Note Book

Date : 20 / /

Aman

Er. Iswor Rawat

Engineer

Construction Materials

The different materials used in construction industry such as stones, bricks, cement, aggregate, lime, mortar, timber, steel, paint, Varnish, plastics, glass etc... & other insulating materials are called Construction materials.

Stone

The stone are derived from rocks which from the earth crust & have no definite shape or size. → Natural materi

→ Crushing strength of good building stone not less then 100 kg/c

→ Crushing strength of building stone Always 1000 kg/cm²

Stone	Heavy stone	Light stone	Soft stone
Suitable	Retaining Wall	Masonry Wall	Ornamental Work's

→ Study of rock, their properties & origin — Petrology

Classification of Rocks / stones

A Based on formation / Geological Classification

① Igneous Rock Igneous rocks are formed by the solidification of molten mass of silicates below or at the surface of earth. Which formed by cooling of magma.

→ main constituent — Silica

Types of Igneous Rock

① Intrusive Rock if the Cooling of magma below the surface of earth. Two Types

(i) plutonic Rock Depth (3–8km) eg; granite, pegmatite etc

(ii) Hypabyssal Rock Depth (2–3km) eg; dolerite, diorite.

Note Book

Date : 20 / /

Anan

⑥ Extrusive Rock if the cooling of magma at the surface of earth
→ also Volcanic Rock · eg; basalt, trap, Obsidian, pumice, dacite etc.
Example of Igneous Rock syenite, gabbro.

② sedimentary Rock sedimentary rocks are formed by the gradual deposition of materials like debris, sand, silt, clay etc.
→ main constituent debris, gravel, sand, silt, clay etc.
→ It is also known as aqueous rock. → process of formation - Petrified
→ Thes are also stratified because these rocks are formed in layers
→ Example : Lime stone, sand stone, gypsum, dolomite, chalk, shale, kanket, conglomerate stone, tripoli, diatomite, chert etc.

③ Metamorphic Rock Metamorphic rocks are formed by the change in texture. or mineral composition or both of igneous or sedimentary rock due to high temperature & heavy pressure.
→ main constituent Igneous & sedimentary rock.
→ Example : Marble, gneiss, quartzite, slate, schist, serpentine

Igneous or sedimentary Rock	Metamorphic Rock
Granite change →	Gneiss
Sand Stone	Quartzite
Shale	Slate & schist
Lime stone & dolomite	Marble
Conglomerate	Gneiss, schist etc.

B Physical classification

① stratified Rock The stratified rocks are those which gives distinct layer which can be seperated.
→ Example : all sedimentary rocks, marble, quartzite.

Note Book

Date : 20 / /

Anan

② **Unstratified Rock** The unstratified rocks are those which do not show any sign of strata & can not be easily split into slab.

Example: All igneous rocks.

③ **Foliated Rock** The foliated rock having tendency to split in a certain direction.

Example: All metamorphic rock except marble & quartzite.

C Chemical classification

Rock	main constituent	Example
① Argillaceous	Clay or alumina	slate, laterite, kaoline
② Siticious	Silica	granite, gneiss, basalt, trap, syenite, sand stone, quartzite
③ Calcareous	Lime or Calcium oxide(CaO)	limestone, marble, dolomite

Characteristics of good building stone

① Appearance & Colour

② Weight

③ Water absorption < 5 % Rejected > 10 %

④ Fire resistance

⑤ Electrical resistance

⑥ Hardness

⑦ Durability

⑧ Easy of working

⑨ Toughness

⑩ Soluble salt of 0 %

⑪ Sp. gravity → not less then 2.4

⑫ minimum crushing strength = 100 kg/cm²

⑬ Heaviness

Note stone को strength wet condition मा 30 – 40 % कम हुन्छ, dry condition को तुलनामा।

Note Book

Date : 20 / /

Aman

Test of stone

Test of stone	Used
Absorption test	To determine amount of water absorbed in 24 hrs.
Acid test	To check weather resistance.
Crushing test	To determine the strength of stone.
Hardness test	To determine hardness of stone.
Impact test	To determine the toughness of stone.
Smith test	To find dirty materials in stone.
Attrition test	To check resistance to abrasion.
Brard test	for frost resistance.
Microscopic test	Find out grain size, existing of pores etc

Important Terms

Quarrying

→ The process of taking out stone from natural rock is known as quarrying. → open part of the natural rock from which useful materials is obtained is known as quarry.

→ During quarry of stone, moisture present in the stone, is called quarry sap. → The process of removing quarry sap from stone is called seasoning of stone. Which process complete = 6-12 months

Tool for quarring: Pick axes (घैंती), Crow bar (जेल), Jumper, wedge etc.

Method of Quarring

① Digging or Excavation: It carried out with the help of tool such as pick axes, crow bar, hammer, shovel (फावड़ा) etc. case soft stone

② Heating: The top surface of rock is heated by placing wood with fuel on it. fire will be allowed for some hours. after heated which separates from the rock.

③ Wedging: This method is applicable when the rock contains cracks

or joints on it. steel wedges or steel points are put in those cracks & hit them with hammer.

④ Blasting. In this method explosive are used to separate the stones from parent rock. Case Hard rock & without any crack. → The holes are drilled in the rock & explosives are arrange in the holes & blasted with proper safety.

Tool for Blasting steel jumper of 1.8 – 3m long & 40mm diameter with chisel, tamping needle, scraping spoon etc.

Explosive Explosive used in blasting are gun powder, dynamite, guncotton, cordite etc. Note gun powder is not used for blasting under water. most powerful Gun cotton.

Dressing

It is the process of giving proper shape, size & finish. it is done either manually or mechanically.

Artifical stone made by cement & natural aggregate with required shape & size.

Tools used in dressing,

(i) soft stone chisel (ii) crow chisel (iii) punch chisel
(iv) Drafting chisel (v) Mason hammer (vi) Fare hammer
(vii) Scrabbling hammer (viii) Spalling hammer (for rough dressing)

Minerals in Rocks

A minerals may be defined as an Oraganic substance, having usually a definite chemical composition, which can be express by a chemical formula & physical properties.

→ The properties of rocks are mainly dependent on the types of minerals present in rock.

Ex. Quartz, mica, calcite, alumina & felsper.

Note Book

Date : 20 / /

Aman

Properties of Minerals

1. **Cleavage** Tendency of minerals to break with smooth flat surface
2. **Texture** arrangement constituent minerals grains available in ston
3. **Lustre** shine surface of minerals. it appearance under reflect light
4. **Colour** is the main characteristics of mineral.
5. **Streak** Colour of powder form of minerals.
6. **Weathering** effect of atmospheric conditions

Moho's Scales

→ It was created in 1812 by the german geologist & mineralogist friedrich moho. → used to determine hardness of stone.

Hardness Moho's Scale	Minerals
1 (softest stone)	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Feldspar
7	Quartz
8	Topoz
9	Sapphire
10 (Hardest stone)	Dimond

Flagstone

→ Sedimentary rock

→ Form of Sandstone composed of felspar & Quartz.

→ Grain size = 0.16 – 2mm

→ Use paving slabs, roofing, memorials etc.

Suitability of stone

Parts of structure	Stone
1. Building constuction	Laterite
2. cement concrete	Basalt & trap
3. Roof Covering, flooring, damp proofing, sill & window.	Slate
4. Interior decoration of building	Serpentine.
5. Railing ballast	Granite, gneiss, trap
6. for fire resistance	Compact Sand stone
7. Road metal	Granite & basalt
8. Bridge, piet, docks	Granite & gneiss
9. ornamental work in building	Real & yello type of basalt & trap.
10. partitions in urinals & bathroom	Slate
11. Ornamental building, monument, statue & curved work	Marble

Some special stones properties

Stone	Type	Nature	Colour	Uses
Granite	Igneous	Hard & Strongest	Gray, green, brownish, to black	Pier, bridge, abutment, light house, road paveme
Basalt, trap	"	Hard & heavy	Gray, bluish, black	Road metal, paving, concrete
Pumice	Igneous (forth)	Light	Gray, brownish	Light weight aggregate.
Lime stone	sedimentary	Stratified	White, gray, yellow, black	
sand stone	"	" & soft	" " " brown	Building element
Shale	"	Laminated, soft		
Conglomerate	"	Granular	Light colour, black	
Gneiss	Metamorphic	Hard	" " "	Paving, road metal
marble	"	Stratified	White, black & mixed	Ornamental work, Statue
Slate	"	Laminated, hard	Gray, black, blue, purple	Roofing, dpc, flooring, bathrooms
Schist	"	Weak	Greenish, yellowise, brownish black	Rearly used for structure
Moorum	"	Hard		Dressing of metal road
Laterite	Argillaceous	soft	Red, Yellow, brown, black	Light road, inferior type building

Note Book

Date : 20 / /

Note Book

Date : 20 / /

Aman

Availability of stones in Nepal

1. Slate: Sindhupalchowk, Nuwakot, Dhading, Tanahun, Chitwan, Rammechap, Dolkha
2. Gravel: Lalitpur, Palpa.
3. Talc: Sindhupalchowk, Makawanpur
4. Sandstone: Kathamandu, Lalitpur, Kaski, Palpa, Dang
5. Marble: Kathamandu, Lalitpur
6. Berril: Taplejung, Sankhusabha
7. Granite: Sankhusabha, Nuwakot
8. Turmalin: Sankhusabha, Nuwakot
9. Limestone: Kathamandue (Ramkot), Dhankuta (Thuliwa, Sudhimarang) chitwan (pile), makawanpur (Nibuwatar), Tanahun (Dandakot)

Cement

cement can be defined as a materials with adhesive (टाँस्ने) & cohesive (जोड्ने) properties which makes it capable of bonding materials fragments (टुक्रा) into a compact whole.

→ It provides good bond between two materials & provides good strength. → It obtained by mixing limestone & clay, burning them & grinding to fine powder.

→ Popular cement: ordinary portland cement (most used)

→ Specific gravity = 3.15 → Water absorption = not more then 5%

→ Density of cement = 1440 kg/m³

Raw Materials of Cement

Ingredients	Comp%	Function
Lime (CaO)	60–65	controls strength, Sound, strong
		Excess: Unsound, expand & disintegrate
Silica (SiO_2)	17–25	Give strength Excess: slow setting.
Alumina (Al_2O_3)	3–8	Quick setting Excess: lowers the strength.

Note Book

Date : 20 / /

Aman

Iron oxide (Fe_2O_3)	0.5–6	Give, hardness, strength & fusion. Excess → discolour
Magnesium oxide (MgO)	0.5–4	Give colour & hardness.
		Excess cracks in mortar & concrete.
Sulphur Trioxide (SO_3)	1–2	Make sound Excess unsound
Alkalies	1.8	Small quantities
		Excess Efflorescence

* Besides, Gypsum ($CaSO_4$) — 2–4 % → control initial setting time

Bogue's compound / composition of cement clinker :

Compound	Comp %	Function
Alite (C_3S)	25–50	→ It generates more heat of hydration
		→ Develops early strengths & hardness.
Belite (C_2S)	25–40	→ It generates less heat of hydration
		→ Develops ultimate strength.
Celite (C_3A)		→ It react rapidly with water.
	5–11	→ It generates more heat of hydration
		→ Help to setting of cement.
Felite (C_4AF)		→ Less cementing value.
	8–14	→ React very slow
		→ Increase volume of cement.
		→ Reduced cost.

All the above compounds undergo some chemical combination during the manufacturing process & from clinker. the constituents of the end product are called Bouge compound.

Note : → High % of Alite & low % of Belite in cement results.
① Rapid hardening. ② High early strength ③ High heat of generation. ④ Less resistance to chemical attack.

→ Low % of Alite & high % of Belite in cement results.
① Slow hardening ② High ultimate strength ③ Less heat of hydration ④ Greater resistance to chemical attack.

* Sum of % of Alite & Belite for portland cement = 70–80 %

Note Book

Date : 20 / /

Aman

Mixing of raw materials	Burning	Grinding
Ball mill	Rotary kiln	Tube mill

Types of cement

① ordinary portland cement (opc) → Properties → Common type of cement. → sufficient resistance shrinkage & cracking Less resistance chemical attack. → medium rate of development of strength heat of hydration Uses → General Construction → Small structures.

② portland pozzolana cement (ppc) pozzolana materials = 10-25%. properties → Gain strength slower then opc → Ultimate strength more then opc → Less heat of hydration → Greater resistance chemical attack. Uses → Under construction of water → Sewage works → Suitable for small concrete works.

③ Rapid hardening portland cement (RHPC) properties → Early strength greater then opc. → Contain Lime more then opc heat of hydration Higher then opc. → C_3S more then opc → 3 day strength of RHPC = 7 day strength of opc → opc से जल्दी हार्डन Uses → Emergency work, Road construction.

Not Use Mass Concrete Construction.

④ Extra rapid hardening cement properties → obtained by Mixing $CaCl_2$ ($\not>$ 2%) with RHC. Uses Road Works.

⑤ sulphate resisting cement (SRC) properties → Manufactured by Grinding opc clinker with gypsum. Uses Marine condition, basement, foundation, Waste Water treatment.

⑥ Super sulphate cement (SSC) Properties → Manufactured by 80-85% granulated slag, 10-15% burnt gypsum & 5% opc clinker. → Highly resistance sulphate attack. Uses Marine Work.

⑦ Low heat cement (LHC) Properties → C_3S & C_3A less & C_2S more → Strength is gained at slow rate. → Ultimate strength same as OPC Uses Mass concrete, dam, retaining wall, bridge, abutment.

Note Book

Date : 20 / /

Aman

(8) Blast furnace cement properties → obtained by Mixing portland cement clinker, gupsum, granulated blast furnace slag. Uses Mass concrete due to low heat of hydration

(9) Quick setting cement properties → Obtained by Adding Al_2SO_4 & $CaCl_2$ with opc → Reduced amount of gypsum Uses Under water construction.

(10) High Alumina cement properties → Amount of alumina & Calcarous materials are high. → can withstand high temperature. Uses Refractory concretes

(11) Resident cement properties → Hardening time = 8-10 min Uses very cold area/ winter season.

(12) Coloured cement properties → Prepared by china clay & Chalk → Amount of pigment = 5–10%. cost 2 times of OPC Uses Architectural purpose.

(13) High strength cement properties → special type of opc → compressive strength higher then opc.

(14) Hydrophobic cement properties obtained by mixing opc clinker with water repellent film from the substance like acetic acid, stearic acid etc.

(15) Masonary cement

(16) Oil well cement

(17) Expansive cement

Temperature at the time of testing = 25°C – 29°C

Maximum % of pigment in colour of cement = 10%

The weight of magnesia should not be greater then 5%

Note Book

Date : 20 / /

Aman

Test of cement

① Fineness test

→ Check proper grinding of cement & Cementing Value.

→ Method ① sieve method ② Air permeability method.

→ sedimentary residue of opc cement should not be greater then 10% of sample in Is sieve no 90micron

1mm = 1000 micron

② consistency test

→ Find the proper amount of water to be added to the cement.

→ performed by Vicat's apparatus Consists, plunger Diameter 10mm Length = 40-50mm →

③ soundnesstest

→ Find the presence of uncombined lime & magnesia in cement which causes the expansion of cement.

→ Done by Le-chatelier's apparatus.

→ According to Is, Expansion = not exceed 10mm, portland cement

④ Setting time test

→ Done by Vicat's apparatus

Types of cement	Initial Setting time (min)	Final setting time (min)
Ordinary portland cement	30	600
Portland Pozzolana cement	30	600
Rapid hardening cement	30	600
Sulphate resisting cement	30	600
Super sulphate cement	240 (4hr)	270 (4hr 30 min)
Low heat cement	60	600
Blast furnace cement	30	600
Quick setting cement	5	30
High alumina cement	30	600
White portland cement	30	600

Aman

⑤ Tensile strength test

→ Tested by Briquette testing machine.

→ Cement & sand ratio 1:3 (mortar)

→ Average tensile strength after 3 day of curing = not less then 20 kg/cm² & 7 day = not less then 25 kg/cm².

⑥ Compressive strength test

→ Standard cube made of good portland cement & sand mortar in ratio 1:3 → Size of cube mould = 7.06 cm

→ Done by compression testing machine

→ Cubes should be kept at temperature 27° ± 2°C

→ Compressive strength after 3 day = not less then 115 kg/cm² & 7 day = 175 kg/cm². → Three cubes are tested

⑦ Loss of ignition test

→ Loss of weight of cement 1 gram of sample is heated at standard temperature → Loss of ignition = not exceed 4%

Manufacture of Cement

① Dry process

→ Limestone & clay are ground separately to fine powders by a grinding mill & mixed together in desired proportions.

→ Water (about 12%) is then added & the resulting product is dried & brunt in kilns.

→ Clinker obtained after burning is added 3-5% of gypsum & ground to fine powder.

→ This final product is cement.

② Wet process

→ Limestone is ground separately.

→ Clay materials are mixed with water in wash mills & stored.

→ Now crushed dry limestone & wet clay are mixed correct proportion.

Note Book

Date : 20 / /

Aman

Dry process	Wet process
→ slow & costly.	→ quick & easy
→ size of the kiln needed to manufacture the cement is smaller.	→ Bigger
→ More economically.	→ Less economically.
→ Moisture contents of this pellets is 12%.	→ Moisture content of this slurry is 30–50%.
→ Amount of heat required is lower. so required lower fuel.	→ Amount of heat required is higher. so required higher fuel.
→ steps	→ steps
① Treatment of raw materials.	① Collection of raw materials.
② Burning of dry mix.	② preparation slurry (crushing, grinding & mixing of raw materials)
③ Grinding of Clinker.	③ Burning, ④ Grinding of Clinker.
④ Packing & storage.	

Specific surface

Types of cement	OPC & PSC	PPC	LHPC	RHPC	SRPC
specific surface area (Cm^2/gm)	2250	3000	3200	3250	4000

Flash set → It is the property of concrete by which upper surface of concrete becomes hard without setting the inner portion.
→ This effect is found due to the presence of tri-calcium aluminate (C_3

Setting & hardening of cement

→ The chemical reaction between cement & water is called hydration of cement. The phenomenon by virtue of which the plastic cement change into a solid mass is known as setting of cement.
→ The phenomenon by virtue of which the elements paste sets & develops setting is known as hardening of cement.

Aman

Strength of Cement

After Months	3	6	12	24
Strength reduced	20%	30%	40%	50%

Freshness of Cement

→ The Colour of cement is uniformly greenish grey.
→ A handful of cement, thrown into a bucket of water, floats.
→ Hand is thrusted into a bag of cement, it feels cool & it feel smooth.

Specification of Storage & transport of cement bag

Height of cement bag = 18 cm
Area of cement bag = 3000 cm^2 (40 × 75)
Space between pile = 1.6 m
Space from Wall = 30 cm (minimum)
Height from ground surface = 20 cm (minimum)
Packing of bags = 50kg per bag
No. of bag should not be more then 15 in horizontally & 10 in Vertically. → Wide ≯ 3m → Height ≯ 2.7m
Transport With help of truck, lorry & tractor etc.

Admixtures

Added Less then 5%.

The admixtures are the materials other then the basic ingredients of cement concrete added to the concrete mix to improve certain properties, like strength, durability, Workability
→ The addition of admixture is done immediately before or during mixing. → Available both powder & aqueous solution.

Functions of Admixtures (उद्देश्य)

→ Improves Workability, strength & durability.
→ Increase bond strength betⁿ Concrete & reinforcement.

Note Book

Date : 20 / /

Aman

→ Improving the water proofing properties.
→ Reduce shrinkage during setting of mortar.
→ Reduce bleeding & segregation effects of concrete.
→ To produce colour of concrete.
→ To decrease weight of concrete.

Note Admixtures को Fresh व hardened concrete मा add गर्न सकिन्छ।

Types of Admixtures

① Accelerator → Added upto 2% by weight of cement.
→ Concrete set & hardened quickly. → Generally used in construction in cold climates → Reduce ultimate strength & initial setting time of concrete. → Examples Aluminium Chloride, Sodium Carbonate, Calcium Chloride, Silicon fluoride etc.

② Retarder → Increase initial setting time & hardening time of concrete. → for long distance → Examples calcium sulphate ($CaSO_4$) gypsum, sugar, glucose, starch, cellulose → Added 2-3%.

③ plasticizer Also water reducing admixtures → Added to concrete mix for making more plastic without any further addition of water. Added below 0.5% → Example salt of hydroxylated acids.

④ Air-entering agent Example Resins, fatty acids, oils, aluminium & zinc powdered etc.

⑤ Bleeding agent Example paraffin wax

⑥ Colouring agent Example Red oxide, ferrous oxides, chromium oxide

Clay & Clay Products

Brick

Bricks are the small, solid structural unit of rectangular shape & convenient size made from suitable types of clay hardened by the heat or chemical action.

Note Book

Date : 20 / /

Aman

Brick	Stone
→ Lighter then stone	→ Heavier then brick.
→ Made of clay.	→ obtained from rock.
→ Sp. gravity = 1.8	→ sp. gravity = 2.6
→ Water absorption = less then 15%	→ Water absorption = less then 5%
→ Less durable then stone.	→ high durable then brick
→ Uniform colour & shape.	→ no uniform colour & shape.
→ Absorbs lesser heat.	→ Absorbs more heat
→ Overall cost of manufacture is less	→ Overall cost of manufacture is high.

. Brick Earth Brick earth is the mixture of clay & sand which when Mixed with water becomes plastic & can be easily moulded. also dried without cracking & warping.

Ingredients of Brick Earth

Ingredients	Comp%	Function
Silica (SiO_2)	50–60	→ main ingredients. → Retain shape.
		→ Imparts durability. → Prevent Shrinkage
		& Warping Excess, Brittle & weak
Alumina (Al_2O_3)	20–30	→ provides plasticity → Makes brick hard on
		drying. Excess crack & warp
Lime (CaO)	< 10%	→ Reduce shrinkage Excess melt & loose its
		shape. Result jhama brick, black colour
Iron oxide	≤ 7%	→ Give red colour Excess dark blue colour,
(Fe_2O_3)		→ not present in the form of iron pyrite.
Magnesia	< 1%	→ Reduce warping & shrinkage.
(MgO)		Excess Yello Colour, decay (क्षति)
Alkalies	< 10%	for quick setting, Help to melt the brick.
		Excess efflorescence.

Note Book

Date : 20 / /

Aman

Harmful Ingredients

Ingredients	Causes
carbonaceous matter	Brick black
Iron Pyrite	Split the brick to pieces.
organic matter	Brick porous
pebbles & gravels	Difficult to mix. Result non-homogenous brick
Sulphur	Brick discolour.
Water	Shrinkage during burning

Manufacture of Bricks/ Preparation of Brick Earth

① Un-soiling It is the process of removal of top layer of earth (≈20cm) to get the soil free from pebbles, gravel, roots etc.

② Digging It is the process of excavation of soil by adding fly ash, sandy, loam, rice husk etc.

③ Weathering It is the process of exposing the soil in open weather after mixing small amount of water to improve plasticity & strength.

④ Blending It is the process of mixing the appropriate constituent of bricks such as sandy earth, calcarious earth etc. Except water

⑤ Tampering It is the process of kneading the soil either by feet of men or pugmill. → The operation of tampering with pug mill is known as puggling. → In tampering water & other substance are mixed together to improve plasticity & durability of bricks.

⑥ Moulding It is the process of making the bricks of required shape & size from the tampered or pugged clay. → Moulding done by either hand or machine. Hand ① Ground ② Table
Machine ① plastic clay ② dry clay

⑦ Drying It is the process of remove the moisture to control th Shrinkage, save fuel & time during drying. → ① Natural drying → slow
→ ② Artifical drying → Fue
→ Cost

⑧ Burning Three stage ① Dehydration (400°–650°C)
② Oxidation (650°–1000°C)
③ Vitrification (900°–1100°C)

Note Book

Date : 20 / /

Aman

→ Kiln मा burnt गरिएको अन्या clamp मा poor quality हुन्छ brick को।

Types of Kiln → Pazawah

① Clamp or open kiln → Temporary structure

② Intermittent kiln → permanent structure → hot continuously

③ Continuous kiln → permanent structure → Burning Continuous

Types of Continuous Kiln → ~~Low initial cost~~ → chimney Ht. = 17m

→ semi-continuous place semi/over ground

④ Bull's trench kiln shape Elliptical Run Dry seasons only 60%

② Hoffman's kiln Shape circular Run full year place over ground

③ Tunnel kiln → 80–90% → High initial cost → Chimney Ht. = 30m

Note 20 tones coal are required for burning of 100000 bricks.

→ The amount of fuel required for burning of bricks is

0.075 – 0.1 T/m³ (coal) & 0.1 – 0.15 T/m³ (wood).

Classification of Bricks

A On the basis of field practice

① First Class Brick

→ They are well brunt & regular shape & size.

→ Have uniform texture & colour. (deep red colour)

→ Sufficiently hard & sound.

→ Minimum crushing strength = 105 kg/cm². 10.5 N/mm²

→ specific gravity = 1.8 → Metallic sound

→ Water absorption capacity = not exceed 15 %. (for 24 hrs)

→ Not break, dropped from height 1–2 m.

→ Size of brick, NS = 230 × 115 × 57 mm.

→ Used in masonary, flooring, facing works.

② Second Class Brick

→ They are well brunt but irregular shape & size

→ Does not have uniform texture & colour.

→ Not so hard. → Ringing sound

Note Book

Date : 20 / /

Aman

→ Minimum crushing strength = 70 kg/cm². 7N/mm²
→ Water absorption capacity = ≤ 20%.
→ Used in interior wall construction.

③ Third class Brick
→ They are under burnt & irregular shape & size.
→ Does not have uniform texture & Yellowish colour.
→ soft → Dull sound
→ Minimum crushing strength = 35–70 kg/cm². 3.5N/mm² – 7N/mm²
→ Water absorption capacity = < 25%.
→ Used in interior & temporary structure.

④ Overburnt or Jhama Brick
→ They are overburnt & irregular shape & size. → Brittle
→ Dark in colour. → Produce metallic ringing sound.
→ Hard & strong → Crushing strength = > 15 N/mm²
→ Used in aggregate for concrete, road metal, filling material

B On the basis of use
① common Brick used for filling, backing
② Facing Brick used in front of building wall. Good appearance
③ Engineering Brick Used → strong, impermeable, smooth & hard.

C On the basis of finish
① Sand face brick (sand ढकेको) ② Rustic brick (विभिन्न colour हुन्छ)

D On the basis of manufacture
① Handmade brick ② Machine made brick

E On the basis of Burning

① Pale brick	② Body brick	③ Arch brick (Clinkers brick)
Unburnt	Well burnt	Over-burnt

Note Book

Date : 20 / /

Aman

Testing of Brick

① Compressive strength test

→ minimum no. of specimen = 5

→ Specimen brick is immersed in water for 24 hours.

→ Frog of brick is filled with 1:3 cement mortar & Stored in damp jute bags for 24 hours.

→ & then immersed in water for 3 days.

→ Specimen placed on compression testing machine.

→ Load is applied at uniform rate of 14 N/mm² per minute.

→ Maximum load is recorded. (specimen fails हुआ को)

→ $\text{Compressive strength} = \frac{\text{Maximum load at failure}}{\text{Loaded area of brick}}$

② Water absorption test

→ 3–5 samples of bricks are taken.

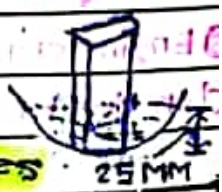
→ It is done at a temperature of 27 ± 2°C

→ The specimen brick is first weighted dry. 'W_1'

→ Then immersed in water for 24 hours.

→ It is weighted again. 'W_2'

→ $\text{Water absorption} = \left(\frac{W_2 - W_1}{W_1}\right) \times 100$



③ Efflorescence test → measure White patches

Efflorescence	Nil	Slight	Moderate	Heavy	Serious
deposits (white)	not found	< 10%	10 – 50%	> 50%	Exposed are

④ Warping test Check bend & twist of brick.

⑤ Dimension test Size Mortar = 10mm

NS = 230 mm × 115 mm × 57 mm

IS = 19 cm × 9 cm × 9 cm → 4 cm

No. of brick, NS (1 m³)	① Hand made – 560	530 IS
	② Machine Made – 530	500

Note Book

Date : 20 / /

Aman

Defect of Bricks

① Under burning. brick Absorbs Water Reduce strength

② over burning. brick produced soften mass Loose shape

③ Chuff Hot brick का cool water मारो, Crack या deformation हुए।

④ Black Core → Carbon या bituminous matter नहीं oxidation द्वारा completely removed होता अर्थात improper burning का कारण हुआ।

⑤ Cracks or checks → Reason Excess of water & lumps of lime.

⑥ Efflorescence → brick मा White या gray salt deposition हुए। Reason Alkalies present in soil.

⑦ Bloating → Brick swollen (फूलेको). Reason Excess of Carbonaceous Matter & Sulphur.

⑧ Lamination → Reason Entrapped air in brick Reduce strength → Weak in structure

⑨ spots → Dark sulphur spots due to iron sulphides.

Some Other Types of Bricks

Fire Bricks / Refractory Bricks

→ It is made of fire clay at high temperature in a special kiln.

→ Crushing Strength = 125 kg/cm² Water absorption = 5–10 %.

→ Used Combustion Chamber → Chromic Natural refractory brick.

→ Dolomite & Bauxite Basic refractory brick. → Unit Weight = 2400 kg/

Hollow Bricks

→ Volume not less then half of the gross volume.

→ Used Non load bearing Wall & ornamental Works.

Other Important Terms

Terracotta → It is a type of fired Clay or earthenware. Made by mixing Clay with Water, shaping. → Burnt in special kiln Name Muffle furnace Temperature 1100–1200°C. Used pottery. sculptur (मूर्तिकला), decorative objects, architectural features, building materia such as roof tiles, bricks etc.

Note Book

Date : 20 / /

Aman

Surkhi → Form of powdered brick. → Made by finely grinding burnt clay bricks. → Mixed with cement to create Mortar. → Substitute for sand → Improve strength & durability of concrete & mortar. Reduce shrinkage & cracking

Fly ash → fine, powdery substance → produce during the combustion of coal. → Used as a partial replacement for cement in concrete. Improve strength & durability. Also used production of bricks, as a soil amendment & as a component in the production of lightweight aggregates.

Porcelain → Type of ceramic material → Made by heating materials, typically including clay in combination with other minerals, at high temperature. Properties Hard, white, translucent (पारदर्शी) & glazed (इनेमल) surface. → zero absorption. Used dinnerware, vases (फूलदान), figurines (मूर्ति) & decorative

Bricks Bond

→ pattern in which bricks are laid to form a wall or other structure.

Types of Bond	Explanation
Stretcher Bond	→ Bricks are laid as stretcher on the face of the
	wall. → Used for single brick wall or half brick wall.
	→ Also used for cavity wall as less cutting required
Header Bond	→ Bricks are laid as header on the face of the wall.
	→ Used for one brick wall
English Bond	→ Bricks are laid by alternate course of headers
	& stretchers. → Strongest bond & carry heavy load.
	→ Commonly used for all wall thickness.
Flemish Bond	→ Bricks ar laid by each course alternate headers
	& stretchers. → More decorative.

Note Book

Date : 20 / /

Aman

Frog → Depression on the top of the brick. → Works as a key at time of laying of bricks. → Size 10cm x 4cm x (10-20)mm

Used Advertisement of manufacture & reduce weight.

Brick Nogging → Construction techniques → Bricks are fill in a Wooden frame. purpose provide additional strength & stability to building. Wall or ceiling.

Quality of Good Brick

① Shape & size → Uniform in size, uniform surface with well defined edge

② Colour → Copper Colour.

③ Structure → Fine compact & uniform structure.

④ Hardness → Sufficiently hard & not be scratched by fingernail.

⑤ porosity → Not absorb too much water.

⑥ Strength → Sufficiently strong & not Crack under loading.

⑦ Durability → Not damaged by the environment.

⑧ Resistance to fire

⑨ Resistance to efflorescence

Note : Compressive strength Hand made brick = 30-150 Kg/cm²

Machine made brick = 150 Kg/cm²

→ Normally, Height of Chimney = 30m

→ Glazing is used to make earthenware impervious.

→ Damper → metal plate → Used Close or open Chimney of kiln.

↳ purpose Regulate the flow of air in the kiln during the firing proces

→ Internal size of mould take slightly (about $\frac{1}{10}$ th) greater then brunt brick

→ Height of wall Can be raised in one day, ① Stone masonry = 60cm.

② Brick masonry = 100cm.

→ Wt of one brick = 2-3 kg → Volume of one brick = 1680 cm²

→ Density of Common red brick = 1620 - 1900 kg/m³

Note Book

Date : 20 / /

Aman

Paints & Varnishes

Paints & Varnishes are used to protect metals, timber or plastered surface from the corrosive effects of weather, heat, moisture or gases. They are also used to improve their appearance.

Paint

It is the fluid paste prepared by mixture of base with vehicle, pigments, thinner, drier, adulterants, extender etc.

Uses / Function of paint ① Decoration purpose ② conservation purpose ③ Hygienic purpose ④ prevents from corrosion.

Ingredients of paints

Ingredients	Functions
1. Base	→ Body of paint. → Also called Oxides of metal.
	→ It gives a thin layer (film) which protects
	from weathering effect. → It has binding
	properties. → Example Used on Wooden
	Surface – White lead, zinc White. Used on
	Metal surface – Red lead, Iron oxide.
	→ Aluminium powder etc.
2. Vehicle	→ Also called Carrier, liquid, drying oil.
	→ It binds based pigments together.
	→ It spread the base over the surface.
	→ Examples Linseed oil (mostly used), Fish oil,
	tung oil, nut oil, poppy oil etc.
3. Pigments	→ Gives Colour to the paint. →
	→ White Colour → White lead, zinc oxide
	→ Red Colour – Red lead, Iron oxide, Carmine, vermillion
	→ Blue colour → Indigo, Cobalt oxide.

Note : Weather resistance in zinc White

Note Book

Date : 20 / /

Aman

	→ Brown Colour — Copper oxide, raw & burnt umber
	→ Green Colour — Chromium oxide, Copper sulphate
	→ Black Colour — Lamp black, Vegetable & ivory black.
	→ Yello Colour — Yello chrome, Ochre, raw Siena.
4. Driet	→ It helps to dry the Vehicle. → < 8%
	→ Example Letharge (mostly used), zinc sulphate,
	lead acetate, red lead, magnesium.
5. Thinner	→ Also called Volatile substance (आसानी से उड़ेर जाने)
(Solvent)	→ Make it's application easy & smooth & thin.
	→ Examples Turpentine (mostly used), petroleum,
	kerosene, sprit, naptha, water etc.
6. Adulterants	→ Increase weight & durability. Reduce cost
(inert filler)	→ Examples Aluminium, silicate, magnesium
	silicate, Calcium Carbonate, Barium sulphate,
7. Extender	→ Increase Volume Examples silica, talc, gypsum

Note more poisonous — Lead paint

Types of paint

Types of paint	Uses
① Aluminium paint	→ Resist High temperature → Uses oil & gas
	storage tank, hot water pipes, electrical
	telephone poles, silos, metal roof etc.
② Asbestos paint	→ Fire resistance → prevents leakages.
	Uses metal roof, gutter, outer surface of basement wal
③ Bronze paint	→ High reflective Used radiator of vehicles.
④ Enamel paint	→ Used Timber, concrete, metal etc.
⑤ Cellulose paint	→ Used in expensive materials. → Ducco paint
	→ Used Air-plane, ships, car etc
⑥ oil paint.	→ Ordinary paint, easily available, cheap
	→ Used Automobiles.

Note Book

Date : 20 / /

Aman

⑦ Emulsion paint	Used concrete surface in wet area.
⑧ Fluorescent paint	→ It has shinning property. → Visible at night
⑨ Cement paint	Base White cement Thinner Water
	→ Used concrete face, plastered surface
⑩ Plastic paint	→ Dense in nature → Give very attractive
	looks Used Auditorium, Showrooms, office etc.
⑪ Bitumen paint	→ It gives highly protective layer
	→ Used Under water pipes
⑫ Casein paint	→ Used plastered surface, Wall & ceiling etc.
⑬ Zinc paint	→ Used Illumination of maps.

Preparation of paints

Stone pestle

① first of all, base is finely ground with the help of muller & then mixed with Vehicle. It gives thick paste.

② Then, this thick paste is mixed with thinner. It gives a consistent/thin paste.

③ Now, separately ground pigment & driers.

④ Then, all above three paste are mixed & give a paint.

Defects in paint

① Blistering → swelling of paint Reason अन्तिम coat मा oil को मात्रा ज्यादा हुदा वा paint surface मा air फसेका कारण। peeling → case of moisture

② Chalking → Conservation of paint into powder form Reason paint मा oil को मात्रा कम हुदा।

③ Checking → formation of cracks on surface of paint (हल्का)

→ Reason paint मा tensile strength कम हुदा। र paint चिसो मौसममा apply गर्दा। Crazing → cracks small area मा produced हुने।

Crocodiling → cracks large area मा produced हुने।

④ Cracking → Cracks developed throughout the thickness of paint.

Reason paint मा drier ज्यादा हुदा।

Note Book

Date : 20 / /

Aman

⑤ Alligatoring → one layer of paint slide over the another.
→ Reason Hard paint is applied over a soft one or vice versa.
⑥ Flaking → Detachment of paint film from the surface.
⑦ Discoloration → Alteration in the orginal Colour.
(रंगरोध)

Varnish

It is a homogenous mixture of natural or synthetic resin with solvent & drier. → Varnish dries off & leaves a transparent or semi-transparent film of resin. → It does not contain pigments.
Function of Varnish ① protects the painted surface ② Gives shinning effect to the painted surface. ③ Gives brillancy to the wooden surface, photograph, map etc.

Ingredient of Varnish

Resin → principle constituent → Examples Copal, amber, gum, mastic → lac, shellac, dammer
Solvent → Examples Linseed oil, turpentine oil, methylated spirit or alcohol (Boiled)
Drier → Examples Lead acetate, White Copper, Letharge.

Types of Varnish

Types of Varnish	Explanation
① Oil Varnish	→ Resin + Linseed oil + Turpentine + drier
	→ Dries off very slow. → Most durable.
	→ Used Exterior & Interior surface.
	→ Example Copal Varnish.
② Spirit Varnish	→ Resin + Methylated spirit → Brilliant appearance
	→ Dries of very quickly → Less durable.
	→ Used Interior surface. → Eg. french polish, lacque
③ Flat Varnish	→ Give dull appearance.
	→ Used Timber for protection.

Note Book

Date : 20 / /

Aman

④ Spar Varnish	→ Sticky in nature as temperature rise
	→ Used spars, Exterior part of ship, boat
⑤ Water Varnish	→ Hot water + ammonium etc.
	→ Used photograph, map.
⑥ Turpentine Varnish	→ Dries off quickly → Less durable then oil Varnish Used Metal painted surface
	→ Not so tough.
⑦ Asphalt Varnish.	Used Fabricated steel Works.

Distempers → Also Called Water paint → Obtained by Mixing White Chalk & Water. Base Chalk Thinner Water Main principle constituents chalk. Removed by Water → Less durable Use Temporary & Interior surface. → Not exposed to atmosphere. → for colour used to pigments

Bitumen

It is a binding material, which is in Solid or semi-solid state.

Properties of Bitumen

Colour Black State semi-solid Sp. gravity 1.09 soluble in Carbon disulphide, Carbon tetra chloride, Chloroform, benzene, ether → Non-Crystalline Solid → Viscous material → gets soften as temperature rise. → Catch fire at 200°C → Ductile in nature. → Chemical Compound Carbon & hydrogen derived from petroleum crude oil (कच्चा तेल) → Bitumen is not affected by air, light or water individually but in Combination they can make in brittle & porous.

Note Book

Date : 20 / /

Aman

Uses of Bitumen

→ Road pavement → paint formation → Crack repairs
→ Heat insulation purpose → DPC, leakage prevention → Batteries
→ Roof sealing → joint filler etc.

Classification of Bitumen

1. General classification

(a) Cutback Bitumen → Obtained by Bitumen + solvent (Kerosene, petroleum, naptha, gasoline etc) → Solvent turns the bitumen from semi-solid to liquid state. → No heat is need before using it.
→ Used Road pavement in cold area, Manufacturing of paint, Soil stabilization. ~~Mountainous area~~

(b) Bitumen Emulsion → Obtained by Bitumen + water + Emulsifier (Stabilizing agent)
→ It is an aqueous solution (पानी मिलाइएको) → Used Road pavement, soil stabilization.

(c) Blown or oxidised Bitumen → Obtained by passing air at high temperature & pressure. Function Heat insulation Used flooring, Roofing, Joint etc.

(d) Plastic Bitumen → Obtained by Bitumen + Inert filler (40–45%)
→ Inert filler Asbestos powder → Used Crack repairs

(e) Rut or straight run Bitumen → Obtained by after distilling a (boiling point) crude oil having required penetration, viscosity. → Used without further treatment.

2. Based on source ① Natural Bitumen ② petroleum Bitumen.

3. Based on consistency (at 18°C)
① Solid Bitumen ② semi-solid Bitumen ③ Liquid Bitumen

4. Based on Application (Uses)
① Road Construction Bitumen ② Building Bitumen ③ Roofing Bitumen

Note Book

Date : 20 / /

Aman

Test of Bitumen

Types of Test	Explanation
① Penetration Test	Equipment penetrometer
	Measure softness or hardness of bitumen.
Note Actual penetration	Expressed $\frac{1}{10}$th of mm
Value (30–40) मा,	Needle allowed penetrates Time = 5 sec
$30 \times \frac{1}{10} - 40 \times \frac{1}{10}$ mm	Standard Temperature 25°c
3 mm – 4 mm Hard.	→ Penetration Value $\frac{30}{40}$, $\frac{80}{100}$ etc.
(80–100) मा,	In 30/40 → 30 = lower penetration limit
8 mm – 10 mm Soft.	→ 40 = Higher " "
② Softening point test	Equipment Ball & Ring
	Measure softening point.
Temperature	Tamperature increase rate 5°c/min
Susceptibility	→ Measured temperature Ball drops from
	Ring. → For good bitumen softening
	point = 35°c – 70°c
③ Ductility Test	Equipment Standard briquette testing
	Machine. Measure elongation, before
At 27°C	failure → pulling rate 50 mm/min.
	→ Measured distance. Bitumen break.
	→ for good bitumen Ductile Value = 50cm
④ Specific Gravity	Equipment pycnometer
	Measure specific gravity.
At 27°C	→ Sp. gravity = 1.09, (0.97 – 1.02) Highway
⑤ Viscosity Test	→ Equipment orifice Viscometer
	Measure Resistance to flow
	→ Measure in term of time (sec).
	→ Size of orifice = 4 mm, 10 mm

Note Book

Date : 20 / /

Aman

⑥ Flash & Fire point test	Equipment pensky martens Tester Measure Flash & Fire point. → Generally, Value = 200°c
⑦ Loss of Ignition Test	Equipment Hot air oven, perforated metal shelf, container, thermometer, Weighing balance. → Measure Loss of Weight → ≯ 1%
⑧ Solubility Test	→ Soluble in Carbon disulphide, Carbon tetra Chloride etc. Measure purity of bitumen. → for good bitumen = 99% soluble (at least)
⑨ Water Absorption	→ ≯ 0.2%

गण्डकी प्रदेश

Tile

Tile is a manufactured piece of fired clay, stone or concrete

Used covering Walls, floor, roof & ornamental or architectural purpose.

Shape Mostly, square & rectangular.

Types of Tiles

[A] Based on Location

① Wall Tiles Laid on Wall Used Both inside & outside of building.
In Inside Bathroom & kitchen Wall In outside Used for cladding.

② Floor Tiles Laid on floor

③ Roof Tiles Laid on Roof of a Single Story house.

④ Paver Tiles Laid on Covering parking area, driveway, surrounding area of a building.

[B] Based on materials & Manufacturing process

① Ceramic Tiles Ingredients clay, silt, Sand & traces other natural substances.

Note Book

Date : 20 / /

Aman

Commonly used Residential building in interior walls & floors.

Types of Ceramic Tiles

① Glazed Ceramic Tiles	② Unglazed Ceramic Tiles
→ Liquid glass coating over the top of tiles. → Appearance Infinite colour, finishes, texture	→ No coating → Appearance Natural, earthy
→ Water proof → Density Less	→ No water proof → Density High
→ Thickness Thick	→ Thickness Thicker
→ Durability Low → Slip	→ Durability More → Slip resistance
→ Cost Expensive	→ Cost Cheaper

② porecelain Tiles similar to ceramic tiles. But Clay grain more finer fired in higher temperature then Ceramic tiles. also, Denser, less porous, durable, resistant to moisture the ceramic tiles.

Used Both residential & commercial building.

③ Mosaic Tiles Made of Ceramic, glass, stone or metal → Decorative pieces used Bathroom, kitchen, Swimming pool etc.

④ Clay Tiles Made by pressing & burning clay.

Used Low cost housing, roof of building.

Testing of Tiles

Test	Explanation
General quality test	→ Well burnt or not → Shape & Colour uniform or not
	→ Cracks are present or not
Warping test	→ ±2% in sides → ±5% in diagonal
Water absorption test	→ ±24%
Dimension test	→ Required dimension or not

Note Book

Date : 20 / /

Aman

गाड़की / कोड़ी प्रदेश

Aggregates

Aggregates are inert materials mixed with a binding material (cement, lime) in the preparation of mortar & concrete.

Types of Aggregates

A] Based on size

① Fine Aggregates	② Coarse Aggregates
→ Small size filler materials in construction.	→ Larger size filler materials in construction.
→ pass 4.75 mm sieve. IS	→ Pass 75mm sieve.
→ Retain 0.075 mm sieve. (75 micron)	→ Retain 4.75 mm sieve
→ Example Sand, Stone Screening surkhi, fly ash etc.	→ Example Gravels, pebbles, brick & stone chips, clinkers etc.
→ Function Voides between the coarse aggregate are fined up.	→ Function Acts as inert filler material for concrete

B] Based on shape

Types of Aggregates	Explanation
① Rounded Aggregates	→ Voids 32–33 % → Good Workability.
	→ Strength More Bond Strength Less.
	→ Not suitable High strength Concrete
② Irregular Aggregates	→ Void generate 35–38 % → Less Workability → So Water & cement are more required for Constant W/C ratio.
	→ Bond strength More then Rounded aggregates
	→ Not suitable High Strength Concrete.
③ Angular Aggregates	→ Voids 38–40 % → Less Workability then Rounded aggregate → Bond Strength More
	→ Suitable High strength Concrete.

Note Book

Date : 20 / /

Aman

C Based on moisture content :

Types of Aggregate	pores	Surface
① Very dry aggregate	No moisture	No moisture
② Dry aggregate	some moisture	No moisture
③ Saturated surface dry aggregate	Filled with water	Dry
④ Moist aggregate	Filled with water	Wet

D Other Aggregate

Types of Aggregate	Explanation
① All-in-aggregate	→ Which contain fine & Coarse aggregate
② Flaky aggregate	→ Least dimension $< 0.6\left(\frac{3}{5}\right)^{th}$ times
	it's mean dimension
③ Elongated aggregate	→ Least dimension > 1.8 or $\left(\frac{9}{5}\right)^{th}$ times
	it's mean dimension
④ Cyclopean aggregate	→ Size > 75mm.

Note Size of aggregate for concrete = 20mm

mass Concrete = 40 mm or more.

Flooring = 10 mm.

B Quality of good Aggregate

① Strength → Sufficient strength to resist stress.

② Durability → Resistance to Weathering, environmental factor

③ Shape & Size → Uniform, compacted, interlocked effectively

④ Water absorption → < 10 %.

⑤ Cleanliness → Free from organic matter, Clay etc.

Test of Aggregate

Types of Test	Explanation
① Impact Test	→ Apparatus Impact testing machine.
	→ Find Toughness.

Note Book

Date : 20 / /

Aman	
② Crushing test	→ Instrument Crushing test machine.
	→ Find strength.
③ Abrasion test	→ Instrument Los Angeles machine.
	→ Find wear & tear.
④ Soundness test	→ Find Durability.
⑤ Water absorption test.	→ <10%
⑥ Bitumen adhesion test	→ Find Stripping Value
	→ Stripping aggregate, यानी bitumen अन्य water तिर आकर्षित हुनु।
⑦ Shape test	→ Determine by % of flaky & elongated particles contained in it & by its angularity.

कोशी प्रदेश

Timber

Timber is a wood that is used for the construction purpose.

→ Freshly felled timber consists of 100% moisture of dry weight & 50% moisture of total weight. (Amount of moisture = Amount of timbe

Seasoning. The process of reduction of moisture from timber.

Method of seasoning

① Natural Method → Air dried is done. → Time consuming (6-8 month → Less efficient (Reduce moisture up to 12-15%) → Economical → Good quality

② Artificial Method / Kiln Method → Controlled heat & humidity is use to reduced the moisture content. → Fast → Reduce moisture up to 0% → Costly ③ → ②Chemical & Electrical seasoning.

Purpose of Seasoning.

→ Make fire resistance → Water proof → Make light, strong, stable → prevents warping, cracking, shrinkage. → resistant to decay by fungi, termites (दमिरा) etc. → resistance to electricity.

Note Book

Date : 20 / /

Aman

Classification of Timber

A Based on Growth Mode

① Endogenous → Growth endward → Example Bamboo, coconut, palm, walnut (अखरोट).

② Exogenous → Growth outward → Example sal, teak, deodar, shisham

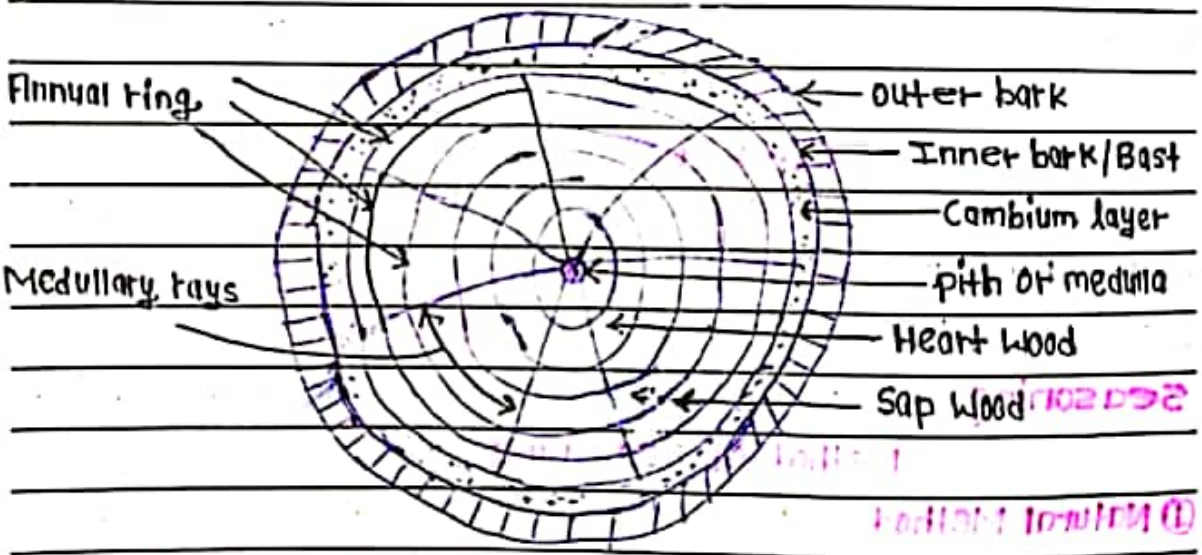
Types of Exogenous

① Conifers	→ Pointed leaves (नुकीले पात) Example Deodar, Chir, Kail
② Deciduous	→ Flat Leaves (चौड़ा पात) Example teak, shisham, oak

B Based on Hardness

① Hard Wood — sal, teak, shisham, oak etc.

② Soft Wood — deodar, walnut, kail, chir etc.



Internal Structure of Wood

① pith Innermost part or core of tree. Also called Medula

② Heart Wood Innermost annual ring. Also called Duramen Resporisible for strength, hardness colour Darker

③ Sap Wood Living part of timber. Colour Light → outermost annual ring → Active & younger part. Function Transmits the sap from roots to branches.

Note Book

Date : 20 / /

Aman

④ Bark outermost skin of tree. Function protects inner portion of tree from external injuries. Inner bark → Live bark. Outer bark → dead bark → Inner bark covering cambium layer.

⑤ Cambium layer Layer of wood between bark & sap wood. → if Cambium layer is exposed to atmosphere, tree dies.

⑥ Annual Ring. Ring formed in timber. (Heartwood – Cambium layer) Determine Age of tree. → Total no. of annual ring = Age of tree.

⑦ Medullary rays → It extends radiany from pith to Cambium layer. Function Binds all annual ring. → Carries nutrients outward.

Defects of Timber

① Foxiness Timber turning into Yellowise Reason → over maturity. → Poor Ventilation. around pith.

② knots → Root of the branch → Annual ring perpendicular to stem.

③ Rind galls → Swollen part of timber due to improper cutting.

④ Bird eye → Small, circular areas on wood surface caused by indented wood fibers.

⑤ Burl → Uneven projection on the body of the tree during it's growth. Reason sock & injury in its young age. → Due to hardening.

⑥ Druxiness → Top surface of timber indicates white spots. Reason Access of fungi.

⑦ Upsets → fibres injured by crushing or compression.

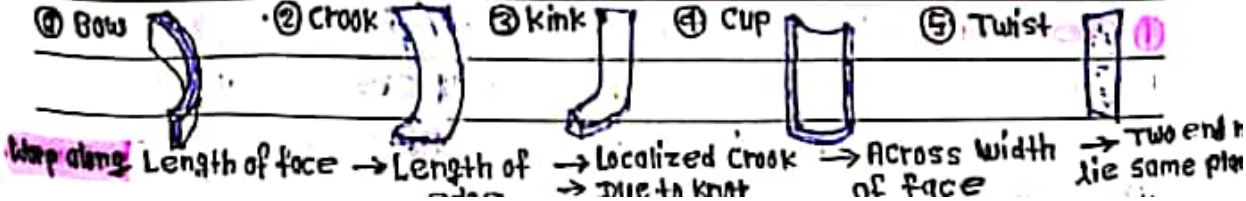
⑧ Rupture → Caused due to injury or impact.

⑨ Twisted fibres → Caused by wind constantly turning the trunk of young tree in one direction.

⑩ Checks & shakes → Lengthwise separation of wood is known as checks while perpendicular to length is called sakes.

⑪ Wood Warping → Deviation from flatness Reason Uneven drying Result of stress & shrinkage.

Types of Wood Warping

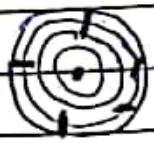


Note Book

Date : 20 / /

Aman

Types of shake

① Heart Shake	② Star Shake	③ Ring Shake
		
→ Cracks in central part.	→ Cracks from bark	→ Separation of annual ring
Caused by over maturity.	→ Caused by over heat of sun & frost.	→ Caused by strong wind

Diseases of Timber

Rot: Rot is a types of diseases due to which life of wood reduces or becomes useless.

Types of Rot

① Dry Rot → Convert wood into fine powder → Reddish-brown; Reason Lack of ventilation & absence of moisture; Agency fungus (कवक); Remedy Well seasoned the timber & painting with Copper sulfate.

② Wet Rot → Convert wood into Grayish-brown powder; Reason Alternate wetting & drying & excess moisture. Agency Excessive Water; Remedy Well seasoned the timber & Paints.

Termites (दीमक) or White ants → Insect (कीड़ा होता) → Damages to timber; Reason Dampness. Agency Insect. Remedy Anti-termite.

preservation of Timber

① Charring → Burning of timber surface. for inserted inside ground. Protects from white ants, fungi.

② Tarring → Applying Coat of tar. for door & window frame.

③ Painting → Oil paint are suitable → prevents from moisture.

④ Creosoting → Prepared by distillation of tar. → Colour black or brown → Unpleasant (अप्रिय) Smell. → Apply Creosote oil on timber. for Wood piles, poles, railway-sleepers etc. Not used fire places.

Note Book

Date : 20 / /

Aman

⑤ Ascu process → Ascu is in powder form. → It is dissolve in water. & applied over timber.

⑥ Wolman salt → Contain 25% sodium fluoride, 25% disodium hydrogen arsenate, 37.5% sodium chromate & 12.5% dinitrophen

*Fire resistance of timber- The fire resistance of timber can be enhanced either by impregnating it with chemical like phosphate of ammonia, ammonium chloride, mixture of ammonium phosphate & ammonium sulphate, borax & boric acid, sodium arsenate, sodium tetra-borate or be designing wood to provide slow burning constituent.

PLY. WOOD

It is combination of veneers. → Veneers are placed to each other by glueing. Veneers Thin sheet of wood sliced from log. → Thickness = 0.4-6mm.

Note : Density of timber = $\frac{1}{12}^{th}$ of steel.

→ Strength of timber = $\frac{1}{10}^{th}$ of steel.

→ Strength of timber increase with increase Medullary ring.

→ Timber is an organic material having cellular structure.

→ Defect due to imperfect seasoning = honey combing

→ Moisture content of timber formwork = ≯ 15%

→ Used Timber formwork → 4-5 times Steel formwork → upto 50 tim

→ Good timber sound = sonorous → Used for railway slipper = Sal, kai

→ Board Thickness = < 5cm & width = exceeds 12cm

→ Strip Thickness = 5cm & width = 10cm

→ Thickness of five play sheet = 6-9mm

→ Thickness of lamin board = 12-25 mm.

Note Book

Date : 20 / /

Anan

Sawing Method

① Ordinary Method / Flat Method

→ Most Shrinkage & warping.

② Tangential Method

→ Less wastages. → Most economical.

③ Radial Method

→ Maximum strength → Maximum wastages.

④ Quarter Method

Terms

① Log Timber obtained after removing all the branches.

② Batten Piece of sawn timber Thickness < 5cm & width < 5cm

③ Plank " " " " Thickness < 5cm & width > 5cm

④ Board " " " " Thickness < 5cm & width ≥ 12cm

⑤ Strip " " " " Thickness < 5cm & width < 10cm

⑥ Boulk " " " " Thickness > 5cm & width > 20cm

फोर्शी प्रदेश

Metals & Alloys

Metal Metal is a solid material which is typically hard, shiny, malleable & ductile with good conductor of heat & electricity.

Types of Metals

① Ferrous Metals main constituent Iron Example Iron, Steel → They are magnetic!
Widely used different engineering structure such as building frames, beams, columns, roof, bridges etc.

② Non-ferrous Metal main constitunt Not iron. → They are not magnetic. Example Aluminium, copper, Lead, zinc, Tin etc

Note Book

Date : 20 / /

Aman

Ore It is type of material used to extract metals.

Name of Ore	Iron content	Chemical Formula
① Magnetite (black iron ore)	70-75 %	Fe_3O_4
② Hematite (Red iron ore)	70 %	Fe_2O_3
③ Limonite (Brown iron ore)	60 %	$2Fe_2O_3 \cdot 3H_2O$
④ Iron pyrite (Iron disulphide)	47 %	FeS_2
⑤ siderite	40 %	$FeCO_3$

Types of Iron

→ Lowest quality → Remove impurities

A Pig Iron → first & basic form → Crude & impure iron.
→ Manufactured in blast furnace. → Carbon content = 3-4 %

Types of Pig Iron

① Bessemer pig. Obtained from Hematite ore Free from sulphur, phosphorus & Copper. Used for make Mild steel.

② Foundry / Gray pig Obtained from Furnace → Sufficient fuel at high temperature → Used for make Cast iron.

③ Forge/White pig → obtained from Furance → sufficient fuel at low temperature → Used for make Wrought iron.

④ Molted pig → Property between foundry & frog pig. Used for heavy casting equipment.

B Cast Iron → Obtained by melting pig iron Obtained from Cupola Furnace → Carbon content = 3 % → More pure then pig iron.
→ Hard & brittle. → Used Structural Work & Cast iron pipes.

C Wrought Iron → purest form of iron. → Carbon content = 0.15 %
→ Soft & easily welded. → produced by Removing impurities of cast iron. Used plate, rivets, sheet, pipe tube, railing, window guirds etc.

D Steel → Most suitable building material.
Unit weight of steel = 7850 kg/m²
Coefficient of thermal expansion = 11.5×10^{-6} per °C.
→ Intermediate form between Cast iron & Wrought Iron.

Note Book

Date : 20 / /

Aman

Classification of steel

Types of steel	① Dead Mild	② Mild	③ medium carbon	④ High carbon	Tool steel
Carbon content (%)	< 0.15	0.15–0.3	0.3–0.8	0.8–1.5	>1

* Mild steel → Low carbon, ductile, malleable & more elastic then wrought iron. → Ultimate comp. strength = 800–1200 N/mm²
Tensile strength = 600–800 N/mm². → Rust quickly.
→ can be permanently magnetized Uses construction work. huts, bolts, plates, reinforcement bars, roof covering etc.
→ Sp. gravity = 7.8 → Tough → soft → Easily froged
* Medium carbon steel → stronger & harder then mild steel. → Less ductile, tough, malleable. Used metal ropes, wires, garden tools, automobile components.
* High carbon steel → Hardest → Less ductile, tough & malleable. → Better resistance wear & tear, shocks & vibrations. → More difficult forge & weld.
→ Ultimate comp. strength = 1350 N/mm² → Tensile strength = 1400–2000 N/mm². → Used To make chisels, hammers, drills, files, lathe tools, hacksaw, blades etc.

Alloys

An alloys is a combination of metals or other substance.

Name of Alloy	Elements	%
1. Brass	copper + zinc	60+40
2. Bronze	Copper + Tin	90+10
3. Invar	Steel + Nickel	64+36
4. Monel metal	Copper + Nickel	60+40
5. Stainless steel	Chromium + Nickel → 16% अथवा इससे अधिक Stainless steel	18+8
6. Solder	Lead + Tin	1:2
7. German silver	Copper + zinc + Nickel.	
8. Brazing Solder	copper + zinc + Tin	4:3:1

Note Chromium is added to make steel Corrosion resistance.

Note Book

Date : 20 / /

Aman	
9. Gun metal	Also called Red brass considered both brass & bronze
	Contains 85 % copper + 5 % tin + 5 % zinc + 5 % Lead
	Used Produce pipes, Valves etc.
10. Galvanising	→ Depositing a fine film of zinc on steel/iron.
11. Electroplating	→ Depositing a fine film of Nickel, Chromium,
	Cadmium, Copper or zinc on surface of metal

Note : → % of Cobalt in Carbon steel to make magnet = 45 %.

→ Vanadium steel is generally used for axle & springs.

→ Yield & tensile strength of low Carbon steel may be improved by the addition of Vanadium.

→ Malleability different shape by heating.

→ Ductility Transferred into wire.

→ Minimum 40 % of iron is available in blackbond.

→ Red Short iron Cracks When bent due to presence of sulphur.

→ Brittleness of cold is due to excessive phosphorous.

Extra

Lime

Lime is basically calcium oxide (CaO). It is not found in nature in free state. It is obtained by burning limestone at 800°C. or calcination of limestone with chalk, kankar & other calcareous substance. → Cementing material → It easy for working.

→ Provides strength to the masonry.

→ Used → plastering, interior surface of wall, preparing concrete for foundation, flooring of ordinary building, washing the rooms, stabilizing the soil & knotting of timber works before painting.

Note : → In Lime manufacturing, fuel not direct contact with lime: flare kiln & direct contact = flame kiln → Sand mixed with lime mortar to prevent shrinkage & cracking.

Note Book

Date : 20 / /

Aman

Types of Lime

[A] Based on source

① Stone Lime From Limestone Uses Mortar, flooring

② Kankar Lime From Kankar Uses Mortar (substructure)

③ Shell Lime From shells of sea animals Uses Lime punning, White Wash & colour Wash.

[B] Based on purity → Obtained by Burning Limestone

① Fat, rich, pure, high Calcium & White Lime

→ Impurity ≯ 5 % → Volume – 2–3 times after slaking

→ Uses plaster, White Washing etc. → Colour milky White

→ Sound produce Hissing → Contains 95 % limestone & 5 % other materials. → Soluble in Water → Setting & hardening action are slow. → Slaking Complete = 3–4 hrs

② Hydraulic Lime / Water Lime

→ Impurity 5–30 % → Volume 2–3 times after slaking.

→ Uses for Making mortar for heavy masonry Works, lime concrete, work under water & foundation. → Colour – Grayish White. → Sound produce Not hissing → Slaking complete 24–48 hrs. Obtained by Burning kankar.

→ Initial setting time = 120 min. → Contain 30 % of Clay.

→ Types of Hydraulic Lime:

(a) Feebly Hydraulic Lime Silica & alumina < 10 %, Slaking time = 5–15 min → Setting time = 21 days.

(b) Moderately Hydraulic Lime Silica & alumina = 10–20 %

→ Slaking time = 1–2 hrs → Setting time = 7 days.

(c) Eminently Hydraulic Lime → Silica & alumina = 20–30 %

→ Slaking time = 2–5 hrs → Setting time = 2–48 hrs.

③ Poor or Lean Lime.

→ Impurity > 30 % → Uses poor mortar & plaster

→ Also called Meager lime → Colour Muddy White

→ Contain > 30 % of Clay

Note Book

Date : 20 / /

Aman

→ Slaking Very Slowly → Hardens Very Slowly. Not set Under Water.

Note: for slaking 10 kg of CaO = 3.2 kg Water Theoretical

C Based on purpose:

@ Class A (Eminently hydraulic lime) → CaO 60–70% → Clay 20–30% setting time = 2–48 hrs. Uses Mortar & Concrete.

ⓑ Class B (Semi hydraulic lime) → CaO 70% → Clay 15% → setting time=7 days → Uses mortar, flooring & Concrete.

© Class C (fat lime) → CaO 93% → Clay 5% → Volume = 2–3 time after slaking. → Uses plaster & White washing.

ⓓ Class D (magnesium lime) → CaO & MgO 85% Uses plaster & White washi

ⓔ Class E (Kankar Lime) → CaO 20% → MgO 5% → Uses mortar, plaster & White washing.

Note: Normal curing period for lime mortar = 7 days.

Terminology

@ Coarse stuff → material of rough or uneven texture.

ⓑ Hydrated lime → dry powder → Obtained by Treatment of quick lime with water → Also called Slaked lime.

© Quick lime → Obtained by Calcination of pure limestone. Also called fat, rich or pure lime.

ⓓ Milk lime → Thin pourable solution of slaked lime with water.

ⓔ Lump lime → quick lime as it comes from kiln.

ⓕ Calcination → process of heating lime stone in contact with air.

ⓖ Slaking → process of adding water to quick lime to form Calcium hydroxide.

ⓗ Lime putty → obtained by slaking or mixing quicklime with water.

Test on Lime

① Visual inspection → Examined for its Colour & lumps.

② Hydraulic acid test → find Carbonate Content of lime.

③ Soundness test → Find quality of lime.

④ Workability test → know the workmanship.

⑤ Ball test → Find expansion & disintegration of ball of lime.

⑥ Impurity test → < 10% good → 10–20% Fair → > 20% poor