BUILDING MATERIALS AND CONCRETE TECHNOLOGY 18CV34

UNIT I

- **INTRODUCTION**

Physical, chemical and engineering properties of building materials. Application of building materials.

- **Bricks**

Types of bricks, manufacturing process of bricks, properties of bricks, Standard requirements and grades of bricks as per BIS.

- **Rocks and Stones**

Classification of rocks, Rock products, Characteristics of stones – Structure, texture, strength, gravity, porosity, absorption, hardness, durability, weight. Standard requirement of building stone.

- **Timber**

Types of timber, Uses and application of timber, Defects in timber and wood, Seasoning, Wood products with specific uses.

Self-Learning topics: Important stones used in construction with its suitability.

BUILDING MATERIALS

DEFINITION

Building material is any material used for construction purpose such as materials for house building.

Wood, cement, aggregates, metals, bricks, concrete, clay are the most common type of building material used in construction.

The choice of these are based on their cost effectiveness for building projects.

PROPERTIES:

1. Physical
2. Chemical
3. Engineering

BUILDING MATERIALS

PHYSICAL PROPERTIES

1. Density
2. Bulk Density
3. Density Index
4. Specific weight
5. Specific gravity
6. Porosity
7. Durability
8. Permeability
9. Water Absorption
10. Resistance to fire and frost
11. Thermal conductivity

Density:

It is the mass of a substance occupied per unit volume. Its unit is kg/m^3.

Density of some common building materials are listed below

Steel = 7800

Brick = 2600

Granite = 2800

Wood = 1500

Bulk Density:

It is the mass of a substance occupied per unit volume in its natural state.

Density Index:

The ratio of bulk density to its density.

Specific Weight:

Specific weight is defined as the weight occupied per unit volume.

$w = \rho \times g$

ρ = Density of the substance in kg/m^3

g = acceleration due gravity in m/s^2

Specific Gravity:

Specific gravity is defined as the ratio of the density of given substance to the density of water at 4°C

Specific gravity is a dimensionless quantity. Specific gravity is denoted by the symbol “G”.

G = Density of substance/Density of water

Density of water is 1 g/cc or 1 KN/m^3

Porosity:

Porosity is defined as the ratio of volume of voids to volume of solids.

The notation of porosity is ‘n’

$n = Vv / V$

Vv =Volume of voids

V = Total volume

Durability:

The property of a material to resist the combined effect of atmosphere and other factors.

Permeability:

Property of a material that lets fluids (such as **water** or **water** vapor) to diffuse through it to another medium without being chemically or physically affected.

Water Absorption:

The ability of a material to absorb and retain water.

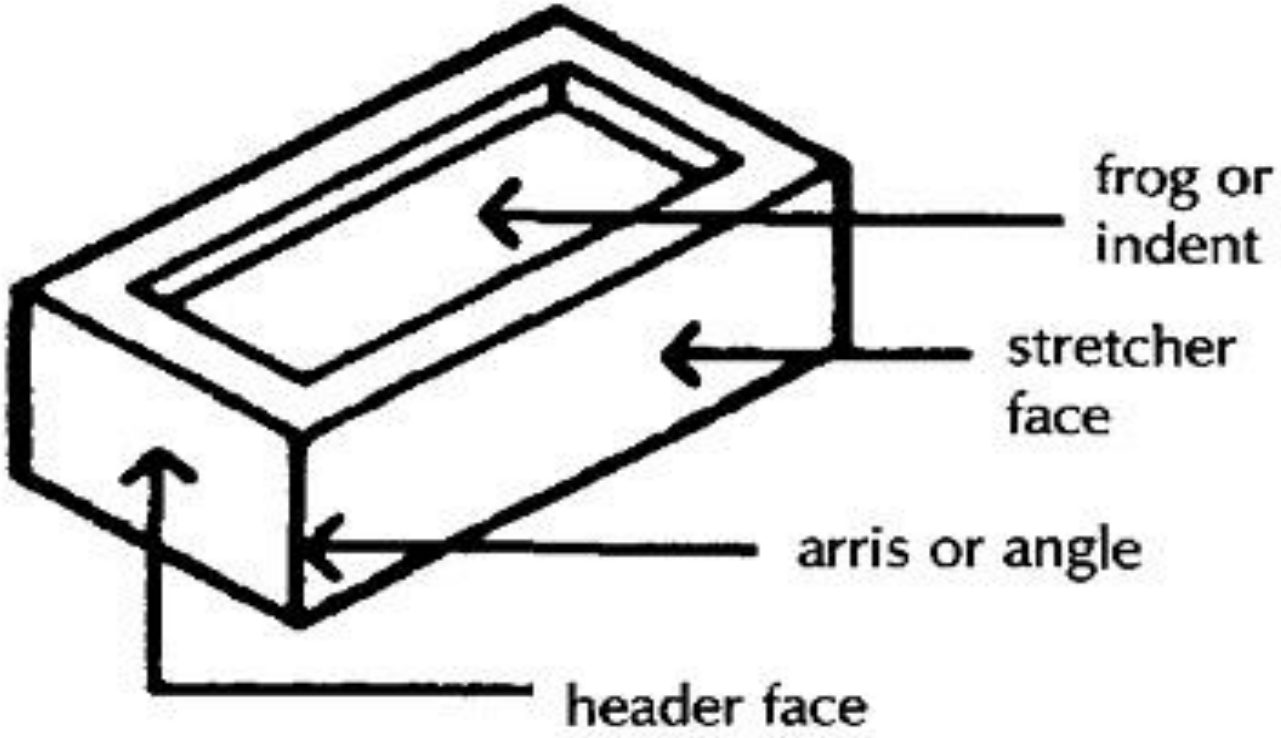
Resistance to Fire and Frost:

The ability of a material to resist the action of fire repeated freezing and thawing of frost.

Thermal conductivity:

A measure of the ability of a material to transfer heat. The **thermal conductivity** is the heat energy transferred per unit time and per unit surface area, divided by the temperature difference.

Details of a Brick



TYPES OF BRICKS

- **Traditional Bricks**

➢ Not standardized.

➢ Dimensions vary - length 20-25cm, width 10-13cm, thickness 5-7.5cm.

➢ Commonly adopted size 23cm*11.4cm*7.6cm

- **Modular Bricks**

➢ Confirm to Bureau of Indian Standard Institution.

➢Size of the brick- 19cm*9cm*9cm.

➢Nominal size – 20cm*10cm*10cm. Includes mortar thickness.

CLASSES OF BRICKS

1. First Class Bricks

✓ Strictly confirm to IS standards.

✓ 10 layers of brick laid in mortar forms a height of 1m.

✓ Uniform colour, well burnt, hard ringing sound emits when two bricks are struck together.

✓Have straight edges, free from cracks, nodules of lime.

✓ When immersed in water for one hour do not absorb water more than $1/6^{th}$ of their weight.

✓ No signs of Effloescence.

2. Second Class Bricks

- ✓ Slightly irregular in shape, colour.
- ✓ When immersed in water for one hour do not absorb water more than $1/4^{th}$ of their weight.

3. Third Class Bricks

- ✓ Irregular in size, shape and finish.
- ✓ Not fully burnt, hence slight yellowish in colour.
- ✓ Low crushing strength.

PROPERTIES OF BRICKS

- The bricks should be table mould, well burnt in kilns, copper coloured, free from cracks and with sharp and square edges. The colour should be uniform and bright.
- The bright bricks should be uniform in shape and should be of standard size.
- The bricks should give clear metallic ringing sound when struck with each other
- The bricks when broken or fractured should show a bright homogeneous and uniform compact structure free from voids.

PROPERTIES OF BRICKS

- The bricks should not absorb water more than 20% by weight for first class bricks and 22% by weight for second-class bricks, when soaked in cold water for a period of 24 hours.
- The bricks should be sufficiently hard. No impression should be left on brick surface, when it is scratched with fingernail.
- The bricks should not break into pieces when dropped flat on hard ground from a height of about one metre.

QUALITIES OF BRICK

- Aesthetic Appearance: Shape
- Durability: Strength and lasting power
- Resistance to Rain Penetration
- Compressive Strength
- Fire Resistance
- Sound Insulation
- Economy
- Versatility in Application
- Low maintenance Requirement

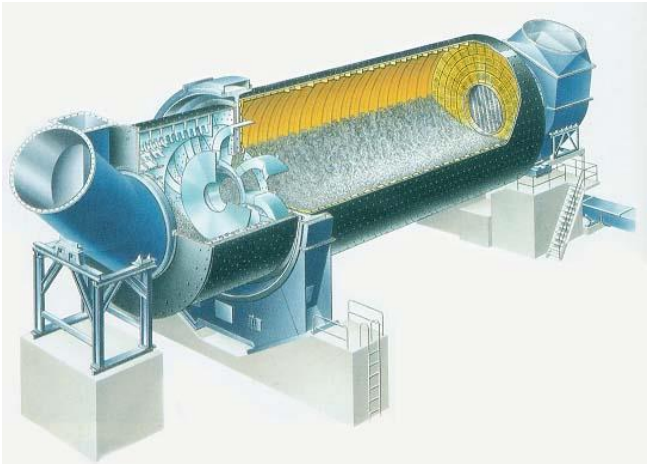
MANUFACTURING OF BRICKS

Considerations

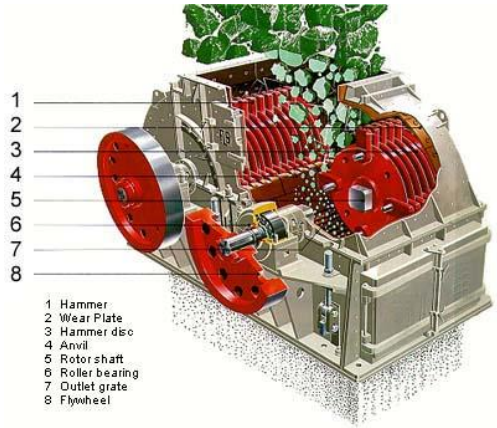
- Material conveyance should be easy.
- Situated on plain ground.
- Raw materials should be easily available.
- Proper Facilities

MANUFACTURING OF BRICKS

- Manufacture - 4 stages
  - Material preparation
  - Manufacturing
  - drying
  - Firing
- **Preparation**: material (clay) washed and grinding (fineness)



Sample of grinding machine for clay

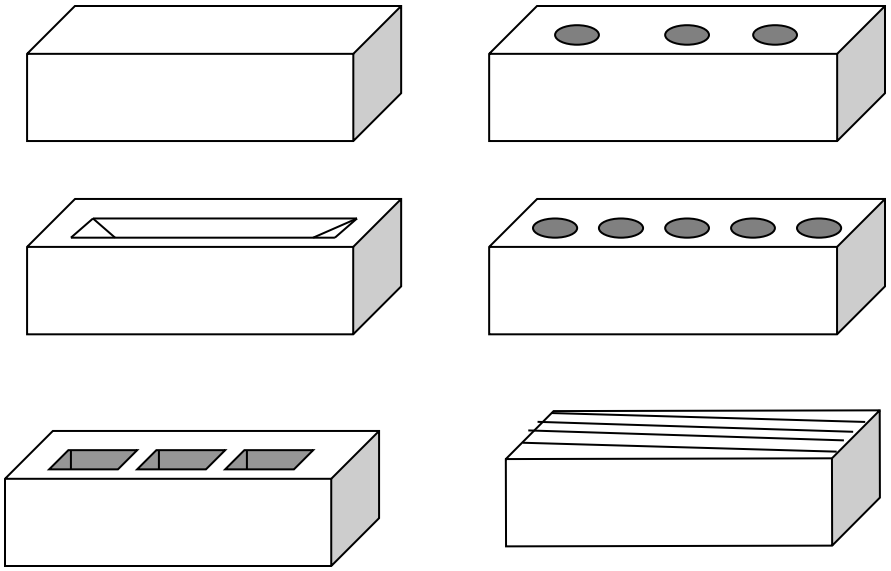


Sample of crushing machine

MANUFACTURING OF BRICKS

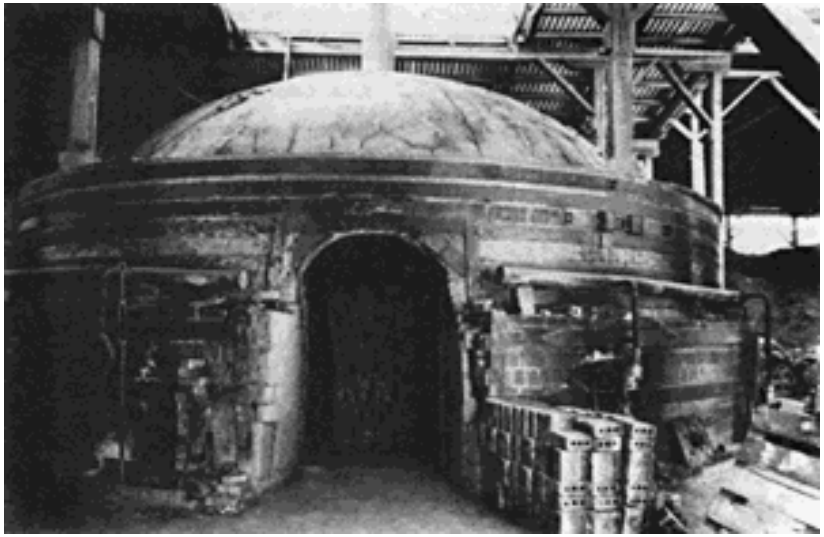
- Clay will be grinded with 15% water. The clay will be pushed through the mould base on the shape. After that, Clay will be cut to get a standard size of brick using wire.
- Sometimes, bricks will be produced using big mould that clay will be pressed using hydraulic machine (This method, clay will grind 10% of water) or without hydraulic press (with 30% of water)

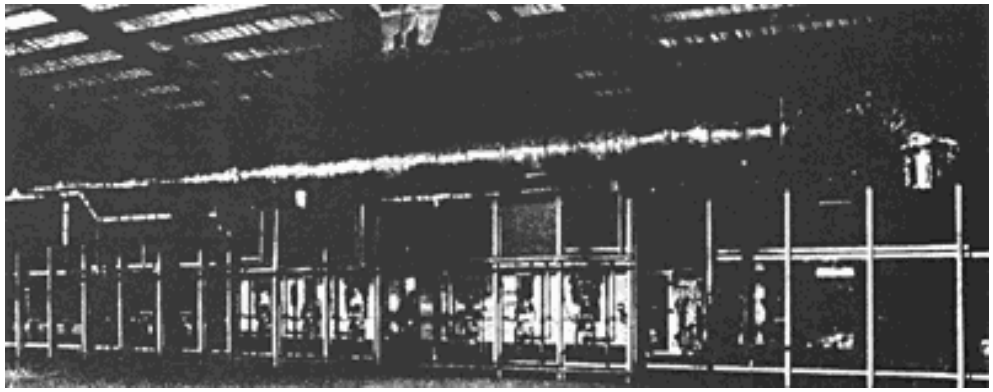
- After bricks in form, indentation or perforation to the bricks.
- **Drying :** Wet unit bricks will be drying in space or room with control temperature to make sure the bricks are complete dry.



Brick compile before bringing to the kiln

- **Firing** : Dry bricks, will be compiled in kiln to firing process with 600^{o}C (temperature). This is to burn the carbon and sulfur that have left over. After that, temperature is increased to 900^{o}C to get a vitrification process.
- Normally, vitrification process occurs around 800^{o}C.
- Bricks become hard/strong after vitrification process.



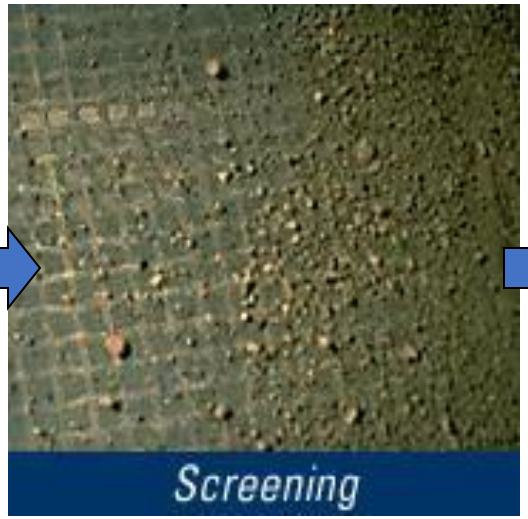



Gathering raw materials


Storage of raw materials


Crushing


Pug mill


Screening


Grinding

MATERIAL PREPARATION

Inside die head

Core hole die

Extruded column

Cutting

Manufacturing

Mold boxes

Throwing brick

Squeegee

Dumping mold box

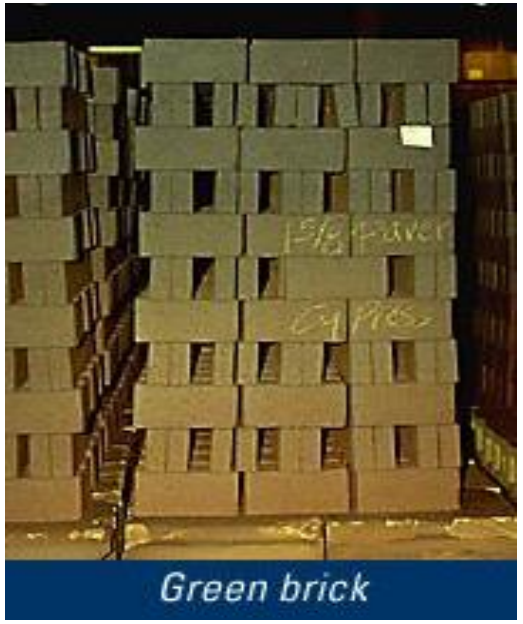
Hand setting

Manufacturing

Setting

Setting machine

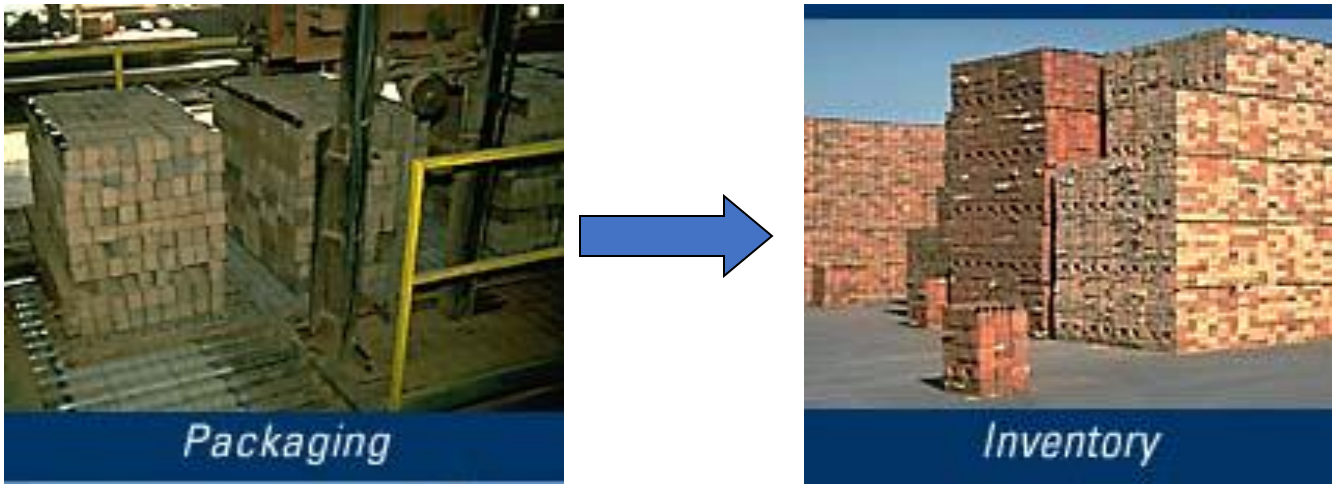
Setting on kiln cars



Green brick

Setting

Firing Process



Packaging

ROCKS AND STONES

ROCKS

Rocks are a combination of minerals that are bonded together formed from minerals. They can be

- Monomineralic- contain one mineral **Eg: Marble and Quartz**
- Polymineralic- contain more than one mineral **Eg: Granite**

CLASSIFICATION OF ROCKS:

Rocks from which stones are obtained for civil engineering works may be classified in the following three ways:

1. Geological classification
2. Physical classification
3. Chemical classification

Geological Classification: It is based on the materials of which rocks are made, the structure of the materials and the formation of the rocks. The rocks are classified as:

- Igneous rocks
- Sedimentary rocks
- Metamorphic rocks

IGNEOUS ROCKS

The earth's interior has extremely high temperature. The rocks are in molten state and are known as magma. The rocks formed by cooling and solidifying of magma are known as igneous rocks. Generally, igneous rocks are strong and durable. These rocks may be further classified as:

Volcanic rocks Hyperbyssal rocks Plutonic rocks

Volcanic rocks

- Formed at the earth's surface due to the cooling of magna spewed out by volcanoes.
- The cooling process is fast these rocks are extremely fine-grained and glossy.
- Basalt and trap are examples of volcanic rocks.

Hyperbyssal rocks

- Formed due to the cooling of magma at a shallow depth in the earth's surface.
- Cooling is relatively slow. Hence these rocks have a fine-grained crystalline structure.
- Quartz, dolerite and gneiss are examples of such rocks.

Plutonic rocks

- Formed due to the slow cooling of magma at a considerable depth from the earth's surface.
- These rocks are very strong and have a crystalline structure.
- Granite and diorite are examples of plutonic rocks.

SEDIMENTARY ROCKS

- Rocks disintegrate due to the weathering action of water, wind and frost.
- The disintegrated material is carried away by wind and flowing water, water being the most powerful medium of transport.
- When flowing water encounters obstacles, the suspended materials are deposited. The deposited material gets consolidated under pressure and heat.
- Chemical action in the deposited materials also contributes to cementing of deposited material. Year after year, fresh layers of materials are formed.
- The rocks formed in this manner are known as sedimentary rocks. These rocks are more uniform and fine grained.
- They have bedded or stratified structure. Sandstone, limestone and mudstone (shale) are examples of sedimentary rocks.

METAMORPHIC ROCKS

- Igneous rocks and sedimentary rocks undergo changes due to metamorphic action of pressure, internal heat and chemical action of water.
- For example, granite becomes gneiss, while trap building materials. Stones and basalt change into schist and laterite. Similarly, limestone changes to marble and mudstone becomes slate.

STONES

- Stone is a solid non-metallic mineral matter, which has been used as a building material from the early age of civilization.
- Stones are nothing but cut pieces of rock, the hard material of the earth's crust exposed on the surface or under the soil.
- Stones have been used in construction—from small residential buildings to large palaces, places of worship and forts—all over the world.
- The pyramids in Egypt, the Taj Mahal in Agra, Red Fort and India Gate in Delhi, Vidhan Soudha in Bangalore, and the Lord Gomateshwar statue in Shravanbelagola are some famous stone structures.

USES OF STONES

- ✓Stones are extensively used for the construction of foundations, walls, columns and arches in buildings.
- ✓They are ideally suited for the construction of retaining walls, forts, piers of bridges and dams.
- ✓Polished granite and marble are used for the face works of important buildings.
- ✓Stone slabs are used for flooring, damp-proof course, lintels, roofing and pavers round the buildings, as well as for footpaths.
- ✓Crushed stones are used as a basic inert material in concrete, for making artificial building blocks, such as railway ballast and to provide base course for roads.

CHARACTERISTICS OF GOOD BUILDING STONES

A good building stone should have the following qualities:

✓**Appearance**

- Building Stones used for the face work of the building should have fine, compact texture. Light coloured stone is usually preferred as dark colours are prone to fade out with time.
- They should be free from clay holes, bands or spots of colour.

✓**Structure**

- A stone when broken, should not be dull in appearance and should show uniformity of texture.
- It should be free from cavities, cracks, and patches of loose or soft material. Stratifications, which are usually found in sedimentary rocks should not be visible to naked eye.

✓**Strength**

- Stones used in construction should be strong and durable to withstand the disintegrating action of weather.
- Generally the stones can withstand the forces they encounter in usual constructions but in case of constructions where the forces encountered are unusual, they should be tested for its strength.
- Stones with compact fine crystalline texture are stronger. Compressive strength of building stones in practice, range between 60 to 200 N/mm^2.

✓**Specific gravity**

- The specific gravity of Building stone is directly proportional to its weight and strength.
- Hence the stones having higher specific gravity should not be used for dams, retaining walls, docks and harbours.
- Specific gravity of a good building stone lies between 2.4 to 2.8.

✓**Hardness**

- When stones are utilized for floors, pavements, aprons of bridges and weirs of rivers, the stones are subjected to abrasive forces which are caused by the wear and friction.
- Hence the stones which are to be used in such places should be tested for hardness.

✓**Toughness**

- It is the measure of impact that a stone can withstand.
- When the stones are supposed to undergo vibrations of machinery and moving loads, they should be tough.

✓**Porosity and Absorption:** The porous building stones are not suitable in construction especially for exposed surfaces of structures.

- The rain water which comes down carry some acidic gases forming light acids which gets soaked on the surface. Acids react with the constituents of stones causing them to crumble.
- In cold regions water freezes in the pores of stones. This water causes the disintegration of stones because of its increase in volume on freezing.
- Stones should be tested for porosity and porous stones should be used only at places where they don’t encounter frost, rain or moisture in any form.
- Water absorption is directly proportional to the porosity of the rock. The more porous the rock is, the more water it will absorb and leads to the damaging of stone.

The types of some of the stones and their maximum limit of water absorption (%) is as follows:

- Sandstone : 10
- Limestone : 10
- Granite : 01
- Trap : 06
- Shale : 10
- Gneiss : 01
- Slate : 01
- Quartzite : 03

✓**Weathering**

- It is the extent to which the face of a stone resists the action of weather.
- Stones with good weathering properties only should be used in the construction of important buildings.

✓**Workability**

- Stones are said to be workable if the wok which is involved in their cutting, dressing and shaping is considered as economical and easy to conduct.

✓**Fire Resistance**

- Building Stones should be free from calcium carbonate, oxides of iron, and minerals having different coefficients of thermal expansion.
- Igneous rock undergo major disintegration because of quartz which disintegrates into small particles at a temperature of about 575 ^{o}C.
- Limestone, however, can withstand a little higher temperature; i.e. up to 800 ^{o}C after which they disintegrate.

TIMBER

- Timber refers to wood used for construction works. The word timber is derived from an old English word ‘Timbrian’ which means ‘to build’.
- A tree that yields good wood for construction is called **“Standing Timber”**
- After felling a tree, its branches are cut and its stem is roughly converted into pieces of suitable length, so that it can be transported to timber yard. This form of timber is known as “**Rough Timber”**
- By sawing, rough timber is converted into various commercial sizes like planks, battens, posts, beams etc. Such form of timber is known as “**Converted Timber”**

USES OF TIMBER

Timber is used for the following works:

1. For heavy construction works like columns, trusses, piles.

2. For light construction works like doors, windows, flooring and roofing.

3. For other permanent works like for railway sleepers, fencing poles, electric poles and gates.

4. For temporary works in construction like scaffolding, centering, shoring and strutting, packingof materials.

5. For decorative works like showcases and furnitures.

6. For body works of buses, lorries, trains and boats

7. For industrial uses like pulps (used in making papers), card boards, wall papers

8. For making sports goods and musical instruments.

PROPERTIES OF TIMBER

- Colour: It should be uniform.
- Odour: It should be pleasant when cut freshly.
- Soundness: A clear ringing sound when struck indicates the timber is good.
- Texture: Texture of good timber is fine and even.
- Grains: In good timber grains are close.
- Density: Higher the density stronger is the timber.
- Hardness: Harder timbers are strong and durable.
- Warping: Good timber do not warp under changing environmental conditions.
- Toughness: Timber should be capable of resisting shock loads.

PROPERTIES OF TIMBER

- Abrasion: Good timber do not deteriorate due to wear. This property should be looked into, if timber is to be used for flooring.
- Strength: Timber should have high strength in bending, shear and direct compression.
- Modulus of Elasticity: Timber with higher modulus of elasticity are preferred in construction.
- Fire resistance: A good timber should have high resistance to fire.
- Permeability: Good timber has low water permeability.
- Workability: Timber should be easily workable. It should not clog the saw.
- Durability: Good timber is one which is capable of resisting the action of fungi and insects attack
- Defects: Good timber is free from defects like dead knots, shakes and cracks.

SEASONING OF TIMBER

This is a process by which moisture content in a freshly cut tree is reduced to a suitable level. By doing so the durability of timber is increased. The various methods of seasoning used may be classified into:

- Natural seasoning
- Artificial seasoning

SEASONING OF TIMBER

Natural Seasoning:

- It may be air seasoning or water seasoning. Air seasoning is carried out in a shed with a platform. On about 300 mm high platform timber balks are stacked. Care is taken to see that there is proper air circulation around each timber balk.
- Over a period, in a natural process moisture content reduces. A well-seasoned timber contains only 15% moisture. This is a slow but a good process of seasoning.
- Water seasoning is carried out on the banks of rivers. The thicker end of the timber is kept pointing upstream side. After a period of 2 to 4 weeks the timber is taken out.
- During this period sap contained in the timber is washed out to a great extent. Then timber is stalked in a shed with free air circulation

SEASONING OF TIMBER

Artificial Seasoning:

In this method timber is seasoned in a chamber with regulated heat, controlled humidity and proper air circulation. Seasoning can be completed in 4 to 5 days only.

The different methods of seasoning are:

(a) Boiling

(b) Kiln seasoning

(c) Chemical seasoning

(d) Electrical seasoning

DEFECTS IN TIMBER

Various defects which are likely to occur in timber may be grouped into the following three:

- Due to natural forces
- Due to defective seasoning and conversions
- Due to attack by fungi and insects

ASSIGNMENTS

1. Make a list of all the Chemical and Engineering Properties of Building Materials. Explain ANY TWO in each category.
2. Explain the different types of Rock Products.
3. Make a list of Wood products with specific uses.

SELF-LEARNING TOPICS

1. Make a list of Important Stones used in Construction with its Suitability

THANK YOU