CE8391 CONSTRUCTION MATERIALS

UNIT I STONES – BRICKS – CONCRETE BLOCKS

Stone as building material – Criteria for selection – Tests on stones – Deterioration and Preservation of stone work – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks – Compressive Strength – Water Absorption – Efflorescence – Bricks for special use – Refractory bricks – Concrete blocks – Lightweight concrete blocks.

UNIT II LIME – CEMENT – AGGREGATES – MORTAR

Lime – Preparation of lime mortar – Cement – Ingredients – Manufacturing process – Types and Grades – Properties of cement and Cement mortar – Hydration – Compressive strength – Tensile strength – Fineness– Soundness and consistency – Setting time – fine aggregates – river sand – crushed stone sand – properties – coarse Aggregates – Crushing strength – Impact strength – Flakiness Index – Elongation Index – Abrasion Resistance – Grading

UNIT III CONCRETE

Concrete – Ingredients – Manufacturing Process – Batching plants –mixing – transporting – placing – compaction of concrete –curing and finishing – Ready mix Concrete – Mix specification.

UNIT IV TIMBER AND OTHER MATERIALS

Timber – Market forms – Industrial timber– Plywood – Veneer – Thermocol – Panels of laminates – Steel – Aluminum and Other Metallic Materials – Composition – Aluminium composite panel – Market forms – Mechanical treatment – Paints – Varnishes – Distempers – Bitumens.

UNIT V MODERN MATERIALS

Glass – Ceramics – Sealants for joints – Fibre glass reinforced plastic – Clay products – Refractories – Composite materials – Types – Applications of laminar composites – Fibre textiles– Geomembranes and Geotextiles for earth reinforcement.

TEXT BOOKS:

1. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2015.

2. Rajput. R.K., "Engineering Materials", S. Chand and Company Ltd., 2008.
3. Gambhir.M.L., "Concrete Technology", 3rd Edition, Tata McGraw Hill Education, 2004
4. Duggal.S.K., "Building Materials", 4th Edition, New Age International, 2008.

REFERENCES:

1. Jagadish.K.S, "Alternative Building Materials Technology", New Age International, 2007.
2. Gambhir. M.L., & Neha Jamwal., "Building Materials, products, properties and systems", Tata McGraw Hill Educations Pvt. Ltd, New Delhi, 2012.
3. IS456 - 2000: Indian Standard specification for plain and reinforced concrete, 2011
4. IS4926 - 2003: Indian Standard specification for ready–mixed concrete, 2012
5. IS383 - 1970: Indian Standard specification for coarse and fine aggregate from natural Sources for concrete, 2011
6. IS1542-1992: Indian standard specification for sand for plaster, 2009
7. IS 10262-2009: Indian Standard Concrete Mix Proportioning –Guidelines, 2009

IMPORTANT QUESTION AND ANSWER

Department of Civil Engineering

SUBJECT CODE : CE8391 - REGULATION 2017

SUBJECT NAME : CONSTRUCTION MATERIALS

YEAR AND SEM : II AND III

Table of Contents

UNIT 1

STONE-BRICK-CONCRETE BLOCKS

PART – A 2 marks)

1. **List any four tests on stones.Apr/May 2015**
   - Attrition test
   - Crushing test
   - Freezing and thawing test
   - Hardness test
   - Impact test
   - Microscopic test
2. **What do you mean by lightweight concrete blocks? Nov/Dec2015**
   - Light weight concrete brick it is also called as Autoclaved Aerated concrete.
   - It is a light weight, precast building material that simultaneously provides structures, insulation, and fire resistance.
3. **How are rocks classified?**
   - Igneous rocks
   - Sedimentary rocks
   - Metamorphic rocks
4. **List the characteristics to be considered in selection of stones. may/june 2016 Nov/Dec2015**

   1. Crushing strength
   2. Appearance
   3. Durability
   4. Fire resistance
   5. Fracture
   6. Density
   7. Easiness of dressing

5. **What are the tests for bricks?**

   1. Absorption test
   2. Crushing strength test
   3. Hardness test
   4. Shape and size test
   5. Soundness test
   6. Test for presence of soluble salts

6. Define water absorption.

- It is defined as the ability of a material to absorb and hold the water. Water absorption can be expressed in terms of percentage of weight or percentage of volume of that material.

7. What are the methods of quarrying stones?

1. Digging or excavating 2. Heating
3. Wedging 4. Blasting

8. What are the classification of bricks?

1. First class bricks 2. Second class bricks
3. Third class bricks 4. Over burnt or Jhama bricks
5. Under burnt or pilla bricks

9. What are the uses of stone in construction?

- Masonry
- Pavements
- Flooring
- Facing work in buildings
- Concrete aggregates

10. Classify bricks according to their use.

- Common bricks
- Engineering bricks special bricks for carrying heavy loads)
- Facing bricks
- Fire bricks
- Specials special shapes)

11. List the tests made on bricks.

- Compressive strength
- Water absorption
- Efflorescence
- Hardness
- Soundness.
- Structure

12. Classify minerals based on abrasion.

- Talc
- Gypsum
- Calcite
- Apatite
- feldspar
- Quartz
- Diamond.

13. What is Preservation of stones?

- It is the preventing process of stones from deterioration by external agencies.

14. Name any four preservatives used in the preservation of stones?

- Coal tar
- Linseed oil
- Paint
- Paraffin
- Alum soap solution

15. What is the standard size of a brick?

19cm x 9cm x 9cm WITHOUT MORTAR)

16. list the different types of refractory bricks. may/june 2016

Silica bricks
Magnesite bricks
Dolomite brick
Bauxite brick
High alumina brick

17. Define the term Efflorescence.Apr/May 2015

The soluble salts if present in the bricks cause white deposit on the surface of bricks which is called as efflorescence.

PART B 13 marks

1. Write short notes on deterioration defects) of stones and preservation of stones? Nov/Dec 2015)

The following are the main causes for deterioration of stones:

1. Alternate wetting and drying.
2. Alternate freezing and thawing.
3. Deleterious substances present in the air such as in the atmosphere near the seashores and industrial areas.
4. Living organisms, growth of vegetation like seedlings of banyan trees that grow from droppings of birds) and living worms or bacteria that live in the stone can cause decay.

Movement of chemicals between materials. This occurs when lime stones and sandstones are used together. The granular limestone can absorb magnisium

5. sulphate present in other rocks if they are used adjacent to the other.
6. Nature of mortar. If the mortar has chemicals, they can affect the stonework.
7. Temperature variation. Large variations of temperature and alternate heating and cooling can cause expansion and contraction which cause cracking of stone.
8. Waterfalls and rainfalls. Falling of water from great heights or falling of water containing chemicals like rainwater absorbing gases from the atmosphere can cause deterioration of stones.
9. Winds blowing for a long time can over deserts contain sand and dust, which passing over the stones for a long lime can cause their deterioration.

Preservation of stones

There are two aspects to be considered under this heading. Firstly, the precautions to be taken before and during the construction of stonework and secondly, the steps to be taken after the stonework has been completed.

I. Precautions during Construction

The precautions to be taken during the construction are the following:

The type and size of stones selected should be good. Only compact and

durable stones should be selected for construction. The size of these stones should be as large as possible to minimize the number of joints. The stones should be well seasoned and washed clean before they are used. The construction should be up to the required specifications. The stones should be placed on their natural beds and the joints completely filled with mortar so that there is no cavity. External renderings like pointing is preferred for exposed stones. Otherwise, it should be plastered with high -quality plaster.

II. Methods of Preservation of Completed Stonework

Stonework after construction also needs careful attention if they are to be preserved in their natural condition. The art of preserving ancient stone statues in museums consists of special techniques and is a specialised subject. For preserving stonework in buildings which tend to deteriorate with time, we usually resort to coating the stone with one of the following preservatives.

a Linseed oil. Raw linseed oil is light in colour while boiled linseed oil is dark and hence discolour the stone.

b Solution of alum and soap. Alum and soap in 40 to 60 proportions respectively dissolved in water can be applied on the stone to act as a protective coating.

c) Solution of barium hydroxide Baryta. If the decay is due to $CaSO_4$, then this treatment is effective. The reaction is as follows

d $BaOH)_2 + CaSO_4 = BaSO_4 + CaOH)_2$

a. The barium sulphate is insoluble and the $CaOH)^2$ absorbs carbon dioxide and gives strength to the stonework.

Paraffin. It is used alone or dissolved in naphtha as a paint medium. However it may changes the colour of the stone.

Paint. Painting preserves the stone but changes the colour of the stone. If applied under pressure, it can till the pores in the stone. The paint should be neutral and should not react with the stone. Modern colourless paints are also available.

coal tar. Even though it is listed as a preservative, it is a highly objectionable material to be used as it completely changes the colour of the stone. The chemicals in

coal tar may not also suit some types of stones.

III. Conservation of Granite

As there are a large number of art works and monuments made of granite in this world, a large amount of research has gone into methods of conservation of granite. In general the following three methods are commonly used depending on the state of existence of the granite work to be made good:

Consolidation using consolidates

Injection using injection materials

2. Explain physical tests on stones.

Physical tests on stones:

Building stones are to be tested for the following tests:

1. Absorption test
2. Smith's test
3. Toughness test
4. Moh's scale of hardness test
5. Acid test
6. Crystallization test
7. Attrition test
8. Crushing test
9. Freezing and thawing test for cold countries)
10. Hardness test
11. Impact test
12. Microscopic test

SIMPLE FIELD TESTS:

i. **Absorption test** This is a simple test that should be done on all stones. It consists of keeping a sample of rock of about 50 gm in distilled water and finding the water absorbed in 24 hours. It should not exceed 0.6 per cent.

ii. **Smith's test** This test is to determine the deterioration of stones when immersed in water. A sample of the stone is placed in distilled water in a glass vessel and vigorously stirred. It is kept in water for at least 24 hours. If the water turns muddy, then the stone contains earthy substances. Some

very consolidated sands which look like sandstones simply slump under water in this test. We should ensure that all stones we use pass this test.

iii. **Toughness test.** Hit the stone with a hammer and find how tough it is to break it with the hammer.

iv. **Mohr's scale of hardness tes**t. One simple way of describing strength of stones is in terms of hardness of the surface. We scratch the stone with a penknife and classify hardness by Moh's scale of hardness. It is based on the relative abrasiveness of minerals the softest being talc and the hardest diamond, the scale being divided into 10 scales as shown below:

1. Talc	2.Gypsum
3.Calcite	4.Fluorspar
5.Apatite	6.Orthoclase feldspar
7.Quartz	8.Topaz
9.Diamond	

Acid test This is to test the presence of poorly weathering calcium carbonates in sandstones. The test consists of placing a cube of the stone weighing about 50 to 100 gm in one per cent hydrochloric acid for 7 days. A good building stone should be free from powder formation on the surface of the cube and the sharp edges should not be broken up after the above immersion.

v. **Crystallization test** This test consists in immersing a sample of stone cubes of say 40mm in 14 per cent sodium sulphate solution for two hours and th en drying it in an oven at 100°C. This procedure is repeated for at least five times. The loss of weight and the presence of cracking are noted. There should not be any visible defect formed, and the loss in weight should be minimal.

LABORATORY TESTS:

i. **Attrition test** as described under coarse aggregates). This is carried out in a Deval testing machine.

ii. **Crushing test** This test consists of finding the compressive strength of a stone cube 40 mm in size in a compression -testing machine. The rate of loading used is 140 kg per cm- per minute.

iii. **Freezing and thawing test**. This test is applicable to the regions where the

temperature can go below the freezing point. It consists of keeping a specimen of the stone in water for 24 hours and then freezing it at —12°C for 24 hours. It is then thawed. This is repeated at least seven times after which the specimens are carefully examined for any damage.

iv. **Hardness test** This test is different from the attrition test. Here, we use the Dorry's testing machine. A cylinder of 25 mm of the rock is rubbed against a steel disc sprinkled with coarse sand. The specimen is given a pressure of 1.25 kg. After 1000 revolutions, the loss in weight is determined.

$$\text{Coefficient of hardness} = \frac{20 \text{ loss of weight in gm}}{3}$$

v. Microscopic test In this test, thin sections of the stone are taken and placed under the microscope to study its grain size, mineral constituents and presence of harmful materials.

3. Describe the various tests on bricks. Nov/Dec 2015

TESTS FOR BRICKS

The tests to be made on bricks

1. Compressive strength
2. Water absorption
3. Efflorescence
4. Dimensional tolerance
5. Hardness
6. Soundness.
7. Structure

1. Compressive strength. Five bricks are taken at random and their dimensions are measured to 1 mm accuracy. They are, then, immersed in water of 25°C to 29°C for 24 hours. The surplus moisture is allowed to drain and the frog. if any. is filled with mortar 1:3 1 cement, 3 clea n coarse sand 3 mm and down. It is kept under a jute

bag for another 24 hours after which it is immersed in clean water for three days. At the time of testing, these bricks are removed from water, wiped dry of any trace of moisture and placed with the flat surface horizontal and mortar- filled face up between three plywood sheets each of 3 mm thickness plaster of Paris may also be used to ensure uniform surface.

The load is applied at the rate of 140 kg/cm 2 per minute till the failure of the specimen takes place as indicated by the needle of the testing machine turning back. Average of the five test values is reported. While finding the average, any single value obtained as compressive strength which is higher than the upper value of the class of the bricks tested, should be taken only as the upper limit of the class. Values less than 20% below the average value should be discarded. The average value should not be less than the specified value.

2. Water absorption. Five bricks are taken for test. They are allowed to dry in an oven at110' to 115° C till they attain a constant weight which usually takes place in 48 hours. They are then allowed to cool at room temperature, which generally takes 4 to 6 hours without a fan and 2 to 3 hours with a fan blowing on it and weight W_1 is measured.

3. Efflorescence. This test should he conducted in a well -ventilated room at 18-30°C.Average value on five samples taken at random is to he reported. The brick is placed vertically in a dish 30 cm x 20 cm approximately in size with 2.5 cm immersed in distilled water. The whole water is allowed to be absorbed by the brick and evaporated through it. After the bricks appear dry, a similar quantity of water is placed in the dish, and the water is allowed to evaporate as before. The brick is to be examined after the second evaporation and reported as follows:

a **Nil.** When there is no perceptible deposit of salt.

b **Slight**. When not more than 10 per cent of the area of brick is covered with salt.

c) **Moderate**. When there is heavy deposit covering up to 50% of the area of the brick but unaccompanied by powdering or flaking of the surface.

d **Heavy.** When there is heavy deposit covering more than 50% of the area of the brick accompanied by powdering or flaking of the surface.

e **Serious.** When there is a heavy deposit of salts accompanied by powdering and/or flaking of the surface and this deposition tends to increase in the repeated wetting of the specimen.

Bricks for general construction should not have more than slight -to –moderate efflorescence.

4. **Dimensional tolerance.** Twenty whole bricks are selected at random to checkmeasurement of length, width, height, etc. These dimensions are to be measured in one or two Variations in dimensions are allowed only within narrow limits, ±3 % for class one and ±8% for other classes.

5. **Hardness**. A scratch is made on the surface of the brick with the finger nail. In a goodbrick, no impression will be left on the surface

4. Write the Criteria for Selection of Stone? May/June2016)

The essential requirements of building stones used for structural work are given below

Strength

Ordinarily, the strength of a stone is not of primary importance, as very often the loads to which it is subjected in a structure are much below its permissible crushing strength

Durability

Stones should possess a natural durability to withstand the destructive effects of various agents continuously operating on them. In fact, the life of a structure depends upon the durability of the materials with which it is built. The durability of a stone depends upon the relation between its chemical composition and that of the atmospheric surroundings. The texture of the stone also influences its durability. Crystalline homogeneous and close-grained varieties of stones with a dense structure should be selected for good works. The surface of a freshly

broken stone should be uniform in texture, colour and hardness. Porous stones or those containing patches of soft or objectionable materials are liable to disintegrate quickly.

Cost

An important consideration in the selection of building stone is its cost. Other things being equal, the cost of a stone depends upon the ease with which it can be quarried out, the proximity of the quarry to the place of use, and the transportation facilities available. The subsequent cost of dressing a stone, before it is placed directly in the structure, should also be low.

Appearance

In the case of the stone used for face work, where appearance is a primary factor, its colour and ability to receive polish is an important factor.

Hardness

The stone used in floors, pavements and aprons of bridges, should be able to resist the abrasive forces caused due to wear and friction. Hardness of stones can be tested by the Mohr's scale of hardness in the laboratory and in the field by scraping the surface with a sharp knife. A hard stone will not show any scratches.

Toughness

Building stones should also be tough enough to withstand stresses developed due to vibrations of machinery and moving loads over them. The stones used in the construction of roads should be hard as well as tough.

Specific Gravity and Weight

The stones used for the construction of dams, weirs, barrages, docks and harbours should be of a heavier variety. In case of dams and roof coverings, lighter varieties of stones are preferred. The specific gravity of good building stones should be between 2.4 and 2.8.

Porosity and Absorption

A good stone should not be porous, rain water, enter the pores which is generally acidic, Chemical Composition of Stone Limestone and weak sandstone are relatively less durable than a good sandstone, granite or gneiss. Air and water, containing carbon dioxide, seriously affect limestone. Iron pyrites also tend to disintegrate stones; excess iron oxide or carbonate in stones develops rust in the presence of moisture; presence of clay affects the efficiency of the cementing materials; soda and potash also have a disintegrating effect; all varieties of mica are soft and are readily decomposed by exposure to atmosphere. Stones with silicates as the cementing material will weather better than those with calcareous or ferruginous binding material.

Texture

The texture of a stone indicates the arrangement of its constituent minerals. Good building stone should be homogeneous in structure. Stones with homogeneous and crystalline texture are hard and compact and superior to non-crystalline and open-texture varieties. Generally, igneous and metamorphic rocks such as granite, trap and gneiss are hard and compact. Sandstone, limestone and some of the metamorphic rocks are porous. Amorphous rocks like glass, flint, etc. have a fused texture and are hard and compact.

5. List the Classification of Bricks

First Class Bricks

1. These are thoroughly burnt and are of deep red, cherry or copper colour.
2. The surface should be smooth and rectangular, with parallel, sharp and straight edges and square corners.
3. These should be free from flaws, cracks and stones.
4. These should have uniform texture.
5. No impression should be left on the brick when a scratch is made by a finger nail.
6. The fractured surface of the brick should not show lumps of lime.

7. A metallic or ringing sound should come when two bricks are struck against each other.

8. Water absorption should be 12–15% of its dry weight when immersed in cold water for 24hours. The crushing strength of the brick should not be less than 10 N/mm2. This limit varies with different Government organizations around the country.

Uses:

First class bricks are recommended for pointing, exposed face work in masonry structures,

Flooring and reinforced brick work.

Second Class Bricks are supposed to have the same requirements as the first class ones except that

1. Small cracks and distortions are permitted.
2. A little higher water absorption of about 16–20% of its dry weight is allowed.
3. The crushing strength should not be less than 7.0 N/mm2.

Uses:

Second class bricks are recommended for all important or unimportant hidden masonry works and centering of reinforced brick and reinforced cement concrete RCC) structures.

Third Class Bricks are underburnt. They are soft and light-coloured producing a dull sound when struck against each other. Water absorption is about 25 per cent of dry weight.

Uses :It is used for building temporary structures.

Fourth Class Bricks are overburnt and badly distorted in shape and size and are brittle in nature.

Uses: The ballast of such bricks is used for foundation and floors in lime concrete and road metal.

On Strength

The Bureau of Indian Standards BIS has clas sified the bricks on the basis of compressive strength.

Classification of Bricks based on Compressive Strength IS: 1077

Class	Average compressive strength not less than N/mm2
35	35.0
30.0	30.0
25.0	25.0
20.0	20.0
17.5	17.5
15.0	15.0
12.5	12.5
10.0	10.0
7.5	7.5
5.0	5.0
3.5	3.5

Notes: 1. The burnt clay bricks having compressive strength more than **40.0 N/mm^2** are known as heavy duty bricks and are used for heavy duty structures such as bridges, foundations for industrial buildings, Multistorey buildings, etc. The water absorption of these bricks is limited to 5 per cent.

2. Each class of bricks as specified above is further divided into subclasses **A** and **B** based on tolerances and shape. Subclass-A bricks should have smooth rectangular faces with sharp corners and uniform colour. Subclass-B bricks may have slightly distorted and round edges.

On the Basis of Use

Common Brick is a general multi-purpose unit manufactured economically without special reference to appearance. These may vary greatly in strength and durability and are used for filling, backing and in walls where appearance is of no consequence.

Facing Bricks are made primarily with a view to have good appearance, either of colour or texture or both. These are durable under severe exposure and are used in fronts of building walls for which a pleasing appearance is desired.

Engineering Bricks are strong, impermeable, smooth, table moulded, hard and conform to defined limits of absorption and strength. These are used for all load bearing structures.

On the Basis of Finish

Sand-faced Brick has textured surface manufactured by sprinkling sand on the inner surfaces of the mould.

Rustic Brick has mechanically textured finish, varying in pattern.

On the Basis of Manufacture

Hand-made: These bricks are hand moulded.

Machine-made: Depending upon mechanical arrangement, bricks are known as wire-cut bricks—bricks cut from clay extruded in a column and cut off into brick sizes by wires; pressed-bricks—when bricks are manufactured from stiff plastic or semi-dry clay and pressed into moulds; moulded bricks—when bricks are moulded by machines imitating hand mixing.

On the Basis of Burning

Pale Bricks are underburnt bricks obtained from outer portion of the kiln.

Body Bricks are well burnt bricks occupying central portion of the kiln.

Arch Bricks are overburnt also known as clinker bricks obtained from inner portion of the kiln.

On the Basis of Types

Solid: Small holes not exceeding 25 per cent of the volume of the brick are permitted; alternatively, frogs not exceeding 20 per cent of the total volume are permitted.

Perforated: Small holes may exceed 25 per cent of the total volume of the brick.

Hollow: The total of holes, which need not be small, may exceed 25 per cent of the volume of the brick.

Cellular: Holes closed at one end exceed 20 per cent of the volume.

Note: Small holes are less than 20 mm or less than 500 mm^2 in cross section.

PART – C (15 MARKS

1. With neat sketches explain in detail about the Manufacturing process of Bricks. May/June2016) Apr/May2015)

Bricks are manufactured by moulding clay in rectangular moulds or blocks) of uniform size and then drying and burning these blocks.

1. Preparation of clay

2. Moulding

3. Drying

4. Burning

Additives in the Manufacture of Bricks

- Certain additives such as fly ash, sandy loam, rice husk ash, basalt stone dust, etc. are often Required not only to modify the shaping, drying and firing behaviour of clay mass, but also to help conserve agricultural land and utilise waste materials available in large quantities.
- These additives should, however, have a desirable level of physical and chemical characteristics so as to modify the behaviour of clay mass within the optimum range without any adverse effect on the performance and durability.

Fly Ash: A waste material available in large quantities from thermal power plants can be added to alluvial, red, black, marine clays, etc. The fly ash contains amorphous glassy material, magnetite, etc. and shows a chemical composition similar to brick earths.

- These silicates also help towards strength development in clay bodies on firing, when mixed in optimum proportion depending on the physio-chemical and plastic properties of soils to be used for brick making. .

Sandy Loam: Addition of sandy loam is often found effective in controlling the drying behaviour of highly plastic soil mass containing expanding group of clay minerals. Sandy loam should preferably have a mechanical composition as specified below. The material should, however, meet the other requirement as well.

Rice Husk Ash: The ash should preferably have un burnt carbon content in the range of 3–5% and

should be free from extraneous material. It can be used with plastic black red soils showing excessive shrinkage.

Basalt Stone Dust: Basalt stone occurs underneath the black cotton soil and its dust is a waste product available in large quantity from basalt stone crushing units. The finer fraction from basalt stone units is mixed with soil mass to modify the shaping, drying and firing behaviour of bricks. The dust recommended for use as an additive with brick earth should be fine passing 1 mm sieve, free from coarse materials or mica flakes and should be of non-calcitic or dolomitic origin.

Operations Involved in Manufacturing of Clay Bricks

Preparation of Brick Earth

It consists of the following operations.

Unsoiling: The soil used for making building bricks should be processed so as to be free of gravel,

coarse sand practical size more than 2 mm, lime and kankar p articles, organic matter, etc. About 20 cm of the top layer of the earth, normally containing stones, pebbles, gravel, roots, etc., is removed after clearing the trees and vegetation.

Digging: After removing the top layer of the earth, proportions of additives such as fly ash, sandy loam, rice husk ash, stone dust, etc. should be spread over the plane ground surface on volume basis. The soil mass is then manually excavated, puddled, watered and left over for weathering and subsequent processing. The digging operation should be done before rains.

Weathering: Stones, gravels, pebbles, roots, etc. are removed from the dug earth and the soil is heaped on level ground in layers of 60–120 cm. The soil is left in heaps and exposed to weather for at least one month in cases where such weathering is considered necessary for the soil.

- This is done to develop homogeneity in the mass of soil, particularly if they are from different sources, and also to eliminate the impurities which get oxidized.

Blending: The earth is then mixed with sandy-earth and calcareous-earth in suitable proportions to modify the composition of soil. Moderate amount of water is mixed so as to obtain the right consistency for moulding. The mass is then mixed uniformly with spades.

- Addition of water to the soil at the dumps is necessary for the easy mixing and workability, but the addition of water should be controlled in such a way that it may not create a problem in moulding and drying. Excessive moisture content may effect the size and shape of the finished brick

Tempering: Tempering consists of kneading the earth with feet so as to make the mass stiff and plastics(by plasticity, we mean the property which wet clay has of being permanently deformed without cracking.

- It should preferably be carried out by storing the soil in a cool place in layers of about 30 cm thickness for not less than 36 hours. This will ensure homogeneity in the mass of clay for subsequent processing. For manufacturing good brick, tempering is done in pug mills and the operation is called pugging.

Moulding

It is a process of giving a required shape to the brick from the prepared brick earth. Moulding may be carried out by hand or by machines. The process of moulding of bricks may be the soft-mud hand moulding, the stiff -mud machine moulding or the dry process moulding using maximum 10 per cent water and forming bricks at higher pressures).

- Fire-brick is made by the soft mud process. Roofing, floor and wall tiles are made by dry-press method. However, the stiff-mud process is used for making all the structural clay products.

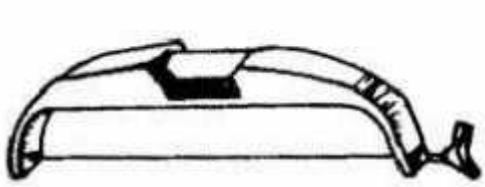
Hand Moulding:

- Hand moulding is further classified as ground moulding and table moulding

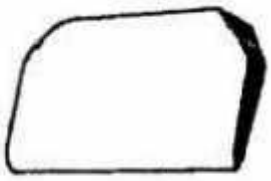
Ground Moulding: In this process, the ground is levelled and sand is sprinkled on it. The moulded

bricks are left on the ground for drying. Such bricks do not have frog and the lower brick surface becomes too rough.

- To overcome these defects, moulding blocks or boards are used at the base of the mould. The process consists of shaping in hands a lump of well pugged earth, slightly more than that of the brick volume. It is then rolled into the sand and with a jerk it is dashed into the mould.



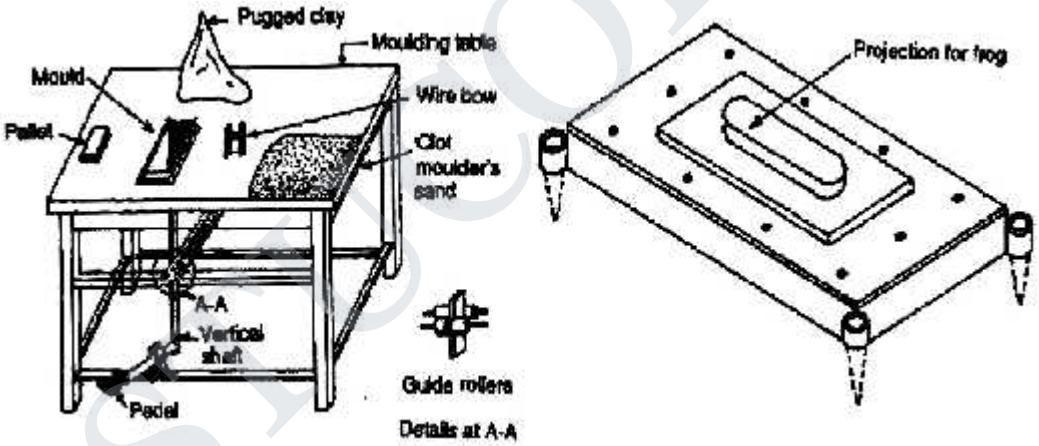
Wire strike



Wooden strike

Table Moulding: The bricks are moulded on stock boards nailed on the moulding table. Stock boards have the projection for forming the frog. The process of filling clay in the mould is the same as explained above. After this, a thin board called pallet is placed over the mould.

- The mould containing the brick is then smartly lifted off the stock board and inverted so that the moulded clay along with the mould rests on the pallet. The mould is then removed as explained beforeand the brick is carried to the drying site.



Machine

Moulding can be done by either of the following processes:

Plastic Method: The pugged, stiffer clay is forced through a rectangular opening of brick size by means of an auger. Clay comes out of the opening in the form of a bar. The bricks are cut from the bar by a frame consisting of several wires at a distance of brick size. This is a quick and economical process.

Dry-press Method: The moist, powdered clay is fed into the mould on a mechanically operated press, where it is subjected to high pressure and the clay in the mould takes

the shape of bricks. Such pressed bricks are more dense, smooth and uniform than ordinary bricks. These are burnt carefully as they are likely to crack.

Drying

Green bricks contain about 7 – 30% moisture depending upon the method of manufacture. The object of drying is to remove the moisture to control the shrinkage and save fuel and time during burning.

- The drying shrinkage is dependent upon pore spaces within the clay and the mixing water. The addition of sand or ground burnt clay reduces shrinkage ,increases porosity and facilities drying. The moisture content is brought down to about 3 per cent underexposed conditions within three to four days. Thus, the strength of the green bricks is increased and the bricks can be handled safely.

Burning

The burning of clay may be divided into three main stages.

Dehydration 400 –650°C): This is also known as water smoking stage. During dehydration,

1 The water which has been retained in the pores of the clay after drying is driven off and the clay loses its plasticity.

2 Some of the carbonaceous matter is burnt

3 A portion of sulp hur is distilled from pyrites.

4 Hydrous minerals like ferric hydroxide are dehydrated

5 The carbonate minerals are more or less decarbonated. Too rapid heating causes cracking or bursting of the bricks.

Vitrification—To convert the mass into glass like substance — the temperature ranges from 900–1100°C for low melting clay and 1000–1250°C for high melting clay. Great care is required in cooling the bricks below the cherry red heat in order to avoid checking and cracking.

Burning in Clamp or Pazawah: The bricks and fuel are placed in alternate layers. The amount of fuel is reduced successively in the top layers. Each brick tier consists of 4–5 layers of bricks. Some space is left between bricks for free circulation of hot gasses.

After 30 per cent loading of the clamp, the fuel in the lowest layer is fired and the remaining loading of bricks and fuel is carried out hurriedly.

Kiln Burning: The kiln used for burning bricks may be underground, e.g. Bull's trench kiln or over ground ,**e.g. Hoffman's kiln.** These may be rectangular, circular or oval in shape. When the process of burning bricks is continuous, the kiln is known as continuous kiln.

e.g. Bull's trench and Hoffman's kilns

Intermittent Kiln: The example of this type of an over ground, rectangular kiln.

After loading the kiln, it is fired, cooled.

Intermittent Kiln

unloaded and then the next loading is done. Since the walls and sides get cooled during reloading and are to be heated again during next firing, there is wastage of fuel.

Continuous Kiln: The examples of continuous kiln are Hoffman's kiln and Bull's trench Kiln In a continuous kiln, bricks are stacked in various chambers wherein the bricks undergodifferent treatments at the same time.

2. Enumerate the characteristics to be considered in selection of stone.

Characteristics to be considered in selection of stones:

The desirable qualities depend on the use of the stone. Hard stones are used for heavy engineering works like building quay walls. Many types of stones are used as aggregates for concrete. Stones like marbles are used for appearance. Now, we will deal with the important general properties to took for.

1. Crushing strength. The following are the ultimate strengths of some of the common types of stones as compared to 15 to 20 N/mm 2 for ordinary concrete.

a Igneous rocks

Granite 80 to 150 N/mm ^{2}

Basalt 150 to 200 N/mm ^{2}

Trap 300 to 350 N/mm ^{2}

b Metamorphic rocks

Gneiss 200 to 350 N/mm ^{2}

Slate 75 to 200 N/mm ^{2}

c) Sedimentary rocks

Limestone 50 to 60 N/mm ^{2}

Sandstone 50 to 70 N/mm ^{2}

Shale 1 to 10 N/mm ^{2}

d Other types

Laterite 2 to 3 N/mm ^{2}

Most of the stones have more than the required compressive strength for masonry, compared to hand -made bricks available in India with a strength of only 2 to 10 N/mm^2.clip

2. Appearance. Appearance is very important for stones used for decorative Works and the facing work of buildings.

3. Density. It should be dense. Its specific gravity should he greater than 2.7

4. Durability. This property is very important, especially when used in exposed conditions,

5. Easiness of dressing. This property depends on its usage. Stones used for tacitly, work should have easiness to get dressed to the required texture.

6. Fire resistance. Argillaceous stones like lime stones resist fire better than the stones containing quartz which explodes on heating. Thus, limestone resists fire up to 800°C.whereas granites with quartz minerals can stand only up to 600°C.

7. Fracture. The grains should be well cemented and sharp if we examine a fractured surface.

8. Impact resistance. It is a measure of toughness of the stone. An impact test value of 19 is good and a value below 13 shows bad quality of stone

9. Hardness. This test gives resistance against wear as in road works. Hardness greater than17 is good and less than 14 is considered as poor .

10. Resistance to wear. Resistance to wear is indicated by attrition test. It is also an important quality for use as coarse aggregate in concrete. For a good facing stone, its value can be as low as 3. However, for use as coarse aggregate a much

higher value is needed.

11. Seasoning. Many type of stones fresh from the quarry contain moisture quarry sap.They can be dressed easily at freshly quarried stage. Such stones should be dressed and kept apart for some time for the moisture to evaporate before they are used. For example, laterite is a special stone which require good seasoning. When quarried, it is soft, and it hardens only when exposed to the atmosphere. The iron compounds get oxidized and gives it the necessary strength. Hence, laterite should always be dressed as soon as it is quarried and stored away from rain for some time before it is used on the works.

12. Texture. It should have a pleasing texture and should be free from cracks and cavities.

13. Water absorption. For durability the percentage of absorption should be less than 0.6 percent. Otherwise, in exposed situations, water can seep into the stone and leach out the salts.

Weathering. It should weather well as shown by its use in similar types of old buildings in which they have weathered well.

UNIT 2

LIME-CEMENT-AGGREGATES-MORTAR

PART A 2marks

1. List the physical tests on Cement.

- Fineness test
- Consistency test
- Soundness test
- Setting time test

2. What is hydration of cement?

- Hydration of cement is a chemical reaction that happens when cement is introduced to water and it produces heat. In very massive construction, this effect can raise the temperature of concrete as much as 50°C. In such cases, we should use low—heat cements or adopt cooling methods.

3. Define flakiness index.

- The flakiness or elongation index of an a aggregate is defined as the percentage weight of particles in the given aggregate which has its length greater than 1.8 times and its least dimension thickness) is less than 3/5 or 0.6 times its mean dimension.

4. What is Impact test?

- This test is for aggregates in concrete that undergoes impact as in runways in airports. Materials passing through 12.5 mm and retained as 10 mm are tilled in the standard cylinder in three layers, each layer tamped with 25 strokes of an iron rod. A hammer weighing 14 kg is dropped from a height of 380 mm 15 times and the resulting material is sieved through a 2.36 mm I.S. sieve. The percentage fine is the aggregate impact test value.

5. Write notes on Abrasion test.

- This test is for the stones used in road construction. We use the Deval's abrasion testing machine or the Los Angeles abrasion machine for this purpose. It should not be more than 16 per cent for a good aggregate.

6. What is curing? State its importance.

It is absolutely essential that moisture should be present in the initial stages for the development of strength of cement. This process of supplying moisture environment is known as curing. Thus, curing of the products of cement is very important in all the works connected with cement like construction of masonry. Plastering, concreting. etc.

7. What is White cement and where is it used?

- White cement is made from chalk or limestone or shelllime free from impurities and white clays like china clay free from oxides of iron, manganese, etc. White cement is very much used for making of mosaic tiles, coloured cements, etc.

8.What are the types of cement produced in India?

- Ordinary portland cement OPC)
- Portland pozzolana cement PPC)

9.What are the IS specifications of Cement?

- Ordinary portland cement OPC) in 3 grades
- Grade 33 IS 269-1989 designated as C-33
- Grade 43 — IS 8112-1989 designated as C-43
- Grade 53 — IS 12269-1987 designated as C-53
- Portland pozzolana cement PPC) a mixture of OPC and Pozzolanas)
- IS 1489 Pan 0 -1991 flyash -based
- IS 1489 Part II -1991 calcined clay -based
- Sulphate -resisting cement—IS 12330-1988
- Portland slag cement—IS 455-1989 PSC)
- Low -heat cement—IS 12600-1989
- Rapid -hardening cement—IS 8041-1990

10. List the tests conducted on aggregates. Nov/Dec2015

- Particle Size,grading shape and flakiness 3tests)
- Organic impurities
- Moisture content
- percent fines value
- Water absorption and specific gravity

- Aggregate crushing value
- Aggregate impact value

11.Define mortar.

- The mortar is a paste like substance prepared by adding required amount of water to a dry mixture of sand or fine aggregate with some binding material like clay, lime or cement.

12.What are the types of mortars?

1.Mud mortar

2.Lime mortar

3.Gauged mortar

13. What are the normal ingredients of cement Apr/May 2015

Lime 60-70%

Silica – 17 – 25%

Alumina 3 – 8%

Iron – oxide 0.5 – 5%

Calcium sulphate 3 – 4%

Magnesia 1 – 3%

Sulphur tri-oxide 1-3%

Alkalis 0.4 – 1.3%

14. Define Elongation index Apr/May 2015

The elongation index iscalculatedas the total weight of the material retained on the various length gauges, expressed as a percentage of the weight of the sample gauged.

15. Write the setting time of cement Nov/Dec2015

Initial setting time -30minutes

Final setting time -10 hours.

PART B 13marks

1. Explain the types of cement produced in India.

TYPES OF CEMENT PRODUCED IN INDIA

- **Ordinary portland cement** OPC) and Portland pozzolana cement PPC), the latter being a mixture of Portland cement and 15 to 35% pozzolanas, are the types of cements prescribed in India. Even though formerly it was mandatory in India to indicate on the cement bags the nature of its contents OPC or PPC) nowadays this is not legally necessary. Only the grade of the cement is marked on the bag.
- Most cements sold in India is portland cement mixed with various proportions of pozzolanes like flyash.

I. **Ordinary portland cement** OPC) in 3 grades

a Grade 33 IS 269-1989 designated as C-33

b Grade 43 — IS 8112-1989 designated as C-43

c) Grade 53 — IS 12269-1987 designated as C-53

2. **Portland pozzolana cement** PPC) a mixture of OPC and Pozzolanas)

a IS 1489 Pan 0 -1991 flyash -based

b IS 1489 Part II -1991 calcined clay -based

3. **Sulphate -resisting cement**—IS 12330-1988
4. **Portland slag cement**—IS 455-1989 PSC)
5. **Low -heat cement**—IS 12600-1989
6. **Rapid -hardening cement**—IS 8041-1990
7. Concrete sleeper -grade cement—IS T40-1985
8. **Coloured cement**—White Cement—IS 8042-1989
9. **Oil well cement**—IS 8229-1986
10. **Hydrophobic cement** -1S 8043-1991
11. Masonry cement—IS 3466-1988

12. **High -alumina cement**—IS 6452-1989
14. Super sulphated cement—IS 6909-1990 Expansive cement
15. **Quick -setting cement.**

The more important types of cement are the following:

1. Ordinary Portland cement OPC) . About 70% of cement produced in India was of this category and in 3 grades, viz. Grade 33, 43 and 53 as already stated above. However pure portland cement is generally not marketed nowadays in bags.

2. Portland pozzolana cement PPC). This type of cement is the most common type available now in the market and is made by blending 10 to 25% reactive pozzolana like flyash or calcined clay with OPC. Addition of pozzolana makes cement sensitive to curing and PPC requires longer curing than OPC. This type PPC) is also available in three grades.

3. Sulphate -resisting Portland cement SRPC or SRC).

- This kind of cement is produced in small quantities in India. It is special OPC with less than 5% C3A and are superior in resistance against sulphates. Cements called Birla Coastal comes in this category.
- They should not be confused with super sulphated cements SSC) made from blast furnace slag, calcium sulphate and small quantities of OPC. SSC is not recommended for use in places with temperatures above 40°C as in India.
- IS 456-2000 recommends that where chlorides is encountered along with sulphate in foundation soil or ground water, OPC with C 3A content 5 to 8 per cent is desirable to be used instead of super sulphate-resisting cement.
- Alternately, Portland slag cement having more than 50% slag or a blend of OPC and slag cement which has been found to be of good performance is recommended.

4. Portland blast furnace slag cement or Portland slag cement BFSC or PSC).

- This type of cement constitutes about 10% of cement produced in India. The slag forms 25 to 60‘1 of the cement. Every ton of cast iron produces about 0.3 tons of blast furnace slag which can be used in the cement industry.

- During its setting, the $CaOH)_2$ liberated by OPC hydration acts as an activator for the slag. They are also less costly than OPC.
- Even though it is equated with OPC, it behaves more like PPC and has lower heat of hydration and better sulphate resistance At present, the BFSC cement produced in India is only Grade -33 and there arc proposals to make Grade -43 cements with 45 -70% slag content.
- Blast furnace slag cement with more than 50% slag has good sulphate resistance too.

5.Hydrophobic cement.

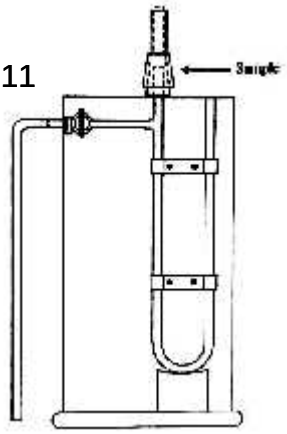
- In places of high rainfall and humidity, normal cement tends to set when stored due to moisture present in the atmosphere By grinding the cement clinker with a water-repellent film forming substance like oleic acid, a water-repellent film is formed around cement particles during the manufacturing itself.
- This prevents setting of cement during storage. During mixing with aggregates, this film is broken and cement behaves as ordinary cement.

6. Blended cement

- For economy, a mixture of Portland cement, blast furnace slag and flyash is allowed to be used in some countries. It is known as blended cement. This type of cement is not marketed in India.

2. Description of physical tests on Cement. or Soundness test of cement May/June 2016) Nov/Dec 2015)

DESCRIPTION OF PHYSICAL TESTS IS 4031: PARTS 1 TO 11



- The physical tests are specified in Parts Ito 11 of IS. We shall briefly deal with some of the main laboratory physical tests in the following sections.
- The concerned Indian Standards should be consulted

for details of these tests. In engineering college laboratories, only physical tests are carried out.

Test for Fineness

- The first requirement is that 90% of cement should pass IS 90 microns. Indian Standards also specifies fineness test by Blaine's Air -permeability method as described in IS 4031-1968. The principle is based on the relation between the rate of flow of air through a cement bed and the surface area of the particles comprising the cement bed of a given porosity.
- The finer the cement the more the surface area and less the porosity in the permeability test. The Blane's apparatus is shown in Fig.

Test for Normal or Standard Consistency

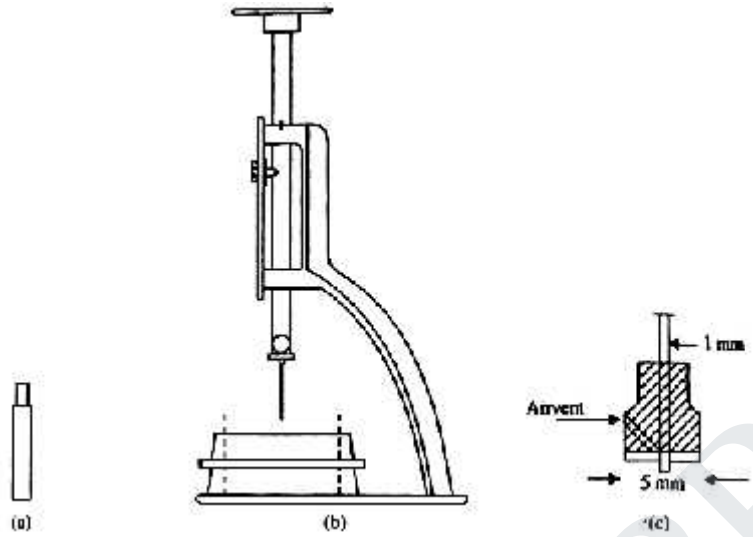
- Many tests for cements like soundness, setting time are to be carried out with cement to which water required to produce what is called the "normal consistency". Normal consistency is determined by the apparatus called Vicars needle.
- It is the consistency at which the Vicat plunger G of 10 mm diameter and 50 mm length will penetrate 33-35 mm within 3 to 5 minutes of mixing. The test procedure is to carry out at least three trial experiments by mixing the cement with distilled water varying from about 24 to 27 per cent of the weight of cement.

Test for Soundness

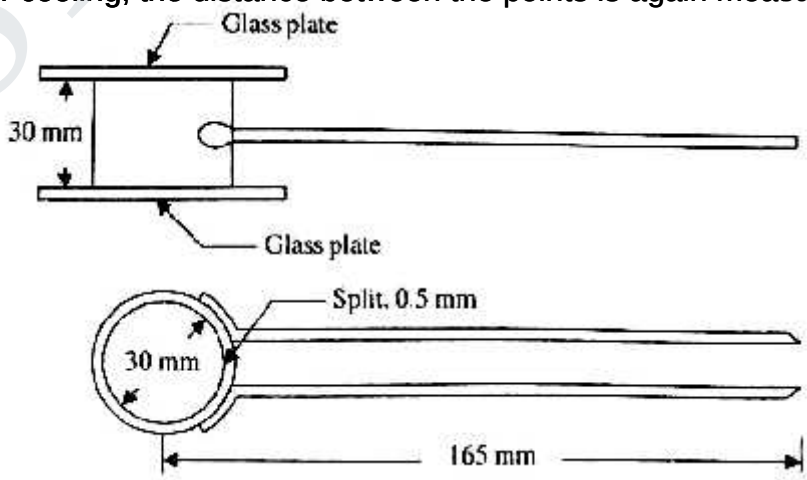
- The soundness test is an indication of excess of lime caused by inadequate burning of cement or excess of magnesia or sulphates. Excess of these substances is harmful and thus. not allowed in cements. The following two types of tests are used for testing for soundness

a Le Chatelier's test using Le Chatelier's apparatus

Le Chatelier's test shows unsoundness due to lime only. Unaerated cement paste at normal consistency is first tested for expansion. If the test results does not satisfy



- Vicat apparatus with various plungers a 10 mm dia needle for normal consistency b q mm square needle for initial set c) 5 mm dia needle for final set. requirement of 10 mm expansion, another test shall be made after aeration of the cement by spreading of the sample to a depth of 75 mm at a relative humidity of 50 to 80% for 7 days. The expansion in this aerated cement test should not be more than 5 mm.
- The apparatus used Cement pastes with normal consistency is filled into the mould. After covering both sides with glass, it is first placed in water of temperature 24 to 35°C for 24 hours.
- It is taken out and the distance between pointers is measured. The mould is then placed in water and the water is heated to the boiling point in 30 minutes.
- The boiling of water is continued for one hour. The mould is then removed and after cooling, the distance between the points is again measured.



Autoclave test.

- Autoclave test is another test used sensitive for soundness ot cement. It is to both lime and magnesia. All the cement having magnesia content more than 3 per cent is to be tested for soundness by this test with unaerated cement.
- The test consists of heating bars made of cement paste with water of normal consistency and measuring its expansion. Effect of unsoundness of cement does not appear in the field for a considerable period of time. hence, these accelerated tests are needed to determine them.
- In autoclave test, we use higher pressure and temperature to accelerate the reactions. The autoclave expansion of unaerated cement should not be more than 0.8 per cent and that of aerated cement not more than 0.6 percent.

Test for Setting Time

- The setting time is also determined by the Vicat's needle on cement paste of normal consistency. For this test, we use a 1 mm square needle needle C). For this needle, the time to penetrate 33-35 mm is taken as initial setting time.
- For final setting time, we use special needle F which has a diameter of 5 mm and the time at which this needle will not penetrate more than 0.5 mm is taken as the final set.
- False set happens when the ratio of the penetration of the Vicat's C needle after 300 seconds to the penetration in 20 seconds is less than 1/2. In such cases the test has to be repeated. The temperature of water and test room should be 27 ± 2°C.

Compressive Strength

- Compressive strength of cement is a very important test. Compressive strength of cement is determined from cubes of face 50 cm 2 in area 7.06 cm cubes) made of cement mortar with one part of cement and three parts of standard sand conforming to IS 650 -1966 by weight and water corresponding to 25% normal consistency plus three per cent of the combined weight of the cement and sand P/4 + 3.0 per cent weight of cement and sand.

- The average cube strength of three samples is taken as the test value. Strengths in 3, 7 and 28 days are to be reported. Usually 555 gm of sand and 185 gm of cement are used for the test. The procedure can be described as follows:

1. 555 gm of standard sand and 185 gm of the given cement enough to make three standard cubes are mixed with water equal to 0.25 normal consistency plus three per cent of the combined weight of the cement and sand to a uniform mix 1:3 mortar with a water cement ratio of 0.4 is also specified for this test.
2. The mortar is placed in the standard 7.05 cm size cubes and compacted in a
3. vibrating machine for 2 minutes The former method of ramming has now been standardized by the vibrating machine.
4. The moulds, with the mortar, is placed under a damp gunny bag or cabin for 24 hours for the cement mortar to set.
5. The cubes are removed after 24 hours and submerged in clean water for curing for 3. 7 or 28 days.
6. The cubes are tested in sets of three after 3 days and 7 days and 28 days after drying the specimen with a cloth. The strengths should conform to the specified.

Heat of Hydration IS 4031-1968

- Hydration of cement is a chemical reaction and it produces heat. In very massive construction this effect can raise the temperature of concrete as much as 50°C. In such cases, we should use low—heat cements or adopt cooling methods.
- This test is, hence, required only as a check for low_ heat cements. It is made by the principle of determining heat gain as in physics experiments; the test is carried out by a Calorimeter. Low heat cements should satisfy the following criteria.

a In 7 days, heat generated should not be more than 65 calories per gram of

cement.

b In 28 days, heat generated should not be more than 75 calories per gram of cement

Chemical Composition Tests Test for LSF

- The Lime Saturation Factor or LSF is the most important factor. It is determined by applying the following formula to the various constituents of the given cement.

Tests for Tensile Strength

- This test was once used as a routine test for cement but has been discontinued as test for cement, but is used for testing mortars .For this test, briquettes are made from 1:3 cement mortar using standard sand and water of 8 per cent the weight of cement and sand. They are cured and the 3 -day and 7 -day tensile strengths are reported.
- It is generally specified that the 3 - day tensile strength should not be less than 2 N/mm- and the 7 -day strength not less than 2.5 N/mm ^{2}.briquettes are tested in a special briquette –testing machine. The shape of briquettes for cement mortar test It has an area of 25.4 x 25 mm or 1 x 1 inch, compared to 38 x 38 mm for test on lime mortar.

3. Explain sampling and testing of aggregates. May/June 2016) Nov/Dec 2015)

SAMPLING AND TESTING OF AGGEGATES

The routine and other tests usually prescribed on coarse aggregates are as follows:

1. **Routine tests**
   - a Particle Size,grading shape and flakiness 3tests)
   - b Organic impurities
   - c) Moisture content
   - d Percent fines value

e Water absorption and specific gravity

2. **Other special tests**

a Aggregate crushing value

b Aggregate impact value

c) Aggregate abrasion value

d Bulk density and void ratio

DESCRIPTION OF ROUTINE TESTS

- Of the above tests, only the first five tests are specified as mandatory and important in many specifications like CPWD specification 77. These are briefly described below:

Particle Size, Shape and Flakiness IS 2386 -1963: Part I

1. Test for particle size. This is carried out in the field by sieve analysis. The results are plotted as a grading curve as already shown for sand.
2. Tests for shape. Aggregates are classified according to their shape as follows:

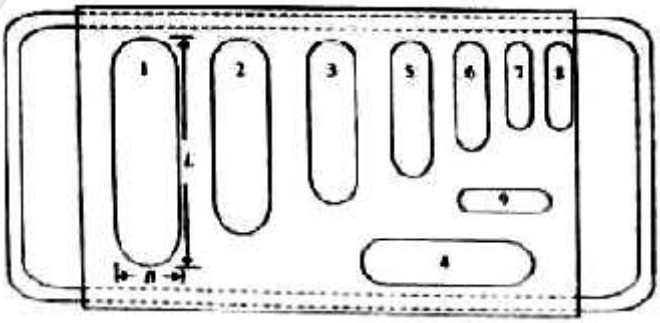
a Rounded

b) Irregular or partly -rounded

c Angular

d) Flaky

- The shape of aggregates becomes important in case of high strength high performance concrete where very low water -cement ratios are to be used.
- In such cases, cubical –shaped aggregates are preferred for better workability. Improved makes of crushers such as Hydrocone crushers, Barma rock or Rock VSI crushers, give better products than ordinary jaw crushers.
- The laboratory test for shape is known as test for flakiness or elongation index.



Apparatus to test flakiness of coarse aggregates

- Test for elongation index flakiness). The flakiness or elongation index of an aggregate is defined as the percentage weight of particles in the given aggregate which has its length greater than 1.8 times and its least dimension thickness) is less than 3/5 or 0.6 times its mean dimension.

1 Take sufficient quantity of the aggreg ate and sieve it through the different standard sizes of sieve shown in Table 8.3 into fractions. Each fraction should be tested for flakiness.

2 Each fraction is gauged in turns through the hole of dimension of thickness 0.6 times and of length 1.8 times the mean size of the aggregate.

3 The total amount passing through the various gauges is weighed to an accuracy of 0.1% of the weight of the sample.

4 Flakiness index is the total weight of the material passing through the gauges of various thickness expressed as a percentage of the total weight of the sample taken.

5 British specifications limit this index to 50 for natural aggregate and 40 for crushed coarse aggregate. For wearing surfaces like roadwork, we may adopt a lower value.

Test for Organic Impurities, Clay Content and Percentage Fines

- The same test as described for fine aggregate sand can be used for coarse aggregate also. The clay content and percentage fines can be found by immersing the aggregate in water and examining the suspended particles in the water.

MEASURE OF STRENGTH OF AGGREGATES

As discussed earlier, the three tests that deal with the strength of aggregates are

1 Ten percent fineness value

2 Aggregate crushing value

3 Aggregate crushing strength

- Of these, the ten per cent fineness value is considered a good test for weak aggregates while the crushing value is considered good for general aggregates. As already stated, crushing strength gives only the strength of the parent rock.

4. List the composition of Portland cement.

COMPOSITION OF PORTLAND CEMENT

- The cementing properties of cement develop due to chemical reaction of the above— mentioned compounds.
- Depending on the raw materials, type of firing, etc., the proportion of these various constituents can be made to differ and the resulting product will also give differing properties. Of all the main constituents of cement, C 3 S and CA control the setting and early strengths and heat of hydration.
- The compound GIS is responsible for strength at longer ages. C3A also generates higher heat than other compounds. Increase in C 3 S results in higher long-term strength and high heat of hydration. If C3 A and C 4 AF are kept low, then the resistance to chemicals such as sulphates is increased.
- Portland cement itself is produced in different types by varying the proportions of the constituents of cement

Description	*Approximate percentage of constituents*			
	C_2S	C_3S	C_3A	C_4AF
1. Normal or ordinary	25	45	12	8
2. Rapid hardening	26	45	5	15
3. Low heat	31	21	6	14

1. We should note the difference between setting of lime and setting of cement. Cement after its final set can set strong under water. Whereas the cementing property of lime depends on its exposure to air, the cementing property of Portland cement is due to the chemical reaction between its various constituents in the presence of moisture

2. It is absolutely essential that moisture should be present in the initial stages for the development of strength of cement. This process of supplying this kind of environment is known as curing. Thus, curing of the products of cement is very important in all the works connected with cement. like construction of masonry. Plastering, concreting.

3. The total percentage of C 2 S and C A S in all types of Portland cements is around 70 percent, so that even though the strength development of two cements at early stages may be different, the final strength obtained after long periods of time may not be different. However, removal of formwork, prestressing of concrete depends to a large extent on the early strength of concrete.

4. When producing low -heat Portland cement the percentage of C 2 S is increased and that of C A S and C 3 A is decreased.

5. This type of cement is of particular use in construction of dams, massive foundation, etc. to reduce the production of heat.

6. Reducing C 3 A increases. Sulphate resistance but the 7 day and 28 day strengths also get lowered as compared to the ordinary Portland cement. Sulphate - resisting Portland cement has less than 5% C 3 A. This type of cement is recommended for sewer works.

7. Rapid hardening cements compared to ordinary cements have more or less the same composition except that the latter is more finely ground and may sometimes contain higher percentage of C 3 S. The increased fineness increases the 7 day strength.

WHITE CEMENT

- White cement is very much used for making of mosaic tiles, coloured cements.
- White cement is made from chalk or limestone or shelllime free from impurities and white clays like china clay kaoline clay free from oxides of iron, manganese.
- Shelllime is on ideal raw material. In some factories, oil is used instead of coal as fuel. Grinding is also done in a special mill to avoid iron oxide.
- White cement is the base for all coloured cements.

5. How do you perform the compression strength of cement mortar? Also explain the procedure for fineness of cement. Apr/May 2015)

Mortar Compressive Strength

Importance:

Cement is usually subjected to compressive stresses when used in the form of **concrete** or **mortar.**

Mortar is a **mixture** of **cement** and sand in a specified ratio on which the **strength** of the **mortar** depends. If the mortar is weak then also its compressive strength is very low but if the **mortar** is a **strong** one then its **compressive strength** is also very high.

The **mixture** of **sand** and **cement** in **water** is generally weak in tension and is strong in compression that is why when the concrete is subjected to tensile forces then it is provided with steel rods in area of tension that is why it is then called as **reinforced** concrete. Therefore it is obvious the mortar will be strong in **compression** as **compared** to **tension.**

Mortar is generally used for **brick masonry** and **plastering.** In first case the **mortar** is subjected to **very high compressive loads** such as the load of the wall above it, therefore it is very much necessary to test the **mortar** for its compressive strength. For this purpose required **cement-sand mixture** is prepared before its use and after **certain period** of curing it is tested. The strength of the mortar depends upon the **fineness** of **cement,** the **gradation** of sand and the most important factor which **water-cement ratio.**

If any one of the above factors is not according to the **ASTM-Standard** then the **strength** of **mortar** is badly effected.

The standards of **ASTM** are provided for **different ratios** of **mixture** with which the test **results** are **compared** and then decided for its use. These values are taken when the mortar is just **removed** from **curing.**

Apparatus and Samples:

For conducting compressive on mortar required ratio mixture is prepared and then it is molded in cubical moulds of two inch sides length. At least **six cubes** are prepared and then tested with the help of **UTM** and **average** of its strength is taken into account.

The apparatus used is described **briefly** below:

UTM: Universal Testing Machine

"A **machine** which is designed to **perform tension, compression, shear** and bend test is called **universal testing machine** i.e. UTM".

The **universal testing machine** mainly consists of two parts:

- One part of **UTM** is called the **straining unit.** In this unit stress is applied on the steel bar.
- The other part is called the load **measuring machine.** In this unit the load applied is **measured electronically** and also it will give the peak value.
- The **UTM** also have a compression additional setup. For compressive test the machine is fitted with the compression unit which consists of two round plates between which the test **cube** is **placed.**
- In addition to these two units there are **certain accessories** such as for **griping** the **test piece, recorders, bending** table etc.

- Fine aggregate. sand.
- Cementing material. cement.
- Clean water.
- 5/8" tampering rod.
- UTM Universal Testing Machine)

Procedure:

i. First of all, we have to prepare a **mixture** of **cement** and sand having ratio of: 1:3. That is one part of **cement** and three parts sand. We take the weight of **cement equal** to 200 grams and therefore the weight of **sand equal** to 300 **grams.** This will make a 1:3 mortar.
ii. Then we have to calculate the amount of **water** for this ratio according to the **ASTM standards.** This is 10% of the weight of total aggregate.
iii. After **calculation** of weights make a **homogeneous mixture** of **dry ingredients,** and then add water carefully to make a paste.
iv. Now, take the two inch **cube mould** and clean them thoroughly from inside and if possible also apply some oil to the inner surface so that during **removal** of **mould** the cubes are not **damaged.** Also fix them tight so that during compaction it is easy to compact.
v. Then fill one third of the mould with mortar and press it with the help of a 5/8 inch, **round-ended,** tampering rod. It should be tampered 25 times.
vi. Then fill the second **one-third** potion of mould, and also tamper it 25 times with the help of tampering rod.
vii. At last fill the remaining **one-third** portion, and also tamper it 25 times.
viii. Adopting the same procedure make six cubes of mortar so that it is easy to take the average of their strengths.
ix. For the upper surface to be **smooth work** it with float.
x. Then keep it in open air for one day and after this **cure** three of them for three days and the remaining three for six days by keeping them in **water.**
xi. After curing of the cubes take them out of the moulds carefully and then bring them for test by **UTM.**
xii. Now place the test specimen in the compression test apparatus of **UTM.**
xiii. Select suitable range for the **UTM loading unit.** Usually the loading range is given up to 20 or 40 tons.
xiv. Now carefully start the machine and start applying load automatic. Apply force to the test **specimen** continuously and uniformly throughout the compression test.

xv. As the load is applied on the cube it will **develop cracks** after **certain** load.

xvi. **Discontinue** the **application** of **load** when the cube has been **crushed** or just cracks are **developed** in it.

xvii. Take out the cube and clean the compression plate surface for next test.

xviii. Continue the above procedure for the **remaining cubes.**

xix. Note down the crushing load for each cube separately and then multiply the load with 2204 so that it is converted to pounds.

xx. Then divide each **crushing load** value by the area of cross section of cube which in this case is 4 in^2. This will give the compressive strength of each cube which may vary in value.

xxi. Then take the average of these values by summing them dividing them by number of cubes. This will be the compressive strength of that mortar

6. Add a note on the process of hydration of cement.May/June2016)

The hydration of cement can be thought of as a two-step process. In the first step, called dissolution, the cement dissolves, releasing ions into the mix water. The mix water is thus no longer pure H2O, but an aqueous solution containing a variety of ionic species, called the pore solution. The gypsum and the cement minerals C_3S and C3A are all highly soluble, meaning that they dissolve quickly. Therefore the concentrations of ionic species in the pore solution increase rapidly as soon as the cement and water are combined. Eventually the concentrations increase to the point that the pore solution is supersaturated, meaning that it is energetically favorable for some of the ions to combine into new solid phases rather than remain dissolved. This second step of the hydration process is called precipitation. A key point, of course, is that these new precipitated solid phases, called hydration products, are different from the starting cement minerals. Precipitation relieves the supersaturation of the pore solution and allows dissolution of the cement minerals to continue. Thus cement hydration is a continuous process by which the cement minerals are replaced by new hydration products, with the pore solution acting as a necessary transition zone between the two solid states

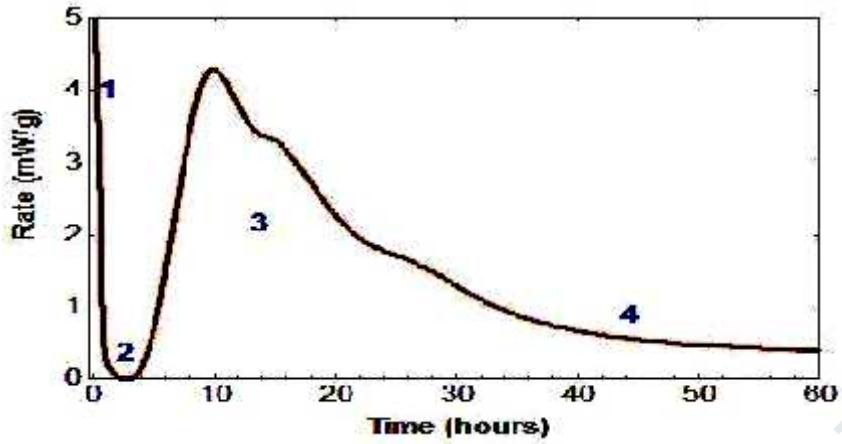


Figure : Schematic of the rate of hydration or heat evolution as a function of time

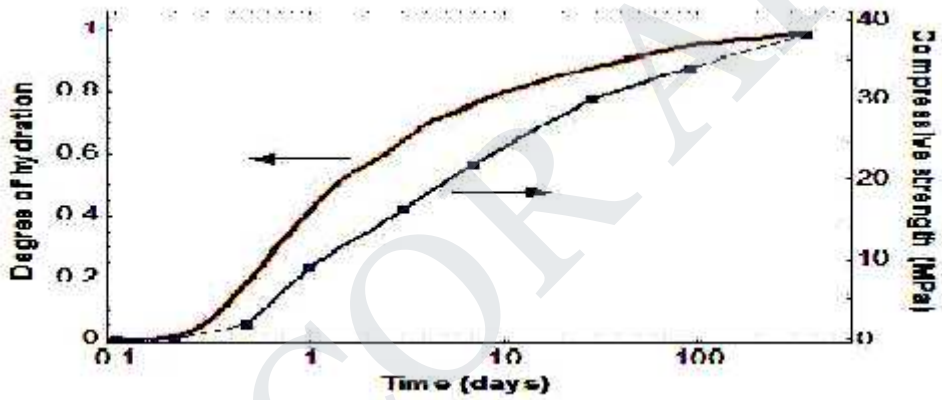


Figure : Typical development of the degree of hydration and compressive strength of a Type I portland cement over time

PART – C (15 MARKS

1. Explain manufacture of Portland cement. Nov/Dec 2015)

MANUFACTURE OF PORTLAND CEMENT

- The specifications laid down by Bureau of Indian Standard BIS — IS : 269-4989 the manufacture of Portland cement are as follows;
- The above mentioned specification of the process of Portland cement manufacture passes through several distinct stages which are enumerated as follows.

- Usually, therefore, cement factories are located closest to the limestone deposits with the clay or shale deposits located nearby. Cement is consumed more in urban and industrial areas and facilities to transport cement from factories to these areas become an important factor in the location of cement plants.

- Equally important are facilities to transport the heavy machinery needed for the plant. Generally, however, the occurrence of limestone deposits is the main factor, the Test site of cement plant will be at the source of good limestone deposites close to the existing railway lines.

i. Preparation of raw materials. The rocky terrain of calcareous materials and argillaceous materials are cleared of overburden. In order to remove the rock mass from its existing position, it is loosened first.

ii. A tremendous energy is produced and the resultant gases try to escape into the air by path of least resistance causing fragmentation of the rock mass. Using power shovel, dragline or other suitable excavating equipments, fragmented rocks are easily removed and carried to the crushing mill at cement plant where the rocks are crushed to the extent to be ready for mixing operation.

iii. Grinding & Mixing of Raw Materials. The grinding and mixing of the raw material Calcareous materials in the form of limestone or chalk and argillac eous materials in the form of clay or shale can be done either in water or in a dry condition, hence the names WET or DRY process, respectively. The choice of method depends also upon hardness of the raw materials used and on their moisture content.

WET PROCESS

- In the wet process limestone brought from the querries is crushed to smaller fragments passing through various crushers. Finally the broken rock particles of required size dispersed in water in a wash mill.
- The wash mill is a circular pit with revolving radial arms carrying rakes which break up the lumps of solid matter. The clay is also broken up and mixed with water, usually in a similar wash mill.
- These two mixtures from the respective storage basin are now pumped into wet

grinding mills to make SLURRY. The slurry is a liquid of creamy consistency with the water content between 35 to 50 percent.

- The slurry is pumped into slurry tanks or basins where it is kept in an agitated conditions by means of rotating arms or blowing compressed air from the bottom to prevent settling of limestone and clay particles.
- The slurry is tested by the experienced cement chemists to achieve the required chemical composition and final adjustments can be made by blending slurries from different storage tanks, sometimes using an elaborate system of blending tanks.
- Finally the corrected slurry is stored in the final storage tank and kept in homogeneous conditions by the agitation of slurry.

DRY PROCESS

- In the dry process, the raw materials are crushed dry and fed in the correct proportions into a grinding mill, where they are dried and reduced in size to a fine powder.
- The dry powder, called RAW MEAL, is then pumped to a blending silo and corrected for its right chemical composition and mixed by means of compressed air. The aerated materials powder tends to behave almost like liquid and in about one hour of aeration, a uniform mixture is obtained.

SEMI -DRY PROCESS

- In the semi -dry process, the blended meal of dry process is further sieved and fed into a rotating disc called GRANULATOR.
- A quantity of water weighing about 12% of the meal is added to make the blended meal into PELLETS. This is done to permit air flow for exchange of heat for further chemical reactions of formation of cement clinkers.

BURNING

- Raw mix, in the form of either slurry with 36% moisture or in the form of dry raw mix or in the terms of nodules with 10 to 12% moisture, is now ready to be fed to the

burning equipment called KILN. Kiln used in India is mostly of rotary type not in shaft type.

- A Rotary kiln is a long slender horizontal steel cylinder lined with fire bricks and rotating at a speed of about 1 rpm revolution per minute.
- The thickness of iron plate of rotary kiln as about 18 to 20 mm.
- The kiln is aligned with a slope of about 4 percent, so that due to the rotation of the kiln, the material fed at the upper end of the kiln is transported to the lower end because of gravity.
- In the wet process, the long rotary kiln is equipped with integral or external heat recuperating systems at the feed end, while in the dry process, it may be either a long rotary kiln fitted with integral heat recuperating system at the feed end or short rotary kiln with external suspension pre -heaters cyclone type at the feed end.
- In the semi - dry process. however, it is a short rotary kiln with a travelling grate heat exchanger at the feed end.
- The slurry in fed in at the upper end of the kiln while the pulverised coal is blown at the lower end of the kiln, where the temperature reaches about 1500 to 1650°C.
- The coal selected for the purpose must not have too high ash content. In India only glade I coal 22 to 25 percent ash content is used. Better grade coal has to be used for better quality reasons.
- In addition to coal, natural gas or furnace oil can also be used for burning purpose. But, natural gas is scarce in India and is not used for the manufacture of the cement. Furnace oil also is very costly and it is not generally used except if the manufacture of white cement.

The slurry, in its movement down the kiln because of the gravity, encounters a progress higher temperature. In the evaporating zone up to 250°) water from the slurry is driven off.

Next it reaches the calcination zone 700 — 1200°C), G0 2 is liberated, further on, the dry material undergoes a series of chemical reactions until finally, in the clinkering zone up to1500 to 1650°C) some 20 to 30 percent of the material becomes liquid and the lime, silica and alumina recombine. The mass then fuses into balls of 3 to 25 mm in diameter called CLINKERS.

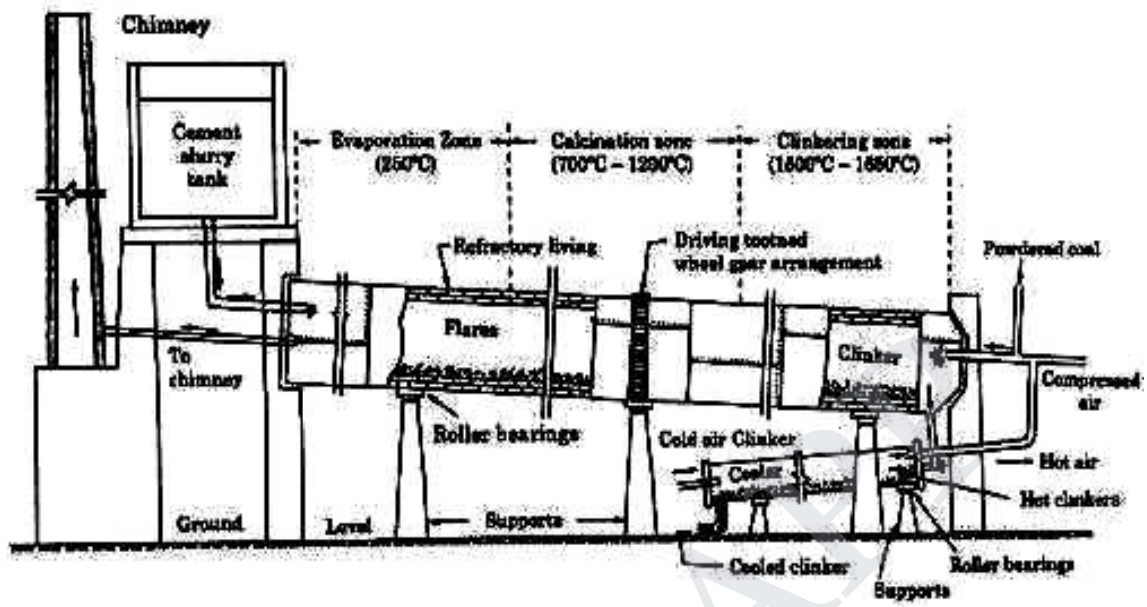


Fig. 2.3 Wet Process rotary kiln.

COOLING

- The clinkers are dropped into another rotary kiln where they are cooled under controlled conditions. It is important to note that the rate of cooling the clinkers greatly influences the properties of the cement.
  - Traditionally cement used to be packed exclusively in jute bags, resulting in a lot of seepage and wastage from the bag, apart from creating a dust nuisance. However, now -a - days, jute packaging is being replaced by woven HDPE High Density Polyethylene or multi wall paper bags.
  - In these type of packing, seepage is almost eliminated, particularly in the case of multi wall paper bags and as a result, dust nuisance is greatly reduced.

Type of cement	Cooling Pattern	Compressive strength (N/mm^2)		
		3 days	7 days	28 days
Normal Cement	Quick	9.9	15.3	26
	Moderate	9.7	21.0	27
	Slow	9.7	19.3	24
	Very Slow	8.7	18.7	23
High Early Strength Cement	Quick	16.2	18.8	29
	Moderate	14.2	26.7	33
	Slow	10.3	21.0	29
	Very Slow	9.1	18.1	28

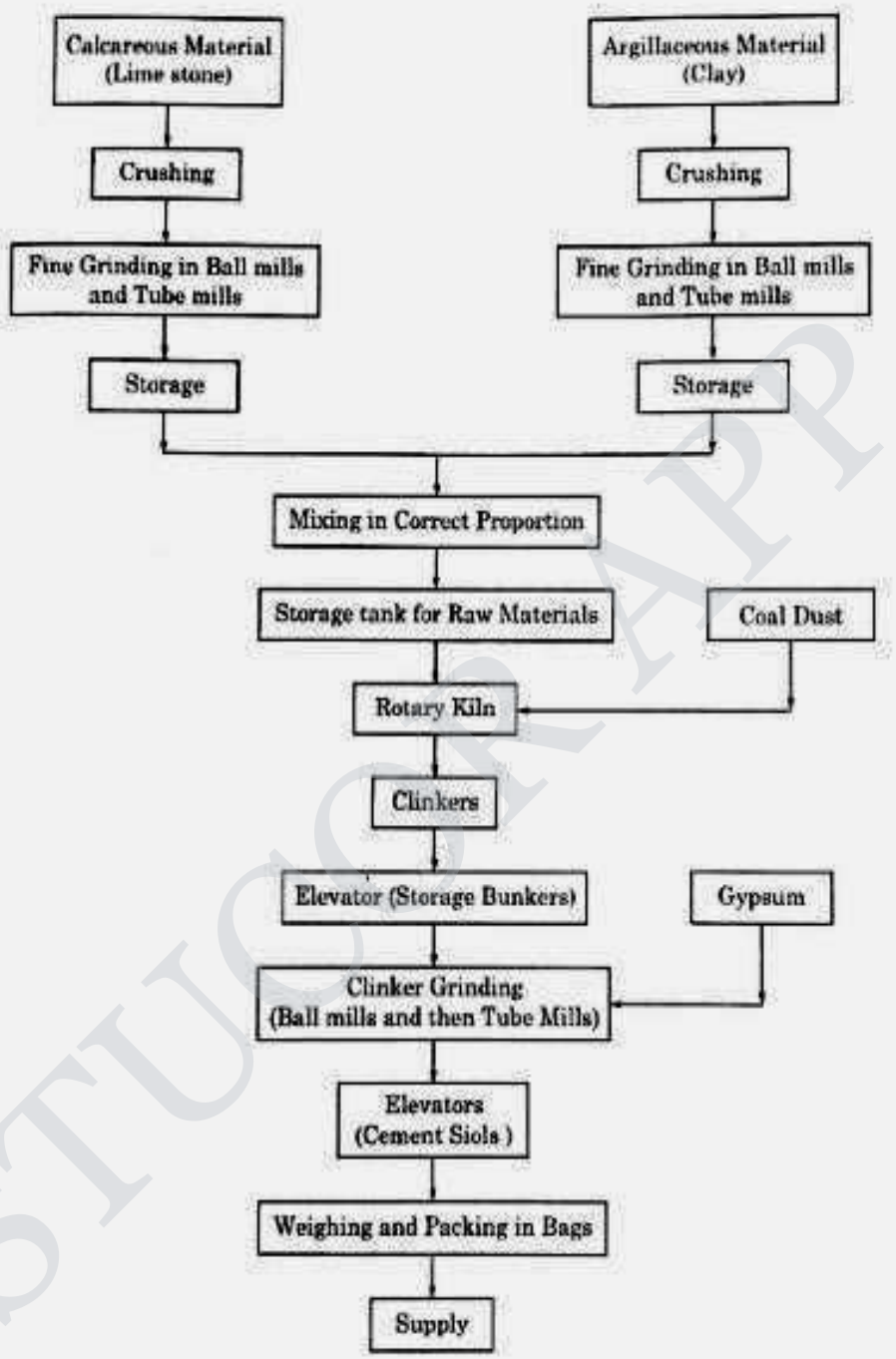
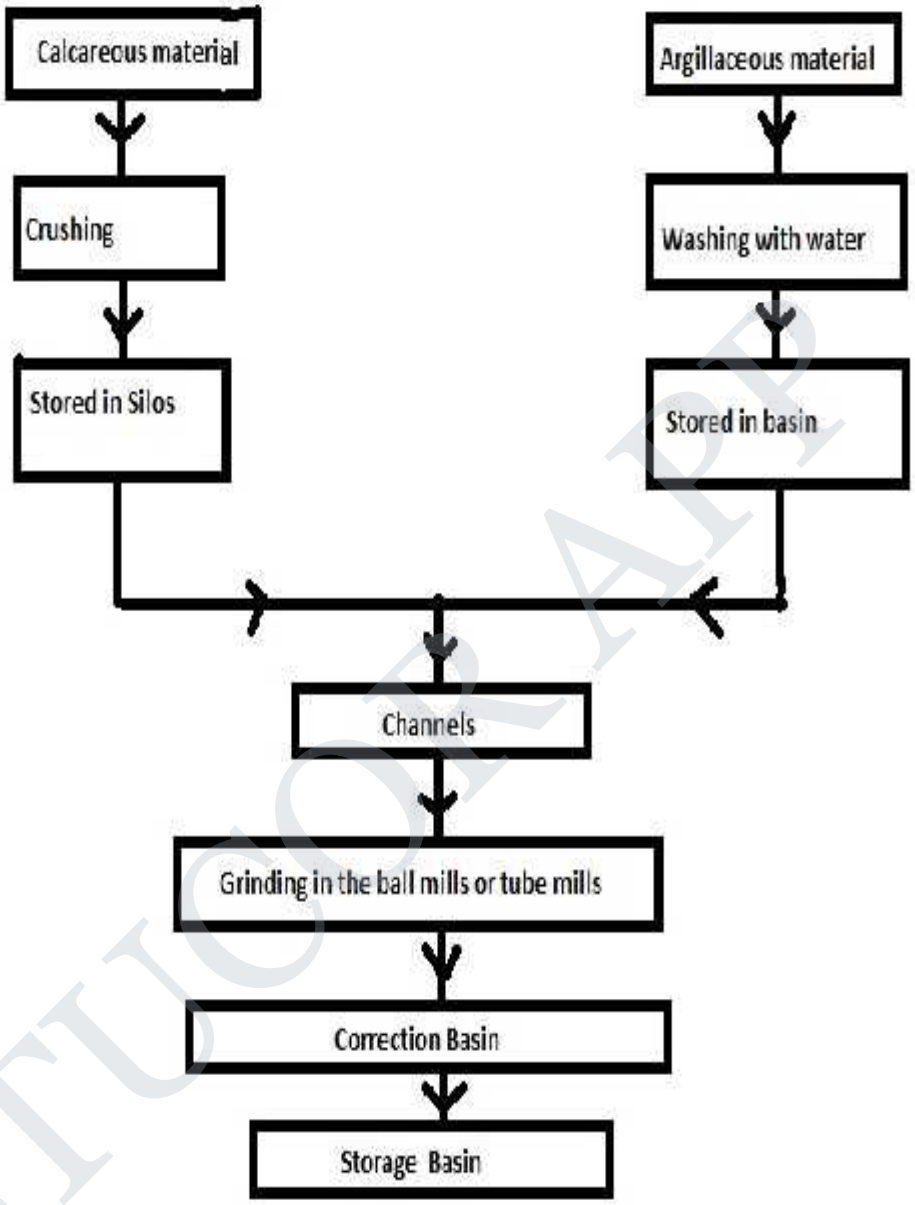


Fig. 1.4-A Flow Diagram of Cement Manufacture (Dry Process)



Flow Program of Cement Manufacture Wet Process)

UNIT -III

CONCRETE

PART-A 2 MARKS

1. **Define workability.Nov/Dec2015**

- It is defined as the property of freshly mixed concrete or mortar which determines the case and homogeneity with which it can be mixed, placed, compacted and finished. The degree of ease in working with concrete is called workability.

2. What are the factors affecting workability?

1.Quantity of water in the mix
2.Proper grading of the aggregate mix
3.Ratio of fine aggregate and coarse aggregate
4.Maximum size of coarse aggregates
5.Method of compaction of concrete.

3. List some tests to measure workability.

- Slump test
- Compacting factor test
- Flow test
- Vee-Bee test
- Kelly ball test

4. What are the stages of concrete?

- Fresh concrete
- Hardened concrete

5. What is Fresh concrete?

- The fresh concrete or plastic concrete is the initial stage of concrete period and it is counted from the mixing stage till it is transported, placed, compacted and finished in the position.

6**. Define segregation.**

- Segregation can be defined as the separation of coarse aggregate from the main mass of concrete in the plastic stage and it occurs in case of dry mix of insufficient and non - uniform mixing.

7**. What is Water-Cement ratio?**

- The water -cement ratio, defined as the ratio of the mass of free water i.e. excluding that absorbed by the aggregate to that of cement in a mix, is the most important factor that controls the strength and many other properties of concrete.
- In practice, this ratio lies generally in the range of 0.35 to 0.65, although the purely chemical requirement for the purpose of complete hydration of cement is only about 0.25.

8 .What are the factors affecting proportioning of concrete mixes?

1.Water cement ratio
2.Cement content
3.Temperature
4.Age of concrete
5.Size, shape and grading of aggregate
6.Curing

9.Define curing of concrete.

- Curing is the operation by which moist conditions are maintained on finished concrete surface, to promote continued hydration of cement.

10.What are the types of concrete used?

- Plum concrete, light weight concrete, air-entrained concrete, no-fines concrete, vaccum concrete, water-proof concrete, reinforced cement concrete, pre-stressed concrete, cellular or aerated concrete, foamed concrete, pre-cast concrete.

11. What is a good concrete?

- A good concrete is one in which the ingredients are properly distributed to make a homogenous mixture and it should not show any sign of segregation or bleeding.

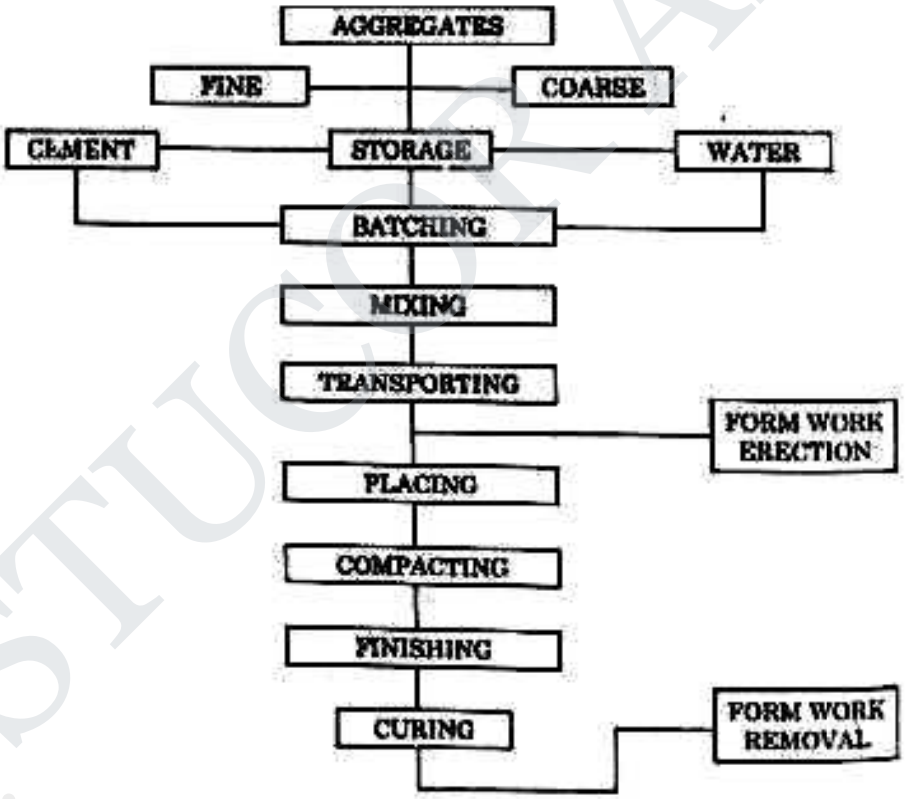
12. Define bleeding.

- Bleeding is a form of segregation in which some of water in the mix tends to rise the surface of freshly placed concrete.
- This is because of the inability of the solid constituents of the mix to hold all the mixing water in the place when they settle downwards.

13.What are the admixtures?

Admixtures are ingredients other than cement, fine aggregate and coarse aggregate to improve the quality of concrete. The addition of an admixture may improve the concrete with respect to its strength ,hardness, workability, water resisting power.

14. List the various operations requires in the production of concrete.



15. Distinguish between HSC and HPC May/June2016Apr/May2015

- For mix made with normal weight aggregates, high strength concrete HSC) is considered to be the one having a compressive strength in excess of 40 MPa.
- High-performance concrete HPC) is relatively new technology. HPC originatedin France in 1980, followed by Canada in 1990. In 1989, under the direction of paul Ziaof North Carolina State University, a major effort in HPC technology began in the United States with the initiation of the Strategic Highway Research Program SHRP.

16. What is meant by modulus of rupture?(Apr/May2015

An ultimate strength pertaining to the failure of beams by flexure equal to the bending moment at rupture divided by the section modulus of the beam.

17. Self-Compacting Concrete Nov/Dec2015

Self-consolidating concrete is a highly flowable type of concrete that spreads into the form without the need of mechanical vibration. Self-compacting concrete is a non-segregating concrete that is placed by means of its own weight. The importance of self-compacting concrete is that maintains all concrete's durability and characteristics, meeting expected performance requirements.

PART-B (13 MARKS

1. Write in detail about curing? Nov / Dec 2015)

- Cement gains strength and hardness because of the chemical action between cement and water. This chemical reaction requires moisture, favourable temperature and time referred to as the curing period.
- The variation of compressive strength with curing period Curing of freshly placed concrete is very important for optimum strength and durability. The major part of the strength in the initial period is contributed by the clinker compound C3S and partly by C2S, and is completed in about three weeks.
- The later strength contributed by C2S is gradual and takes long time. As such sufficient water should be made available to concrete to allow it to gain full

strength. The process of keeping concrete damp for this purpose is known as curing.

- The object is to prevent the loss of moisture from concrete due to evaporation or any other reason, supply additional moisture or heat and moisture to accelerate the gain of strength.
- Curing must be done for at least three weeks and in no case for less than ten days. Approximately 14 litres of water is required to hydrate each bag of cement.
- Soon after the concrete is placed, the increase in strength is very rapid 3 to 7 days) and continues slowly thereafter for an indefinite period.
- Concrete moist cured for 7 days is about 50 per cent stronger than that which is exposed to dry air for the entire period. If the concrete is kept damp for one month, the strength is about double than that of concrete exposed only to dry air.

Methods of Curing

- Concrete may be kept moist by a number of ways. The methods consist in either supplying additional moisture to concrete during early hardening period by ponding, spraying, sprinkling, etc. or by preventing loss of moisture from concrete by sealing the surface of concrete by membrane formed by curing compounds. Following are some of the prevelent methods of curing.

1. Water Curing
2. Steam Curing
3. Curing by Infra Red Radiation:
4. Electrical Curing
5. Chemical Curing

The Efficiency of Curing

- Curing is the name given to procedures used for promoting the hydration of cement, and consist of a control of temperature and of the moisture movement from and into the concrete.
- Hydration of cement takes place in capillaries filled with water. By keeping concrete saturated, loss of water by evaporation from the capillaries is prevented and loss of water by self desiccation due to the chemical reactions of hydration of cement from outside. Cuing should be continued until the originally

water filled space in the fresh cement paste has been filled by product of hydration to the desired extent. Curing temperature should be from 23° to 30°C 27°C average.

- The curing must be adequate at favourable temperature for sufficient period which helps in attaining the maximum strength and other desirable properties.

2. Explain the Factors Affecting Workability

The factors helping concrete to have lubricating effect workability to reduce internal friction, for helping easy compaction are listed below;

a Water content
b Mix proportion
c) Size of aggregate
d Shape of aggregate
e Surface texture of aggregate
f Grading of aggregate
g Use of admixtures.

a Water Content

- The basic factor affecting the workability is water content which is expressed in litres of water per cubic meter of concrete. The higher the water content, higher will be the fluidity of concrete but subject to limitation of water -cement ratio.
- More water can be added, provided a correspondingly higher quantity of cement is also added to keep the w/c ratio same so that the strength of concrete remains unchanged.

b) Mix Proportion

- Aggregate/cement ratio is the inversely proportion to the workability. With lower aggregate/cement ratio rich concrete, more paste is available to make the mix cohesive and fatty to give better workability.
- On the other hand, the higher aggregate/cement ratio leaner concrete, less quantity of paste is available to provide lubrication and thereby lowers workability.

c **Size of Aggregate**

- For the given quantity of water and paste, bigger size of aggregate will give higher workability because of reduction of total specific surface area and inter -particle frictional resistance.

d **Shape of Aggregate**

- The shape of aggregates influences the workability greatly. Angular/elongated/flaky aggregate makes the concrete very harsh whereas rounded aggregate enhances the workability in good measure because of reduction in total specific surface area and inter - particle frictional resistance for a given volume or weight.
- This explains the reason why river sand and gravel provide greater workability to concrete than crushed sand crushed aggregate.

e **Surface Texture of Aggregate**

- Rough textured aggregate will exhibit poor workability whereas smooth or glossy textured aggregate will impart better workability because of reduction of inter -particle frictional resistance offered by smooth surface thereby contributing higher workability.

f **Grading of Aggregate**

- A well graded aggregate has lesser amount of voids in a given volume. Other factors being constant, if the total voids are less, excess paste is available to give better lubricating effect.
- The mixture becomes cohesive and fatty preventing segregation of particles. Therefore, better is grading, less is the void content and higher is the workability.

g) Properties of Cement

- The workability is also affected by the physical and chemical properties of cement, but to a much lesser extent.
- Rapid -hardening cement will have reduced workability as compared to ordinary portland cement because of higher specific surfaces.

h) Use of Admixtures

- The presence and nature of admixtures affect the workability considerably.

The use of the plasticizers and super plasticizers improve the workability manifolds.

- Use of air - entraining agents which are normally surface-active, reduces the internal friction between the particles.
- The air –entraining agents like resin, soap or chemicals introduce a large number of very minute air bubbles which act as rollers and increase workability. They decrease bleeding and segregation also.

3. Write in detail about High Strength Concrete and High Performance Concrete? Nov / Dec 2015)

High Strength Concrete

- For mix made with normal weight aggregates, high strength concrete HSC) is considered to be the one having a compressive strength in excess of 40 MPa.
- To produce concrete above this strength more stringent quality control and more care in selection and proportioning of materials are needed.
- The tricalcium aluminate component is kept as low as possible <8%.
- Most cements used to produce HSC have fineness in the range of 300–400m^2/kg with an exception of high early strength cement for which fineness should be at least 450 m^2/kg.
- For HSC a smaller maximum size of coarse aggregate leads to higher strength. Fine aggregate should have a Fineness Modulus >3.

Reasons for high strength concrete:

- The utilization of fine pozzolanic materials in high strength concrete leads to reduction of the size of crystalline compounds.
- Hence there is a reduction of the thickness of interficial transition zone occurs, thus the disinfection contribute to the strength of concrete

Applications

- Highway bridges long span bridges)
- High rise structure over 30 stories.
- Columns and piles

- Domes, shells and arches.

HIGH PERFORMANCE CONCRETE

- High-performance concrete HPC) is relatively new technology. HPC originated in France in 1980, followed by Canada in 1990. In 1989, under the direction of paul Ziaof North Carolina State University, a major effort in HPC technology began in the United States with the initiation of the Strategic Highway Research Program SHRP.
- SHRP defined HPC in terms of strength, low w/c, and freeze/thaw durability. These early efforts were in response to alarming deterioration rates of the nation's roads and bridges. The concept of HPC has certainly evolved with time.
- What exactly is "high performance Various parameters have been attached to HPC, with high strength being a popular descriptor.
- While equating HPC with high strength certainly has some merit, it doesn't present a complete or, in some cases, accurate picture. Other properties of the concrete must also be considered, and may even override the strength issue.
- Three influences must be considered: the structure in which the concrete will be used, including support; the environment in which the structure will be placed; and the type and number of forces to which the structure will be subjected. These considerations are discussed in detail, before defining HPC.

Characteristics:

- Easy to pump
- Posses good workability
- Resistance to crack
- Electrical resistivity
- Posses good durability

Applications:

- Off – shore structures
- Oil – drilling platforms
- Oil – storage cells
- Pre-stressed concrete shafts

4. Explain in detail about Ready Mixed Concrete RMC ?

- Ready mixed concrete RMC) is a concrete, delivered at site or into the purchaser's vehicle, in plastic condition and requires no further treatment before being placed in a position in which it is to set and harden.
- It is a high quality concrete of required grade produced under strictly controlled conditions in a centralised automatic batching plant and supplied to the customer in a transit mixer truck for its placement at site.

- The concrete can be mixed either dry at the batching plant, loaded into agitator truck
  mixers and water added during transportation; or it can be mixed wet at the batching plant, discharged into the agitator truck mixers and transported to site.
- The first RMC plant was established in the year 1992 in Pune. At present, RMC plantsare located in almost all the cities of India.
  Admixtures of RMC
- Generally RMC is transported to sites which are located at long distances from the batching plants. At the delivery point, concrete should be workable and plastic. The transit period is sometimes four to five hours.
- The ordinary concrete will suffer slump loss due to the time lost in transit and evaporation of water due to atmospheric conditions such as high temperature. Therefore, admixtures will be required to extend the setting time and, retention of specified slump of concrete.
- Super plasticizers are, therefore, used to assure quality, workability, and strength of ready mixed concrete. Two types of admixtures are in use—the high performance water reducing admixtures and a high range water-reducing super-plasticizers.
- High performance water reducing admixtures have been specially designed to retain workability even in high ambient temperature. The examples are conplast RMC P 333 and conplast RMC P 505.
- The advantages of using high performance water reducing admixtures are:
  1. Improved cohesion and reduced bleeding and segregation.

2. Makes the mix cohesive even if the aggregates are of slightly poor grading.

3. Since chloride free it is safe for use in reinforced and prestressed concrete.

4. Improved workability and workability retention with controlled extended setting time

and hence ideal for use in hot weather condition.

5. Workability increases without extra water addition.

6. Assists in producing dense, close textured, low permeability concrete thus enhancing durability.

7. Water reduction helps in improvement of compressive strength at all ages.

Advantages of RMC

1. Enhanced quality and durability resulting in lower maintenance costs and increased speed of construction.

2. Ready mix concrete is consistently of the same quality and provides a high quality of construction material; construction time is also reduced.

3. It reduces congestion at the site and prevents traffic jams.

4. It hastens infrastructure development and thus provides more employment opportunities.

5. It is an environmentally safer alternative.

6. With ready mixed concrete, modern construction techniques can be followed.

7. Convenience—Ready Mix Concrete is delivered at the site with minimum logistical hassles.

8. Different types of concretes can be made for different applications.

5. Explain Properties of Fresh Concrete.

The concrete is a basic prime building material because of various properties being possessed during its hardened state which starts from the day it attains the full designed strength to the end of its life. For hardened concrete, the various properties which need consideration are as follows.

A STRENGTH

a Compressive strength

bTensile strength

b Flexural strength

c) Shear strength

d Bond strength

B Durability

C) Impermeability

D) Dimensional Changes

a Elasticity

b Shrinkage

c) Creep

d Thermal expansion

e Fatigue

E Fire Resistance

Strength of Concrete

- The strength of concrete is the most important property as far as structural designs are concerned. Indirectly, it gives the idea of other properties Impermeability, durability, wear resistance etc) also.
- A strong concrete is more dense, compact, impermeable and resistant to weathering and chemical attacks. Meaning thereby, the strength of concrete gives an overall idea of its quality.
- Strength of concrete is defined as the ability to resist force and for structural purposes, it is taken as the unit force required to cause rupture which may be caused by compressive stress, tensile stress, flexural stress, shear stress, bond stress etc.

Compressive Strength of Concrete

- The compressive strength of concrete is considered the basic character of the concrete. Consequently, it is known as the CHARACTERISTIC COMPRESSIVE

STRENGTH OF CONCRETE fck) which is defined as that value below which not more than five percent of test results are expected to fall based on IS: 456-2000. In this definition the test results are based on 150 mm cube cured in water under temp. of 27 ± 2°C for 28 days and tested in the most saturated condition under direct compression.

- Other strength viz, direct tensile stress, flexural stress, shear stress and bond stress also are directly proportional to the compressive stress. Higher is the compressive stress, higher is other stresses also.
- Not only stresses, other properties for example modulus of elasticity, abrasion and impact resistances, durability are also taken to be related to the compressive strength, hence, the compressive strength is an index of overall quality of concrete.

Factors Affecting Compressive Strength

- Among the materials and mix variables, WATER -CEMENT RATIO is the most important parameter governing the compressive strength. Besides W/C ratio, following factors also affect the compressive strength.

  • The characteristics of cement.
  • The characteristics and properties of aggregates.
  • The degree of compaction
  • The efficiency of curing
  • Age at the time of testing.
  • Conditions of testing.

Water -Cement Ratio

- The water -cement ratio, defined as the ratio of the mass of free water i.e. excluding that absorbed by the aggregate to that of cement in a mix, is the most important factor that controls the strength and many other properties of concrete.
- In practice, this ratio lies generally in the range of 0.35 to 0.65, although the purely chemical requirement for the purpose of complete hydration of cement is only about 0.25.

6. Explain the various specifications for Self Compacting Concrete SCC Apr/May2015)

Self-Compacting Concrete

Self-consolidating concrete is a highly flowable type of concrete that spreads into the form without the need of mechanical vibration. Self-compacting concrete is a non-segregating concrete that is placed by means of its own weight. The importance of self-compacting concrete is that maintains all concrete's durability and characteristics, meeting expected performance requirements.

In certain instances the addition of super plasticizers and viscosity modifier are added to the mix, reducing bleeding and segregation. Concrete that segregates loses strength and results in honeycombed areas next to the formwork. A well designed SCC mix does not segregate, has high deformability and excellent stability characteristics

Self-Compacting Concrete Properties

Self-compacting concrete produces resistance to segregation by using mineral fillers or fines, and using special admixtures. Self-consolidating concrete is required to flow and fill special forms under its own weight, it shall be flowable enough to pass through highly reinforced areas, and must be able to avoid aggregate segregation. This type of concrete must meet special project requirements in terms of placement and flow.

Self-compacting concrete with a similar water cement or cement binder ratio will usually have a slightly higher strength compared with traditional vibrated concrete, due to the lack of vibration giving an improved interface between the aggregate and hardened paste.

The concrete mix of SCC must be placed at a relatively higher velocity than that of regular concrete. Self-compacting concrete has been placed from heights taller than 5 meters without aggregate segregation. It can also be used in areas with normal and congested reinforcement, with aggregates as large as 2 inches.

Self-Compacting Concrete Uses

Self-compacting concrete has been used in bridges and even on pre-cast sections. One of the most remarkable projects built using self-compacting concrete is the Akashi-Kaikyo Suspension Bridge. In this project, the SCC was mixed on-site and pumped through a piping system to the specified point, located 200 meters away. On this particular project, the construction time was reduced from 2.5 years to 2 years. This type of concrete is ideal to be used in the following applications:

- Drilled shafts
- Columns
- Earth retaining systems
- Areas with high concentration of rebar and pipes/conduits

Self Compacting Concrete Benefits

Using self-compacting concrete produce several benefits and advantages over regular concrete. Some of those benefits are:

- Improved constructability.
- Labor reduction.
- Bond to reinforcing steel.
- Improved structural Integrity.
- Accelerates project schedules.
- Reduces skilled labor.
- Flows into complex forms.
- Reduces equipment wear.
- Minimizes voids on highly reinforced areas.
- Produces superior surface finishes.
- Superior strength and durability.
- Allows for easier pumping procedure.
- Fast placement without vibration or mechanical consolidation.
- Lowering noise levels produced by mechanical vibrators.

- Produces a uniform surface.
- Allows for innovative architectural features.
- It is recommended for deep sections or long-span applications.
- Produces a wider variety of placement techniques.

Factors Affecting Self Compacting Concrete

Using self-compacting concrete must not be used indiscriminately. These factors can affect the behavior and performance of self-compacting concrete:

- Hot weather.
- Long haul distances can reduce flowability of self-compacting concrete.
- Delays on job site could affect the concrete mix design performance.
- Job site water addition to Self-Compacting Concrete may not always yield the expected increase in flowability and could cause stability problems.

Self-Compacting Concrete Special Considerations

Self-compacting concrete can have benefits and will shorten your construction time. However, special attention should be focused on:

- Full capacity mixer of self-compacting concrete might not be feasible due to potential spillage along the road, producing environmental and contamination hazards.
- Formwork should be designed to withstand fluid concrete pressure that will be higher than regular concrete.
- Self-Consolidating Concrete may have to be placed in lifts in taller elements.
- Production of SCC requires more experience and care than the conventional vibrated concrete.
- Self-consolidating concrete can add up to $50 per yards to your construction costs. This cost will vary among ready-mix concrete producers.

7. Explain the various tests to be performed on hardened concrete. Nov/Dec 2015)

Properties of Hardened Concrete

- Early volume change
- Creep Properties
- Permeability
- Stress-Strain Relation

I. Early Volume Change Shrinkage

What is the problem? >> May result in cracking

Plastic Shrinkage

Due to water loss from fresh paste by evaporation or from suction by dry surface

- Volume decrease ~ 1% when the paste is still plastic
- How to prevent: control water loss

Drying Shrinkage

Due to loss of water and/or cooling.

- 15-30% of dry shrinkage occurs in the first 2 weeks, 65-85% in first year

Can be induced by

– lack of curing

– high water-cement ratio

– high cement content

– low coarse aggregate content

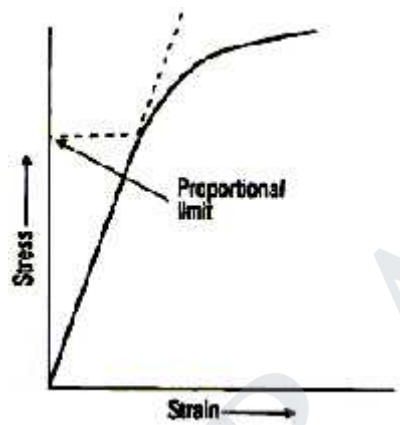
– existence of steel reinforcement

- Depends on size and shape of concrete structure
- May be non-uniform due to non-uniform loss of water

Swelling

May occur if concrete is cured continuously in water after settling. Its effects are relatively small and does not cause significant problems.

II. Stress-Strain Relation



- Concrete is not perfectly elastic
- Rate of loading affects the E value Non -Linear

– Aggregate and cement paste individually show a linear stress-strain, but concrete is nonlinear

– Why? Micro-cracking between the aggregate and cement paste interface

- For structural design, we need compressive strength fc) and modulus of elasticity E

Tests performed on hardened concrete are:

- Compressive strength test most common – DT
- Modulus of Elasticity – NDT
- Split-tension test – DT
- Flexural strength test – DT

- Rebound hammer test – NDT
- Penetration resistance test – NDT
- Ultrasonic pulse velocity test – NDT
- Maturity test – NDT

II.1. Compressive Strength Test fc'

- ASTM C39: cylindrical specimen 6 in. by 12 in.

– For normal-weight concrete: fc' range is 21 MPa to 34 MPa 3000 psi to 5000 psi

- Compressive strength depends on specimen size

– Larger specimens = greater probability for weaker elements, reducing strength
– Larger specimens have less variability and better representation of actual concrete

II.2. Modulus of Elasticity – Ec

- ASTM C469 – determine the chord modulus.
- 3-4 loading steps are needed in this method. Same sample is used.
- A useful relationship with strength
- The range is 14 GPa – 41 GPa 2000 ksi to 6000 ksi

Poisson's Ratio

- Also determined using ASTM C469
- Range is between 0.11 to 0.21, depending on aggregate, moisture, age, and compressive strength

II.3. Split Tension Test

- Measures the tensile strength on concrete ASTM C496
- Cylinder is subjected to compressive load along vertical diameter at a constant rate until fatigue
- Failure occurs along vertical diameter due to tension developed in transverse direction
- Split tension is computed by T = 2p/BLD

T = tensile strength, MPa psi

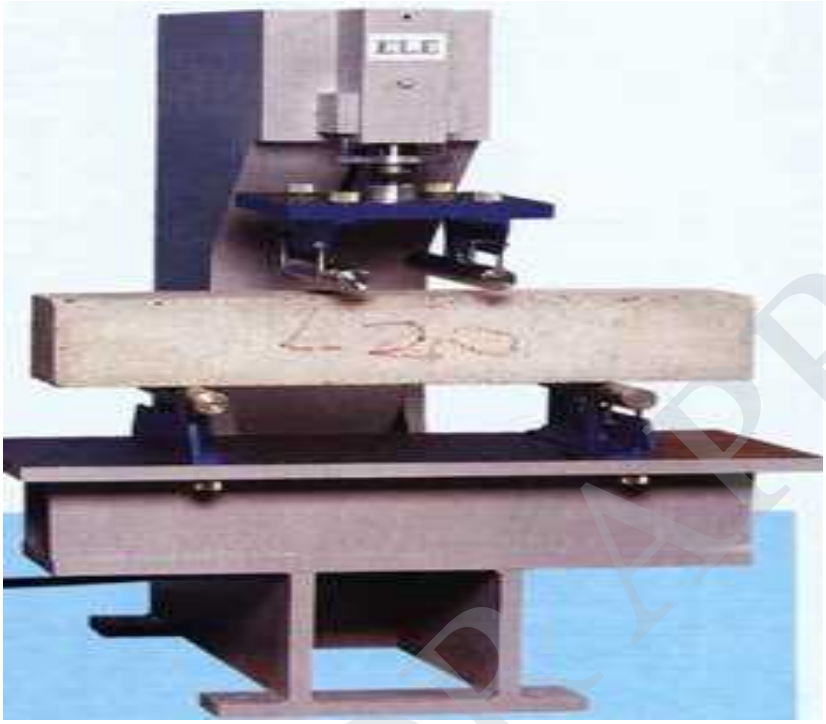
p= load at failure, N psi

L = length of specimen, mm in.

D = diameter of specimen, mm in.

- Tensile strength varies from 2.5 MPa to 31 MPa 360 psi to 450 psi, about 10% of compressive strength

II.4. Flexure Strength Test ASTM C78



- Used for measuring Modulus of Rupture MR)
- Important test for road and airport concrete pavements

Beam specimen of square x-section is loaded into a 3-point loading apparatus

II.5. Rebound Hammer Test Schmidt Hammer Test

- Non-destructive test performed on hardened concrete

– A spring-loaded mass hits the concrete's surface
– A scale measures how far the mass rebounds
– The higher the rebound, the harder the concrete's surface, and the greater the

concrete's strength

- Use a calibration chart graphs supplied to related the rebound to strength

– 10 to 12 reading are performed per specimen

- The test is used to test the uniformity of the concrete

II.6. Penetration Resistance Test Windsor Probe Test -A non-destructive test

- Gun-like device shoots probes into the concrete's structure

– Performed on each of three holes in a special template.

- An average depth is then found.

– Depth is inversely related to the strength.
– It gives a better estimate than the rebound hammer.
Rebound hammer tests only the surface while penetration resistance test make measurements into the depth of the sample
II.7. Ultrasonic Pulse Velocity Test ASTM C597

- Measures the velocity of an ultrasonic wave passing through the concrete
- The length between transducers/the travel time = average velocity of wave propagation
- It is used to detect discontinuities, cracks and internal deterioration in the structure of concrete

II.8. Maturity Test ASTM C1074

- Maturity – degree of cement hydration
- Varies with time and temperature
- It is assumed that the strength is a function of maturity for a particular concrete mixture
- Devices are used to measure the temperature of concrete with time

III. Permeability

Effects the durability of hardened concrete

- Allows water and chemicals to penetrate its surface
- Cause reduced resistance to

– frost
– alkali-aggregate reactivity and other chemicals
– corrosion of steel rebars

- Air voids that affect permeability are obtained from

– incomplete consolidation of fresh concrete
– evaporation of mixing water that is not used for hydration of cement

- Increasing the water/cement ratio has strong effects on permeability

· Other factors affecting permeability:

- age of concrete, fineness of cement particles, air entraining agents

IV. Creep Properties

Creep – The gradual increase in strain, with time, under sustained load

- Long term process several years)
- Vary with type of structure

– Increased deflection and increased stress in steel
– Gradual transfer of load from concrete to steel
– Losing some of the prestress force in prestressed concrete

PART – C (15 MARKS

1. Write down the complete procedure of concrete mix design as per BIS specifications. Assume necessary data. May/June2016)

Factors to be considered for mix design

The grade designation giving the characteristic strength requirement of concrete.

The type of cement influences the rate of development of compressive strength of concrete.

Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS 456:2000.

The cement content is to be limited from shrinkage, cracking and creep.

The workability of concrete for satisfactory placing and compaction is related to the size and shape of section, quantity and spacing of reinforcement and technique used for transportation, placing and compaction.

Procedure:

1. Determine the mean target strength f_t from the specified characteristic compressive strength at 28-day f_{ck} and the level of quality control.

   $f_t = f_{ck} + 1.65\ S$

   where S is the standard deviation obtained from the Table of approximate contents given after the design mix.

2. Obtain the water cement ratio for the desired mean target using the emperical relationship between compressive strength and water cement ratio so chosen is checked against the limiting water cement ratio. The water cement ratio so chosen is checked against the limiting water cement ratio for the requirements of durability given in table and adopts the lower of the two values.

3. Estimate the amount of entrapped air for maximum nominal size of the aggregate from the table.

4. Select the water content, for the required workability and maximum size of aggregates for aggregates in saturated surface dry condition from table.

5. Determine the percentage of fine aggregate in total aggregate by absolute volume from table for the concrete using crushed coarse aggregate.

6. Adjust the values of water content and percentage of sand as provided in the table for any difference in workability, water cement ratio, grading of fine aggregate and for rounded aggregate the values are given in table.

7. Calculate the cement content form the water-cement ratio and the final water content as arrived after adjustment. Check the cement against the minimum cement content from the requirements of the durability, and greater of the two values is adopted.

8. From the quantities of water and cement per unit volume of concrete and the percentage of sand already determined in steps 6 and 7 above, calculate the content of coarse and fine aggregates per unit volume of concrete from the following relations:

$$V = \left[W + \frac{C}{S_c} + \frac{1}{p}\frac{f_a}{S_{fa}}\right] \times \frac{1}{1000}$$

$$V = \left[W + \frac{C}{S_c} + \frac{1}{1-p}\frac{C_a}{S_{ca}}\right] \times \frac{1}{1000}$$

where V = absolute volume of concrete

= gross volume 1m ^{3} minus the volume of entrapped air

S_c = specific gravity of cement

W = Mass of water per cubic metre of concrete, kg

C = mass of cement per cubic metre of concrete, kg

p = ratio of fine aggregate to total aggregate by absolute volume

f_a, C_a = total masses of fine and coarse aggregates, per cubic metre of concrete, respectively, kg, and

S_{fa}, S_{ca} = specific gravities of saturated surface dry fine and coarse aggregates, respectively

9. Determine the concrete mix proportions for the first trial mix.

10. Prepare the concrete using the calculated proportions and cast three cubes of 150 mm size and test them wet after 28-days moist curing and check for the strength.

11. Prepare trial mixes with suitable adjustments till the final mix proportions are arrived at.

2. Write the short note on Production manufacture) of Concrete/Concrete Operations May/June2016)

PRODUCTION OF CONCRETE/CONCRETE OPERATIONS

The concrete operations i.e. the various operations required in production of concrete for a concrete construction project are listed down as follows;

i Storing

a Storing of cement

b Storing of aggregates

c) Storing of water

ii Batching

a Batching of cement

b Hatching of aggregates

c) Batching of water

iii Mixing

aHand mixing

bMachine -mixing

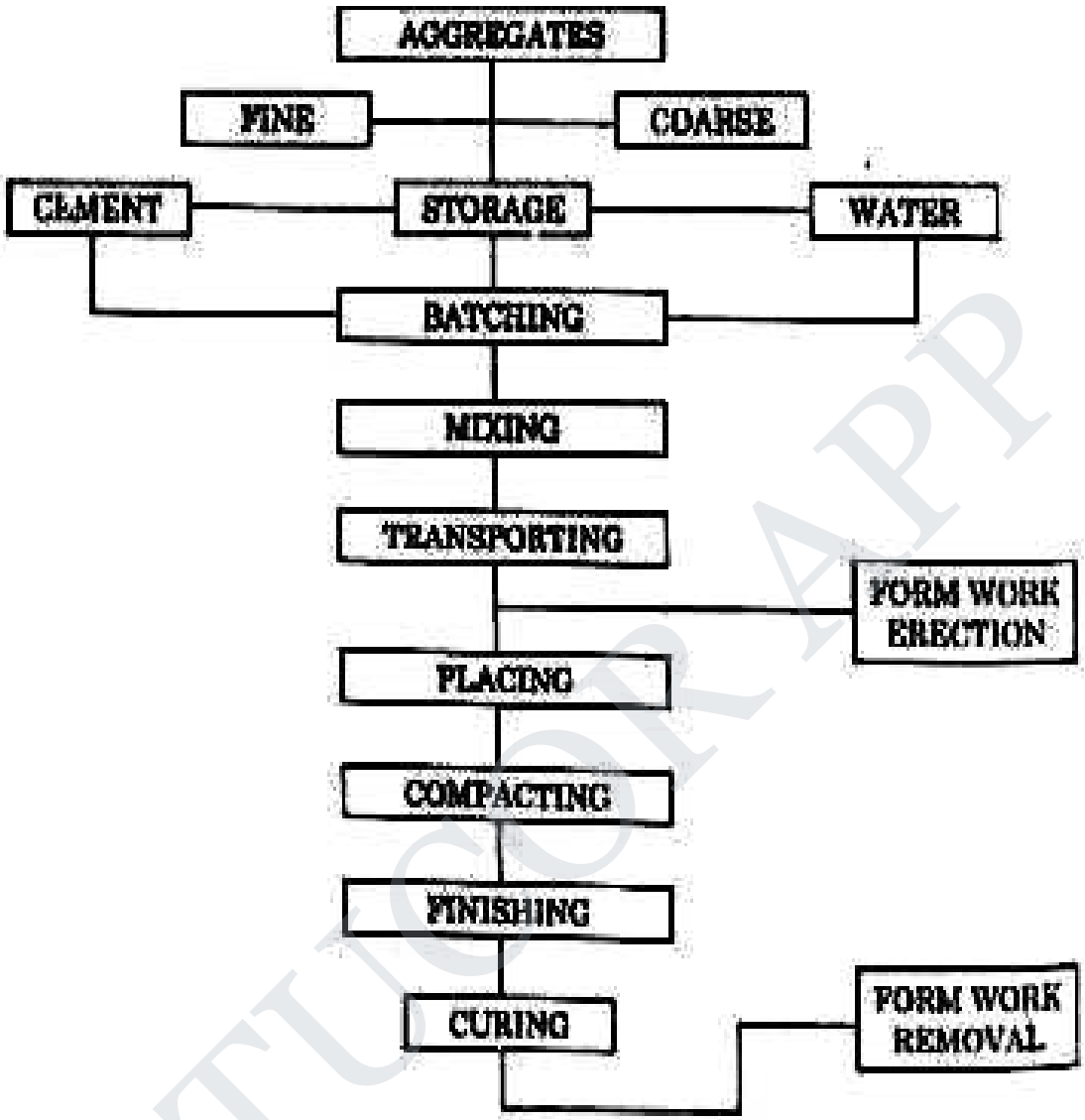
iv Handling and Transporting

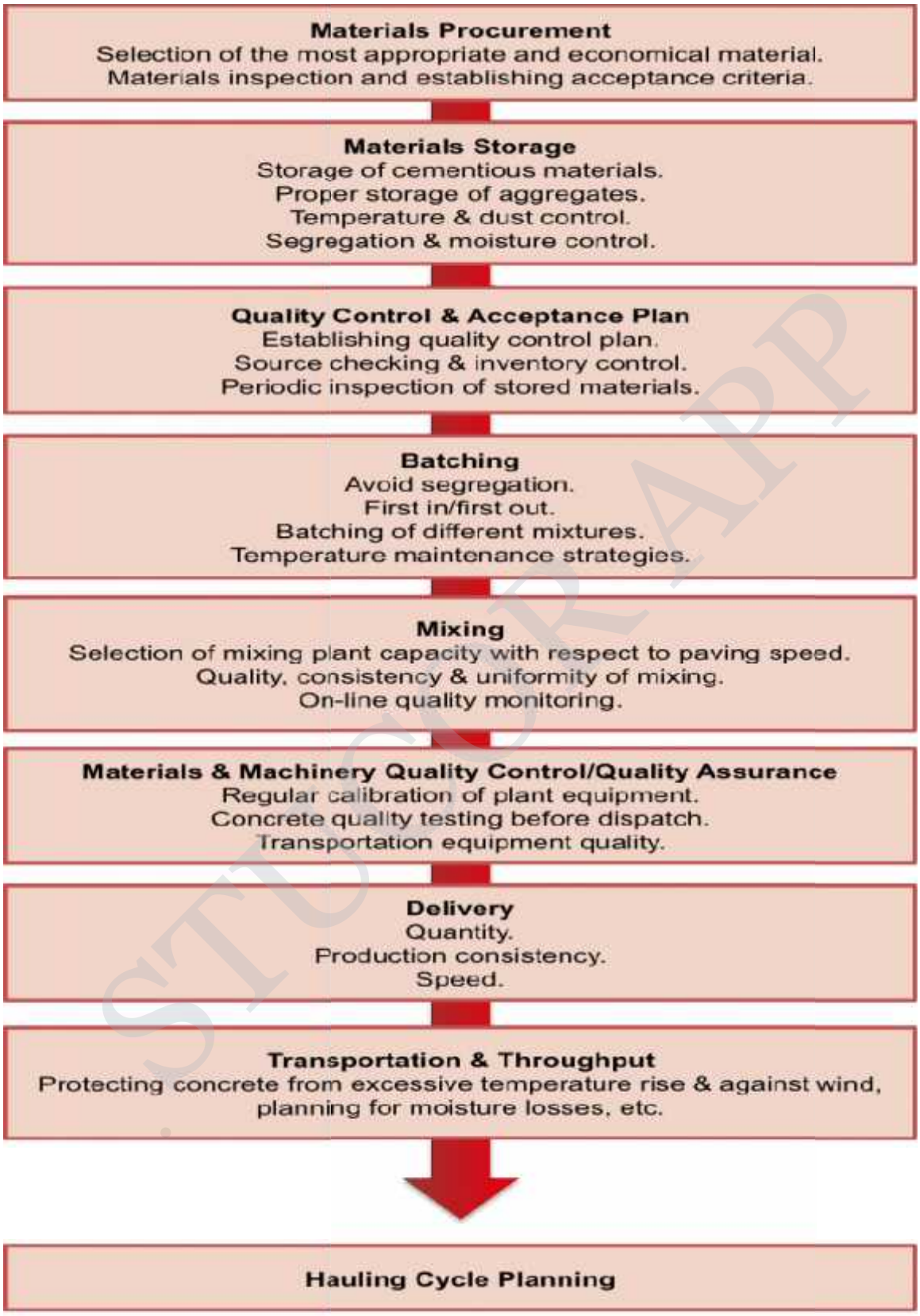
v) Placing

vi Compacting

vii Finishing

viii Curing





Graph originally printed in Iowa State University & Portland Cement Association's Guide for Roller-Compacted Concrete Pavements, August 2010.

Process of manufacture of concrete

1. **BATCHING**

   Batching is the process of measuring concrete mix ingredients by either mass or volume and introducing them into the mixer . To produce concrete of uniform quality, the ingredients must be measured accurately for each batch.

2. **Mixing** The mixing should be ensure that the mass becomes Homogeneous , uniform in colour and consistency .

   Methods of Mixing : 1.Hands(using hand shovels) 2.Stationary Mixers 3.Ready mix concrete

   Hand Mixing: Mixing ingredients of concrete by hands using ordinary tools like, hand shovels etc. This type of mixing is done for Less output of concrete.

   Stationary Mixers: Concrete is sometime mixed at jobsite in a stationary mixer having a size of 9 cubic meter. These mixers may be of : 1. Tilting type , 2. Non-Tilting type ,

   Tilting type mixer: It consist a conical drum which rotates on an inclinable axis. It has only one opening. The drum charged directly and discharged by tilting and reversing the drum.

   Non tilting type mixer : The mixing drum is cylindrical in shape and revolves two – horizontal axis. It has opening on both sides. The ingredients are charged in from one opening. For discharging concrete chute is introducing to other opening by operating a lever.

   Ready Mixed Concrete Ready mixed concrete is proportioned and mixed off at the project site and is delivered to the construction area in a freshly mixed and unhardened state. It can be manufactured by any of the following methods: 1.Central-mixed concrete¬ 2.Truck-mixed concrete.

3. **Transporting**

Mortar Pan : Concrete is carried in small Quantities

Wheelbarrows and Buggies : Short flat hauls on all types of onsite concrete construction

Belt Conveyors : Conveying concrete horizontally or higher/lower level.

Cranes and Buckets : Used forWork above ground level , Buckets use with Cranes, cableways, and helicopters.

Pumps : Conveying concrete from central discharge point to formwork.

Transit Mixer : used for transporting the concrete over long distance particularly in RMC plant .

4. **Compaction of concrete** Compaction of concrete is process adopted for expelling the entrapped air from the concrete. In the process of mixing , transporting and placing of concrete air is likely to get entrapped in the concrete. It has been found from the experimental studies that 1% air in the concrete approximately reduces the strength by 6%. If we don't expel this air, it will result into honeycombing and reduced strength

Different Methods Of Concrete Compaction

1 Hand Compaction Rodding Ramming Tamping

2 Compaction by Vibration

Internal vibrator . Formwork Vibrator

Table Vibrator, Platform vibrator

Surface vibrator .

Hand Compaction • Hand compaction is used for ordinary and unimportant structures. Workability should be decided in such a way that the chances of honeycombing should be minimum. The various methods of hand compaction are as given below: Roddingϖ It is a method of poking with 2m long, 16 mm dia.

rod at sharp corners and edges. The thickness of layers for rodding should be 15 to 20 cm.

Rammingϖ • It is generally used for compaction on ground in plain concrete. It is not used either in RCC or on upper floors. Tampingϖ • It is a method in which the top surface is beaten by wooden cross beam of cross section 10 cm x 10 cm. both compaction and leveling are achieved simultaneously. It is mainly used for roof slabs and road pavements.

Compaction by Vibration • Vibration is imparted to the concrete by mechanical means. It causes temporary liquefaction so that air bubbles come on to the top and expelled ultimately. Mechanical vibration can be of various types as given under. Internal Vibrationϖ It is most commonly used technique of concrete vibration. Vibration is achieved due to eccentric weights attached to the shaft. The needle diameter varies from 20 mm to 75 mm and its length varies from 25 cm to 90 cm. the frequency range adopted is normally 3500 to 5000 rpm. The correct and incorrect methods of vibration using internal vibration needles are shown below.

External Vibration • This is adopted where internal vibration can't be used due to either thin sections or heavy reinforcement. External vibration is less effective and it consumes more power as compared to the internal vibration. The formwork also has to be made extra strong when external vibration is used

Table Vibration • It is mainly used for laboratories where concrete is put on the table

Platform Vibration • t is similar to table vibrators but these are generally used on a very large scale

Surface Vibration • These are also called screed board vibrators. The action is similar to that of tamping. The vibrator is placed on screed board and vibration is given on the surface. It is mainly used for roof slabs, road pavements etc., but it is not effective beyond 15 cm depth.

UNIT IV

TIMBER AND OTHER MATERIALS

PART-A

1. What is timber?

Timber is obtained from trees. Timber denotes structural wood.

2.What is standing timber?

A standing living tree is known as standing timber.

3. What is rough timber?

When tree has been cut and its stem and branches are roughly converted into pieces of suitable lengths, it is known as rough timber.

4.What is converted timber?

When roughly converted timber is further sawn and converted into commercial sizes such as planks, logs, battens, posts, beams, etc, it is called converted timber.

5.What is conversion of timber?

The process by which timber is cut and sawn into suitable marketable sizes is known as conversion of timber.

6. Define seasoning of timber?(Nov/Dec 2015

A freshly felled tree contains lot of moisture which is usually in form of sap. The excess of moisture have to be removed, before timber can be used for any structural purposes.

The process of removing excess surplus moisture from freshly converted timber is known as seasoning of timber.

7.Name some common diseases of timber.

i Dry rot ii Wet rot

8. What is meant by distempering?

It is a process of applying wash or coating like white-washing or colour washing on the surface.

9. What is meant by varnish?

Varnish is a solution of some resinous substance in alcohol, oil or turpentine. The process of covering the surface with varnish is known as varnishing. Varnishing is done on wooden surface.

10.What are the constituents of the varnish?

- Resinous material
- Driers
- Solvents

11.What are the constituents of oil paints? Nov/Dec 2015

A base, an inert extender or filler, a vehicle or carrier, a drier, a solvent or thinner, a colouring pigment.

12.Define glazing.

It is a process of covering the earthen ware, stone ware and porcelain products with an impervious film of glaze. It is a glassy coat of about 0.1 to 0.2 mm thickness, applied on the surface and then fused into the product by burning at high temperature.

13. Write notes on Varnishes.

Varnish is a transparent, hard, protective finish or film primarily used in wood finishing but also for other materials. Varnish is traditionally a combination of a drying oil, a resin, and a thinner or solvent.

Varnish finishes are usually glossy but may be designed to produce satin or semi-gloss sheens by the addition of "flatting" agents.

14. What is bitumen?

- Bitumen is a sticky, black and highly viscous liquid or semi-solid form of petroleum.
- It may be found in natural deposits or may be a refined product.

15. Define Plywood.

Plywood is a laminate made of thin layers of wood.

16. Write about Veneer.

- In woodworking, veneer refers to thin slices of wood, usually thinner than 3 mm, that typically are glued onto core panels typically, wood, particle board or medium-density fibreboard to produce flat panels such as

doors, tops and panels for cabinets, parquet floors and parts of furniture.

17. List the application of Aluminium composites.May/June 2016

A popular application for aluminium composite is folded structures. From sign trays to fascia panels and column cladding aluminium composite is easy to form and light enough to install easily. Using the correct type of tooling aluminium composite can be scored and then folded.

18. Write notes on Paint.

Paint is any liquid, liquefiable, or mastic composition that, after application to a substrate in a thin layer, converts to a solid film. It is most commonly used to protect, colour, or provide texture to objects.

19. What is a binder?

The binder is the film-forming component of paint. It is the only component that must be present. The binder imparts adhesion and strongly influences properties such as gloss, durability, flexibility, and toughness.

20. What are the Advantages of using veneer?

Furniture made with wood veneer uses less wood than the same piece of furniture made with solid wood. Some projects built using wood veneer would not be possible to construct using solid lumber, owing to expansion and contraction caused by fluctuation of temperature and humidity.

21. List the applications of Thermocole.Apr/May 2015

Its high thermal insulation makes it an excellent material to use in the construction of walls and ceilings and its high sound absorption makes it the ideal choice forsound-proofing.

Another recent application of Thermocol EPS is as —Geofoaml in landfills.

This application is made possible because of Thermocol's(EPS's) light weight,water resistance, dimensional stability and inert nature.

22. list the various forms of steelMay/June 2016

Mild steel bars

High yield strength deformed bars

UNIT IV

TIMBER AND OTHER MATERIALS

PART-B 13MARKS)

1. **Write notes on Aluminium Composite. Apr / May 2015)**

Aluminium Composite material:

- Composite materials can be selected to give combination of properties such as stiffness, strength, high temperature performance, corrosion resistance, hardness, conductivity etc. Aluminium matrix composites are finding wide range of applications in automobile, aerospace, defence and general engineering sectors, because of their higher specific strength and stiffness, good wear and seizure resistance and improved high temperature properties as compared to the base alloy.
- The strength and wear resistance of AMCs were found to be comparable to cast irons. AMCs are lighter than cast iron or steels and the former one have better specific strength and wear resistance as compared to the later one.
- Thus, considerable efforts are being made to replace these components with AMCs. It will not only improve the life of components but also reduce the weight and improve the fuel efficiency Aluminium composite is a lightweight panel material which is designed for interior and exterior applications.
- Aluminium Composite sheet has a polyethylene core. This make up 90% of the structure of each sheet. Depending on which brand of Aluminium Composite you use this core will be either a Clear/ Grey or Black colour.
- The polyethylene core of your Aluminium Composite sheet is faced with two thin sheets of aluminium. This aluminium is bonded onto the core during the manufacturing process and it is virtually impossible to separate the layers of material once they have been bonded.
- The applications for aluminium composite are wide and varied. Versatile lightweight and durable material aluminium composite performs well for internal and external applications.
- Addition of second phase particles to aluminium based alloys has emerged as a

potential technique for the development of aluminium - alloy composite materials especially suitable for structural and elevated temperature applications.

- In this case, usually one set of properties is improved at the cost of the other and hence a compromise has to be made in the case of composite materials in this regard.
- Much lighter than other metal and plastic sheet aluminium composite allows the creation of lightweight yet strong structures.
- Manufactured from plastic and aluminium this material is easy to handle and simple to machine.
- A popular application for aluminium composite is folded structures. From sign trays to fascia panels and column cladding aluminium composite is easy to form and light enough to install easily.

2. Explain applications of Bitumens. May/June 2016)

- Bitumen is a sticky, black and highly viscous liquid or semi-solid form of petroleum. It
  may be found in natural deposits or may be a refined product; it is a substance classed as a pitch.
- Bitumen is an oil based substance. It is a semi-solid hydrocarbon product produced by removing the lighter fractions such as liquid petroleum gas, petrol and diesel from heavy crude oil during the refining process. As such, it is correctly known as refined bitumen.
- The primary use of asphalt/bitumen is in road construction, where it is used as the glue or binder mixed with aggregate particles to create asphalt concrete. Its other main uses are for bituminous waterproofing products, including production of roofing felt and for sealing flat roofs.
- The vast majority of refined bitumen is used in construction: primarily as a constituent of products used in paving and roofing applications. According to the

requirements of the end use bitumen is produced to specification.

- This is achieved either by refining process or blending. The production of asphalt involves mixing sand, gravel and crushed rock with bitumen, which acts as the binding agent. Other materials, such as polymers, may be added to the bitumen to alter its properties according to the application for which the asphalt is ultimately intended.
- **85%** of all the bitumen produced is used as the binder in asphalt for roads. It is also used in other paved areas such as airport runways, car parks and footways. A further 10% of global bitumen production is used in roofing applications, where its waterproofing qualities are invaluable.
- The remaining 5% of bitumen is used mainly for sealing and insulating purposes in a variety of building materials, such as pipe coatings, carpet tile backing and paint.
- Naturally occurring asphalt/bitumen is sometimes specified by the term "crude bitumen". Its viscosity is similar to that of cold molasses while the material obtained from the fractional distillation of crude oil boiling at **525 °C 977 °F)** is sometimes referred to as "refined bitumen".

3. Explain in detail the application of timber in construction. May/June 2016)

- In comparison with other construction materials, using timber is energy saving. The manifold material values can also be expanded with the material selection.
- The selection between different materials like round wood, squared wood, sawn wood or glued laminated timber which has been improved through industrial methods, or different sorts of plywood, provides different resistance qualities with economical and competitive construction possibilities.
- Wood sections are a further quality to take into account beside resistance criteria when using round- or sawn wood.
- The treatment preceding the drying and the considering of the extension of the

year rings in different forms of sections, as well as the profiles of the wood sections are most important for an economical formation of detail in the constructive use of timber.

Techniques and Means of Assembling

- New highly efficient means of assembling, i.e. connections with lower section weakening and needs of steal, have to be developed for a highest possible degree of pre-fabrication in the workshop and in order to reduce the working time on the site as much as possible.
- The use of new connecting systems like nailed tinplate's, screws, lag bolts as well as connectors with wood contact allow a much higher quality of more filigree supporting systems when linked with deterministic non-destructive testing methods in order to avoid sporadic problems, which arise in highly stressed construction elements. Connectors combining fiberglass and mechanical fasteners allow also a noticeable increase in the load capacity, as shown in a recent study on fiberglass reinforced timber joints.
- In order to give timber a new chance as a construction material, the different research development and marketing programs should not aim at the quantity of material used, but at the manifold quality of material steadiness, section variability, material diversity as well as facilitated construction control and quick usage of the new techniques in timber engineering construction.
- Timber as load-bearing material has only a chance if the conception of the construction can show a quality which is not only functional, technical or architectural, but which can also justify its economy.
- This presupposes, how-ever, a more important planning and a better cooperation between architect and engineer, in order to make the most of the diversity of forms, structures and techniques applicable to timber.
- It is essential to define clearly the quality criteria of a timber construction and to aim at reading easily the force and load fluctuations, and reducing the material through load- and detail planning with an optimally functional adaptation to technique and construction.

New Techniques in Timber Construction

- The increasing use of timber in the construction depends on engineering developments of timber as a load-bearing material, in order to raise the modest portion of the total construction volume from about 1 per cent to perhaps 2 or 3 per cent.
- The criteria of development are: better evaluation of the timber quality, increase of the diversity and better treatment of material varieties, development of new time-sparing assembling techniques which allow the highest possible degree of pre-fabrication.
- Quantity related techniques for floors, walls and roofs of the dense housing and public buildings linked with other massive construction materials, as well as quality related high-tech systems, which play a significant role in the modern architecture of roof, hall and bridge construction, should correct the image of timber and offer a competitive alternative to other materials used in construction.
- The material selection is no proof for "good architecture". It is, however, an important contribution to the environmental conservation, even if it needs more concentration on the planning phase.

4. Write short notes on Plywood, Veneer and Thermacole? May/June 2016) Nov / Dec 2015)

VENEER

- In woodworking, veneer refers to thin slices of wood, usually thinner than 3 mm 1/8 inch, that typically are glued onto core panels typically, wood, particle board or medium-density fibreboard to produce flat panels such as doors, tops and panels for cabinets, parquet floors and parts of furniture.
- Plywood consists of three or more layers of veneer, each glued with its grain at right angles to adjacent layers for strength.
- Veneer beading is a thin layer of decorative edging placed around objects, such as jewellery boxes. Veneer is also used to replace decorative papers in Wood

Veneer HPL. Veneer is also a type of manufactured board.

- Veneer is obtained either by "peeling" the trunk of a tree or by slicing large rectangular blocks of wood known as flitches.
- The appearance of the grain and figure in wood comes from slicing through the growth rings of a tree and depends upon the angle at which the wood is sliced. There are three main types of veneer-making equipment used commercially:
- A rotary lathe in which the wood is turned against a very sharp blade and peeled off in one continuous or semi-continuous roll. Rotary-cut veneer is mainly used for plywood, as the appearance is not desirable because the veneer is cut concentric to the growth rings.
- A slicing machine in which the flitch or piece of log is raised and lowered against the blade and slices of the log are made. This yields veneer that looks like sawn pieces of wood, cut across the growth rings; such veneer is referred to as "crown cut".
- A half-round lathe in which the log or piece of log can be turned and moved in such a way as to expose the most interesting parts of the grain.
- Each slicing processes gives a very distinctive type of grain, depending upon the tree species. In any of the veneer-slicing methods, when the veneer is sliced, a distortion of the grain occurs.
- As it hits the wood, the knife blade creates a "loose" side where the cells have been opened up by the blade, and a "tight" side.

Types:

- **Raw** veneer has no backing on it and can be used with either side facing up. It is important to note that the two sides will appear different when a finish has been applied, due to the cell structure of the wood.
- **Paper backed** veneer is, as the name suggests, veneers that are backed with paper. The advantage to this is it is available in large sizes, or sheets, as smaller pieces are joined together prior to adding the backing.
- This is helpful for users that do not wish to join smaller pieces of raw veneers together. This is also helpful when veneering curves and columns as the veneer is less likely to crack.

- **Phenolic backed** veneer is less common and is used for composite, or manmade wood veneers. Due to concern for the natural resource, this is becoming more popular. It too has the advantage of being available in sheets, and is also less likely to crack when being used on curves.

Laid up veneer is raw veneer that has been joined together to make larger pieces. The process is time-consuming and requires great care, but is not difficult and requires no expensive tools or machinery. Veneers can be ordered through some companies already laid up to any size, shape or design.

Reconstituted veneer is made from fast-growing tropical species. Raw veneer is cut from a log, and dyed if necessary. Once dyed, the sheets are laminated together to form a block. The block is then sliced so that the edges of the laminated veneer become the —grain of the reconstituted veneer

Advantages:

Furniture made with wood veneer uses less wood than the same piece of furniture made with solid wood. Some projects built using wood veneer would not be possible to construct using solid lumber, owing to expansion and contraction caused by fluctuation of temperature and humidity.

THERMACOLE:

- Its high thermal insulation makes it an excellent material to use in the construction of walls and ceilings and its high sound absorption makes it the ideal choice for sound-proofing.
- Another recent application of Thermocol EPS is as —Geofoaml in landfills. This application is made possible because of Thermocol's EPS's) light weight, water resistance, dimensional stability and inert nature.

Construction with EPS

- By using EPS rigid foam, architects and construction engineers today are also at the same time making use of the opportunity presented by system solutions and incorporate them in their plans appropriately for the functions concerned.

- The trend is clearly toward specific insulation systems, such as external wall and roof insulation systems, under floor heating systems etc. Such systems give the owner of a building under construction not only considerable cost/benefit advantages but also reduce the risk of technical errors in the planning and execution of work. Even today, 4 decades after its invention, EPS has lost nothing of its attractiveness and is more a part of today's construction industry than ever.

Roof constructions with EPS:

- From the viewpoint of construction physics, the roof, nomatter of what design, is the most highly stressed party of a building. Heat and Cold, dryness and wetness, storms and snow act from the outside, internal relative humidity acts from inside, either alternately or both at the same time.
- Roof designs and materials have to be adapted to these conditions if the roof is to fulfill its protective function. Plastics play a significant part in this connection as insulation layers, waterproofing membranes, vapor barriers, underlays, gutters, downpipes and many other functional elements. Whether a flat.

Flat roofs: Flat roof insulation is an important field of application for EPSThermocolsheets.

- Depending on the roof design, the insulation material is laid loosely, fixed by hot or cold adhesive or mechanically fastened to the underlying surface. The insulation of a non ventilated flat roof is performed simply and economically by means of insulation units of EPS which have been precoated with roofing felt.

Pitched roofs: In many countries, use of the roof space for living purposes is already consideration during the planning of a building.

- Even on existing buildings, roof space is increasingly being developed as additional living areas for guest rooms, play rooms or hobby rooms. Adequate thermal insulation of the roof surface – as the area bounding indoors from outdoors – must be provided.

Wall constructions with EPS: A wall is both a load-bearing and a protective building unit.It protects the surrounded space against the effects of temperature and weather and against noise.

- Nowadays, the thermal insulation function is assumed by modern insulating materials, such as EPS sheets. In what is the optimum type of external insulation from a construction physics viewpoint, the EPS insulating layer is applied on the outside of the load-bearing masonry and weather-protected either by a reinforced special plaster or by a ventilated facing layer

Insulating plaster A further possibility of improving the thermal insulation of external wallsis to coat them with a thermally insulating lightweight plaster.

- In this case, small, foamed EPS particles are added to the plastering mortar mix, substantially reducing the apparent density of the plaster and thus increasing its thermal insulation.

Lightweight concrete Foamed EPS beads are not only suitable for lightweight plasters, butalso for the production of lightweight concrete and porous bricks.

- The possible applications of EPS concrete as a thermally insulating, light-weight construction material have already been investigated and formulations for various apparent density ranges with different concrete properties developed.

Prefabricated Systems The use of EPS sheets as thermal insulation in large format façadeunits of normal concrete sandwich construction has long since proven successful.

- The high mechanical load-bearing capacity and dimensional stability of EPS sheets also make possible a trouble-free production of large panel lightweight units which can be covered with various materials depending on the intended application.

PLYWOOD

- Itis a sheet material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to90 degrees to one another.
- It is an engineered wood from the family of manufactured boards which includes medium-density fibreboard MDF) and particle board chipboard.

- All plywoods bind resin and wood fiber sheets cellulose cells are long, strong and thin to form a composite material. T his alternation of the grain is called cross-graining and has several important benefits: it reduces the tendency of wood to split when nailed at the edges; it reduces expansion and shrinkage, providing improved dimensional stability and it makes the strength of the panel consistent across all directions.
- There are usually an odd number of plies, so that the sheet is balanced—this reduces warping. Because plywood is bonded with grains running against one another and with an odd number of composite parts, it is very hard to bend it perpendicular to the grain direction of the surface ply.
- Smaller thinner plywoods and lower quality plywoods see Average -quality plywood photo below and right may only have their plies layers) arranged at rightangles to each other, though many better quality plywood products will by design have five plies in steps of 45 degrees 0, 45, 90, 135, and 180 degrees), giving strength in
  Multiple axis.
- The highest quality specialty plywood often have plies at 30 degrees 0,30, 60, 90, 120, 150, and 180 degrees) in seven layers, or have nine layers with two layers of 45 and 135 degrees in the sandwich. The smaller the step rotations the harder it is to manufacture, increasing manufacturing costs and consequently retail price.

Types

Different varieties of plywood exist for different applications:

a Softwood plywood &Hardwood plywood

b) Tropical plywood

c Aircraft plywood

d) Decorative plywood overlaid plywood)

e Flexible plywood

f Marine plywood

g) Other plywood

Applications

- Plywood is used in many applications that need high-quality, high-strength sheet material. Quality in this context means resistance to cracking, breaking, shrinkage, twisting and warping.
- Exterior glued plywood is suitable for outdoor use, but because moisture affects the strength of wood, optimal performance is achieved in end uses where the wood's moisture content remains relatively low.
- On the other hand, sub-zero conditions don't affect plywood's dimensional or strength properties ,which makes some special applications possible.
- Plywood is also used as an engineering material for stressed-skin applications. Ithas been used for marine and aviation applications since WWII. Most notable is the British de Havilland Mosquito bomber, which was primarily made using a moulded sandwich of two layers of birch plywood around a balsa core.
- Plywood was also used for the hulls in the hard-chine Motor Torpedo Boats MTB and Motor Gun Boats MGBbuilt by the British Power Boat Company and Vosper's.

Softwood plywood applications

Typical end uses of spruce plywood are:

- Floors, walls and roofs in home constructions
- Wind bracing panels
- Vehicle internal body work
- Packages and boxes
- Fencing

There are coating solutions available that mask the prominent grain structure of spruce plywood. For these coated plywood there are some end uses where reasonable strength is needed but the lightness of spruce is a benefit e.g.:

Concrete shuttering panels

Ready-to-paint surfaces for constructions

Hardwood plywood applications

Phenolic resin film coated Film Faced plywood is typically used as a ready -to-install component e.g.:

1. Panels in concrete form work systems
2. Floors, walls and roofs in transport vehicles
3. Container floors
4. Floors subjected to heavy wear in various buildings and factories
5. Scaffolding materials

"Wire" or other styles of imprinting available for better traction

Birch plywood is used as a structural material in special applications e.g.:

1. Wind turbine blades
2. Insulation boxes for liquefied natural gas LNG carriers Smooth surface and accurate thickness combined with the durability of the material makes birch plywood a favorable material for many special end uses e.g.:
   1. High-end loud speakers
   2. Die-cutting boards
   3. Supporting structure for parquet
   4. Playground equipment
   5. Furniture
   6. Signs and fences for demanding outdoor advertising
   7. Musical instruments
   8. Sports equipment

Tropical plywood applications

- Tropical plywood is widely available from the South-East Asia region, mainly from Malaysia and Indonesia. Tropical plywood boasts premium quality, and strength. Depending on machinery, tropical plywood can be made with high accuracy in thickness, and is a highly preferable choice in America, Japan, Middle East, Korea, and other regions around the world.

1. Common plywood
2. Concrete panel
3. Floor base
4. Structure panel

5. Container flooring
6. Lamina board
7. Laminated veneer lumber LVL

5. Explain in detail about Panels of Laminates.

- Laminate panel is a type of manufactured timber made from thin sheets of substrates or wood veneer. It is similar to the more widely used plywood, except that it has a plastic, protective layer on one or both sides. Laminate panels are used instead of plywood because of their resistance to impact, weather, moisture, shattering in coldductility, and chemicals.
- Laminate panel layers called veneers) are glued together with adjacent plies having their grain at right angles to each other for greater strength. The plastic layers)added for protection vary in composition, thickness, colour and texture according to the application.

Types

A number of varieties of laminate panel exist for different applications.

- Plywood + ABS laminate panels
- Plywood + FRP laminate panels
- Plywood + aluminum laminated panels
- Lightweight composite panels

Sizes

- The most commonly used thickness range from 1/8" to 1/2" and 3/8", in a variety of colours and textures.

Applications

Laminate panels are used in many applications that need weather-proof, impact resistant sheet material. Typical end uses of spruce plywood are:

- Floors, walls and roofs in clean rooms
- Vehicle internal body work
- Packages and boxes
- Road cases

6. Explain in detail about Manufacturing Methods of Steel.Apr/May2015)

- Steel is the most suitable building material among metallic materials. This is due to awide range and combination of physical and mechanical properties that steels can have.By suitably controlling the carbon content, alloying elements and heat treatment, adesired combination of hardness, ductility, and strength can be obtained in steel. On thebasis of carbon content steel may be classified as under:

Type of steel	**Carbon content %**
Dead mild steel	< 0.15
Mild steel	0.15–0.3
Medium carbonsteel	0.3–0.8
High carbon steel	0.8–1.5
Hard steel	> 1 is also called cast steel or toolsteel

Manufacturing Methods

The prominent steel-making processes are:

1. Bessemer process
2. Cementation process
3. Crucible process
4. Open Hearth process
5. Electric Smelting process
6. Duplex process
7. Lintz and Donawitz L.D. process

- The most prominent present-day steel-making process is the Bessemer process was introduced in 1856. The pig iron is first melted in Cupola furnace and sent to Bessemer converter Blast of hot air is given to oxidize the carbon.
- Depending upon the requirement, some carbon and manganese is added to the converter and hot air is blasted once again. Then the molten material is poured into moulds to form ingots. L.D. process is modification of the Bessemer process in which there in no control over temperature.

- By this method steel can be made in hardly 25 minutes. In Open-hearth process also known as Siemen's-Martin process, the steel produced is more homogeneous than by Bessemer's.
- The electric process is costly but no ash or smoke is produced. The Crucible process involves melting of blister steel or bars of wrought iron in fire clay crucibles.
- Cast steel so obtained is very hard and is used for making surgical equipment. The Duplex process is a combination of Acid Bessemer process and Basic Open Hearth process.

Properties and Uses

Mild Steel Also known as low carbon or soft steel. It is ductile, malleable; tougher and more elastic than wrought iron. Mild steel can be forged and welded, difficult to temper and harden. It rusts quickly and can be permanently magnetized.

- The properties are: Sp.gr. = 7.30, ultimate compressive and tensile strengths 800–1200N/mm2 and 600–800N/mm^2.
- Mild steel is used in the form of rolled sections, reinforcing bars, roof coverings and sheet piles and in railway tracks.

High Carbon Steel: The carbon content in high carbon steel varies from 0.55 to1.50%. It is also known as hard steel. It is tougher and more elastic than mild steel.

- It can be forged and welded with difficulty. Its ultimate compressive and tensile strengths are 1350 N/mm2 and 1400–2000 N/mm2, respectively.
- Its Sp. gr. is 7.90. High carbon steel is used for reinforcing cement concrete and prestressed concrete members. It can take shocks and vibrations and is used for making tools and machine parts.

High Tensile steel: The carbon content in high tensile steel is 0.6–0.8%, manganese 0.6%, silicon 0.2%, sulphur 0.05% and phosphorus 0.05%.

- It is also known as high strength steel and is essentially a medium carbon steel. The ultimate tensile strength is of the order of 2000 N/mm2 and a minimum elongation of 10 per cent.
- High Tensile steel is used in prestressed concrete construction.

Properties of Steel

- The factors influencing the properties of steel are chemical composition, heat treatment, and mechanical work.

Chemical Composition

- The presence of carbon in steel gives high degree of hardness and strength. Then addition of carbon to iron decreases the malleability and ductility of the metal, and reduces its permeability to magnetic forces.
- The tensile strength of hot rolled steel bars is maximum between 1.0 and 1.2 per cent carbon. The elastic limit and the ultimate strength of steel increase with carbon content but at a lower rate. The compressive strength of steel increases directly with carbon content up to 1.0 per cent.

7. Explain the Characteristics Of An Ideal Paint.

- The requirements are uniform spread as a thin film, high coverage, good workability and durability, sufficient elasticity to remain unaffected by expansion or contraction of the surface to be painted or by weathering action of atmosphere. The paints should also be: impervious to air and water, cheap and economical to form a hard surface.

Preparation of Paint

The base is ground in a vehicle to the consistency of paste in a stone pestle known as

muller. Linseed oil, is intermittently added to the paste in small quantities and the mixture is stirred with a wooden puddle. In case of coloured paints, the pigment is mixed with linseed oil separately and the paste is formed as explained above.

- Driers are also ground separately in linseed oil. The three pastes so prepared are mixed and a little linseed oil is added further to soften the paste. The mixture is continuously stirred till a consistency of cream is obtained.

- The mixture is thereafter strained through fine canvas or a sieve. The paint is now ready for use. The paint so prepared can be used by adding oil or a thinner to make it of workable consistency before application.
- For commercial manufacturing of paints a four-storey building is used to have gravitational flow of materials. Pigments, oil, thinner, plasticizer, drier, etc. are stored on the fourth floor and are fed by means of chutes in proper proportions, to the grinding mill placed on the third floor and are ground.
- The thoroughly ground materials are then sent to storage tanks on the second floor. The charge in the tanks is kept in motion by agitation mechanism so that settling of materials does not take place.

The factors affecting the quality of paint so prepared are quality of ingredients, grinding, intimate mixing and proportioning, straining, packing, etc. Ready mixed paints are also available in the market with different trade names, e.g., Asian, Ducco, Shalimar, Berger Nerolac, etc.

8. Enumerate the advantages of aluminium in construction.

Applications

The best application can be obtained in some typical cases, which are characterised in getting profit at least of one of the main basic properties: lightness, corrosion resistance and functionality. The structural applications which best fit these properties in the field of civil engineering are the following:

1. Long-span roof systems in which live loads are small compared with dead loads, as in the case of reticular space structures and geodetic domes covering large span areas, like halls and auditoriums.

2. Structures located in inaccessible places far from the fabrication shop, for which transport economy and ease of erection are of extreme importance, like for instance electrical transmission towers, which can be carried by helicopter.

3. Structures situated in corrosive or humid environments such as swimming pool roofs, river bridges, hydraulic structures and offshore super-structures.

4. Structures having moving parts, such as sewage plant crane bridges and moving bridges, where lightness means economy of power under service.

5. Structures for special purposes, for which maintenance operations are particularly difficult and must be limited, as in case of masts, lighting towers, antennas towers, sign motorway portals, and so on.

Advantages

1. Lightweight

Aluminium is one of the lightest available commercial metals with a density approximately one third that of steel or copper.

2. Excellent Corrosion Resistance

Aluminium has excellent resistance to corrosion due to the thin layer of aluminium oxide that forms on the surface of aluminium when it is exposed to air

3. Strong at Low Temperatures

Where as steel becomes brittle at low temperatures, aluminium increases in tensile strength and retains excellent toughness.

4. Easy to Work

Aluminium can be easily fabricated into various forms such as foil, sheets, geometric shapes, rod, tube and wire.

5. Easy Surface Treatment

For many applications, aluminium requires no protective or decorative coating; the surface supplied is entirely adequate without further finishing

Disadvantages:

1. Thermal insulation was almost definitely insufficient: aluminium being a good thermal conductor.

2. Poor water proofing due to the inadequately designed/executed joints between the roof aluminium sheets
3. General noise caused by rain or hail falling on aluminium roof and wall sheets.

Aluminium is the second most widely specified metal in buildings after steel, and is used in all construction sectors, from commercial buildings to domestic dwellings. 40% of the UK annual production of aluminium is utilized within the construction industry, which equates to roughly 150,000 tonnes of aluminium per annum, of which approximately 65,000 tonnes is extruded products, and 25,000 tonnes sheet materials.

The main market sectors are windows, roofing, cladding, curtain walling and structural glazing, prefabricated buildings, architectural hardware, H&V, shop fitting and partitions. Aluminium is also used extensively in plant, ladders and scaffolding.

Skyscrapers
Pavilions
Sports Facilities

PART – C (15 MARKS

1. Discuss the possible sources of defects in timber.

Defects in timber

Since timber is a natural product, developed through many years of growth in the open air, exposed to continual and varying climate conditions, it is prone to many defects.

Defects cannot be corrected and therefore each individual piece must be inspected before use and judged on its own merits. Defects can be caused during growth, during drying, through insects, through fungi or during subsequent

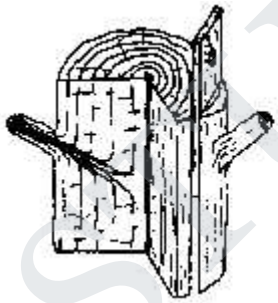
handling or machining, and each should be known, so that imperfect pieces can be detected and rejected.

a During growth

- Shake is called a partial or complete separation between adjoining layers of wood, due initially to causes other than drying. The three types are Heart shake, Cup shake and Star shake.

Starshake **Heartshake** **Cupshake**

- Knots can be caused by a branch or limb being cut through the process of sawing up the log. Knots are classified in two groups: live knot and dead knot. Live knot is left by a branch when the tree is felled.



Live knot

- Dead knot is left by branches that have been cut off or broken before felling, and which cannot be relied on to remain in position in the piece.

Dead knot

- Gum pocket is a cavity which has contained or contains gum.

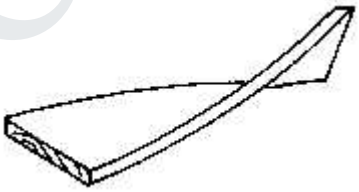
Gum pocket

b During or after drying process

- Bow is a deviation from the flat, the piece being arched.

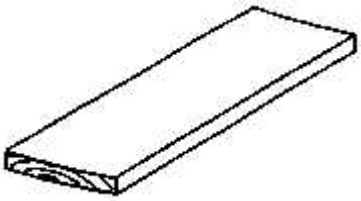
Bow

- Twist is a spiral distortion along the length of a piece of timber.



Twist

- Cup is a curvature across the width of a piece of timber.



Cup

c) Defects through insects

- Termites or white ants attack timber structures and are a serious problem in Papua New Guinea.

The species that causes the damage live in the ground. Precautions involve treating timber with a preservative or avoiding direct timber contact with the ground.

Types of termite damage

Left unchecked termites eat the wood, leaving the outer shell intact. Often their presence is not evident until serious damage has occurred

2. **Write notes on Paints, Varnishes and Distempers? May/June 2016) Nov / Dec 2015**

PAINTS,

- **Paint** is any liquid, liquefiable, or mastic composition that, after application to a substrate
  in a thin layer, converts to a solid film. It is most commonly used to protect, colour, or provide texture to objects.
- Paint can be made or purchased in many colours—and in many different types,

such as watercolour, artificial, etc. Paint is typically stored, sold, and applied as a liquid, but dries into a solid.

- The **binder**, commonly called the vehicle, is the film-forming component of paint. It is the only component that must be present. Components listed below are included optionally, depending on the desired properties of the cured film.
- The binder imparts adhesion and strongly influences properties such as gloss, durability, flexibility, and toughness.
- Binders include synthetic or natural resins such as alkyds, acrylics, vinyl-acrylics, vinyl acetate/ethylene VAE, polyurethanes, polyesters, melamine resins, epoxy, or oils.
- Binders can be categorized according to the mechanisms for drying or curing. Although drying may refer to evaporation of the solvent or thinner, it usually refers to oxidative cross-linking of the binders and is indistinguishable from curing. Some paints form by solvent evaporation only, but most rely on cross-linking processes.
- The main purposes of the **diluents** are to dissolve the polymer and adjust the viscosity of the paint. It is volatile and does not become part of the paint film.
- It also controls flow and application properties, and in some cases can affect the stability of the paint while in liquid state.
- Its main **function** is as the carrier for the non volatile components.
- To spread heavier oils for example, linseed as in oil -based interior house paint, a thinner oil is required.
- These volatile substances impart their properties temporarily—once the solvent has evaporated, the remaining paint is fixed to the surface.
- This component is optional: some paints have no diluent. Water is the main diluent for water-borne paints, even the co-solvent types. Solvent-borne, also called oil-based, paints can have various combinations of organic solvents as the diluent, including aliphatics, aromatics, alcohols, ketones and white spirit.
- Specific examples are organic solvents such as petroleum distillate, esters, glycol ethers, and the like. Sometimes volatile low-molecular weight synthetic resins also serve as diluents.

- **Pigments** are granular solids incorporated in the paint to contribute color. Fillers are granular solids incorporate to impart toughness, texture, give the paint special properties, or to reduce the cost of the paint. Alternatively, some paints contain dyes instead of or in combination with pigments.
- **Fillers** are a special type of pigment that serve to thicken the film, support its structure and increase the volume of the paint. Fillers are usually cheap and inert materials, such as diatomaceous earth, talc, lime, barytes, clay, etc.
- Floor paints that must resist abrasion may contain fine quartz sand as filler. Not all paints include fillers. On the other hand, some paints contain large proportions of pigment/filler and binder.

Applications:

- Paint can be applied as a solid, a gaseous suspension aerosol or a liquid. Techniques vary depending on the practical or artistic results desired. As a solid usually used in industrial and automotive applications), the paint is applied as a very fine powder, and then baked at high temperature.
- This melts the powder and causes it to adhere to the surface. The reasons for doing this involve the chemistries of the paint, the surface itself, and perhaps even the chemistry of the substrate the object being painted. This is called "powder coating" an object. As a gas or as a gaseous suspension, the paint is suspended in solid or liquid form in agas that is sprayed on an object. The paint sticks to the object. This is called "spray painting" an object.
- In the liquid application, paint can be applied by direct application using brushes, paint rollers, blades, other instruments, or body parts such as fingers and thumbs.
- Rollers generally have a handle that allows for different lengths of poles to be attached, allowing painting at different heights. Generally, roller application requires two coats for even color. A roller with a thicker nap is used to apply paint on uneven surfaces. Edges are often finished with an angled brush

VARNISHES:

- Varnish is a transparent, hard, protective finish or film primarily used in wood finishing but also for other materials. Varnish is traditionally a combination of a drying oil, a resin, and a thinner or solvent.
- Varnish finishes are usually glossy but may be designed to produce satin or semi-gloss sheens by the addition of "flatting" agents.
- Varnish has little or no colour, is transparent, and has no added pigment, as opposed to paints or wood stains, which contain pigment and generally range from opaque to translucent.
- Varnishes are also applied over wood stains as a final step to achieve a film for gloss and protection. Some products are marketed as a combined stain and varnish.
- After being applied, the film-forming substances in varnishes either harden directly, as soon as the solvent has fully evaporated, or harden after evaporation of the solvent through certain curing processes, primarily chemical reaction between oils and oxygen from the air autoxidation and chemical reactions between components of the varnish.
- Resin varnishes "dry" by evaporation of the solvent and harden almost immediately upon drying. Acrylic and waterborne varnishes "dry" upon evaporation of the water but experience an extended curing period. Oil, polyurethane, and epoxy varnishes remain liquid even after evaporation of the solvent but quickly begin to cure, undergoing successive stages from liquid or syrupy, to tacky or sticky, to dry gummy, to "dry to the touch", to hard.
- Environmental factors such as heat and humidity play a very large role in the drying and curing times of varnishes.
- In classic varnish the cure rate depends on the type of oil used and, to some extent, on the ratio of oil to resin. The drying and curing time of all varnishes may be sped up by exposure to an energy. source such as sunlight, ultraviolet light, or heat.
- Varnishes and drying oils may cause fires. Many varnishes contain plant-derived oils e.g. linseed oil, synthetic oils e.g. polyurethanes) or resins as

their binder in combination with organic solvents. These are highly flammable in their liquid state.

DISTEMPER:

- Distemper is an early form of whitewash, also used as a medium for artistic painting, usually made from powdered chalk or lime and size a gelatinous substance.
- Alternatives to chalk include the toxic substance white lead.
- Distempered surfaces can be easily marked and discoloured, and cannot be washed down, so distemper is best suited to temporary and interior decoration. The technique of painting on distempered surfaces blends watercolours with whiting and glue. The colours are mixed with whitening, or finely-ground chalk, and tempered with size.

Properties

- Light in colour
- Coatings are thicker
- Give reflective coating.
- Less durable than oil paint but cheeper
- Coatings are thicker and more durable when compared too other water paints.

UNIT - V

MODERN MATERIALS

PART-A

1. What is a geofabric?

These are synthetic fabrics which are sufficiently durable to last a good length of time in soil environment used in geotechnical engineering. Some geofabrics are polyester, nylon, polyethylene and geotechnical engineering.

2. What is a Fibre-Reinforced Plastic?

Fibre-reinforced plastic FRP also fibre -reinforced polymer is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, basalt or aramid, although other fibres such as paper or wood or asbestos have been sometimes used.

3.What is a laminar composite?

A laminar composite is a composite material that consists of two or more layers of different materials that are bonded together. They are also called laminated composites or laminates. A laminate usually consists of two or more layers of planar composites in which each layer also called lamina or ply may be of the same or different materials.

4. Define Refractories.

Refractories are defined as non-metallic materials having those chemical and physical properties that make them applicable for structures, or as components of systems, that are exposed to environments above 1,000 °F. A refractory material is one that retains its strength at high temperatures.

5. What is a sealant? May/June 2016 Apr/May2015 Nov/Dec 2015

Sealants are typically lower strength, yet flexible, bonding agents used between substrates of differing physical properties to form a seal between the materials. A sealant may be viscous material that has little or no flow characteristics and which stay where they are applied.

6. What is a ceramic?

A ceramic is an inorganic, nonmetallic solid prepared by the action of heat and subsequent cooling. Ceramic materials may have a crystalline or partly crystalline structure, or may be amorphous e.g., a glass).

7.What are the classifications of geofabrics?

- Geotextiles
- Geogrids
- Geomembranes
- Linear strips for soil reinforcement

8. Define fibre textiles. Nov/Dec 2015

Textile Fibers Are Special Many fibrous materials are not suitable to make into fabrics,e.g., corn silk or wood slivers. Textile fibers must have certain properties: flexible, thin but nottoo thin, long enough, cohesive, and strongenough.Textile fibers must be flexible.

9.What are the classification of Glass?

- Soda-lime Glass
- Lead Glass
- Boro-silicate Glass

Commercial Forms

- Sheet Glass
- Plate Glass
- Tempered Glass
- Wired Glass
- Heat absorbing Glass
- Ground Glass
- Coloured Glass
- Enamel Glass

10. Define clay products

- Clay products are one of the most important classes of structural materials. The raw materialsused in their manufacture are clay blended with quartz, sand, chamatte refractory clay burned at1000 –1400°C and crushed, slag, sawdust and pulverized coal.
- Structural clay products or building ceramics are basically fabricated by moulding, drying and burning a clay mass.

11. Differentiate between Geomembranes and Geotextiles: May/June 2016 Apr/May2015

1. **Geotextiles**: These materials consist of either woven or non-woven fabrics and aregenerally used for separation, drainage, filtration and reinforcement. From strength considerations, the strongest of these are woven fabrics, then the resin bonded, melt bonded and finally the needle punched fabrics.
2. **Geomembranes**: These materials are available in wide range of permeability. Continuousgeomembrane barriers of sufficiently low permeability can be used to control fluid migration in geotechnical engineering while those of high permeability are used for drainage.

UNIT V

MODERN MATERIALS

PART-B (13 MARKS

1. Explain in detail about Geofabrics.

- Geofabrics are also called geosynthesis or geotextiles. These are synthetic fabrics which are sufficiently durable to last a good length of time in soil environment used in geotechnical engineering.
- Some geofabrics are polyester, nylon, polyethylene and geotechnical engineering. The fabric may be woven, knitted or punched. They are used for the following functions:
  1. Drainage paths for water for soil consolidation
  2. Separation of different types of soil materials

3. Soil reinforcement in reinforced earth construction
4. Filtration of water from soil.
   - Geosynthesis are ideal for use in soil as they do not deteriorate by corrosion in the presence of chemicals. They last for a long time when not exposed to direct sunlight and are also not affected by water.
   - They are extensively used for Mechanically Stabilized Earth MSE / Reinforced Earth Construction.

Uses

1. As drainage paths to assist consolidation. Geotextiles are used as drainage wicks to assist f=drainage and consolidation of clayey deposits. The modern readymade —plastic geotextile drainll consists of a plastic drain core and a geotextile jacket covering the plastic core pipe. They are efficient for soil drainage to assist in preloading of foundations.
2. As a separation medium. It is used as under railway track, to separate the ballast from sub grade, thus decreasing penetration of ballast into the weak sub grade.
3. As soil reinforcement. These reinforcements are used in the reinforced earth techniques for the following purposes
   a. For retaining walls and stability of slopes
   b. For improving the bearing capacity of foundations.
4. As a filtration medium for drainage. In many situations, when used for drainage and separation, it also acts as a filter.

Classification

3. **Geotextiles**: These materials consist of either woven or non-woven fabrics and are generally used for separation, drainage, filtration and reinforcement. From strength considerations, the strongest of these are woven fabrics, then the resin bonded, melt bonded and finally the needle punched fabrics.
4. **Geogrids**: They have large openings and are made of materials with high tensile strength ,low elongation and dimensional stability. They are made from plain polymer sheets by punching holes in it followed by 2 stretching operations so that

a grid is formed. They can be designed to have different strength or same strength in two directions.

5. **Geomembranes**: These materials are available in wide range of permeability. Continuous geomembrane barriers of sufficiently low permeability can be used to control fluid migration in geotechnical engineering while those of high permeability are used for drainage.
6. **Linear strips for soil reinforcement**: Polymer fibres are made into strips which can be used for reinforced earth in retaining walls. Glass- reinforced plastics are also considered as suitable for soil reinforcement.

Use in Embankments

- As the embankments for flyovers in cities should occupy as little width as possible, the use of geotextiles as soil reinforcement for these embankments comes in very handy.
- Much steeper slopes than normally admissible with earth only can be provided by using soil reinforcement in the embankment.
- Similarly, consolidation of foundations of many new railway embankments for Indian Railways has been carried out by using plastic geotextile drains instead of old fashioned sand or wick drains.

2. Discuss about the manufacture and properties of Clay Products. May/June2016)

- Structural clay products, ceramic products intended for use in building construction. Typical structural clay products are building brick, paving brick, terra-cotta facing tile, roofing tile, and drainage pipe.
- These objects are made from commonly occurring natural materials, which are mixed with water, formed into the desired shape, and fired in a kiln in order to give the clay mixture a permanent bond.
- Finished structural clay products display such essential properties as load-bearing strength, resistance to wear, resistance to chemical attack, attractive appearance, and an ability to take a decorative finish.

Manufacture

- Structural clay products are made from 35 to 55 percent clays or argillaceous clayey shales, 25 to 45 percent quartz, and 25 to 55 percent feldspar. As with all traditional ceramic products, the clay portion acts as a former, providing shaping ability; the quartz silica serves as filler, providing strength to the formed object; and the feldspar serves as a fluxing agent, lowering the melting temperatures of the clay and quartz during firing.
- The proportions cited above are often found directly in shale deposits, so that blending is often not necessary. In addition, little or no beneficiation, or crushing and grinding of the mined material, is employed.
- Local clays or shales of highly variable composition are used in order to keep transportation costs as low as possible. The colour of the finished product derives from impurities, most notably iron oxides, present in the raw materials.
- Colours can range from buff and other light shades of brown through red to black, depending upon whether an oxidizing or reducing atmosphere exists in the kiln.
- In the processing of structural clay products, stiff-mud plastic-forming operations predominate—for example, pressing operations for brick and extrusion for brick or pipe. Formed objects are usually fired in continuous conveyor belt or railcar operations, with the ware, as it traverses the tunnel kiln, proceeding from room temperature into a hot zone and finally to a cooler zone at the other end.

Properties

- The properties exhibited by structural clay products are determined by particle size, firing temperature, and ultimate microstructure. Compared with finer ceramic products such as white wares, much coarser filler particles are used, and lower firing temperatures are employed—typically in the range of 1,050° to 1,100° C approximately 1,925° to 2,000° F).
- At such low temperatures the filler particles usually crushed quartz are normally not affected. Instead, the clay or shale ingredients contain sufficient

impurities to melt and form a glass, thus bonding the particles together. As is the case with white wares, crystalline mullite needles grow into this glassy phase.

- The resulting microstructure consists of large secondary particles embedded in a matrix of fine-grained mullite and glass—all containing a substantial volume of large pores.
- Because of the presence of large and small particles in their microstructures, fired clay products have relatively high compressive strengths. This ability to bear relatively heavy loads without fracture is the prime property qualifying these products for structural applications.
- The size and number of pores is also important. If underfired, structural clay products have low strength and poor resistance to frost and freezing, owing to the presence of many small pores in the clay regions.
- Over fired ware, on the other hand, has too much glass. It is strong but brittle and is susceptible to failure under mechanical and thermal stress. Furthermore, it is impossible to obtain a good bond when glassy products are used with mortars.
- Small pores and high glass content are desirable, however, when chemical resistance and imperviousness to water penetration are required.

Products

- By some estimates structural clay products make up as much as 50 percent of the entire ceramics market. The industry is highly conservative, with development aimed primarily at automation and labour minimization rather than the introduction of new products.

- There is a wide variety of structural clay products, broadly classified as facing materials, load-bearing materials, paving materials, roofing tile, and chemically resistant materials. Examples of facing materials are face brick, terra-cotta, brick veneer, sculptured brick, glazed brick and tile, and decorative brick.

- Building brick, hollow brick, and structural tile for floors and walls are examples of load-bearing materials. Paving materials include light traffic pavers, quarry tile, and paving brick—this last product once in more common use than at present.
- Roofing tiles are quite common in many parts of the world, red and black colours being of particular note. Chemically resistant materials include sewer pipe, industrial floor brick, drain tile, flue liners, chimney brick, and chemical stoneware.

3. . Explain in detail about laminar composites Apr/May 2015)

- A laminar composite is a composite material that consists of two or more layers of different materials that are bonded together.
- They are also called laminated composites or laminates. A laminate usually consists of two or more layers of planar composites in which each layer also called lamina or ply may be of the same or different materials.
- Similarly, a sandwich laminate is a composite construction in which a metallic or composite core layer is sandwiched between two metallic or composite face layers. The composite face layers may also be in the form of laminates.
- Laminated and sandwich composite structures are very strong and stiff, and are commonly recommended for lightweight structural applications. In materials science,
- Composite laminates are assemblies of layers of fibrous composite materials which can be joined to provide required engineering properties, including in-plane stiffness, bending stiffness, strength, and coefficient of thermal expansion.
- The individual layers consist of high-modulus, high-strength fibers in a polymeric, metallic, or ceramic matrix material. Typical fibers used include graphite, glass, boron, and silicon carbide, and some matrix materials are epoxies, polyimides, aluminium, titanium, and alumina.
- Layers of different materials may be used, resulting in a hybrid laminate. The

individual layers generally are orthotropic that is, with principal properties in orthogonal directions) or transversely isotropic with isotropic properties in the transverse plane with the laminate then exhibiting anisotropic with variable direction of principal properties), orthotropic, or quasi-isotropic properties. Quasi-isotropic laminates exhibit isotropic that is, independent of direction in plane response but are not restricted to isotropic out-of-plane bending response.

- Depending upon the stacking sequence of the individual layers, the laminate may exhibit coupling between inplane and out-of-plane response. An example of bending-stretching coupling is the presence of curvature developing as a result of in-plane loading.

4. Explain in detail about ceramics. Nov/Dec2015)

A **ceramic** is an inorganic, non metallic solid material comprising metal, non metal or metalloid atoms primarily held in ionic and covalent bonds.

A ceramic material is an inorganic, non-metallic, often crystalline oxide, nitride or carbide material. Some elements, such as carbon or silicon, may be considered ceramics. Ceramic materials are brittle, hard, strong in compression, weak in shearing and tension.

Crystalline ceramics

Crystalline ceramic materials are not amenable to a great range of processing. Methods for dealing with them tend to fall into one of two categories – either make the ceramic in the desired shape, by reaction *in situ*, or by "forming" powders into the desired shape, and then sintering to form a solid body. Ceramic forming techniques include shaping by hand sometimes including a rotation process called "throwing", slip casting, tape casting used for making very thin ceramic capacitors, e.g., injection molding, dry pressing, and other variations. Details of these processes are described in the two books listed below. A few methods use a hybrid between the two approaches.

Noncrystalline ceramics

Noncrystalline ceramics, being glass, tend to be formed from melts. The glass is shaped when either fully molten, by casting, or when in a state of toffee-like viscosity, by methods such as blowing into a mold. If later heat treatments cause this glass to become partly crystalline, the resulting material is known as a glass-ceramic, widely used as cook-top and also as a glass composite material for nuclear waste disposal.

Mechanical properties are important in structural and building materials as well as textile fabrics. They include the many properties used to describe the strength of materials such as: elasticity / plasticity, tensile strength, compressive strength, shear strength, fracture toughness & ductility low in brittle materials), and indentation hardness

Electrical properties

Semiconductors

Semiconducting ceramics are also employed as gas sensors. When various gases are passed over a polycrystalline ceramic, its electrical resistance changes. With tuning to the possible gas mixtures, very inexpensive devices can be produced.

Superconductivity

Under some conditions, such as extremely low temperature, some ceramics exhibit high temperature superconductivity. The exact reason for this is not known, but there are two major families of superconducting ceramics.

Boron oxide is used in body armor

Silicon carbide SiC) is used as a susceptor in microwave furnaces, a commonly used abrasive, and as a refractory material.

Silicon nitride Si_3N_4 is used as an abrasive powder.

Steatite magnesium silicates) is used as an electrical insulator.

Titanium carbide Used in space shuttle re-entry shields and scratchproof watches.

Uranium oxide UO_2, use d as fuel in nuclear reactors.Zinc oxide ZnO, which is a semiconductor, and used in the construction of varistors

5. Explain in detail about Fibre glass reinforced plastic.

Fiberglass or **fibreglass** is a type of fiber-reinforced plastic where the reinforcement fiber is specifically glass fiber. The glass fiber may be randomly arranged, flattened into a sheet called a chopped s trand mat, or woven into a fabric. The plastic matrix may be a thermosetting plastic – most often epoxy, polyester resin – or vinylester, or a thermoplastic.

The glass fibers are made of various types of glass depending upon the fiberglass use. These glasses all contain silica or silicate, with varying amounts of oxides of calcium, magnesium, and sometimes boron. To be used in fiberglass, glass fibers have to be made with very low levels of defects.

Fiberglass is a strong lightweight material and is used for many products. Although it is not as strong and stiff as composites based on carbon fiber, it is less brittle, and its raw materials are much cheaper. Its bulk strength and weight are also better than many metals, and it can be more readily molded into complex shapes. Applications of fiberglass include aircraft, boats, automobiles, bath tubs and enclosures, swimming pools, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins.

Other common names for fiberglass are **glass-reinforced plastic GRP**, **glass-fiber reinforced plastic GFRP**

Applications

Storage tanks

House building

Piping

GRP and GRE pipe can be used in a variety of above- and below-ground systems, including those for:

- Desalination
- Water treatment
- Water distribution networks
- Chemical process plants
- Firewater
- Hot and Cold water
- Drinking water
- Wastewater/sewage, Municipal waste

Examples

DIY bows / youth recurve; longbows
Pole vaulting poles
Equipment handles(Hammers, axes, etc.
Traffic lights
Ship hulls
Rowing shells and oars
Waterpipes

PART – C (15 MARKS

1. Write notes on types of Glass and its properties.may / june 2016)

- Silica is the main constituent of glass. But it is to be added with sodium potassium carbonate to bring down melting point. To make it durable lime or lead oxide is also added.
- Manganese oxide is added to nullify the adverse effects of unwanted iron present in the impure silica. The raw materials are ground and sieved. They are mixed in specific proportion and melted in furnace.

- Then glass items are manufactured by blowing, flat drawing, rolling and pressing.

Important Properties of Glass:

1. It absorbs, refracts or transmits light. It can be made transparent or translucent.
2. It can take excellent polish.
3. It is an excellent electrical insulator.
4. It is strong and brittle.
5. It can be blown, drawn or pressed.
6. It is not affected by atmosphere.
7. It has excellent resistance to chemicals.
8. It is available in various beautiful colours.
9. With the advancement in technology, it is possible to make glass lighter than cork or stronger than steel.
10. Glass panes can be cleaned easily.

Types of Glass

The glass may be broadly classified as:

1. **Soda Lime Glass:** It is mainly a mixture of sodium silicate and calcium silicate. It isfusible at low temperature. In the fusion condition it can be blown or welded easily. It is colourless. It is used as window panes and for the laboratory tubes and apparatus.

2. **Potash Lime Glass:** It is mainly a mixture of potassium silicate and calcium silicate. It isalso known as hard glass. It fuses at high temperature. It is used in the manufacture of glass articles which have to with stand high temperatures.

3. **Potash Lead Glass:** It is mainly a mixture of potassium silicate and lead silicate.

Itpossesses bright lustre and great refractive power. It is used in the manufacture of artificial gems, electric bulbs, lenses, prisms etc.

4. **Common Glass:** It is mainly a mixture of sodium silicate, calcium silicate and ironsilicate. It is brown, green or yellow in colour. It is mainly used in the manufacture of medicine bottles.

5. **Special Glasses:** Properties of glasses can be suitably altered by changing basic ingredients and adding few more ingredients. It has now emerged as versatile material to meet many special requirements in engineering. The following is the list of some of the special glasses:

a Fibre glass
b Foam glass
c) Bullet proof glass
d Structural glass
e Glass black
f Wired glass
g Ultraviolet ray glass
h Perforated glass.

2. Explain the methods of forming Fibre-reinforced plastic FRP). Also state its merits and demerits. Nov/Dec2015)

- Fibre-reinforced plastic FRP also fibre -reinforced polymer is a composite material made of a polymer matrix reinforced with fibres. The fibres are usually glass, carbon, basalt or aramid, although other fibres such as paper or wood or asbestos have been sometimes used.
- The polymer is usually an epoxy, vinyl ester or polyester thermosetting plastic, and phenol formaldehyde resins are still in use. FRPs are commonly used in the aerospace, automotive, marine, construction industries and ballistic armor.

- The moulding processes of FRP plastic begins by placing the fibre preform on or in the mold. The fibre preform can be dry fibre, or fibre that already contains a

measured amount of resin called "prepreg". Dry fibres are "wetted" with resin either by hand or the resin is injected into a closed mold.

- The part is then cured, leaving the matrix and fibres in the shape created by the mold. Heat and/or pressure are sometimes used to cure the resin and improve the quality of the final part. The different methods of forming are listed below.

Bladder moulding

- Individual sheets of material are laid up and placed in a female-style mould along with a balloon-like bladder.
- The mould is closed and placed in a heated press. Finally, the bladder is pressurized forcing the layers of material against the mould walls.

Compression moulding

- When the raw material plastic block, rubber block, plastic sheet, or granules) contains reinforcing fibres, a compression molded part qualifies as a fibre-reinforced plastic.
- More typically the plastic preform used in compression molding does not contain reinforcing fibres. In compression molding, A "preform" or "charge", of SMC, BMC is placed into mould cavity.
- The mould is closed and the material is formed & cured inside by pressure and heat. Compression moulding offers excellent detailing for geometric shapes ranging from pattern and relief detailing to complex curves and creative forms, to precision engineering all within a maximum curing time of 20 minutes.

Autoclave / vacuum bag

- Individual sheets of material are laid-up and placed in an open mold. The material is covered with release film, bleeder/breather material and a vacuum bag. A vacuum is pulled on part and the entire mould is placed into an autoclave heated pressure vessel. The part is cured with a continuous

vacuum to extract entrapped gasses from laminate.

- This is a very common process in the aerospace industry because it affords precise control over moulding due to a long, slow cure cycle that is anywhere from one to several hours.
- This precise control creates the exact laminate geometric forms needed to ensure strength and safety in the aerospace industry, but it is also slow and labour-intensive, meaning costs often confine it to the aerospace industry.

Mandrel wrapping

- Sheets of material are wrapped around a steel or aluminium mandrel. The material is compacted by nylon or polypropylene cello tape. Parts are typically batch cured by vacuum bagging and hanging in an oven.
- After cure the cello and mandrel are removed leaving a hollow carbon tube. This process creates strong and robust hollow carbon tubes.

Wet layup

- Wet layup forming combines fibre reinforcement and the matrix as they are placed on the forming tool. Reinforcing Fibre layers are placed in an open mould and then saturated with a wet [resin] by pouring it over the fabric and working it into the fabric.
- The mould is then left so that the resin will cure, usually at room temperature, though heat is sometimes used to ensure a proper cure.
- Sometimes a vacuum bag is used to compress a wet layup. Glass fibres are most commonly used for this process, the results are widely known as fibreglass, and are used to make common products like skis, canoes, kayaks and surf boards.

Chopper gun

- Continuous strands of fibreglass are pushed through a hand-held gun that both chops the strands and combines them with a catalysed resin such as

polyester. The impregnated chopped glass is shot onto the mould surface in whatever thickness the design and human operator think is appropriate.

- This process is good for large production runs at economical cost, but produces geometric shapes with less strength than other moulding processes and has poor dimensional tolerance.

Filament winding

- Machines pull fibre bundles through a wet bath of resin and wound over a rotating steel mandrel in specific orientations Parts are cured either room temperature or elevated temperatures. Mandrel is extracted, leaving a final geometric shape but can be left in some cases.

Pultrusion

- Fibre bundles and slit fabrics are pulled through a wet bath of resin and formed into the rough part shape. Saturated material is extruded from a heated closed die curing while being continuously pulled through die.
- Some of the end products are structural shapes, i.e. I beam, angle, channel and flat sheet. These materials can be used to create all sorts of fibreglass structures such as ladders, platforms, handrail systems tank, pipe and pump supports.

RTM & VARTM

- Also called resin infusion. Fabrics are placed into a mould which wet resin is then injected into. Resin is typically pressurized and forced into a cavity which is under vacuum in RTM Resin Transfer Molding.
- Resin is entirely pulled into cavity under vacuum in VARTM Vacuum - Assisted Resin Transfer Molding. This moulding process allows precise tolerances and detailed shaping but can sometimes fail to fully saturate the fabric leading to weak spots in the final shape.

Advantages and limitations

- FRP allows the alignment of the glass fibres of thermoplastics to suit specific design programs. Specifying the orientation of reinforcing fibres can increase the strength and resistance to deformation of the polymer.

  - Glass reinforced polymers are strongest and most resistive to deforming forces when the polymers fibres are parallel to the force being exerted, and are weakest when the fibres are perpendicular. Thus this ability is at once either an advantage or a limitation depending on the context of use.

  - Weak spots of perpendicular fibres can be used for natural hinges and connections, but can also lead to material failure when production processes fail to properly orient the fibres parallel to expected forces.

  - When forces are exerted perpendicular to the orientation of fibres the strength and elasticity of the polymer is less than the matrix alone.

  - In cast resin components made of glass reinforced polymers, the orientation of fibres can be oriented in two-dimensional and three-dimensional weaves. This means that when forces are possibly perpendicular to one orientation, they are parallel to another orientation; this eliminates the potential for weak spots in the polymer.

Failure modes

Structural failure can occur in FRP materials when:

- Tensile forces stretch the matrix more than the fibres, causing the material to shear at the interface between matrix and fibres.

- Tensile forces near the end of the fibres exceed the tolerances of the matrix, separating the fibres from the matrix.

- Tensile forces can also exceed the tolerances of the fibres causing the fibres themselves to fracture leading to material failure.

3 i Explain various Applications of geomembranes.May/June2016)

Geomembranes have been used in the following environmental, geotechnical, hydraulic, transportation, and private develepment applications:

- As liners for potable water
- As liners for reserve water e.g., safe shutdown of nuclear facilities)
- As liners for waste liquids e.g., sewage sludge
- Liners for radioactive or hazardous waste liquid
- As liners for secondary containment of underground storage tanks
- As liners for solar ponds
- As liners for brine solutions
- As liners for the agriculture industry
- As liners for the aquiculture industry, such as fish/shrimp pond
- As liners for golf course water holes and sand bunkers
- As liners for all types of decorative and architectural ponds
- As liners for water conveyance canals
- As liners for various waste conveyance canals
- As liners for primary, secondary, and/or tertiary solid-waste landfills and waste piles
- As covers caps) for solid -waste landfills
- As covers for aerobic and anaerobic manure digesters in the agriculture industry
- As covers for power plant coal ash
- As liners for vertical walls: single or double with leak detection
- As cutoffs within zoned earth dams for seepage control
- As linings for emergency spillways

- As waterproofing liners within tunnels and pipelines
- As waterproof facing of earth and rockfill dams
- As waterproof facing for roller compacted concrete dams
- As waterproof facing for masonry and concrete dams
- Within cofferdams for seepage control
- As floating reservoirs for seepage control
- As floating reservoir covers for preventing pollution
- To contain and transport liquids in trucks
- To contain and transport potable water and other liquids in the ocean
- As a barrier to odors from landfills
- As a barrier to vapors radon, hydrocarbons, etc. beneath buildings
- To control expansive soils
- To control frost-susceptible soils
- To shield sinkhole-susceptible areas from flowing water
- To prevent infiltration of water in sensitive areas
- To form barrier tubes as dams
- To face structural supports as temporary cofferdams
- To conduct water flow into preferred paths
- Beneath highways to prevent pollution from deicing salts
- Beneath and adjacent to highways to capture hazardous liquid spills
- As containment structures for temporary surcharges
- To aid in establishing uniformity of subsurface compressibility and subsidence
- Beneath asphalt overlays as a waterproofing layer
- To contain seepage losses in existing above-ground tanks
- As flexible forms where loss of material cannot be allowed.

3 ii. Explain various Applications of geotextiles. May/June2016)

Geotextiles and related products have many applications and currently support many civil engineering applications including roads, airfields, railroads, embankments, retaining structures, reservoirs, canals, dams, bank protection, coastal engineering and construction site silt fences or geotube. Usually geotextiles are placed at the tension surface to strengthen the soil. Geotextiles are also used for sand dune armoring to protect upland coastal property from storm surge, wave action and flooding. A large sand-filled container SFC) within the dune system prevents storm erosion from proceeding beyond the SFC. Using a sloped unit rather than a single tube eliminates damaging scour.

Erosion control manuals comment on the effectiveness of sloped, stepped shapes in mitigating shoreline erosion damage from storms. Geotextile sand-filled units provide a "soft" armoring solution for upland property protection. Geotextiles are used as matting to stabilize flow in stream channels and swales.

Geotextiles can improve soil strength at a lower cost than conventional soil nailing

In addition, geotextiles allow planting on steep slopes, further securing the slope.

Geotextiles have been used to protect the fossil hominid footprints of Laetoli in Tanzania from erosion, rain, and tree roots.

In building demolition, geotextile fabrics in combination with steel wire fencing can contain explosive debris.

Coir coconut fiber geotextiles are popular for erosion control, slope stabilization and bioengineering, due to the fabric's substantial mechanical strength. Coir geotextiles last approximately 3 to 5 years depending on the fabric weight. The product degrades into humus, enriching the soil

Reg. No. | | | | | | | | | | | | |

Question Paper Code : 57152

B.E/B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Fourth Semester

Civil Engineering

CE 6401T – CONSTRUCTION MATERIALS

(Common to Environmental Engineering)

(Regulations 2013)

me : Three Hours | Maximum : 100 Marks

Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

Write down the characteristics of good stone.

List the different types of refractory bricks.

What do you understand by Transition Zone ?

What is bulking of sand ? Why is it important ?

Distinguish between HSC and HPC.

Why do we need compaction of concrete ?

Give the application of Aluminium composites.

8. Enumerate the various market forms of steel.

9. What is a sealant ? State its applications.

10. Differentiate between geo membranes and geo textile.

PART – B (5 × 16 = 80 Marks)

11. (a) Explain the various types of stones which are used for building works and g in brief the specifications for a good building stone.

OR

(b) With sketches explain in detail about the manufacturing process of conventio bricks.

12. (a) (i) Add a note on the process of hydration of cement.

(ii) How do you perform the soundness test of cement ? Why it is important

OR

(b) What are tests to be conducted for conventional course aggregates ? Explain a four tests in detail.

13. (a) With a flow chart explain the step by step process of manufacturing of concrete

OR

(b) Write down the complete procedure of concrete mix design as per BIS. Assum necessary data.

14. (a) (i) Discuss the possible sources of defects in timber.

(ii) Briefly explain the following terms :

(1) Veneer

(2) Thermacole

OR

(b) Explain in detail about :

(i) Preparation of paint

(ii) Distemper

(iii) Bitumen

15. (a) (i) Add a note on types of Glass and its properties.

(ii) Discuss about the manufacture and properties of various clay products.

OR

(b) Explain various applications of

(i) Geomembranes

(ii) Geo textiles

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 77060

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Fourth Semester

Civil Engineering

CE 6401 – CONSTRUCTION MATERIALS

(Common to Environmental Engineering)

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List any four tests on stones.
2. Define the term Efflorescence.
3. What are the normal ingredients of cement?
4. Define Elongation index.
5. What is meant by modulus of rupture?
6. Define HPC as per ACI.
7. What are the advantages of Thermacole?
8. What are the advantages of bituminous roadsover concrete roads?
9. What are the characteristics of good sealants?
10. Differentiate geo membranes and geo textiles.

PART B — (5 × 16 = 80 marks)

11. (a) Explain in detail about the manufacturing process of bricks.

Or

(b) Explain the recent advancements in bricks.

12. (a) How do you perform the compression strength of cement mortar cube? Also explain the procedure for fineness of cement.

Or

(b) Explain with codal provision for testing of conventional coarse aggregates.

13. (a) With sketches explain in detail about the different flow properties of concrete.

Or

(b) With sketches explain the various specifications for self compacting concrete.

14. (a) Explain the manufacturing process and civil engg applications of steel.

Or

(b) Explain in detail about :

(i) Aluminium composite panel (8)

(ii) Distember (4)

(iii) Paint. (4)

15. (a) Explain in detail about

(i) Ceramics (8)

(ii) Fibre glass reinforced plastic. (8)

Or

(b) Describe the various applications of (i) Laminar Composites (ii) Geo textiles.

———————

Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 27101

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fourth Semester

Civil Engineering

CE 6401 — CONSTRUCTION MATERIALS

(Common to Environmental Engineering)

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State any four characteristics of good building stone.

2. What do you mean by lightweight concrete blocks?

3. Define the term setting time of cement.

4. List the test for coarse aggregates.

5. What is meant by workability?

6. Define self compacting concrete.

7. What is seasoning of timber?

8. What are the basic components of paint?

9. Define sealent.

10. What is fibre textile?

PART B — (5 × 16 = 80 marks)

11. (a) Briefly discuss the defects and preservation of stones. (16)

Or

(b) Describe the various tests on bricks. (16)

12. (a) Describe the manufacturing process of cement. (16)

Or

(b) Explain briefly about

(i) Consistency test on cement

(ii) Soundness of cement

(iii) Crushing strength of aggregate

(iv) Impact strength of aggregate.

13. (a) Explain the various tests to be performed on hardened concrete. (16)

Or

(b) Write in detail about

(i) Curing (8)

(ii) High strength concrete. (8)

14. (a) (i) Enumerate the advantages of aluminium in construction. (8)

(ii) Explain the defects in timber. (8)

Or

(b) Write short notes on :

(i) Thermacole (4)

(ii) Steel (4)

(iii) Distemper (4)

(iv) Varnish. (4)

15. (a) Write short note on :

(i) Glass (8)

(ii) Fibre glass reinforced plastic. (8)

Or

(b) Explain in detail about refractories. (16)

———————