

# 2019 GATE

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# Civil Engineering

## Construction Materials & Management

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# **GATE**

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# **2019**

**CONSTRUCTION  
MATERIALS &  
MANAGEMENT**

**CIVIL ENGINEERING**



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Publications



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**SECTION-A**  
**BUILDING MATERIAL**



## CHAPTER - 1

### CEMENT

#### 1.1 INTRODUCTION

1. Cement is a material which has cohesive and adhesive properties in the presence of water.
2. Cement is a product obtained by pulverizing clinker formed by calcinating raw-materials primarily consisting of Lime (CaO), Silicate (SiO<sub>2</sub>), Alumina (Al<sub>2</sub>O<sub>3</sub>) and Iron oxide (Fe<sub>2</sub>O<sub>3</sub>)
3. It was invented by Joseph Aspdin of UK in 1824. He named it portland cement because the hardened concrete made out of the cement aggregate and water in definite proportion resembled the natural stone occurring at portland in England.



1. **Pulverize:** Make into a powder by breaking up or cause to become dust
2. **Clinker:** A hard brick used as a paving stone.
3. **Calcination:** The process of heating a substance to a high temperature but below the melting or fusing point, causing loss of moisture, reduction on oxidation, and dissociation into simpler sub-stances.

4. When cement is mixed with water it forms a paste which hardens and binds aggregates (fine and coarse) together to form a hard durable mass called concrete.
5. Cements used in construction industry can be classified as hydraulic and non hydraulic.
6. Hydraulic cement set and harden in presence of water (*Due* to the chemical action between cement and water known as hydration) and results in water-resistant product which is stable. eg. Portland cement.
7. Non-hydraulic cements Are derived from calcination of gypsum or limestone because their products of hydration are not resistant to water; however, the addition of pozzolanic materials can render gypsum and lime cement hydraulic. Ex-Plaster of Paris.
8. Cement can be manufactured either from natural cement stones or artificially by using calcareous and argillaceous materials. Examples of natural cements are Roman cement, Puzzolona cement and Medina cement and of artificial cement are Portland cement and special cements.



Argillaceous	Calcareous
(i) Shale and clay	(i) Limestone
(ii) Cement rock	(ii) Chalk
(iii) Blast furnace slag	(iii) Marine shells
(iv) Marl	

## CHAPTER - 2

### CONCRETE

#### 2.1 INTRODUCTION

1. Concrete is a composite man made material and is most widely used building material in the construction industry.
2. It is a mixture of binding material such as lime or cement, well graded coarse and fine aggregate, water and sometime admixture.
3. Most of the ancient structures and historical buildings had been constructed with lime concrete but with the invention of cement, use of lime concrete is limited so making bases of concrete foundations and roof terracing.
4. Also production of good concrete is found difficult. Now a question arise what is "Good concrete".
5. Basic requirement of Good concrete is that it should be satisfactory in its hardened state, and also in its, fresh state while being transported from mixture and placed in form work.
6. In fresh state, consistency of mix should be such that it can be compacted by the desired means without excessive effort, and also the mix should be cohesive enough for the methods of transporting and placing used so as not to cause segregation.
7. In hardened state satisfactory compressive strength and an adequate durability is required.

##### 2.1.1 Classification

###### 1. Based on Cementing Material

- (i) Lime concrete
- (ii) Gypsum concrete
- (iii) Cement concrete

###### 2. Based on Perspective Specification

- (i) Cement concrete is specified by proportions of different ingredients, e.g., 1 (cement) : 1.5 (fine aggregate) : 3 (Coarse aggregate).
- (ii) It is presumed that by adhering to such perspective specifications satisfactory performance may be achieved
- (iii) This type of concrete mix is also known as nominal mix.
- (iv) Conventional nominal mix proportions have limited significance, since the quantity of fine aggregate is fixed irrespective of the cement content, water-cement ratio and the maximum size of aggregate to be used.

##### Mix Proportions of Cement Concrete

Grade of concrete	M10	M15	M20	M25
Mix Proportion	1:3:6	1:2:4	1:1.5:3	1:1:2
Perspective characteristics Strength (N/mm)	10	15	20	25

Here M refers to mix. IS-456 restricts use of nominal mix upto M-20 grade only

## ESE OBJ QUESTIONS

1. Consider the following statements for selecting building stones:

1. Seasoning of stones is essential and is done by soaking in water
2. Specific gravity of stone is to be more than 2.7
3. Porosity of stone affects its durability
4. Climatic conditions decide the type of stone to be used in construction

Which of the above statements are correct?

[ESE - 2018]

- (a) 1, 2 and 3 only                      (b) 1, 2 and 4 only  
(c) 1, 3 and 4 only                      (d) 2, 3 and 4 only

**2. Statement (I):** Glass, used as sheets in buildings, is a crystalline solids and is transparent.

**Statement (II):** Glass is obtained by the fusion of silicates of sodium and calcium, both of which are crystalline is structure.

[ESE - 2018]

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).  
(b) Both Statement (I) and Statement (II) are individually true but statement (II) is not the correct explanation of Statement (I).  
(c) Statement (I) is true but Statement (II) is false.  
(d) Statement (I) is false but Statement (II) is true.

**3. Statement (I):** Aluminium alloy with less than 6% copper is used in making automobile pistons.

**Statement (II):** Duraluminium containing 4% copper has a high tensile strength and is well usable wherever alkaline environment is not present.

[ESE - 2018]

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).

(b) Both Statement (I) and Statement (II) are individually true but statement (II) is not the correct explanation of Statement (I).

(c) Statement (I) is true but Statement (II) is false.

(d) Statement (I) is false but Statement (II) is true.

4. Which of the following statements is/are correct regarding the strength of cement?

1. Particle sizes less than 3  $\mu\text{m}$  increase the viscous nature of the cement.

2. Finer particles in cement can be replaced by fly-ash to improve the strength.

[ESE - 2016]

- (a) 1 only  
(b) 2 only  
(c) Both 1 and 2  
(d) Neither 1 nor 2

**5. Statement (I):** Positive displacement pumps can be used for pumping of ready-mixed concrete.

**Statement (II):** The coarse aggregate in the mix is unlikely to be crushed during positive displacement.

[ESE - 2016]

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).  
(b) Both Statement (I) and Statement (II) are individually true but statement (II) is not the correct explanation of Statement (I).  
(c) Statement (I) is true but Statement (II) is false.  
(d) Statement (I) is false but Statement (II) is true.

6. In a concrete mix of properties 1:3:6, the actual quantity of sand, which is judged to have undergone 15% bulking, per unit volume of cement, will be

[ESE - 2016]

# SOLUTIONS

**Sol. 1. (d)**

For good building material specific gravity of stone should be more than 2.7.

Stones with high porosity are less durable.

Suitability of stones depends on its characteristics also on local environmental and climatic conditions.

**Sol. 2. Sol. (d)**

I – Glass is a non-crystalline amorphous solid

II – Glass is manufactured by using some of the crystalline solids like silicates of sodium, calcium etc.

Thus, statement I is incorrect.

**Sol. 3. (b)**

(i) Y-alloy consist of Al (92%) and Cu around 4-5% is generally used is piston of IC engine

(ii) Composition of duralium is as follows

Cu	Mn	He	Mg	Al
3.5– 4.5%	0.4– 0.7%	<0.7%	0.4– 0.7	Rest

**Sol. 4. (c)**

1. As particle size decreases viscous nature of cement decreases.

2. Fly ash reacts with available lime and alkali in concrete, producing additional cementitious compounds as calcium silicate hydrate (C-S-H) binder.

This additional binder produced by fly ash reaction with available binder allows fly ash concrete to gain strength over time. This will ultimately exceed the strength of fly ash concrete than of cement concrete mixes.

**Sol. 5. (a)****Sol. 6. (b)**

Mix Proportion = 1 : 3 : 6

Let the volume of cement = 1 m<sup>3</sup>

(unit volume of cement)

Volume of sand = 3 m<sup>3</sup>

Volume of aggregate = 6 m<sup>3</sup>

Actual volume of sand =  $3 \left( 1 + \frac{15}{100} \right) = 3.45 \text{ m}^3$

**Sol. 7. (c)****Sol. 8. (b)****Sol. 9. (d)****Sol. 10. (b)****Sol. 11. (b)****Sol. 12. (b)****Sol. 13. (c)****Sol. 14. (c)**

Water to be used is 0.85 P. Le chatelier's apparatus is used to determine soundness due to lime. So, option (c) is correct.

**Sol. 15. (c)**

Low heat cement sets slower than OPC. Setting time has no relation with strength of cement.

So, option (c) is correct.

**Sol. 16. (c)**

Since, low heat cement has very low heat of hydration which is suitable for mass concreting such as dams, so, option (c) is correct.

**Sol. 17. (b)**

Silica imparts strength to the cement. So, option (b) is correct.

**Sol. 18. (c)****Sol. 19. (c)****Sol. 20. (b)**

Fly ash, an industrial waste of thermal power plants is used in cement manufacturing. Free lime in cement is always tried to kept low.

## ESE OBJ QUESTIONS

1. Consider the following statements regarding Cyclopean Concrete

1. Size of aggregate is more than 150 mm.
2. Size of aggregate is less than 150 mm.
3. High slump.
4. High temperature rise due to heat of hydration.

Which of the above statements are correct?

[ESE - 2017]

- (a) 1 and 3 only                      (b) 1 and 4 only  
(c) 2 and 3 only                      (d) 2 and 4 only

2. Consider the following particulars in respect of a concrete mix design

	Weight	Specific Gravity
Cement	400 kg/m <sup>3</sup>	3.2
Fine aggregates	--	2.5
Coarse aggregates	1040 kg/m <sup>3</sup>	2.6
Water	200 kg/m <sup>3</sup>	1.0

What shall be the weight of the Fine aggregates?

[ESE - 2017]

- (a) 520 kg/m<sup>3</sup>                      (b) 570 kg/m<sup>3</sup>  
(c) 690 kg/m<sup>3</sup>                      (d) 1000 kg/m<sup>3</sup>

3. Pozzolana used as an admixture in concrete has the following advantages:

1. It improves workability with lesser amount of water.
2. It increases the heat of hydration and so lets the concrete set quickly.
3. It increases the resistance of concrete to attack by salts and sulphates.
4. It leaches out calcium hydroxide.

Select the correct answer using the codes given below

[ESE - 2017]

- (a) 1, 2 and 3 only                      (b) 1, 2 and 4 only  
(c) 1, 3 and 4 only                      (d) 2, 3 and 4 only

4. Consider the following statements:

- 1.If more water is added to concrete for increasing its workability, it results into concrete of low strength.
- 2.No slump is an indication of a good workable concrete.
- 3.Higher the slump of concrete, lower will be its workability.
- 4.Workability of concrete is affected by water content as well as water-cement ratio.

Which of the above statements are correct?

[ESE - 2017]

- (a) 1 and 3 only                      (b) 2 and 3 only  
(c) 1 and 4 only                      (d) 2 and 4 only

5. The constituent compound in Portland cement which reacts immediately with water, and also sets earliest, is

[ESE - 2016]

- (a) Tricalcium silicate  
(b) Dicalcium silicate  
(c) Tricalcium aluminate  
(d) Tetracalcium aluminoferrite

6. The Rheological behavior of concrete, when represented by shear stress vs rate of shear, is characterized as

[ESE - 2016]

- (a)  $\tau = \tau_0 + \mu \cdot \dot{\gamma}$   
(b)  $\tau_0 = \tau + \mu \cdot \dot{\gamma}$   
(c)  $\frac{\tau}{\tau_0} = \mu \cdot \dot{\gamma}$   
(d)  $\tau = \mu \cdot \dot{\gamma}$

Where,

$\tau$  is shear stress,  
 $\tau_0$  is (initial) yield value,  
 $\mu$  is at point plastic viscosity  
 $\dot{\gamma}$  is at point rate of shear

# SOLUTIONS

**Sol. 1. (b)**

In cyclopean concrete size of aggregate is more than 14 cm and slump is very low because cyclopean concrete is stiff in nature.

**Sol. 2. (c)**

Let us assume the weight of the fine aggregated by absolute volume principle

$$\frac{M_c}{f_c} + \frac{M_{fa}}{\rho_{fa}} + \frac{M_{ca}}{f_{ca}} + V_w = 1$$

$$\frac{400}{3200} + \frac{x}{2500} + \frac{1040}{2000} + \frac{200}{1000} = 1$$

$$\frac{x}{2500} + \frac{29}{40} = 1$$

$$x = 687.5 \text{ kg/m}^3$$

Weight of fine aggregate 690 kg/m<sup>3</sup>

**Sol. 3. (c)**

1. Pozzolana due to its ball bearing action increases the workability without increasing the amount of water but the amount of pozzolana should be in appropriate amount otherwise it will make paste sticky.

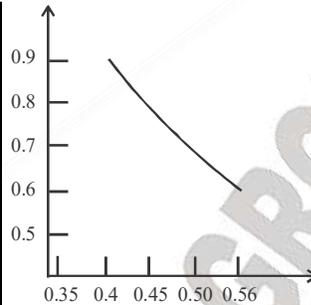
2. Pozzolana reacts slowly so initially heat of hydration is low and concrete setting becomes slow.

3. Pozzolana + Ca(OH)<sub>2</sub> → C-S-H (low density). On the later stage more C-S-H gel and fill the void so make the concrete durable and increases the resistance against sulphate attack.

4. Pozzolana reacts with excess Ca(OH)<sub>2</sub>. So Ca(OH)<sub>2</sub> amount reduces.

**Sol. 4. (c)**

(1) Fluidity of concrete increases with water content because addition of water enhance interparticle lubrication so it increases the workability and lowers the strength of concrete by increasing water content w/c ratio increases.



(2) Slump test is an indication of workability.

(3) Higher the slump of concrete higher will be its workability.

(4) Workability of concrete is affected by water content as well as water cement ratio

Hence option (c) 1 and 2 only

**Sol. 5. (a)**

Rate of hydration is

$$C_3A > C_4AF > C_3S > C_2S$$

C<sub>4</sub>AF and C<sub>3</sub>A are responsible for flash set, when water is added to the cement, the quickest to react with water is C<sub>3</sub>A.

**Sol. 6. (a)**

Concrete is most often assumed to behave as a bingham fluid.

$$\text{Hence, } \tau = \tau_0 + \mu \dot{\gamma}$$

**Sol. 7. (c)**

High pressure steam curing is generally recommended for rapid gain of strength of concrete.

**Sol. 8. (d)**

Properties of autoclaved aerated concrete are as follows

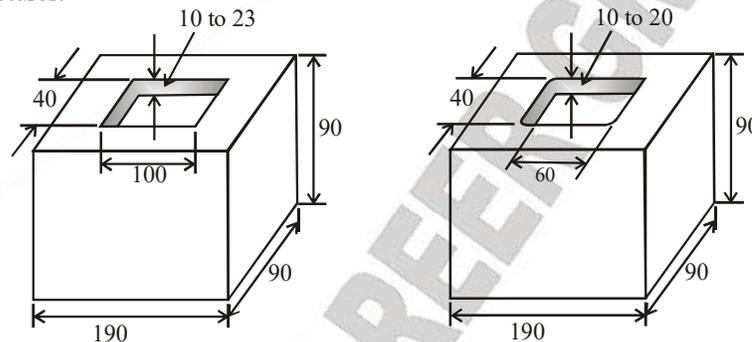
- (i) Thermal efficiency
- (ii) Superior fire resistance
- (iii) Light weight
- (iv) Great ventilation
- (v) Non toxic

**CHAPTER - 3****BRICKS****3.1 INTRODUCTION**

1. Bricks is one of the oldest building material and it is extensively used at present as a building material in construction methods because of its durability, strength, reliability, low cost, easy availability etc.

2. Bricks are manufactured by moulding burnt clay or mixture of sand and lime or of portland cement, concrete, in rectangular blocks of uniform size and then drying and burning these blocks.

3. Bricks are used for building-up exterior and interior walls, partitions, piers, footings and other load bearing structures.



4. Size of standard brick (also known as modular brick) is  $19 \times 9 \times 9$  cm and  $19 \times 9 \times 4$ , when placed in masonry  $19 \times 9 \times 9$  cm brick with mortar it becomes  $20 \times 10 \times 10$  cm and weight of such brick is 3 kg

5. An indent called frog, 1.2 cm deep is provided in the brick and size of frog should be  $10 \times 4 \times 1$  cm.

6. Purpose of providing frog is to form a key for holding the mortar, and therefore the bricks are laid with frogs on top.



In many parts of the country, bricks are still made in non-standard size which are called as traditional bricks or field bricks. Size of such bricks is =  $9^2 \times 4 \frac{1}{2} \times 3$  (23 × 11.4 × 7.6 cm).

**3.2 CLASSIFICATION OF BRICKS****3.2.1 On Field Practice**

Clay bricks are classified as first class, second class, third class and fourth class based on their physical and mechanical properties.

**1. First Class Bricks**

(i) These bricks are table moulded and they are burnt in kilns.

## ESE OBJ QUESTIONS

1. Consider the following statements regarding refractory bricks in furnaces:

1. The furnace is fired at temperature more than 1700°C
  2. Silica content in the soil should be less than 40%
  3. Water absorption of bricks should not exceed 10%
  4. Chrome bricks are known as basic bricks.
- Which of the above statements are correct?

[ESE - 2017]

- (a) 1 and 2 only                      (b) 2 and 4 only  
(c) 1 and 3 only                      (d) 3 and 4 only

2. Consider the following statements:

1. IS 3583 refers to Burnt Clay Paving Bricks.
  2. IS 5779 refers to Burnt Clay Soling Bricks.
  3. IS 3952 refers to Burnt Clay Hollow Bricks.
  4. IS 2222 refers to Burnt Clay Lay Bricks
- Which of the above statements are correct?

[ESE - 2017]

- (a) 1, 2 and 3 only                      (b) 1, 2 and 4 only  
(c) 3 and 4 only                      (d) 1, 2, 3 and 4

**3. Assertion (A):** Mud bricks can completely replaced by Flyash lime-Gypsum (Fal-G) bricks in-building

**Reason (R):** Useful fertile soil is used in manufacturing mud bricks, causing high CO<sub>2</sub> release in the atmosphere.

[ESE - 2017]

**Codes:**

- (a) Both A and R true and R is the correct explanation of A  
(b) Both A and R are true but R is not correct explanation of A  
(c) A is true but R is false.  
(d) A is false but R is true.

**4. Assertion (A):** Contemporarily, even in highrise buildings, ordinary brick is being replaced by glass blocks for load-bearing wall.

**Reason (R):** Bricks have high thermal conductivity and area not heat insulators.

[ESE - 2017]

**Codes:**

- (a) Both A and R true and R is the correct explanation of A  
(b) Both A and R are true but R is not correct explanation of A  
(c) A is true but R is false.  
(d) A is false but R is true.

5. Efflorescence of bricks is due to

[ESE - 2016]

- (a) Excessive burning of bricks
- (b) High silt content in brick clay
- (c) High porosity of bricks
- (d) Soluble salts present in parent clay.

6. Disintegration of brick masonry walls is primarily due to

[ESE - 2016]

1. Efflorescence
2. Magnesium sulphate in bricks
3. Calcined clay admistures
4. Kankar nodules

Which of the above statements are correct?

- (a) 1, 2 and 3 only  
(b) 1, 2 and 4 only  
(c) 3 and 4 only  
(d) 1, 2, 3 and 4

**7. Statement (I):** The forward edge of wheels or outriggers acts as a fulcrum in determining the lifting capacity of a mobile crane.

**Statement (II):** There is in-built security and safety against sudden dropping of load, as well as against abrupt swinting, in the working of a mobile crane.

[ESE - 2016]

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).

## SOLUTIONS

**Sol. 1. (c)**

1. Fire clays are capable of resisting very high temperature upto 1700°C without limiting or softening and resist spelling.
2. Silica content in slice bricks are upto 95%.
3. The water absorption of fireclay bricks varies from 4-10%.
4. Chroma bricks are known as neutral bricks.

**Sol. 2. (a)**

Burnt clay paving bricks-153583  
 Burnt clay soiling bricks-155779  
 Burnt clay hollow bricks-153952  
 Burnt clay perforated bricks-152222

**Sol. 3. (a)****Sol. 4. (d)****Sol. 5. (d)**

Efflorescence is caused because of alkalis present in clay. Salts such as sulphates of sodium and potassium, if present in clay are dissolved by the absorbed water. On drying grey or white powder patches appear on the brick surface, which is called as efflorescence.

**Sol. 6. (d)****Sol. 7. (b)**

The stability-limited rated load for a mobile crane supported on outriggers is 85% of tipping load.

∴ Tipping takes about fulcrum.

**Sol. 8. (a)****Sol. 9. (b)****Sol. 10. (d)**

Addition of saw dust decreases the workability because of water absorption.

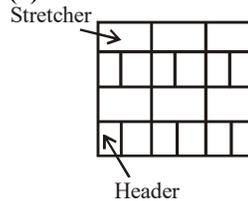
**Sol. 11. (a)****Sol. 12. (b)****Sol. 13. (a)****Sol. 14. (d)****Sol. 15. (b)****Sol. 16. (a)****Sol. 17. (a)****Sol. 18. (b)****Sol. 19. (d)****Sol. 20. (a)**

The code for heavy duty bricks is IS 2180 and not IS 2980. As per Cl 3.1 2180, the compressive strength should be classified as:-

**Classification**

Class 400: Compressive strength not less than 40.0 N/mm<sup>2</sup>. (400 kgf/cm<sup>2</sup>)

Class 450: Compressive strength not less than 45.0 N/mm<sup>2</sup>, (450 kgf/cm<sup>2</sup>)

**Sol. 21. (c)****Sol. 22. (d)****Sol. 23. (a)****Sol. 24. (b)****Sol. 25. (d)****Sol. 26. (b)**

## CHAPTER - 4

### TIMBER

#### 4.1 INTRODUCTION

1. Timber denotes wood which is suitable for building or carpentry or various other engineering purposes and it is applied to the trees measuring not less than 600 mm in circumference of the trunk

2. Following three terms are to be noted in connection with the timber:

(i) **Converted timber:** Timber which is sawn and cut into suitable commercial sizes.

(ii) **Rough timber:** Timber which is obtained after felling a tree.

(iii) **Standing timber:** Timber contained in a living tree.

3. Timber or wood, as building material, possesses a number of valuable properties such as low heat conductivity, amenability to mechanical work, small bulk density, relatively high strength, etc.

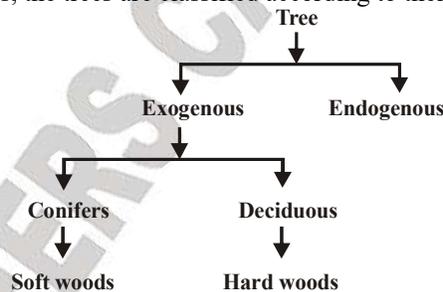
4. Owing to the above mentioned advantages wood is very widely used in buildings as doors windows, frames, temporary partition walls etc and in roof trusses and ceilings apart from formwork.

5. But it also has some drawbacks such as susceptibility to decay and inflammability, fluctuations in properties due to changes in moisture content, variations in strength in length and across fibers, etc.

6. These drawback of timber can greatly be reduced by the application of some of the modern wood processing techniques.

#### 4.2 CLASSIFICATION OF TREE

For the engineering purposes, the trees are classified according to their mode of growth.



##### 1. Endogenous Tree

(i) These trees grow inwards.

(ii) Timber from these trees has very limited engineering applications.

(iii) Examples of endogenous trees are bamboo, cane, palm etc.

##### 2. Exogenous Tree

(i) These trees grow outwards

(ii) These trees are used for making structural elements

(iii) They are further divided as conifers and deciduous.

## ESE OBJ QUESTIONS

**1. Assertion (A):** Compreg' timbers have higher specific gravity of up to 1.30 and are stronger than other timbers.

**Reason (R):** Impregnation of resins and special curing methods are adopted to develop 'Compreg' timbers.

[ESE - 2017]

**Codes:**

- (a) Both A and R true and R is the correct explanation of A
- (b) Both A and R are true but R is not correct explanation of A
- (c) A is true but R is false.
- (d) A is false but R is true.

**2.** Consider the following statements regarding timber:

1. The strength of timber increases by Kiln seasoning.
2. Cutting of wood is to be done prior to treatment.
3. Water seasoning is good for prevention of warping.
4. ASCU treatment enhances the strength of wood

Which of the above statements are correct?

[ESE - 2017]

- (a) 1, 2 and 3 only
- (b) 2, 3 and 4 only
- (c) 1, 3 and 4 only
- (d) 1, 2, 3 and 4

**3.** Consider the following statements:

1. There will be no defects in select grade timbers.
2. The codal values for strength of grade-II timber without defects may be reduced by 37.5%.
3. For timber used as columns, the permissible stress in ungraded timbers is adopted with a multiplying factor of 0-50.
4. In case of wind force and earthquakes, a modification factor of 1.33 is adopted.

Which of the above statements are correct?

[ESE - 2016]

- (a) 1 and 3 only
- (c) 2 and 4 only

- (b) 1 and 4 only
- (d) 2 and 3 only

**4. Statement (I):** Water containing less than 2000 ppm of dissolved solids can generally be used satisfactorily for making concrete.

**Statement (II):** The presence of any of zinc, manganese, tin, copper or lead reduces the strength of concrete considerably.

[ESE - 2016]

**Codes:**

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

**5. Statement (I):** Fire resistance of plastering can be achieved by mixing surkhi to the cement mortar.

**Statement (II):** Insulation against sound and fire can be achieved by adding sufficient water in-situ just before applying the mortar.

[ESE - 2016]

**Codes:**

- (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).
- (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)
- (c) Statement (I) is true but Statement (II) is false
- (d) Statement (I) is false but Statement (II) is true

**6. Statement (I):** Hardwoods are used in special purpose heavy constructions.

**SOLUTIONS**

**Sol. 1. (a)**

**Sol. 2. (a)**

Seasoning of timber causes increases in strength, durability, workability and resilience.

Timber for treatment must be sound and dried to an appropriate moisture content. All wood working processes like cutting to size, boring etc. shall be done prior to treatment.

Seasoning reduces shrinkage and warping.

ASCU treatment is a method of preservation of timber, which results in durability of wood and not strength.

**Sol. 3. (c)**

Some defects are permitted in all grades of timber and all other defects unlikely to affect any of the mechanical strength properties.

1. As IS: 1331-1971 provides for reduction in strength of Grade-II timber without defect not by more than 37.55%.

2. Permissible stress in ungraded timbers is adopted with a multiplying factor of 0.80.

3. Modification factor of 1.33 is adopted in case of wind and earthquake forces.

**Sol. 4. (b)**

**Sol. 5. (c)**

**Sol. 6. (b)**

Hardwoods are used in special purpose heavy construction because they are strong in tension, compression and shear, strong along and across the grains.

All hardwoods have vessels (little pipelines) that are used in sap production. When the vessels are cut across the end grain, they are referred to as pores, thus hardwoods are known as "porous woods".

**Sol. 7. (a)**

Cambium layer occurs in innerbarks and sap wood.

**Sol. 8. (a)**

**Sol. 9. (d)**

Timbers suitable for furniture is obtained deciduous trees only.

**Sol. 10. (\*)**

**Sol. 11. (c)**

**Sol. 12. (b)**

**Sol. 13. (a)**

In the question we are asked about preservation and not preservative. So, all are correction. If it had been preservative in the question then option 'c' would be correct because preservation neither increase the strength nor reduce the moisture content.

**Sol. 14. (c)**

IS 1141-1958 → Seasoning of timber.

**Sol. 15. (b)**

**Sol. 16. (a)**

Dry rot is a fungal defect and is caused due to wet and humid conditions.

**Sol. 17. (b)**

Sir Abel's process is used.

**Sol. 18. (b)**

Excrescence are formed when a tree has received shock or injury in its young are due to such injury, growth of tree is completely upset and irregular projections appear on body of timber.

**Sol. 19. (b)**

Druxiness is a defect indicated by white decayed spot which are concealed by healthy wood caused by access of fungi.

**Sol. 20. (a)**

**SECTION-B**  
**CONSTRUCTION MANAGEMENT**

**CHAPTER - 1****FUNDAMENTAL OF EQUIPMENTS****1.1 INTRODUCTION**

1. Construction equipments are one of the very important resource of modern-day construction, especially in infrastructure projects.

2. In such projects equipments are used for most of the works including earth moving operation, aggregate production, concrete production and its placement etc. In fact, we cannot think of any major construction activity without the involvement of construction equipment.

3. There are types of construction equipments suitable for different activities in a construction project.

4. The selection of construction equipment defines the construction method, which in a way leads to the determination of time and cost for the project.

5. For selection the right equipment to perform a specific task at the least cost, it is essential to know the features of a construction equipment including its rate of production and the associated cost to operate the equipment.

6. While dealing with the construction stage, selection of the most suitable equipment is a very typical problem which is generally faced by the construction engineers or contractors.

7. A contractor may not afford to have all types or sizes of equipment which are required for execution of the projects.

8. Choice is made after considering many factors like nature of the project, cost of equipment, depreciation possibility of its future uses on other projects, its resale value after certain period the saving expected from the use of such equipments etc.

**1.1.1 Classification of Construction Equipments**

Construction equipments can be classified into many ways.

1. Basis of function of equipment-for example, material loading function, material – transporting function etc.

On the basis functions equipments can be grouped into

(i) Power Units

(ii) Prime movers

(iii) Tractors

(iv) Material-Handling equipment

(v) Material-processing equipment

2. Basis of Operation of equipment:

(i) Equipments used for moving and loosening the materials found in their natural state eg-pumps, excavators, earth moving, trenchers, compressors etc.

(ii) Equipments for processing the materials, for example aggregate, concrete and asphalt production.

(iii) Equipments used for transporting the processed materials

(iv) Equipments used for placing finish materials

3. Basis of purpose of equipment

(i) General Purpose: Earthwork equipment, Hoisting Concreting.

(ii) Special equipments: Piling rig, coffer dams, tunnel boring machine, caissons equipments etc.

## ESE OBJ QUESTIONS

1. Consider the following statements:

1. hydrophobic cement grains possesses low wetting ability.
2. Rapid – hardening cement is useful in concreting under static, or running water
3. Quick – setting cement helps concrete to attain high strength in the initial period
4. White cement is just a variety of ordinary cement free of colouring oxides.

Which of the above statements are correct?

[ESE - 2018]

- (a) 1 and 4 only (b) 1 and 3 only  
(c) 2 and 4 only (d) 2 and 3 only

**2. Statement (I):** Cement, as a refractory material (Clay 80% + Aluminium 20%), is used in the construction of rocket and jets.

**Statement (II):** Cement containing metals, which are stable at temperatures as high as 600°C, resists sudden shocks.

[ESE – 2018]

**Codes:**

- (a) Both Statement (I) and Statement (II) are individually true and statement (II) is the correct explanation of statement (I).  
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).  
(c) Statement (I) is true but Statement (II) is false.  
(d) Statement (I) is false but Statement (II) is true.

3. Consider the following statements regarding quality control:

[ESE - 2017]

1. It refers to absolute conformity to specifications.
2. It may not vouch against overspending.
3. It may unknowingly resort to overdesign in the hope of risk minimization.
4. It is intended to reduce maintenance costs.

Which of the above statements are correct?

- (a) 1 and 3 only (b) 2 and 3 only  
(c) 2 and 4 only (d) 1 and 4 only

**4. Statement (I):** For implementing weigh-batching, separate compartments are made for storing large quantities of the aggregates. Besides lifting and loading equipments, there must be regular assessment of grading and also of moisture content.

**Statement (II):** Whereas eventual strength of the mix depends also on the grading of the ingredients, the water needs to be properly computed and implemented.

[ESE - 2016]

**Codes:**

- (a) Both Statement (I) and Statement (II) are individually true and statement (II) is the correct explanation of statement (I).  
(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).  
(c) Statement (I) is true but Statement (II) is false.  
(d) Statement (I) is false but Statement (II) is true.

5. Engines are related at specified conditions. Then which of the following statements are correct?

1. Power developed increases as local temperature increases.
2. Power developed increases as local temperature decreases.
3. Power developed is not dependent on local temperature.
4. Power developed increases as local atmospheric pressure increases.
5. Power developed increases as local atmospheric pressure decreases.

Select the correct answer using the code given below.

[ESE - 2014]

# SOLUTIONS

**Sol. 1. (a)**

(i) Hydrophobic cement contains admixtures which decrease the wetting ability of cement grains.

(ii) Rapid hardening cement is similar to OPC, except it has more  $C_3S$  and it is ground more finely. It helps in attainment of early strength and used where early removal of formwork is required.

(iii) Quick setting cement has low gypsum content which gives the quick setting property but it does not affect the strength gain.

(iv) White cement are free from iron oxides.

**Sol. 2. (a)**

The composition of most cements: 80% ceramic (clay) and 20% metals (Al, Ni, Fe etc). These cermets are mainly used as high refractories where high temp as well as shock resistant. Thus cermets are used in rockets and jet engine port

**Sol. 3. (b)****Sol. 4. (b)****Sol. 5. (d)**

$$\frac{H}{P} \sqrt{T} = \text{constant}$$

Where, H → Horse power of engine

P → Pressure in mm of  $H_g$

T → Temperature in K

Power developed is directly proportional to local atmospheric pressure and inversely pressure to the square root of local temperature.

**Sol. 6. (b)**

A crawler truck it is used for moving heavy units on rough surface having poor traction. The optimum pull that a crawler truck can provide depends upon its weight and is equal to the coefficient of traction (depending upon road

surfaces) multiplied by the weight of unit, regard less of the power supplied by the engine. Having more tractive effort a crawler truck can operate on soft footing such as loose or muddy soil. A wheel tractor possesses a lower coefficient of traction between rubber tyres and some soil surfaces.

**Sol. 7. (c)**

$$\begin{aligned} \text{Effective capacity of loader} &= \frac{90}{100} \times 1.6 \\ &= 1.44 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Total productivity per hour} &= \frac{50 \times 60}{64} \times 1.44 \\ &= 67.5 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Total productivity in 4h shift} &= 67.5 \times 4 \\ &= 270 \text{ m}^3 \end{aligned}$$

**Sol. 8. (d)**

Hourly output

$$= \frac{100C}{\frac{D}{30} + 2.8} = \frac{100 \times 7}{\frac{65}{30} + 2.8} = 140.94 \text{ m}^3$$

**Sol. 9. (d)**

Tractive effort = Rolling resistance

+ Grade resistance

$$= 42 \times 25 + (42 \times 25) \times \frac{5}{100}$$

$$= 1050 + 52.5 = 1102.5 \text{ kg}$$

**Sol. 10. (a)**

Advantages of ADT over RDT are:

- (i) Higher Manoeuverability
- (ii) Lower turning radius
- (iii) Higher tractive effort
- (iv) Better operator comfort
- (v) Faster cycle times and therefore low fleet costs.

**Sol. 11. (a)**

If the depth of face from which a shovel is excavating material us to shallow, then it will be

**CHAPTER - 2****EXCAVATION EQUIPMENT****2.1 INTRODUCTION**

1. The type of foundation to be used for any particular structure will have to be determined at the planning stage. The type chosen will depend to a large extent on the surface or subsurface conditions encountered at the site.

2. Thus, to build on clear a foundation, an excavation is required, and this operation will usually be carried out by some type of powered excavation equipment.

3. This unit describes the different types of excavating equipment used in construction.

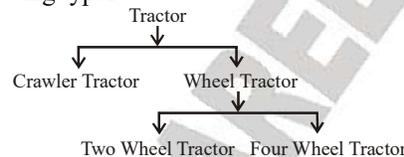
**2.2 TRACTOR**

1. Primary purpose of a tractor is to pull or push loads, and it may be used also be mount for many types of equipment such as bulldozer, shovel, dragline, hoe, trenchers etc. Therefore.

2. It is considered as one of the most important equipments and is indispensable on most of the construction projects whether small or big.

**2.2.1 Types of Tractors**

Tractors are divided into following types:

**1. Factors affecting in selection of a tractor**

In selecting a tractor, several factors should be considered and some of them are enumerated as follows;

- (i) Size required as per magnitude of the job
- (ii) Kind of job for which it is to be used like bulldozing, pulling a scraper, clearing land etc.
- (iii) Type of footing over which it is operate i.e. high tractive or low tractive efficiency.
- (iv) Firmness of haul road.
- (v) Smoothness of haul road
- (vi) Slope of haul road
- (vii) Slope of haul road
- (viii) Type of work it is no do after this job is completed.

**2. Crawler tractor**

(i) If a tractor is mounted on crawler, it is called crawler tractor.

(ii) Crawler is an endless chain consisting of steel links made of steel plates connected together by pins and bushings.

(iii) It is used for moving heavy units on rough surface having poor traction. The optimum pull that a crawler tractor can provide depends upon its weight and is equal to the coefficient of traction (depending upon road surfaces) multiplied by the weight of unit, regardless of the power supplied by the engine. Its

(iv) Maximum speed is limited to 10 kmph while average speed lies between 4.5 to 5.6 kmph. It is suited for short haul say 60 to 150 m.



# SOLUTIONS

**Sol. 1. (c)**

Bleeding can be reduced by the use of uniformly graded aggregates, pozzolana – by breaking the continuous water channel, or by using – entraining agents, finer cement, alkali cement and rich mix.

**Sol. 2. (b)**

Volume of one bag of cement =  $0.035\text{m}^3$   
 Cement: sand : Aggregate :: 1 : 1.5 : 3 (by volume)  
 $\therefore$  Volume of dry mix  
 $= 0.035 + 1.5 \times 0.035 + 3 \times 0.035 = 0.1925\text{ m}^3$   
 $\therefore$  For wet mix yield of concrete  
 $= \frac{2}{3} \times 0.1925 = 0.128\text{m}^3$

**Sol. 3. (c)**

(i) Workability of concrete is the ease with which a concrete can be transported, placed and 100% compacted without excessive bleeding or segregation.  
 (ii) Concrete having large sized aggregate has high workability due to less surface area of large aggregate which requires less paste.  
 (iii) Slump value of zero is an indication of extremely low workability of mixture

**Sol. 4. (b)**

Statement I and II both are correct  
 Cement mortar has better quality as compare to lime – surkhi mortar.

**Sol. 5. (a)**

Rapid method of concrete mix-design takes only 3 days for trials.  
 The procedure is based on the use of accelerated curing (using warm water)

**Sol. 6. (a)**

Ready mix concrete (RMC) is preferably used in large project as it possess the following major properties:

(i) Better quality concrete is produced.

(ii) Elimination of storage space for basic materials at site.

(iii) It can achieve any desired strength of concrete.

Thus helps in easy completion of large projects .

**Sol. 7. (b)**

Desired strength of concrete depends on workability which is in-turn depended on surface area of aggregates.

**Sol. 8. (b)**

Limonite is one special type of aggregate having density 2.7 – 4.3g/cc.

**Sol. 9. (a)**

Short term modular ratio =  $\frac{E_s}{E_c}$

$$= \frac{2 \times 10^5 \text{ MPa}}{5000 \sqrt{f_{ck}} \text{ Mpa}}$$

$$= \frac{2 \times 10^5}{5000 \sqrt{25}} = 8$$

Long term modular ratio (including effect of

$$\text{creep}) = \frac{280}{3\sigma_{cbc}}$$

$$\sigma_{cbc} \text{ for M 25} = 8.5$$

$$\text{Long term modular ratio} = \frac{280}{3 \times 8.5}$$

$$= 10.98 \approx 11$$

**Sol. 10. (a)**

Direct compression =  $0.4 f_{ck} = 0.4 \times 25 = 10$  Mpa

(In case of column, in axial compression the value of direct compression the value of direct compression strength of concrete is assumed as  $0.4 f_{ck}$ ).

$$\text{Bending compression strength} = 0.46 f_{ck} = 11.15 \text{ MPa}$$

## CHAPTER - 3

### HOISTING EQUIPMENTS

#### 1.1 INTRODUCTION

1. Hoisting is the operation of lifting a weight from one location and moving it to another location which is at reasonable distance and then dumping it.

2. In Most of the construction projects materials and structural members are required to be raised from the ground level to the height where they are required to be placed and this lifting is done with the help of jacks, winches, chain hoists and cranes.

3. Hoisting equipment should be strong enough to negotiate the load and should consume minimum time possible in the operation and it should be quite safe while handling.

#### 1.2 TYPES OF HOISTING EQUIPMENTS

##### 1. Pulley

Pulley and sheave are used for lifting rough surfaced and heavy objects. Both chains and wire ropes are used for this purpose.

##### 2. Chain Hoists

These are used for lifting loads up to 50 tonnes. This system consists of hand chain and the load chain. Pull applied through the hand chain is transmitted to the load chain.

##### 3. Jacks

These are based on the principle of inclined plane. It is short name of Screw Jack. Smallest jack may have capacities for 5 tonne generally used for lifting an automobile wheel. Where as the bigger one may be to of 100 tonnes capacity. These are primarily of two types (i) Mechanical (ii) Hydraulic.

In mechanical system, load is mounted on the platform which is attached with spirally threaded spindle. The platform is rotated and load is lifted.

IN hydraulic type, pressure is exerted by a liquid on the surface.

##### 4. Winch

This is a combination of gears (spur and pinion), clutches and brakes. Operation is controlled through a series of leavers. It is commonly used in lifting the railway gates.

##### 5. Cranes

These are most widely used equipment as an independent unit. Lifting capacity varies from ½ tone to 500 tonnes.

Cranes does the hoisting operation seedily with safety and precision.

(i) Cranes are broadly be divided into four classes

(a) Stationary cranes, sometimes called Derrick cranes.

(b) Mobile cranes

(c) Overhead or Gantry cranes

(d) Tower cranes

(e) Traveler cranes

## ESE OBJ QUESTIONS

1. Consider the following statements regarding flow net  
 1. It helps determine the quantity of seepage.  
 2. It helps determine the upward lift below a hydraulic structure.  
 3. It is applicable to rotational flow only.  
 Which of the above statements are correct?  
**[ESE - 2016]**  
 (a) 1 and 2 only (b) 1 and 3 only  
 (c) 2 and 3 only (d) 1, 2 and 3
2. Consider the following statements about 'cranes'.  
 1. Mobile cranes are suitable in small operations.  
 2. Whirely crane is a stationary crane with a long boom.  
 3. Tower crane is used in lifting heavy machinery.  
 4. A guy-derrick can operate in a limited area only.  
 Which of the above statements are correct?  
**[ESE - 2014]**  
 (a) 1 and 4 (b) 2 and 4  
 (c) 1 and 3 (d) 2 and 3
3. **Statement (I):** In the erection of tall building tower crane is preferred.  
**Statement (II):** Tower crane is a combination crane and it is suitable when the area is small and congested.  
**[ESE - 2013]**  
 (a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I).  
 (b) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I).  
 (c) Statement (I) is true but Statement (II) is false.  
 (d) Statement (I) is false but Statement (II) is true.
4. In a group housing project, it is proposed to use pre-fabricated RCC beams and columns. The most useful construction equipment is  
**[ESE - 2011]**  
 (a) Derrick Crane (b) Chute  
 (c) Weigh Batcher (d) Transit Mixer
5. A four-wheel tractor whose operating weight is 13,000 kg is pulled along a haul road having a slope of 4% at a uniform speed with a rolling resistance of 10 kg/ton for 1% slope. The tension in the toe cable is 1105 kg. The rolling resistance of the haul road is  
**[ESE - 2010]**  
 (a) 35 kg/ton (b) 45 kg/ton  
 (c) 55 kg/ton (d) 65 kg/ton
6. Match the List-I (Equipment) with List-II (category) and select the correct answer using the codes given below lists:  
**List-I**  
 A. Derrick crane  
 B. Hoe  
 C. Clamshell  
 D. Dumper Truck  
**List-II**  
 (i) Excavating equipment  
 (ii) Hauling equipment  
 (iii) Hoisting equipment  
 (iv) Vertical lifting equipment  
**[ESE - 2009]**
- Codes:**  
 (a) A-ii, B-i, C-iv, D-iii  
 (b) A-iii, B-i, C-iv, D-ii  
 (c) A-ii, B-iv, C-i, D-iii  
 (d) A-iii, B-iv, C-i, D-ii
7. Match List-I (Equipment) with List-II (Category) and select the correct answer using the codes given below the lists:  
**List-I**  
 A. Derrick Crane  
 B. Hoe  
 C. Clamshell

# SOLUTIONS

**Sol. 1. (a)**

(i) Flow net is graphical representation of path taken by water particle and head variation along the path which are used for seepage calculation.

(ii) In hydraulic structures which are generally used for retaining or restricting water, water seeps into the soil below structure and creates upward pore water pressure which can be calculated using flow net because it also gives head variation along the path and gives idea about exit gradient.

(iii) Since equations of flow net are derived from Laplace equation i.e.,

$$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = 0$$

and the flow which satisfies Laplace equation is irrotational flow. Hence, seepage through flownet is irrotational flow.

**Sol. 2. (a)**

1. Whirley crane is not a stationary crane
2. Tower crane is used in lifting construction materials.

**Sol. 3. (a)****Sol. 4. (a)**

**Derrick crane** Is a hoisting equipment used to lift the load, hold it in suspension during transfer from one location to the other and finally place it on the desired location.

**Chutes** When concrete is to be deposited below ground at a level at a higher depth it can be discharged through a steel shaft called chute. Height of fall is avoided. It may be used in pile foundation.

**Weight batcher** Used for batching of materials for a desired concrete mix.

**Transient mixer** A transit mixer is a truck on which a concrete mixer is mounted. The aggregates and cement are charged into the mixer at a central batching plant and water is added to the mixer on route to the job. Mixing

process gets completed by the time it reaches the site.

**Sol. 5. (b)**

Operating weight of tractor,

$$W = \frac{13000}{1000} = 13 \text{ tonnes.}$$

Total grade resistance

$$= 13 \times 10 \times 4 = 52 \text{ kg}$$

Required tractive effort, P

$$= \text{Tension in toe cable}$$

$$- \text{Total grade resistance}$$

$$= 1105 - 520 = 585 \text{ kg}$$

∴ Rolling resistance

$$R = \frac{585}{13} = 45 \text{ kg / tonnes}$$

**Sol. 6. (b)****Sol. 7. (a)****Sol. 8. (c)****Sol. 9. (c)****Sol. 10. (a)**

Tower cranes provide high lifting height and good working radius, while taking up a very limited area. These advantages are achieved at the expense of low lifting capacity and limited mobility as compared to mobile cranes. Gantry crane is specially advantageous where the load has to be moved three dimensionally.

**Sol. 11. (a)****Sol. 12. (b)**

Tower crane is used for erection of very tall industrial and residential buildings.

Gantry crane is used in factories and workshops.

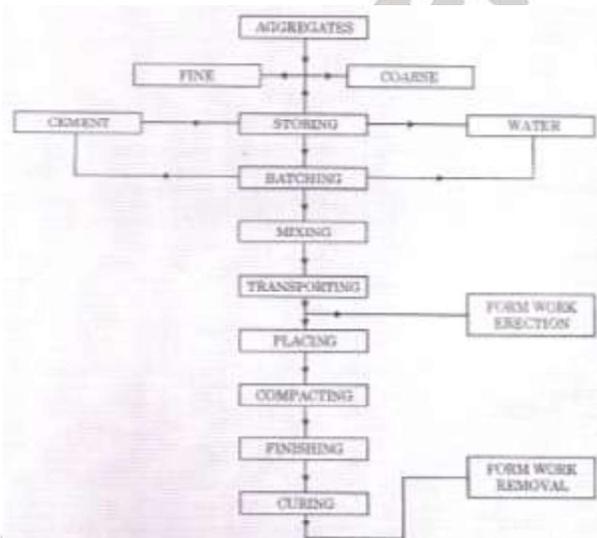
**Sol. 13. (a)****Sol. 14. (c)**

## CHAPTER - 4

### CONCRETING EQUIPMENT

#### 4.1 INTRODUCTION

1. In any construction job, ingredients of concrete – aggregate, sand, cement and water have to be mixed properly to produce a quality concrete.
2. Concrete is most widely used man made construction material.
3. Such versatility of concrete is due to the fact that, from the common ingredients, namely cement, fine and coarse aggregate.
4. It is possible to change the properties of concrete to meet the demands of any particular situation.
5. For manufacturing of concrete various equipment's are may be required either the job is large or small.
6. Once concrete is produced it has to be transported and placed by pumps, boom placer or by some other means.
7. The transporting equipment conveys concrete from the concrete manufacturing plant in suitable containers.



8. Generally following operation are preformed during concreting.

- (i) Storing
  - (a) Storing of cement
  - (b) Storing of aggregates
  - (c) Storing of water.
- (ii) Batching
  - (a) Batching of cement
  - (b) Batching of aggregates
  - (c) Batching of water

## ESE OBJ QUESTIONS

1. Consider the following statements in respect of 'mixers'

1. Mass batch mixing of ingredients is the most desirable method.
  2. Charging all materials into a drum mixer is done 'at once'.
  3. The quantity of materials fed into a mixer should be not more than the quantity that can be used in less than 30 minutes after completion of mixing.
  4. Reversing mixers have less capacity than tilting mixers.
  5. In large mixers, additional time of mixing is allowed.
- Which of the above statements are correct?

[ESE - 2014]

- (a) 1, 2 and 3                      (b) 1, 3 and 5  
(c) 2, 3 and 4                      (d) 2, 4 and 5

**2. Assertion (A):** Pumps for concreting are generally of the positive displacement category.  
**Reason (R):** Roto-dynamic pumps may effect more crushing of the coarse aggregate.

[ESE - 2011]

- (a) Both A and R are individually true and R is the correct explanation of A  
(b) Both A and R individually true and R is the correct explanation of A  
(c) A is true but R is false  
(d) A is false but R is true.

3. Match List-I with List-II and select the correct answer using the code given below the lists

**List-I**

- A. Concrete pumps  
B. Agitating trucks  
C. Transit Mixer  
D. Crane Bucket

**List-II**

- (i) Ready Mix concrete  
(ii) Multi-storey concreting works  
(iii) Tunnel works  
(iv) Built-up and busy area.

[ESE - 2011]

**Codes:**

- (a) A-iii, B-iv, C-i, D-ii  
(b) A-ii, B-i, C-iv, D-iii  
(c) A-iii, B-i, C-iv, D-ii  
(d) A-ii, B-iv, C-i, D-iii

4. How are concrete mixers specified?

[ESE - 2007]

- (a) By the number of cement bags used in a batch  
(b) By the nominal volume of concrete that can be mixed in a batch  
(c) By the volume of water used  
(d) By the volume of aggregate used

5. Consider the following statements

A mixer designated 400 NT indicates that

1. It is non-tilting type mixer.
  2. Its nominal mix batch capacity is 400 litres
  3. It requires 400 revolutions for proper mixing of the batch using one bag of cement.
- Which of these statements are correct?

[ESE - 2006]

- (a) Only 1 and 3                      (b) Only 1 and 3  
(c) Only 2 and 3                      (d) 1, 2 and 3

6. Two centrifugal pumps work in parallel at a common delivery head of 18 m. The first pump delivers 90 ℓps at an efficiency of 60% and the second pump delivers 60 ℓps at an efficiency of 50%. What is the overall efficiency of the system?

[ESE - 2004]

- (a) 62.5%                              (b) 58%  
(c) 55.5%                              (d) 52%

7. Match List-I (Type of compactor) with List-II (Soil best suited) and select the correct answer using the codes given below the lists

**List-I**

- A. Sheepsfoot compactor  
B. Steel tandem compactor with 2 or 3 axles

# SOLUTIONS

**Sol. 1. (b)**

1. Batch mixing is always desirable as per the mass or weight of ingredients.
2. Normally initial setting time is 30 minutes hence placing of concrete should be done before it.
3. For large mixers, additional time of mixing is allowed.

**Sol. 2. (a)**

A positive displacement pump causes fluid to move by trapping a fixed amount of it then forcing (displacing) that trapped volume into the discharge pipe. These pumps are used for pumping highly viscous fluids including concrete and heavy oils, and under special applications demanding low flow rates against high resistance. Positive displacement pumps, unlike centrifugal or roto-dynamic pumps, will produce the same flow at a given speed (RPM) no matter what the discharge pressure which is helpful in concreting works. Also roto dynamic pumps cause segregation of concrete mix and crushing of the aggregates.

**Sol. 3. (c)**

Crane bucket helps to deposit concrete at different elevations around a structure e.g. multistorey building.

**Concrete Pumps** Are commonly used on tunnel works and on locations which are not easily accessible.

**Transit mixer** A transit mixer is a truck on which a concrete mixer is mounted. The aggregates and cement are charged into the mixer at a central batching plant and water is added to the mixer en route to the job. Mixing process gets completed by the time it reaches the site.

**Agitating Truck** If the unit is used to haul ready mixed concrete which requires agitation en route to prevent it from segregation, the unit is called an agitator truck.

**Sol. 4. (b)****Sol. 5. (b)****Sol. 6. (c)****Sol. 7. (c)****Sol. 8. (b)**

The non-tilting type of mixer is suitable for small works and aggregate size not greater than 7.5 cm. With large sized aggregates, segregation may take place.

**Sol. 9. (b)****Sol. 10. (d)**

Surface vibrators are placed directly on the concrete mass. These are best suited for the compaction of shallow elements and should not be used when depth of concrete to be vibrated is more than 250 mm.

**Sol. 11. (b)**

When mechanical vibrators are used, the mix should not have high slump.

**Sol. 12. (c)**

Material	Impact	Pressure	Vibration	Kneading
Gravel	Poor	No	Good	Very good
Sand	Poor	No	Excellent	Good
Silt	Good	Good	Poor	Excellent
Clay	Excellent with Confinement	Very good	No	Good

Sheepfoot roller compact by tamping and kneading. Therefore they are suitable for silt and clay i.e. cohesive soils.

**Sol. 13. (c)**

Graders are multipurpose machines used for finishing, shaping, bank sloping and ditching.

**Sol. 14. (b)****Sol. 15. (a)**

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