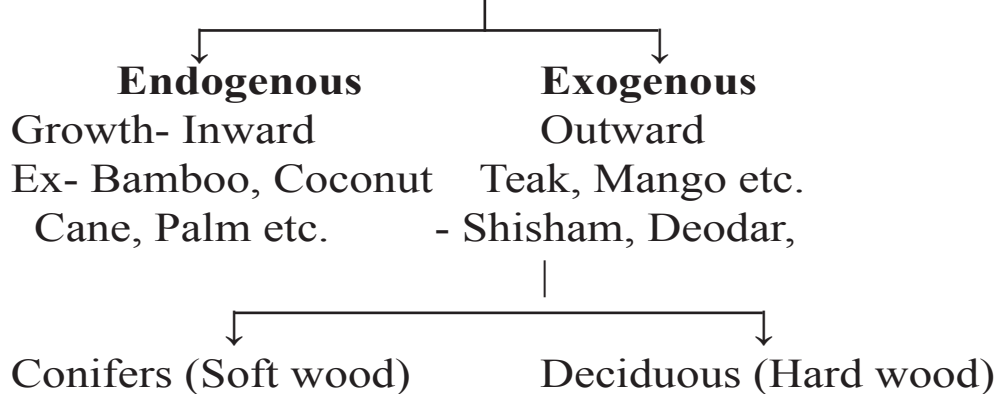
*** Required Consistency for various cement test-**

Test Performed	Water %
Initial & final setting time test	0.85P
Soundness test	0.78P
Compressive strength test	$\left(\frac{P}{4} + 3.5\right) \%$
Tensile strength test	$\left(\frac{P}{5} + 2.5\right) \%$

*** Reduction in Compressive Strength of Cement due to aging:-**

Period	Reduction in Strength
3 months	20%
6 months	30%
12 months	40%
24 months	50%

*** Classification on the Basis of Growth-Timber**



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	Used for ordinary masonry work	For superior type of masonry work	Use in very damp places

*** Setting Time of Cement & Use-**

Cement type	Setting time		Use
	Initial	Final	
Rapid Hardening Cement (IS:8041)	30 Min.	10 Hrs.	Bridge, road maintenance or repairing work
High Alumina Cement (IS:6452)	30-120 Min.	5 Hrs.	Precast structure, refractory bricks, used where chemical attacks are more
Quick Setting Cement	5 Min.	30 Min.	Foudation, basement, under water structure, mass concrete raft foundation
Low heat cemnent	60 Min.	600 Min.	Mass conc. work such as Dam
Portland Pozzolana Cement (IS:1489 P-1)	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 Cement (IS:12330)	30 Min.	600 Min.	Sea water works, sewers, lining of canals
Portland Slag Cement (IS:455-1989)	30 Min.	600 Min.	Mass concreting used as OPC.
White Cement Coloured Cement (IS:8042)	-	-	Plaster, ceiling ornamental works Terrazo floor
Hydrophobic Cement (IS:8043)	-	-	Water tight structure in basement
Masonry Cement (IS:3466)	90Min.	24 Hrs.	Masonry works

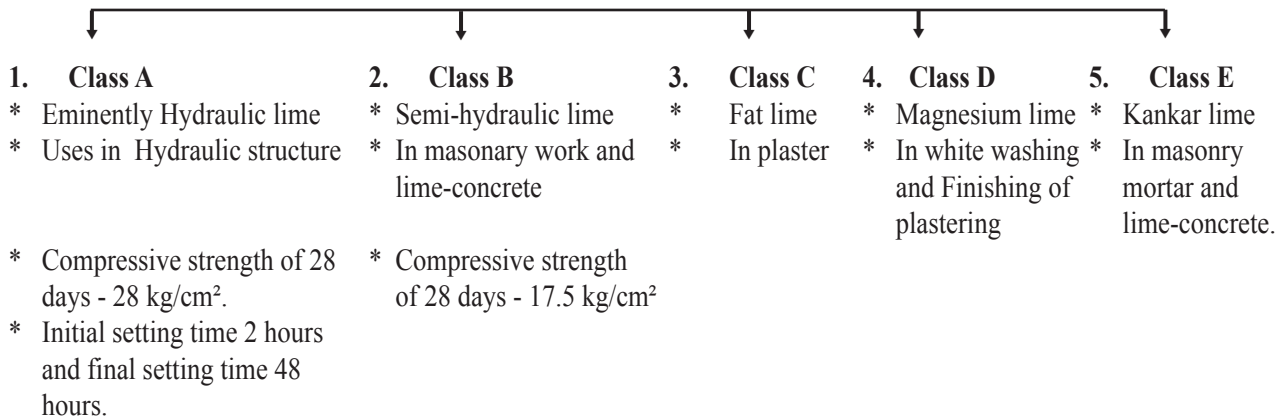
*** Minimum Surface Area of Various Cement-**

Cement Type	Min. Surface Area (In cm ² /gm)
OPC	2250
PPC	3000
LHC	3200
RHC	3250
HAC	2250
SSC	4000
Hydrophobic cement	3500

*** Macro Structure of Exogenous Tree :**

Terms	Brief definition
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 septra (Medullary rays)	The vascular tissue which Encloses the pith.
Annual rings	A cellular tissue and woody fibre arranged in distinct concentric circle.

Classification of lime as per B.I.S. (I.S. 712)



*** Properties of a Good Timber :**

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

* **At 12% Moisture Content :**

Shear strength	6.5 - 14.5 N/mm ²
Bending strength	10.2 - 18.2 N/mm ²
Compressive strength	30 - 77.5 N/mm ²
Tensile strength	80 - 190 N/mm ²

* ASCU Treatment-Developed by Forest Institute Dehradun

* Timber can be made fire resistant by Sir Abel's Process.

* **Various Use of Timber :**

Guava	Scientific instruments
Babool	Agricultural Instruments
Mulberry	Sports Goods
Jackfruit	Musical instruments
Benteak	Boat

* **Ingredients of Paint :**

Properties

Base	* Metallic oxide is the principal constituent.
	* Zinc white is weather resistant.
	* Aluminium powder used for all aluminium paints
	Ex : White lead, Red lead, Zinc oxide, Aluminium oxide, Iron oxide, Lithophone etc.
Vehicle/Binder	* Holds the constituent of paint and spread over surface.
	* If forms the body of the paint.
	* Linseed oil is the most widely used as vehicle.
	Ex : Linseed oil, Nut oil, Poppy oil and Tung oil.
Solvent/Thinners	* Used to thin the paints, 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 ₃ O ₄)]
Adultrants/Extenders	* Reduce weight, increase durability.
	* Best Adultrant is Barium Sulphate.
	Ex : Barium Sulphate, Calcium Carbonate, Magnesium Silicate & Silica.

* **Colouring Pigments-**

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

* **Ingredients for Different Types of Paint-**

- **Aluminium Paints-**

Base	Aluminium powder
Vehicle	Spirit or Oil Varnish
Use	Painting in Poles, Tower, Metal roofs & Storage tanks etc.

- **Asbestos/ Fire proof Paints-**

Base	Asbestos minerals
Use	Stopping leakage in slopy roofs, painting of gutters etc

- **Bitumenous Paints-**

Base	Natural Asphalt or residual bitumen
Solvent/Thinner	Mineral spirit or Neptha. It is alkali resistant.

- **Plastic Paint-**

Base	Plastic powder
Thinner	Water
Uses	Interiors of auditorium, showrooms and offices.

- **Cellulose Paints-**

Base	Methyl or Ethyl Cellulose
Vehicle	Petroleum
Use	Painting cars, ships and aeroplanes.

- **Cement Paints [IS:5410]-**

Base	White or coloured cement (<65%)
Vehicle	Water
Use	Exterior surface of building

- **Enamel Paints-**

Base	White Zinc, White Lead
Thinner	Varnish
Use	Acid resistance, alkalis & water proof

- **Luminous Paints-**

Base	Calcium Sulphide
Thinner	Varnish
Use	Metal surface & sign board

* **Type of Varnishes-**

- **Oil Varnish-**

Solvent	Linseed Oil
Resinous material	Copal or Amber
Use	For exposed work

- **Turpentine Varnish-**

Solvent	Turpentine Oil
Use	Interior work used

- **Spirit Varnish-**

Solvent	Alcohol
Resinous material	Lac or shellac

- **Flat Varnish-** Was as a resinous material.

- **Water Varnish-**

Solvent	Boiled water
Resin material	Lac or Shellac
Use	In picture or map