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ESE 2021

**Preliminary
Examination**

Detailed Solutions of

**Civil
Engineering**

Set-A

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Expected Cutoff of ESE 2021 Prelims Exam (Out of 500 Marks)				
Branch	Gen	OBC	SC	ST
CE	260-270	250-260	220-230	220-230
ME	280-290	270-280	230-240	220-230
EE	250-260	240-250	210-220	200-210
E&T	270-280	260-270	220-230	210-220

Actual Cutoff of ESE 2020 Prelims Exam (Out of 500 Marks)				
Branch	Gen	OBC	SC	ST
CE	238	238	202	227
ME	262	250	214	202
EE	238	229	187	194
E&T	245	245	205	202

Civil Engineering Paper Analysis of ESE 2021 Preliminary Examination

Sl.	Subjects	No. of Questions
1	Building Materials	15
2	Strength of Materials	17
3	Structural Analysis	04
4	Design of Steel Structures	14
5	RCC & Prestress Concrete	15
6	Construction Practice, Planning & Management	10
7	Fluid & Hydraulic Machines + OCF	13
8	Engineering Hydrology	03
9	Irrigation Engineering	12
10	Environmental Engineering	10
11	Geo-technical Engineering	12
12	Surveying and Geology	13
13	Transportation Engineering (Highway, Tunnel, Railway Engg.)	12

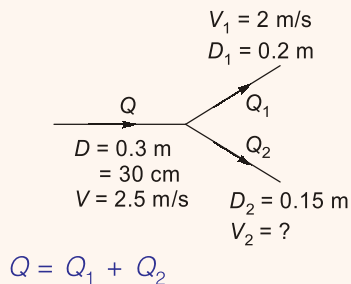
UPSC ESE/IES Prelims Exam 2021
Civil Engineering analysis and expected cutoff
by MADE EASY faculties

https://www.youtube.com/watch?v=9fex_oNhp9E



- Q.1** A network of pipes conveying water to a city has the following specifications. The diameter of a main pipe is 30 cm and it branches into two pipes of diameters 20 cm and 15 cm respectively. If the average velocity in the main pipe is 2.5 m/s and the average velocity in the 20 cm pipe is measured as 2 m/s, what is the velocity in the 15 cm pipe?
- (a) 8.84 m/s (b) 7.44 m/s
(c) 5.84 m/s (d) 6.44 m/s

Ans. (d)



$$Q = Q_1 + Q_2$$

$$\frac{\pi}{4}(0.3)^2(2.5) = \frac{\pi}{4}(0.2)^2 \cdot 2 + \frac{\pi}{4}(0.15)^2 V_2$$

$$V_2 = 6.44 \text{ m/s}$$

End of Solution

- Q.2** A centrifugal pump delivers water against a net head of 14.5 m and a design speed of 1000 rpm. The vanes are curved back to an angle of 30° with the periphery. The impeller diameter is 300 mm and the outlet width is 50 mm. What is the tangential velocity of impeller at outlet?
- (a) 15.7 m/s (b) 13.2 m/s
(c) 9.7 m/s (d) 11.2 m/s

Ans. (a)

Centrifugal pump

$$H_m = 14.5 \text{ m}$$

$$H = 1000 \text{ rpm}$$

$$\phi = 30^\circ$$

$$\text{Impeller Dia. } (D_2) = 300 \text{ mm} = 0.3 \text{ m}$$

$$B_2 = 50 \text{ mm} = 0.05 \text{ m}$$

$$u_2 = ?$$

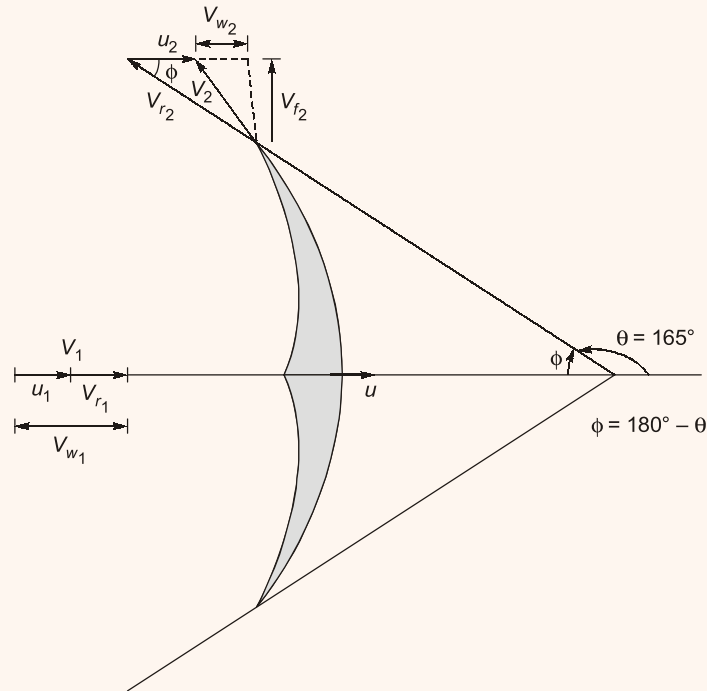
$$u_2 = \frac{\pi D_2 N}{60} = \frac{\pi(0.3)(1000)}{60}$$

$$u_2 = 15.7 \text{ m/s}$$

End of Solution

- Q.3** A 7.5 cm diameter jet of water strikes a curved plate at its centre with a velocity of 20 m/s. The curved plate is moving with a velocity of 8 m/s in the direction of the jet. The jet is deflected through an angle of 165° . By assuming the plate as smooth, what is the angle made by the relative velocity at the outlet of the plate?
- (a) 45° (b) 30°
(c) 15° (d) 0°

Ans. (c)



Given: Jet diameter, $d = 7.5 \text{ cm} = 7.5 \times 10^{-2} \text{ m}$

$$V_1 = 20 \text{ m/s}$$

$$u_1 = 8 \text{ m/s}$$

$$S = 165^\circ$$

Plate smooth $V_{r2} = V_{r1}$

Angle made by relative velocity at outlet

$$\phi = ?$$

$$\phi = 180^\circ - 165^\circ$$

$$\phi = 15^\circ$$

End of Solution



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- Q.4** A reservoir has a head of 40 m and a channel leading from the reservoir permits a flow rate of 34 m³/s. If the rotational speed of the rotor is 150 rpm, what is the power of the turbine? (Take $g = 9.81 \text{ m/s}^2$)
- (a) 14.34 MW (b) 13.34 MW
(c) 12.34 MW (d) 11.34 MW

Ans. (b)

$$H = 40 \text{ m}$$

$$Q = 34 \text{ m}^3/\text{s}$$

$$N = 150 \text{ rpm}$$

$$g = 9.81 \text{ m/s}^2$$

Power of turbine = ?

$$= \dot{m} \cdot g \cdot H$$

$$= \rho \cdot Q \cdot g \cdot h$$

$$= (10^3)(34)(9.81)(40)$$

$$= 13.3416 \text{ MW}$$

End of Solution

- Q.5** A stream function is given by $\psi = 3x^2 - y^3$. What is the magnitude of velocity components at the point (2,1)?
- (a) 8.52 (b) 9.17
(c) 10.81 (d) 12.37

Ans. (d)

$$\psi = 3x^2 - y^3$$

u & v at (2, 1)

$$u = -\frac{\partial \psi}{\partial y} = -\frac{\partial}{\partial y}(3x^2 - y^3)$$

$$u = 3y^2$$

$$v = \frac{\partial \psi}{\partial x} = \frac{\partial}{\partial x}(3x^2 - y^3)$$

$$v = 6x$$

At (2, 1)

$$u = 3(1)^2 = 3 \text{ units}$$

$$v = 6(2) = 12 \text{ units}$$

$$|\vec{v}| = \sqrt{u^2 + v^2}$$

$$= \sqrt{3^2 + 12^2} = \sqrt{153}$$

$$|\vec{v}| = 12.37 \text{ m/s}$$

End of Solution

Q.6 Full load is supplied by the turbine shaft when the diameter of jet issuing from the nozzle is 150 mm. If the load suddenly drops to 36% of the full load, what diameter of the jet should be attained by regulating the spear rod?

- (a) 15 mm (b) 45 mm
(c) 90 mm (d) 180 mm

Ans. (c)

$$P = \dot{m}gH = \rho QgH$$

$$P \propto D^2$$

$$\frac{P_2}{P_1} = \frac{D_2^2}{D_1^2}$$

$$\frac{0.36}{1} = \frac{D_2^2}{(0.15)^2}$$

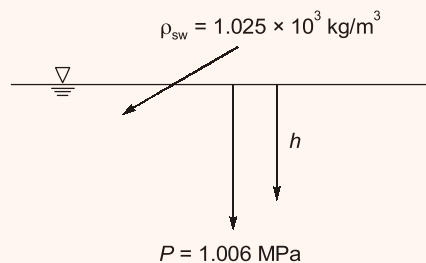
$$D_2 = 90 \text{ mm}$$

End of Solution

Q.7 What is the depth of a point below water surface in sea, where pressure intensity is 1.006 MN/m²? (Specific gravity of sea water is 1.025)

- (a) 60 m (b) 80 m
(c) 100 m (d) 120 m

Ans. (c)



$$P = \rho_{sw}gh$$

$$1.006 \times 10^6 = 1.025 \times 10^3 \times 9.81 \times h$$

$$h = 100.05 \text{ m}$$

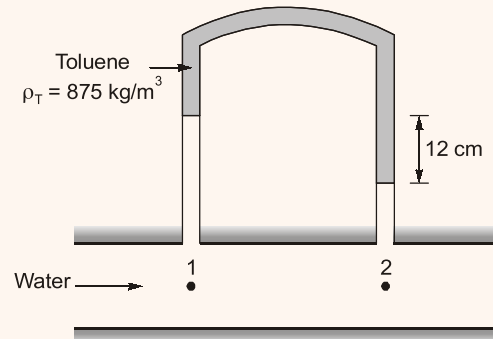
End of Solution

Q.8 Two pressure points in a water pipe are connected to a manometer which has the form of an inverted U-tube. The space above the water in the two limbs of the manometer is filled with toluene (specific gravity is 0.875). If the difference of level of water columns in the two limbs reads 12.0 cm, what is the corresponding difference of pressure? (Take $g = 9.81 \text{ m/s}^2$)

- (a) 110.49 N/m² (b) 128.12 N/m²
(c) 131.34 N/m² (d) 147.15 N/m²

Ans. (d)

Inverted U-tube manometer



$$\frac{P_1 - P_2}{\rho_w \times g} = h = x \left(1 - \frac{\rho_m}{\rho_w} \right)$$

$$P_1 - P_2 = (10^3) (9.81) (0.12) \left(1 - \frac{875}{10^3} \right)$$

$$P_1 - P_2 = 147.15 \text{ N/m}^2$$

End of Solution

Q.9 What is the minimum size of glass tube that can be used to measure water level if the capillary rise in the tube is to be restricted to 2 mm? (Take surface tension of water in contact with air as 0.073575 N/m)

- (a) 1.5 cm (b) 1.0 cm
(c) 2.5 cm (d) 2.0 cm

Ans. (a)

Water in glass tube

$$h = 2 \text{ mm}$$

$$\sigma_{w-a} = 0.073575 \text{ N/m}$$

$$d = ?$$

$$h = \frac{2 \cos \theta}{\rho g R}$$

$$2 \times 10^{-3} = \frac{2(0.073575) \cos \theta}{(10^3)(9.81)R}$$

$$R = \frac{2(0.073575)}{2 \times 10^{-3} \times 10^3 \times 9.81} = 7.5 \times 10^{-3} \text{ m}$$

$$D = 2R = 15 \text{ mm}$$

$$D = 1.5 \text{ cm}$$

End of Solution

Q.10 A semi-tubular cylinder of 75 mm radius with concave side upstream (drag coefficient = 2.3) is submerged in flowing water of velocity 0.6 m/s. If the cylinder is 7.2 m long and density of water is 1000 kg/m^3 , what is the drag?

- (a) 150 N (b) 173 N
(c) 955 N (d) 223 N

Ans. (*)

$$C_D = 2.3$$

$$u_\infty = 0.6 \text{ m/s}$$

$$L = 7.2 \text{ m}$$

$$R = 0.075 \text{ m (75 mm)}$$

$$\rho_w = 10^3 \text{ kg/m}^3$$

$$F_D = C_D \times \frac{1}{2} \times \rho \times A \times U_\infty^2$$

$$= 2.3 \times \frac{1}{2} \times 10^3 \times (L \times D) \times 0.6^2$$

$$= 2.3 \times \frac{1}{2} \times 10^3 \times 7.2 \times 0.075 \times 2 \times 0.6^2$$

$$= 447.12 \text{ N}$$

Note: If we take $A = R \times L$
 $= 0.075 \times 7.2$

Then option (d) is matching.

End of Solution

Q.11 A double acting reciprocating pump having piston area 0.1 m^2 has a stroke length 0.30 m. The pump is discharging 2.4 m^3 of water per minute at 45 rpm through a height of 10 m. What is the slip of the pump?

- (a) $0.005 \text{ m}^3/\text{s}$ (b) $0.015 \text{ m}^3/\text{s}$
(c) $0.025 \text{ m}^3/\text{s}$ (d) $0.035 \text{ m}^3/\text{s}$

Ans. (a)

Piston area, $A = 0.1 \text{ m}^2$

Stroke length, $L = 0.3 \text{ m}$

Pump discharge, $Q = 2.4 \text{ m}^3/\text{min}$

$$= \frac{2.4}{60} \text{ m}^3/\text{s} = 0.04 \text{ m}^3/\text{s}$$

$$N = 45 \text{ rpm}$$

Height, $(h_s + h_d) = 10 \text{ m}$

$$\text{Slip} = Q_{\text{theo}} - Q_{\text{act}}$$

$$Q_{\text{theo}} = \frac{2ALN}{60}$$

$$Q_{\text{theo}} = \frac{2(0.1)(0.3)(45)}{60}$$

$$= 0.045 \text{ m}^3/\text{s}$$

$$\text{Slip} = 0.045 - 0.04$$

$$\text{Slip} = 5 \times 10^{-3} \text{ m}^3/\text{s}$$

End of Solution

Q.12 If pressure head of water is 100 m and specific gravity of kerosene is 0.81, what is the pressure head of kerosene?

- (a) 123.5 m of kerosene (b) 241.3 m of kerosene
(c) 75.1 m of kerosene (d) 52.4 m of kerosene

Ans. (a)

$$P = 100 \text{ m of H}_2\text{O} = (10^3) g (100) \text{ Pa}$$

$$S_{\text{kerosene}} = 0.81$$

$$P = \rho_k gh$$

$$(10^3)g(100) = (0.81) \times 10^3 \times (9.81)h$$

$$\frac{100}{0.81} = h$$

$$h = 123.46 \text{ m of kerosene}$$

End of Solution

Q.13 A lake has an area of 15 km². Observation of hydrological variable during a certain year has shown as follows:

Precipitation = 700 mm/year;

Average inflow $Q_{\text{in}} = 1.4 \text{ m}^3/\text{s}$

Average outflow $Q_{\text{out}} = 1.6 \text{ m}^3/\text{s}$.

Assume that there is not net water exchange between the lake and the groundwater. What is the evaporation during this year?

- (a) 480 mm (b) 280 mm
(c) 380 mm (d) 10 mm

Ans. (b)

From water budget equation or mass conservation principle,

Net inflow per unit time = Net outflow per unit time ± change in storage per unit time

$$\therefore I = Q \pm \frac{\Delta S}{\Delta t}$$

$$I = 70 \text{ cm} + 1.4 \text{ m}^3/\text{sec}$$

$$I = 70 + \left[1.4 \times \frac{1 \times 365 \times 86400 \text{ sec}}{15 \times 10^6 \text{ m}^2} \times 100 \right] \text{ cm}$$

$$= 70\text{cm} + \frac{294336000}{10^6}\text{cm}$$

$$= 70 + 294.336 = 364.336 \text{ cm}$$

$$\text{Net outflow, } Q = 1.6 \text{ m}^3/\text{sec} + E$$

$$= \left\{ 1.6 \frac{\text{m}^3}{\text{sec}} \times \frac{1 \times 365 \times 86400 \text{ sec}}{15 \times 10^6 \text{ m}^2} \times 100 \right\} \text{cm} + E$$

$$= 336.384 + E$$

$$\Delta S = 0$$

$$\therefore I = Q$$

$$\Rightarrow 364.336 = 336.384 + E$$

$$\therefore E = 27.952 \text{ cm} = 279.52 \text{ mm} \simeq 280 \text{ mm}$$

End of Solution

Q.14 A bridge has an expected life of 25 years and is designed for a flood magnitude of return period 100 years. What is the risk of this hydrologic design?

(a) $1 - \left(\frac{100}{99}\right)^{25}$

(b) $\left(\frac{99}{100}\right)^{25}$

(c) $1 - \left(\frac{99}{100}\right)^{25}$

(d) $\left(\frac{100}{99}\right)^{25}$

Ans. (c)

Probability of occurrence, $p = \frac{1}{T} = \frac{1}{100} = 0.01$

Probability of non-occurrence, $q = 1 - p$
 $= 1 - 0.01 = 0.99$

Risk for a design life of 25 years is given by

$$R = 1 - q^n$$

$$= 1 - (0.99)^{25} = 1 - \left(\frac{99}{100}\right)^{25}$$

End of Solution

Q.15 In a groundwater field test, a tracer took 8 hours to travel between two observation wells which are 56 m apart. The difference in water table elevations in these wells was 0.70 m. The volume of the void of the aquifer is 30% of the total volume of the aquifer. What is the hydraulic conductivity of the aquifer, if the dynamic viscosity of water is $0.995 \times 10^{-3} \text{ Ns/m}^2$?

(a) 4.664 cm/s

(b) 3.664 cm/hr

(c) 2.664 mm/s

(d) 1.664 cm/hr

Q.19 A tile drainage system draining 12 hectares, flows at a design capacity for two days, following a storm. If the system is designed using a drainage coefficient of 1.25 cm, how much of water will be removed during this period?

- (a) 1500 m³ (b) 4500 m³
(c) 3000 m³ (d) 3500 m³

Ans. (c)

$$A = 12 \text{ ha}$$

Drainage coefficient, $q = 1.25$ (depth of water removed in 1 day)

∴ In 2 days, depth of water removed = 2.5 cm = 0.025 m

Volume of water drained = $0.025 \times 12 \times 10^4 \text{ m}^3 = 3000 \text{ m}^3$

End of Solution

Q.20 What is the hydraulic radius of a stable canal carrying a discharge of 27 m³/s using Lacey's method? (Assume silt factor is 1.0)

- (a) 1.44 m (b) 2.67 m
(c) 3.14 m (d) 4.28 m

Ans. (a)

$$Q = 27 \text{ m}^3/\text{s}$$

$$f = 1.0$$

$$R = 0.47 \left(\frac{Q}{f} \right)^{1/3} = 1.41 \text{ m}$$

1.44 is the closest answer.

End of Solution

Q.21 Consider the following statements regarding loss of water in canals:

1. The water lost by evaporation is generally very small, as compared to the water loss by seepage in certain channels.
2. In percolation, there exists a one of continuous saturation from the canal to the water-table and a direct flow is established.
3. In absorption, a small saturated soil zone exists around the canal section and is surrounded by a zone of decreasing saturation.

Which of the above statements are correct?

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

Ans. (d)

End of Solution

- Q.22 The chief aim of river training is
- (a) to protect water from loss
 - (b) bed scouring
 - (c) to achieve ultimate stability of river with the aid of river training measures.
 - (d) pitching of banks and provision of launching aprons.

Ans. (c)

End of Solution

- Q.23 Which one of the following conditions is correct for a channel to behave in true regime?
- (a) Discharge is non-uniform
 - (b) Flow is non-uniform
 - (c) Silt grade is varying
 - (d) Silt change in constant

Ans. (d)

Following are the conditions for true regime:

1. Discharge is constant
2. Flow is uniform
3. Silt grade is constant
4. Silt charge is constant

End of Solution

- Q.24 What is the delta for a crop when its duty is 864 hectares/ cumec on the field and the base period of this crop is 120 days?
- (a) 120 cm
 - (b) 140 cm
 - (c) 160 cm
 - (d) 172 cm

Ans. (a)

$$\Delta = 8.64 \times \frac{B}{D} = \frac{8.64 \times 120}{864} = 1.2 \text{ m} = 120 \text{ cm}$$

End of Solution

- Q.25 Which one of the following the merit of combined sewer system?
- (a) Rain water dilutes the sewage, therefore, it can be easily and economically treated.
 - (b) Initial cost is high as compared with separate system.
 - (c) If the whole sewage is to be disposed off by pumping, it is uneconomical.
 - (d) During heavy rains, the overflowing of sewers will endanger the public health.

Ans. (a)

End of Solution

- Q.26 Which one of the following is a device used for measuring the velocity of flowing water in pipes or open channels?
- (a) Pitot tube
 - (b) Piezometer
 - (c) Venturimeter
 - (d) Venturi tube

Ans. (a)

Local velocity measurement device is pitot tube.

End of Solution



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- Q.27** Which one of the following is the process in which ammonia is oxidized to nitrites and then to nitrates by aerobic bacteria?
- (a) Nitrification (b) Denitrification
(c) Adsorption (d) Regeneration

Ans. (a)

End of Solution

- Q.28** A tank into which raw or partly treated sewage is collected, left to stay, and discharged at such a rate as may be necessary for subsequent treatment, is called
- (a) Dosing tank (b) Sedimentation tank
(c) Skimming tank (d) Settling tank

Ans. (a)

Dosing tanks were used previously when the discharge was not huge and it was possible to collect and let the sewage (untreated or partially treated) be left to stay even for several hours. Now a days, various other techniques are used. Now a days, dosing tanks are used only for low rate reactors.

End of Solution

- Q.29** In the context of sludge conditioning, Elutriation is synonymous to
- (a) Washing (b) Heating
(c) Compacting (d) Filtering

Ans. (a)

Elutriation is a process of sludge conditioning in which sludge is washed either by fresh water or plant effluent.

End of Solution

- Q.30** Sludge thickening is commonly achieved by the following method:
1. Gravity thickening
 2. Air flotation
 3. Centrifugation
- Which of the above methods are correct?
- (a) 2 and 3 only (b) 1 and 2 only
(c) 1 and 3 only (d) 1, 2 and 3

Ans. (d)

Following are sludge thickening methods:

1. Gravity thickening
2. Air floatation
3. Centrifugation
4. Rotary drum thickener

End of Solution

- Q.31** Which one of the following is the process whereby chemicals are added to a wastewater resulting in a reduction of the forces tending to keep suspended particles apart?
- (a) Coagulation (b) Flocculation
(c) Clarification (d) Sedimentation

Ans. (a)

End of Solution

- Q.32** Which one of the following is a grit-removal unit which also removes silt as well as some organic matter along with grit?
- (a) Detritus tank (b) Skimming tank
(c) Detention tank (d) Suspension tank

Ans. (a)

End of Solution

- Q.33** The domestic sewage of a town was tested for total solids and the following results were obtained:

Weight of sample of sewage = 1000 gm

Weight of solids after evaporation of liquid = 0.952 gm

Weight of dry residue after ignition = 0.516 gm

What is the value of volatile solids?

- (a) 952 ppm (b) 516 ppm
(c) 436 ppm (d) 694 ppm

Ans. (c)

Weight of sewage sample = 1000 g

After evaporation of water, weight = 0.952 g

∴ Weight of water = 1000 – 0.952 g = 999.048 g

After further ignition weight = 0.516 g

∴ Weight of volatile solids which are loss during ignition
= 0.952 – 0.516
= 0.436 g = 436 mg

436 mg of volatile solids in 999.048 g of water.

Taking sewage density as roughly 1 kg/lit. or 1000 g/lit.

∴ 436 mg in 1 lit. = 436 ppm

End of Solution

- Q.34** The quantity of nitrogen present in wastewater before the decomposition of organic matter has started, is indicated by
- (a) Albuminoid Nitrogen (b) Free Ammonia
(c) Organic Nitrogen (d) Nitrate Nitrogen

Ans. (*)

There are two possible ways in which the question can be interpreted:

- The nitrogen which we measure are in the forms of NH_3 , NO_2 , NO_3 and N_2 in the measurement process. If we take the quantity of nitrogen before the decomposition of organic matter is started, it will be free ammonia which will be measured.*
- The other scenario can be quantity of nitrogen after ammonia leaves the system. In that case, organic or albuminoid nitrogen will be present in the system. So the other answer can be either (a) or (c).*

End of Solution

- Q.35** Which one of the following is that (low) water content of the soil at which plants can be longer extract sufficient water for this growth?
- (a) Wilting point (b) Tail water
(c) Irrigating head (d) Capillary water

Ans. (a)

End of Solution

- Q.36** Which one of the following is the advantages of using activated carbon for water treatment?
- (a) When used in powdered form after coagulation, it does not aid in coagulation.
(b) It increases the chlorine demand of treated water.
(c) It removes organic matter present in water.
(d) Its overdose is harmful.

Ans. (c)

End of Solution

- Q.37** A soil has bulk density of 20.1 kN/m^3 and water content 15%. What is the water content if the soil partially dries to a density of 19.4 kN/m^3 and the void ratio remains unchanged?
- (a) 10.86% (b) 10.76%
(c) 10.68% (d) 10.66%

Ans. (a)

$$\gamma_{t1} = 20.1 \text{ kN/m}^3$$

$$w_1 = 15\%$$

$$\gamma_{t2} = 19.4 \text{ kN/m}^3$$

$$w_2 = ?$$

$$e = \text{void ratio}$$

$$\gamma_t = \frac{G_s \gamma_w (1+w)}{1+e}$$

$$\frac{\gamma_{t2}}{\gamma_{t1}} = \frac{G_s \gamma_w (1+w_2)}{1+e} \times \frac{1+e}{G_s \gamma_w (1+w_1)}$$

Since 'e' is constant and for the same soil G_s is same.

$$\frac{19.4}{20.1} = \frac{1+w_2}{1+0.15}$$

$$\Rightarrow w_2 = 10.995\%$$

End of Solution

Q.38 A fine grained soil is found to have a liquid limit of 90% and a plasticity index of 50. The natural water content is 28% What is the liquidity index?

(a) -0.34

(b) -0.14

(c) -0.24

(d) -2.40

Ans. (c)

$$w_l = 90\%, I_p = 50, w = 28\%$$

$$w_p = w_l - I_p = 90 - 50 = 40\%$$

$$I_l = \text{liquidity index,}$$

$$I_l = \frac{w - w_p}{I_p} = \frac{28 - 40}{50} = -0.24$$

End of Solution

Q.39 A concentrated load of 2000 kN is applied at the ground surface. What is the vertical stress at a point 6 m directly below the load?

(a) 16.42 kN/m²(b) 26.53 kN/m²(c) 36.12 kN/m²(d) 40.51 kN/m²

Ans. (b)

$$Q = 2000 \text{ kN}, Z = 6 \text{ m}, r = 0$$

By Boussineq's equation,

$$\bar{\sigma}_z = \frac{Q}{z^2} \left\{ \frac{3}{2\pi} \times \frac{1}{[1+(r/z)^2]^{5/2}} \right\}$$

$$\bar{\sigma}_z = k_B \frac{Q}{z^2}, k_B = \frac{3}{2\pi} \frac{1}{[1+(r/z)^2]^{5/2}}$$

$$\text{at } r = 0, k_B = 0.477$$

$$\therefore \text{at } z = 6 \text{ m}$$

$$\begin{aligned} \bar{\sigma}_z &= \frac{0.477 \times 2000}{6^2} \text{ kN/m}^2 \\ &= 26.5 \text{ kN/m}^2 \end{aligned}$$

End of Solution

Q.40 Which one of the following is a characteristic of local shear failure?

- (a) Failure pattern is not clearly defined.
- (b) Failure surfaces reach ground surfaces.
- (c) There is no bulging of soil around the footing
- (d) Failure is not sudden and there is no tilting of footing

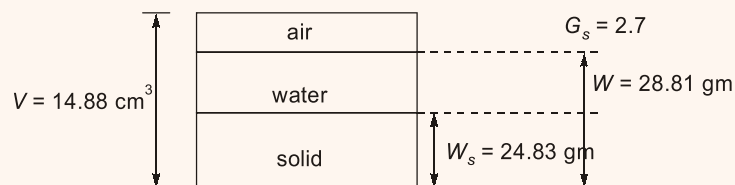
Ans. (d)

End of Solution

Q.41 A sample of silty clay has a volume of 14.88 cm^3 , a total mass of 28.81 gm , a dry mass of 24.83 gm and a specific gravity of solids 2.7 . What is the void ratio?

- (a) 0.412
- (b) 0.521
- (c) 0.618
- (d) 0.663

Ans. (c)



$$V_s = \frac{W_s}{G_s \gamma_w} = \frac{24.83}{2.7 \times 1} = 9.196 \text{ cc}$$

$$e = \frac{V_v}{V_s} = \frac{V - V_s}{V_s} = \frac{14.88 - 9.196}{9.196} = 0.618$$

End of Solution

- Q.42** A constant head permeability test is carried out on a cylindrical sample of sand 10 cm diameter and 15 cm height. 160 cm³ of water is collected in 1.75 minutes, under a head of 30 cm. What is the coefficient of permeability in m/year?
- (a) 1257 m/year (b) 2111 m/year
(c) 3060 m/year (d) 3332 m/year

Ans. (c)

$$D = 10 \text{ cm}, l = 15 \text{ cm}, V = 160 \text{ cm}^3, t = 1.75 \text{ min.}$$

$$\text{Head, } h = 30 \text{ cm}$$

$$Q = kiA$$

$$\Rightarrow \frac{V}{t} = k \times \frac{h}{l} \times \frac{\pi}{4} \times D^2$$

$$\Rightarrow \frac{160}{1.75} = k \times \frac{30}{15} \times \frac{\pi}{4} \times 10^2$$

$$\Rightarrow k = 0.582 \text{ cm/min}$$

$$\begin{aligned} \Rightarrow k &= \frac{0.582}{100} \times 60 \times 24 \times 365 \\ &= 3058.99 \text{ m/year} \approx 3060 \text{ m/year} \end{aligned}$$

End of Solution

- 43** Which one of the following is the correct assumption of Rankine's theory?
- (a) The soil mass is infinite.
(b) The soil mass is non homogeneous
(c) The soil mass is cohesive.
(d) The ground surface is a plane which may be horizontal or inclined.

Ans. (d)

Rankine's theory: Rankine's theory considered stress in soil mass when it attains plastic equilibrium

Assumption in Rankine's Theory:

1. Soil is semi infinite homogenous, isotropic, dry and cohesionless.
2. Soil is the state of plastic equilibrium condition at the time of active and passive earth pressure generation.
3. Backfill surface is planner which may be horizontal or inclined.
4. Back of wall is vertical and smooth.
5. Rapture surface is planner surface.

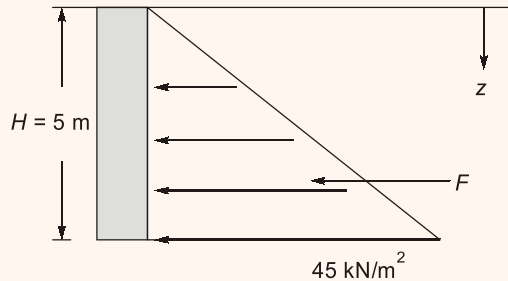
End of Solution

- 44.** If a retaining wall 5 m high is restrained from yielding, what is the at-rest earth pressure per meter length of wall? (Consider the backfill is cohesionless soil having $\phi = 30^\circ$ and $\gamma = 18 \text{ kN/m}^3$)
- (a) 108 kN/m (b) 112.5 kN/m
(c) 115 kN/m (d) 124 kN/m

Ans. (b)

$$H = 5 \text{ m}, \phi = 30^\circ, \gamma = 18 \text{ kN/m}^2$$

k_o = earth pressure at rest coefficient



at $z = 5 \text{ m}$,

$$\begin{aligned} P_o &= k_o \times \gamma_t \times z \\ &= (1 - \sin 30^\circ) 18 \times 5 \\ &= 45 \text{ kN/m}^2 \end{aligned}$$

F = thrust due to earth pressure at rest.

$$F = \frac{1}{2} \times 45 \times 5 = 112.5 \text{ kN/m}$$

End of Solution

45. Consider the following steps related to construction with the use of geotextiles:
1. Starts with an adequate working surface and staging areas.
 2. Lay a geotextile sheet of proper width on the ground surface.
 3. Construction equipment must work from the soil backfill and be kept off the unprotected geotextile.

Which of the above steps are correct?

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

Ans. (d)

The construction procedure with the use of geotextile is explained in following figures. The geotextile serve both as reinforcement and also as facing unit. The procedure is described below.

1. Start with adequate working surface and staging area. (a)
2. Lay a geotextile sheet of proper width on the ground surface with 4 to 7 feet at the wall face draped over temporary wooden form (b).
3. Backfill over the sheet with soil. Granular soil or soils containing maximum 30 percentage silt and for 5% clay are customary (c).
4. Construction equipment must work from the soil backfill and be kept off the unprotected geotextile. The spreading equipment should be a wide-tracked bulldozer that exerts little pressure against the ground on which it rests. Rolling equipment likewise should be of relatively light weight.
5. When the first layer has been loaded over the process should be repeated for the second layer with the temporary facing from being extended from the original ground surface or wall being stepped back about 6 inch so that the form can be supported from the first layer. In the later case the support stakes must penetrate the fabric.

- Q.47** What is the coefficient of volume change (using change in void ratio method) for pressure range 100 kN/m² to 200 kN/m²? (Consider $\sigma'_0 = 100$ kN/m², $e_0 = 1.121$, $\sigma' = 200$ kN/m², $e_0 = 0.964$, $\Delta\sigma' = 100$ kN/m² and $\Delta e = -0.157$)
- (a) 0.25 m²/MN (b) 0.48 m²/MN
(c) 0.69 m²/MN (d) 0.74 m²/MN

Ans. (d)

m_v = Coefficient of volume change or coefficient of volume compressibility

$$m_v = \frac{a_v}{1+e_0} = \frac{\Delta e}{\Delta\sigma'(1+e_0)} = \frac{0.157}{100 \times (1+1.121)} \times 10^3 \text{ m}^2/\text{MN}$$

$$= 0.74 \text{ m}^2/\text{MN}$$

End of Solution

- Q.48** What one of the following problems is required to be studied in the design of earth dams?
- (a) The prediction of the position of the line of seepage in the longitudinal section.
(b) The computation of seepage loss.
(c) The seepage line should cut the down-stream slope.
(d) The seepage loss through the dam should be maximum.

Ans. (b)

- The prediction of the position of the line of seepage in the cross-section.
- The seepage line should not cut the downstream slope.
- The seepage loss through the dam should be minimum.

End of Solution

- Q.49** Which one of the following is not an instrument for setting out right angles?
- (a) Cross staff (b) Site square
(c) Prism square (d) Optical staff

Ans. (d)

Instrument	Used for:
• Cross-staff – 90°	Angle measurement.
• Site square – 90°	Angle measurement.
• Prism square – 90°	Angle measurement.
• Optical staff – X.	

End of Solution

- Q.50** Which one of the following is correct for Prismatic Compass?
- (a) The graduated ring rotates with line sight.
(b) Instrument cannot be used without tripod.
(c) The graduation are engraved inverted.
(d) The readings can directly be taken of seeing through the top of the glass.

Ans. (c)

Graduation are inverted in prismatic compass which can be seen in correct form from prism attached with box.

End of Solution

Q.51 Magnetic declination at a place is the horizontal angle between:

- (a) the true meridian and the arbitrary meridian
- (b) the magnetic meridian and the arbitrary meridian
- (c) the true bearing and the magnetic bearing
- (d) the true meridian and the magnetic meridian

Ans. (d)

Generally, magnetic meridian and true meridian at a place do not coincide with each other. The horizontal angle which the magnetic meridian makes with the true meridian is known as the magnetic declination or simply declination at that place.

End of Solution

Q.52 The magnetic bearing of a line AB is $S28^{\circ}30'E$. What is the true bearing of line AB if the magnetic declination is $7^{\circ}30'$ toward west?

- (a) $S36^{\circ}E$
- (b) $N21^{\circ}W$
- (c) $S21^{\circ}E$
- (d) $N36^{\circ}W$

Ans. (a)

Method 1:

Magnetic bearing, $MB = S28^{\circ}30'E$

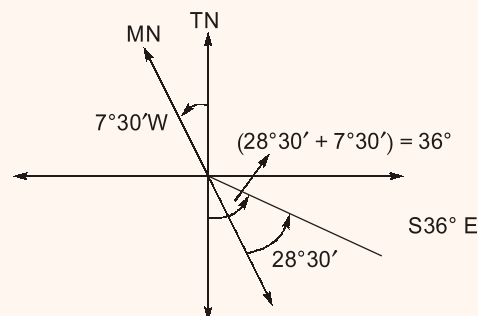
In WCB, $MB = 180^{\circ} - 28^{\circ}30' = 151^{\circ}30'$

Declination, $\delta_w = 7^{\circ}30' W$

\therefore True bearing, $TB = MB - \delta_w = 151^{\circ}30' - 7^{\circ}30' = 144^{\circ}$

In QB system, $TB = 180^{\circ} - 144^{\circ} = 36^{\circ}$ i.e. $S36^{\circ}E$

Method 2:



End of Solution



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- Q.53** The Zenith is/are
- (a) the point on the upper portion of the celestial sphere marked by plumb line above the observer.
 - (b) the point on the lower portion of the celestial sphere marked by plumb line below the observer.
 - (c) the two points in which the Earth's axis of rotation meets the Earth's sphere.
 - (d) the great circle of the Earth, the plane of which is the right angles to the axis of rotation.

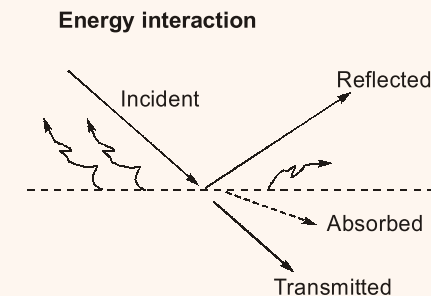
Ans. (a)

The Zenith and Nadir : The Zenith (Z) is the point on the upper portion of the celestial sphere marked by plumb line above the observer. It is thus the point on the celestial sphere immediately above the observer's station. The Nadir (Z') is the point on the lower portion of the celestial sphere marked by the plumb line below the observer. It is thus the point on the celestial sphere vertically below the observer's station.

End of Solution

- Q.54** Which one of the statements is not correct for remote sensing?
- (a) It requires energy source.
 - (b) It requires propagation of energy through atmosphere.
 - (c) It requires energy interaction with the Earth's surface features.
 - (d) It requires absorption of energy by the Earth's surface.

Ans. (d)



Note: Adsorption has no role in remote sensing

End of Solution

- Q.55** Energy in remote sensing deals with which region of electromagnetic spectrum?
- (a) Ultraviolet
 - (b) Infrared
 - (c) X-Ray
 - (d) Gamma Ray

Ans. (b)

End of Solution

Q.56 Consider the following statements related to the classification based upon the object of survey:

1. Archaeological surveys for unearthing relics of antiquity.
2. Geological surveys for determining different strata in the Earth's crust.
3. Mine surveys for exploring mineral wealth such as gold, coal, etc.

Which of the above statements are correct?

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

Ans. (d)

End of Solution

Q.57 In setting up to plane table at a station P, the corresponding point on the plan was not accurately centered above P. If the displacement of P was 30 cm in a direction at right angle to the ray and scale is 1 cm = 2 m, how much on the plan would be the consequent displacement of point from its true position?

- (a) 0.15 mm (b) 6.0 mm
(c) 1.5 mm (d) 0.3 mm

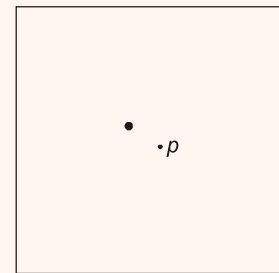
Ans. (c)

$$\begin{aligned} \text{Scale} &= 1 \text{ cm} = 2 \text{ m} \\ 10 \text{ mm} &= 200 \text{ cm} \end{aligned}$$

$$1 \text{ cm} = \frac{10}{200} = \frac{1}{20} \text{ mm}$$

$$PP = 30 \text{ cm on ground}$$

$$(\text{PP on plan}), pp = 30 \text{ cm} = \frac{1}{20} \times 30 = 1.5 \text{ mm}$$



End of Solution

Q.58 A photographic survey is carried out to a scale of 1 : 20000. A camera with a wide angle lens of $f = 170 \text{ mm}$ was used with $25 \text{ cm} \times 25 \text{ cm}$ plane size for a net 65% overlap along the line of flight. What is the error in height given by an error of 0.15 mm in measuring the parallax of the point?

- (a) 5.15 m (b) 5.27 m
(c) 5.83 m (d) 6.45 m

Ans. (c)

$$S = 20000, f = 170 \text{ mm}, l = 25 \text{ cm}, b = 25 \text{ cm}, p_l = 65\%$$

$$\Delta p = 0.15 \text{ mm}, \Delta h = ?$$

$$\text{Scale} = \frac{1}{20000} = \frac{f}{H}$$

$$\Rightarrow \frac{1}{20000} = \frac{170/1000}{H}$$

$$H = 3400 \text{ m}$$

$$\text{Length of air base, } B = (1 - p_l) l s = (1 - 0.65) \times \frac{25}{100} \times 20000 = 1750 \text{ m}$$

$$\Delta h = \frac{(H - h)^2}{Bf} \times \Delta p$$

$$= \frac{(3400 - 0)^2}{1750 \times 170} \times 0.15 = 5.83 \text{ m}$$

End of Solution

Q.59 What is the aeroplane flying height to obtain the average scale of the photograph equal to $\frac{1}{7200}$? (Ground surface elevations vary from 160 m to 430 m and focal length of the camera lens is 153 mm)

- (a) 1021 m (b) 1145 m
(c) 1284 m (d) 1397 m

Ans. (d)

$$\text{Scale} = \frac{f}{H - h_{avg}}$$

$$\frac{1}{7200} = \frac{0.153}{H - \left(\frac{160 + 430}{2}\right)}$$

$$H = 1396.6 \text{ m} \approx 1397 \text{ m}$$

End of Solution

Q.60 Which one of the following conditions shall be fulfilled when a transition curve is inserted between the tangent and circular curve?

- (a) It should not meet the original straight tangentially.
(b) It should not meet the circular curve tangentially.
(c) Its radius at the junction with the circular curve should be the same as that of the circular curve.
(d) The rate of decrease of curvature along the transition curve should be same as that of increase in superelevation

Ans. (c)

It should be tangential to the straight line and also meet the circular curve tangentially at the junction.

- It's curvature should be zero ($R = \infty$) at one end and its curvature should be equal to $(1/R)$ where it meets the circular curve ($R =$ Radius of circular curve).
- The rate of increase of curvature along the transition curve should be equal to rate of increase of superelevation.

Therefore, length of transition curve should be such that full superelevation is achieved at the junction with the circular curve.

End of Solution

Q.61 Consider the following statements related to road pavements:

1. Deflections measured near cracks are normally much lower than the measurements in non-distressed areas.
2. Deflection measurements near longitudinal joints, transverse joints or corners are higher than those measured at mid-slab for concrete pavements.
3. Thermal and moisture gradient in the vertical direction of concrete slabs does not have any influence of deflection measurements.
4. Measurements taken at night or in the early morning are considerably different from those obtained in the afternoon.

Which of the above statements are not correct?

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

Ans. (b)

End of Solution

Q.62 Which one of the following tunneling methods is adopted of the situations where the metro alignment passage under residential buildings or a canal?

- (a) Earth pressure balance tunnelling machine method
(b) Tunnel boring machine method
(c) Tube tunnelling method
(d) Driven shield tunnelling method

Ans. (c)

End of Solution

Q.63 Consider the following statements related to the advantages of concrete sleepers:

1. Concrete sleepers can generally be mass produced using local resources.
2. Concrete sleepers are not suitably for beater packing.
3. Concrete sleepers have a very long life-span.
4. Concrete sleepers have no scrap value.

Which of the above statements is/are correct?

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

Ans. (c)

- Concrete sleepers being heavy give more elastic modulus, strength and stability to the track. They are specially suitable for long welded rail track due to great resistance to the buckling of the track.
- Concrete sleepers with elastic fastening maintain better gauge, cross level and alignment. It retains packing also very well.
- Concrete sleepers being flat at bottom are best suited for modern methods of track maintenance like mechanical maintenance and measured shoulder packing (MSP)
- Concrete sleepers can also be used in track circuited areas as concrete is poor conductor of electricity.
- Concrete sleepers neither are susceptible to attack by vermin, corrosion, nor they are inflammable.
- The life of concrete sleepers is very long about 50 to 60 years. Thus rail and sleeper renewals can be matched, which is very big economical advantage.
- Concrete sleeper can be manufactured from local materials also.

End of Solution

Q.64 Which one of the following is not the method of tunnelling in hard rock?

- (a) Full-face heading method (b) Heading and bench method
(c) Drift method (d) Shaft method

Ans. (d)

End of Solution

Q.65 Consider the following statements related to the advantages of uniformity of rail gauges:

1. At transshipping is not required, there is breakage of goods.
2. Large sheds to store goods are not required.
3. Labour strikes, etc. do not affect the service and operation of trains.

Which of the above statements are correct?

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

Ans. (b)

The uniformity of gauges results in the following advantages:

1. As the transshipping is not required, there is no breakage of goods.
2. Large sheds to store goods are not required.
3. Labour strikes, etc. do not affect the service and operation of trains.

End of Solution

Q.66 Which one of the following are provided to give access to properties along an import highway with controlled access to expressway freeway?

- (a) Lay-bye (b) Frontage roads
(c) Driveways (d) Cycle tracks

Ans. (b)

End of Solution

- Q.67** When properly designed traffic signals are used, which one of the following is the advantages to traffic signals?
- (a) The signals allow crossing of the heavy traffic flow with safety.
 - (b) The rear-end collision may increase.
 - (c) Improper design and location of signals may lead to violation of the control system.
 - (d) Failure of the signal due to electric power failure may cause confusion to the road users.

Ans. (a)

End of Solution

- Q.68** If the ruling gradient is 1 in 150 on a particular section of broad gauge and at the same time a curve of 4 degree is situated on this ruling gradient, what is the allowable ruling gradient?
- (a) 1 in 10
 - (b) 1 in 72
 - (c) 1 in 196
 - (d) 1 in 245

Ans. (c)

As per recommendation of IS grade compensation of BG is 0.04 percent per degree of curve.

Then compensation for 4° curve = $0.04 \times 4 = 0.16$ percent

Now, ruling gradient 1 in 150 = $\frac{1}{150} \times 100 = 0.67$ percent

So, maximum allowable gradient or actual gradient to be provided = $0.67 - 0.16 = 0.51$ percent.

or $\frac{0.51}{100}$ i.e, 1 in 196

End of Solution

- Q.69** What is the value of headlight sight distance for a highway with a design speed of 65 kmph? (Take $f = 0.36$ and $t = 2.5$ sec)
- (a) 66.5 m
 - (b) 81.3 m
 - (c) 91.4 m
 - (d) 182.8 m

Ans. (c)

$$\begin{aligned} \text{HSD} = \text{SSD} &= \left(0.278vt_R + \frac{v^2}{254f} \right) \\ &= \left(0.278 \times 65 \times 2.5 + \frac{65^2}{254 \times 0.36} \right) = 91.38 \approx 91.4 \text{ m} \end{aligned}$$

End of Solution

- Q.70** What is the minimum stopping sight distance on a -3.5% grade for a design speed of 110 kmph? (Consider friction coefficient $f = 0.28$, $t = 2.5$ sec and $G = 0.035$)
- (a) 76.4 m (b) 194.4 m
(c) 214.6 m (d) 270.8 m

Ans. (d)

$$\begin{aligned} S &= 0.278vt_R + \frac{v^2}{254(f - S\%)} \\ &= 0.278 \times 110 \times 2.5 + \frac{110^2}{254(0.28 - 0.035)} \\ &= 270.88 \text{ m} \end{aligned}$$

End of Solution

- Q.71** The free mean speed on a roadway is found to be 80 kmph. Under stopped condition, the average spacing between the vehicles is 6.9 m. What is the capacity flow?
- (a) 5800 Vehicles/hour (per lane) (b) 7200 Vehicles/hour (per lane)
(c) 1450 Vehicles/hour (per lane) (d) 2900 Vehicles/hour (per lane)

Ans. (d)

$$\begin{aligned} v_f &= 80 \text{ kmph} \\ k_j &= \left(\frac{1000}{6.9} \right) \\ q_{\max} &= \left(\frac{1}{4} v_f k_j \right) = \left(\frac{1}{4} \times 80 \times \frac{1000}{6.9} \right) = 2898.55 \text{ veh/hr} \\ &\simeq 2900 \text{ veh/hr} \end{aligned}$$

End of Solution

- Q.72** For a street lighting system, having the following conditions:
Street width = 15 m
Mounting height = 7.5 m
Lamp size = 6000 lumen
Luminaire type = II
Coefficient of utilization = 0.44
Maintenance factor = 0.8
What is the spacing between lighting units to produce average Lux = 6?
- (a) 18 m (b) 20 m
(c) 23 m (d) 27 m

Ans. (c)

Street width = 15, Mounting height = 7.5 m
Lamp size = 6000 lumen

$$\frac{\text{Pavement width}}{\text{Mounting height}} = \frac{15}{7.5} = 2.0$$

Coefficient of utilization = 0.44

Maintenance factor = 0.8

$$\begin{aligned} \text{Spacing} &= \frac{\text{Lamp Lumen} \times \text{coefficient of utilisation} \times \text{Maintenance factor}}{\text{Average Lux} \times \text{width of road}} \\ &= \frac{6000 \times 0.44 \times 0.8}{6 \times 15} = 23.46 \text{ m} \end{aligned}$$

End of Solution

Q.73 Consider the following for the objects of seasoning wood:

1. Reduce the shrinkage and warping after placement in structure
2. Increase its tendency to split and decay
3. Decrease workability
4. Reduce its weight

Which of the above objects are correct?

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

Ans. (b)

Seasoning of wood results in

- (a) Reduction of shrinkage and warping after placement in structure.
(b) Increase of strength, durability and workability.
(c) decrease of tendency to split and decay.
(d) suitability for painting.
(e) Reduction of weight.

End of Solution

Q.74 The hardness of aggregate is tested by

- (a) Impact test (b) Crushing strength test
(c) Abrasion test (d) Soundness test

Ans. (c)

Hardness of aggregate is tested by Abrasion test.

End of Solution



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E&T
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MADE EASY students top in GATE 2021

11 All India Rank 1 (CE, ME, EE, EC, CS, IN, PI, XE, ES)

63 Selections in Top 10

346 Selections in Top 100

CE
9
in Top 10

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EC
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PI
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IN
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Q.75 Which one of the following statements is correct in respect of mild steel?

- (a) It has high carbon content
- (b) It is tougher than hard steel
- (c) It is more elastic than hard steel
- (d) It can be forged and welded easily

Ans. (d)

End of Solution

Q.76 The chemical composition 'Silicates of iron and alumina' is found in which one of the following minerals?

- (a) Garnet
- (b) Serpentine
- (c) Olivine
- (d) Calcite

Ans. (a)

- Garnet is having silicates of iron and alumina.
- Serpentine has hydrous silicate of magnesia.
- Olivine has silicate of iron and magnesia.
- Calcite has calcium carbonate.

End of Solution

Q.77 The drawback of electric seasoning of timber is

- (a) Checks
- (b) Splitting
- (c) Cracks
- (d) Reduced Strength

Ans. (b)

In electric seasoning the logs are placed in such a way that their two ends touch the electrodes. Current is passed through the setup, being a bad conductor, wood resist flow of current, generating heat in the process, which results in its during. The drawback is that the wood may split.

End of Solution

Q.78 Which one of the following is a product obtained by distilling tar and is used largely as an effective preservative for wood?

- (a) Creosote
- (b) Solignum
- (c) Coal tar
- (d) Wax polish

Ans. (a)

Creosote oil is obtained by distillation of tar and use of creosote oil over timber surface is known as Bethel's process.

End of Solution

Q.79 Pozzolanas are

- (a) argillaceous materials
- (b) calcareous materials
- (c) accelerators
- (d) siliceous materials

Ans. (d)

Pozzolana defined as siliceous material which itself possess no cementitious properties, either processed or unprocessed and in finely divided term, reacts in presence of water with lime at normal temperature to form compound of low solubility having cementitious property.

End of Solution

Q.80 For better chemical resistance, proportion of which one of the following compounds in cement clinker shall be increased?

- (a) Tricalcium Silicate (b) Dicalcium Silicate
(c) Tetracalcium Aluminate (d) Tetracalcium Aluminoferrite

Ans. (b)

Dicalcium silicate is about 25% – 40% of cement. It hydrates and hardness slowly and takes long time to add strength. It imparts resistance to chemical attack.

End of Solution

Q.81 The finishing coat in X-ray room walls is done preferably with

- (a) Barium plaster (b) Cement plaster
(c) Gypsum (d) Plaster of Paris

Ans. (a)

Barium plaster is used as a final coat for surface of x-ray room so as to protect the person working in and around x-ray room. It is essentially made from barium sulphate.

End of Solution

Q.82 The most suitable type of cement for mass concreting works is

- (a) Rapid Hardening Cement
(b) High Alumina Cement
(c) Low Heat Portland Cement
(d) Quick Setting Cement

Ans. (c)

- Low heat cement is most suitable for mass concreting because of lower heat of hydration.

End of Solution

Q.83 Which one of the non-destructive tests can be performed on fresh concrete?

- (a) Ultrasonic test (b) Penetration test
(c) Core test (d) Hammer test

Ans. (a)

- Ultrasonic test, maturity test can be done on fresh concrete.
- Penetration test, core test and hammer test is done on hardened concrete.

End of Solution

- Q.84** In a concrete mix, for given cement content and workability, higher proportion of fine aggregate will be required if,
- maximum size of aggregate is large
 - maximum size of aggregate is small
 - rounded aggregate is used
 - all in aggregate is used

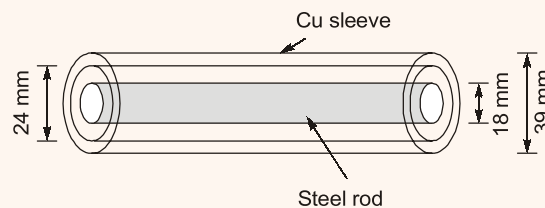
Ans. (b)

When the maximum size of the coarse aggregate is decreased then the surface area will increase. So fine aggregate amount is increased to maintain workability.

End of Solution

- Q.85** A central steel rod 18 mm diameter passes through a copper sleeve with 24 mm inside and 39 mm outside diameter. It is provided with nuts and washers at each end and the nuts are tightened until a stress of 10 N/mm² is set up in the steel. Then, the stress developed in copper tube is
- 29.1 N/mm², Compressive
 - 3.4 N/mm², Compressive
 - 3.4 N/mm², Tensile
 - 29.1 N/mm², Tensile

Ans. (b)



Steel rod = Tensile stress
 Cu sleeve = Compressive stress
 $(F_{Cu})_{sleeve} = F_{steel\ rod}$

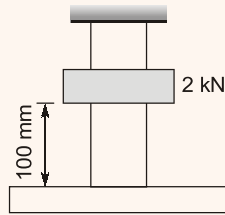
$$(\sigma) \frac{\pi}{4} (39^2 - 24^2) = (10) \frac{\pi}{4} (18)^2$$

$$\sigma = 3.43 \text{ MPa (Compressive stress)}$$

End of Solution

- Q.86** A 2 m long alloy bar of 1500 mm² cross-sectional area hangs vertically and has a collar securely fixed at its lower end. What is the stress induced in the bar when a weight of 2 kN falls from a height of 100 mm on the collar? (Take E = 120 GPa)
- 126.5 MPa
 - 158.3 MPa
 - 161.2 MPa
 - 181.3 MPa

Ans. (a)



$$\sigma_{\text{static}} = \frac{2 \times 10^3}{1500} = 1.33 \text{ MPa}$$

$$\delta_{\text{static}} = \frac{PL}{AE} = \frac{(2 \times 10^3)(2 \times 10^3)}{(1500)(120 \times 10^3)} = 0.022 \text{ mm}$$

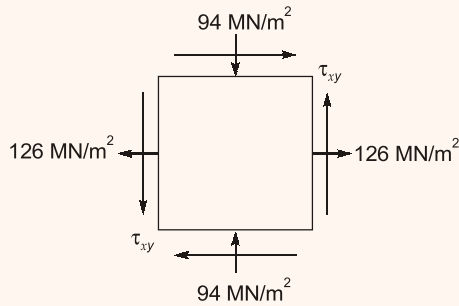
$$\begin{aligned} \sigma_{\text{impact}} &= \sigma_{\text{static}} \left[1 + \sqrt{1 + \frac{2h}{\delta_{\text{static}}}} \right] \\ &= (1.33) \left[1 + \sqrt{1 + \frac{2(100)}{0.022}} \right] \\ &= 127.51 \text{ MPa} \end{aligned}$$

End of Solution

Q.87 Normal stresses of 126 MN/m^2 (Tensile) and 94 MN/m^2 (Compressive) are acting at a point in an elastic material at right angles to each other. If the maximum principal stress is limited to 146 MN/m^2 , the shear stress that may be allowed at that point in the same plane is

- (a) 170 MN/m^2 (b) 89 MN/m^2
(c) 69 MN/m^2 (d) 96 MN/m^2

Ans. (c)



$$\sigma_{p1}/\sigma_{p2} = \frac{\sigma_x + \sigma_y}{2} \pm \frac{1}{2} \sqrt{(\sigma_y - \sigma_x)^2 + 4\tau_{xy}^2}$$

$$146 = \frac{126 + (-94)}{2} + \frac{1}{2} \sqrt{(-94 - 126)^2 + 4\tau_{xy}^2}$$

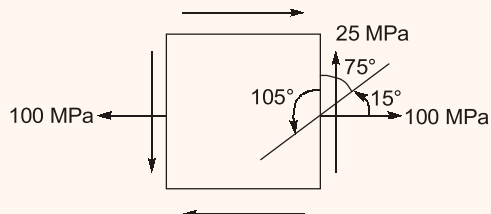
$$\tau_{xy} = 69.28 \text{ MN/m}^2$$

End of Solution

Q.88 A plane element in a body is subjected to a tensile of 100 MPa and shear stress of 25 MPa. What is the normal stress on a plane inclined at 15° with the tensile stress?

- (a) – 5.8 MPa (b) – 4.8 MPa
(c) – 3.8 MPa (d) – 2.8 MPa

Ans. (a)



$$\sigma_x = 100 \text{ MPa}$$

$$\sigma_y = 0$$

$$\tau_{xy} = 25$$

$$\sigma_x' = \sigma_x \cos^2 \theta + \sigma_y \sin^2 \theta + 2\tau_{xy} \cos \theta \sin \theta$$

$$= 100 \cos^2 105^\circ + 2(25) \cos 105^\circ \sin 105^\circ$$

$$\sigma_x' = 6.69 + [-12.5]$$

$$= -5.81 \text{ MPa}$$

End of Solution

- Q.89** A load of 2100 N is dropped axially on a closed-coiled helical spring from a height of 240 mm. The spring has 22 coils each of mean diameter 180 mm and wire diameter is 25 mm. If modulus of rigidity $C = 84000 \text{ N/mm}^2$ and amount of compression $\delta = 255 \text{ mm}$, what is the maximum shear stress produced in the spring?
- (a) 156 N/mm^2 (b) 346 N/mm^2
(c) 239 N/mm^2 (d) 123 N/mm^2

Ans. (c)

$$\delta_{\text{static}} = \frac{64PR^3n}{Gd^4} = \frac{64(2100)(90)^3(22)}{84000 \times (25)^4} = 65.69 \text{ mm}$$

$$\delta_{\text{impact}} = k\delta_{\text{static}}$$

$$\Rightarrow k = \frac{255}{65.69} = 3.88$$

$$\tau_{\text{shear}} = k(\tau')$$

$$= 3.88 \left[\frac{16 \times 2100 \times 90}{\pi(25)^3} \right]$$

$$= 239.02 \text{ MPa}$$

End of Solution

- Q.90** An I-section purlin of span 4 m is subjected to a total uniformly distributed load of 5 kN. The purlin will be designed for maximum bending moment of
- (a) 2000 Nm (b) 20 kNm
(c) 2500 Nm (d) 25 kNm

Ans. (a)

Purlins are designed as continuous beams, so

$$\text{BM} = \frac{WL}{10} = \frac{5 \text{ kN} \times 4 \text{ m}}{10}$$

$$= 2 \text{ kNm or } 2000 \text{ Nm}$$

End of Solution

- Q.91** A 1.4 m long laminated carriage spring h leaves of 100 mm width and 10 mm thickness. The spring has to absorb 125 N-m of energy when straightened, without exceeding the bending stress of 160 MPa. What is the number of leaves? (Take the elastic modulus of material of spring as 200 GPa)
- (a) 11 (b) 9
(c) 7 (d) 5

Ans. (b)

Workdone = Energy stored

$$\frac{1}{2}PS = \frac{\sigma^2 Lntb}{12E}$$

$$125 \times 10^3 = \frac{(160)^2 (1.4 \times 10^3)(n)(100)(10)}{12 \times 200 \times 10^3}$$

$$n = 8.3 \approx 9$$

End of Solution

Q.92 A wooden floor is required to carry a load 12 kN/m² and is to be supported by wooden joists of 120 mm × 250 mm in section over a span of 4 m. If the bending stress in the wooden joists is not to exceed 8 MPa, what is the spacing of the joists?

- (a) 356 mm (b) 318 mm
(c) 432 mm (d) 417 mm

Ans. (d)

Load from wooden floor = 12 kN/m²

Assuming spacing between joist = s meter

⇒ Load on wooden joist (w) = 12 × s kN/m²

$$\text{Maximum bending moment} = \frac{wl^2}{8} = \frac{12s \times 4^2}{8}$$

$$M_{\max} = 24s \text{ kNm}$$

$$\sigma_{\max} = \frac{M_{\max}}{z} = \frac{M_{\max}}{bd^2/6}$$

$$\Rightarrow 8 = \frac{24 \times s \times 10^6}{120 \times \frac{(250)^2}{6}}$$

$$\Rightarrow s = 0.41667 \text{ m} = 416.67 \text{ mm}$$

End of Solution

Q.93 A motor driving a solid circular shaft transmits 30 kW at 500 r.p.m. What is the torque activity on the shaft, if allowable shear stress is 42 MPa?

- (a) 427 Nm (b) 573 Nm
(c) 180 Nm (d) 219 Nm

Ans. (b)

Power = Torque × (ω)

$$30 \times 10^3 = (T) \left(2\pi \times \frac{500}{60} \right)$$

$$\text{Torque} = 572.95 \text{ N-m} \approx 573 \text{ N-m}$$

End of Solution

- Q.94** An open-coiled helical spring of wire diameter 12 mm, mean coil radius 84 mm, helix angle 60° carries an axial load of 480 N. What is the twisting moment?
 (a) 10.22 Nm (b) 20.16 Nm
 (c) 14.24 Nm (d) 24.11 Nm

Ans. (b)

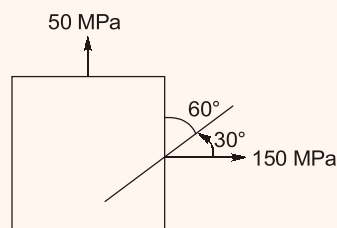
$$\begin{aligned} \text{Twisting moment, } TM &= PR \cos\alpha \\ &= 480 \times 0.084 \times \cos 60^\circ \\ &= 20.16 \text{ N-m} \end{aligned}$$

End of Solution

- Q.95** The stresses at a point of a machine component are 150 MPa and 50 MPa, both tensile. What is the intensity of normal stress on a plane inclined at an angle of 30° with the axis of major tensile stress?
 (a) 25 MPa (b) 50 MPa
 (c) 75 MPa (d) 100 MPa

Ans. (c)

$$\begin{aligned} \sigma_x &= 150 \text{ MPa} \\ \sigma_y &= 50 \text{ MPa} \end{aligned}$$



$$\theta = -60^\circ$$

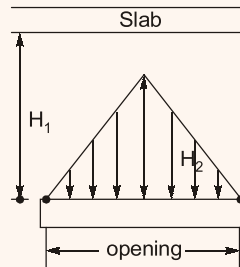
$$\begin{aligned} \sigma_x' &= 150 \cos^2(-60^\circ) + 50 \sin^2(-60^\circ) \\ &= 75 \text{ MPa} \end{aligned}$$

End of Solution

- Q.96** In case of lintel design, the load enclosed in an equilateral triangle is fully transferred to the lintel provided the height of wall above lintel is
 (a) not less than 1.25 times the height of the equilateral triangle.
 (b) less than twice the height of the equilateral triangle
 (c) less than 1.25 times the height of the equilateral triangle.
 (d) greater than twice the height of the equilateral triangle.

Ans. (a)

If $H_1 > 1.25 H_2$



Arching action is formed and load enclosed in equilateral triangle only is fully transferred over the lintel.

End of Solution

Q.97 Consider the following statements for Euler's equation to find critical load of a column:

1. Critical load of a column is proportional to the flexural rigidity.
2. Critical load of a column depends upon yield stress.
3. Critical load of a column is inversely proportional to the length of column.
4. Critical load of a column is inversely proportional to the square of the length of column.

Which of the above statements are correct?

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

Ans. (b)

$$P_{cr} = \frac{\pi^2 EI}{L_e^2}$$

EI = Flexural rigidity

$$P_{cr} \propto EI$$

$$P_{cr} \propto \frac{1}{L_e^2}$$

End of Solution

Q.98 A steel plate 120 mm wide and 20 mm thick is bent into a circular arc of radius 10 m. What is the maximum stress produced and the bending moment which can produce this stress respectively? (Take $E = 200 \text{ GPa}$)

- (a) 100 MPa, 32 kN-m (b) 200 MPa, 160 N-mm
(c) 200 MPa, 1600 N-m (d) 20 MPa, 160 kN-m

Ans. (c)

$$\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

$$M = \frac{EI}{R} = \frac{(200 \times 10^3) \left[\frac{120(20)^3}{12} \right]}{10 \times 10^3}$$

$$M = 1600 \text{ Nm}$$

$$\sigma = \frac{Ey}{R} = \frac{10}{10 \times 10^3} \times (200 \times 10^3) = 200 \text{ MPa}$$

End of Solution

Q.99 Consider the following statements regarding shearing force and bending moment:

1. Point of contraflexure is the point where bending moment changes its sign.
2. Shear force is the rate of change of bending moment.
3. For bending moment to be the maximum or minimum, shear force should change its sign.
4. Rate of change of loading is equal to shear force.

Which of the above statements are correct?

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

Ans. (d)

$$V = \frac{dM}{dx}$$

Rate change of shear force is equal to Loading, $W = \frac{dV}{dx}$.

End of Solution

Q.100 Consider the following statements:

Moment Area Method proves advantageous in analyzing

1. Cantilever beams.
2. Symmetrically loaded simply supported beams.
3. Fixed beams.
4. Continuous beams.

Which of the above statements are correct?

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

Ans. (d)

End of Solution



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by **Ayaz Khan Sir**
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(Founder, Patanjali IAS)
18th October, 2021 (Offline classes)

Engineering Optionals (CE, ME, EE) Online & Offline batches commencing from **18th October, 2021**

Q.101 Consider the following statements regarding continuous beam:

1. A beam is said to be a continuous beam if it is supported on more than two supports.
2. A continuous beam is a statically indeterminate structure.
3. The degree of indeterminacy depends upon the number of supports and also on the nature of the supports.

Which of the above statements are correct?

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

Ans. (c)

End of Solution

Q.102 In case of flexural tension or flexural compression, the minimum length of the bar which must be embedded in concrete beyond any section to develop its full strength, is termed as

- | | |
|--------------------|------------------------|
| (a) Twisted length | (b) Flexural length |
| (c) Bond length | (d) Development length |

Ans. (d)

“Development length is the minimum length of reinforcement required to be embedded inside concrete so that strength of bond becomes not less than tensile or compressive strength of steel so full strength of steel can be utilized and reinforcement will not come out from concrete.”

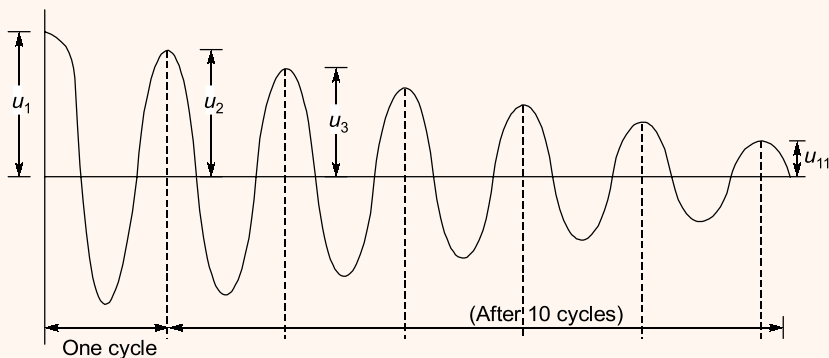
End of Solution

Q.103 It is observed experimentally that the amplitude of free vibration of a certain structure modelled as a single degree of freedom system, decreases from 1.0 to 0.4 in 10 cycles. What is the percentage of critical damping?

(Take $\ln 2 = 0.693$ and $\ln 10 = 2.303$)

- | | |
|-----------|-----------|
| (a) 5.21% | (b) 1.46% |
| (c) 2.37% | (d) 3.22% |

Ans. (b)



For a free undamped vibration

$$\frac{u_1}{u_2} = e^{\frac{2\pi\xi}{\sqrt{1-\xi^2}}}$$

For smaller magnitude of ξ , ξ^2 can be neglected.

$$\therefore \frac{u_1}{u_2} = e^{2\pi\xi}$$

As the ratio of two consecutive amplitude will remain constant.

$$\therefore \frac{u_1}{u_2} = \frac{u_2}{u_3} = \frac{u_3}{u_4} \dots = \text{constant}$$

\therefore After 10 cycles

$$\frac{u_1}{u_{11}} = \frac{u_1}{u_2} \times \frac{u_2}{u_3} \times \dots \times \frac{u_9}{u_{10}} \times \frac{u_{10}}{u_{11}}$$

$$\Rightarrow \frac{u_1}{u_{11}} = \left(\frac{u_1}{u_2}\right)^{10} = (2\pi\xi)^{10}$$

$$\Rightarrow \log_e \left(\frac{u_1}{u_{11}}\right) = 10(2\pi\xi)$$

$$\Rightarrow \xi = \frac{1}{20\pi} \log_e \left(\frac{1.0}{0.4}\right) = \frac{1}{20\pi} \log_e \left(\frac{10}{4}\right)$$

$$\begin{aligned} \Rightarrow \xi &= \frac{1}{20\pi} [\log_e 10 - 2\log_e 2] \\ &= \frac{1}{20\pi} [2.303 - (2 \times 0.693)] \\ &= 0.01459 = 1.459\% \end{aligned}$$

End of Solution

Q.104 The ultimate tensile strain in steel is in the range of

- | | |
|-------------------|-----------------------|
| (a) 0.012 – 0.020 | (b) 0.0012 – 0.0020 |
| (c) 0.12 – 0.20 | (d) 0.00012 – 0.00020 |

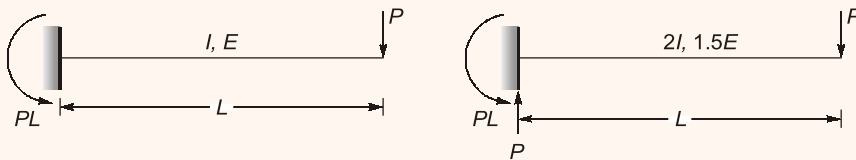
Ans. (c)

End of Solution

- Q.105 Consider the following statements regarding statically determinate structures:
1. Conditions of equilibrium are sufficient to fully analyses the structure.
 2. The bending moment at a section or the force in any member is independent of the material of the components of the structure.
 3. The bending moment at a section or the force in any member is independent of the cross-sectional areas of the components.
- Which of the above statements are correct?
- (a) 1 and 2 only (b) 2 and 3 only
(c) 1, 2 and 3 (d) 1 and 3 only

Ans. (c)
Fore determinate structure the forces are independent of material and cross-sectional properties.

Example:

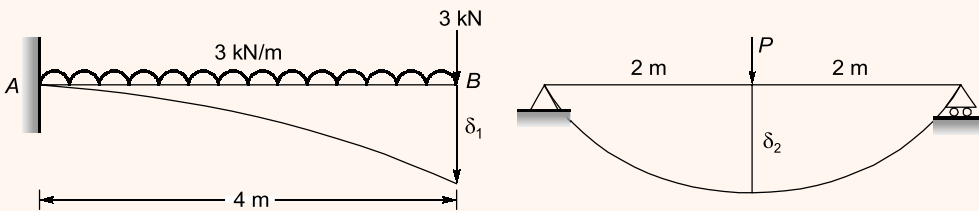


Even by changing material and cross-section the forces are not changing.

End of Solution

- Q.106 A cantilever beam of 4 m span carries a UDL of 3 kN/m over its entire span and a point load of 3 kN at the free end. If the same beam is simply supported at two ends, what point load at the centre should it carry to have same deflection as the cantilever?
- (a) 60 kN (b) 120 kN
(c) 160 kN (d) 210 kN

Ans. (b)



$$\delta_1 = \frac{3(4)^3}{3EI} + \frac{(3)(4)^4}{8EI}$$

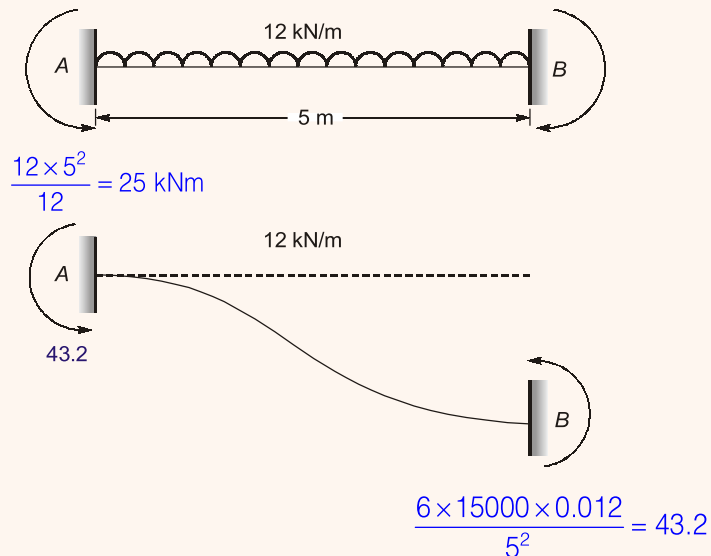
$$\delta_2 = \frac{(P)(4)^3}{48EI}$$

$$\delta_1 = \delta_2$$
$$P = 120 \text{ kN}$$

End of Solution

- Q.107** A beam AB of span 5 m fixed at both ends carries a UDL of 12 kN/m over the whole span. If the right end B settles down by 12 mm, what are the end moments for the beam? (Take $EI = 15000 \text{ kNm}^2$)
- (a) $M_a = 68.2 \text{ kNm}$ (hogging) and $M_b = 18.2 \text{ kNm}$ (sagging)
 - (b) $M_a = 18.2 \text{ kNm}$ (hogging) and $M_b = 68.2 \text{ kNm}$ (sagging)
 - (c) $M_a = 68.2 \text{ kNm}$ (hogging) and $M_b = 68.2 \text{ kNm}$ (sagging)
 - (d) $M_a = 18.2 \text{ kNm}$ (hogging) and $M_b = 18.2 \text{ kNm}$ (sagging)

Ans. (a)

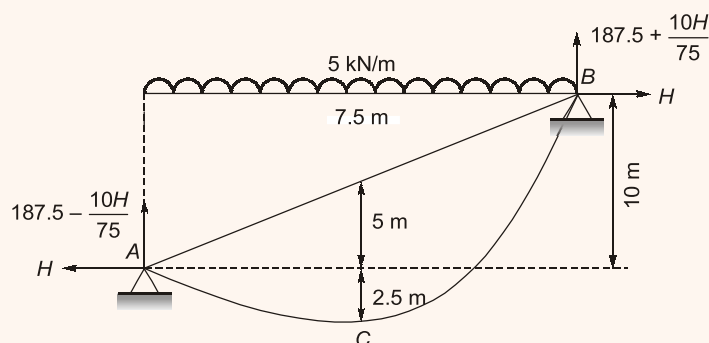


Net moment at A = 68.2 kNm (Hogging)
Net moment at B = 18.2 kNm (Sagging)

End of Solution

- Q.108** A cable is suspended between two points, 75 m apart horizontally with its left end lower than the right end by 10 m. The cable supports a UDL of 5 kN/m along the horizontal span. What is the horizontal tension in the cable if central sag is 7.5 m?
- (a) 385.13 kN
 - (b) 468.75 kN
 - (c) 145.15 kN
 - (d) 528.62 kN

Ans. (b)



From the principle of superposition,

$$V_A = 187.5 - \frac{10H}{75}$$

$$V_B = 187.5 + \frac{10H}{75}$$

$$\sum M_{cr} = 0$$

$$-\left(187.5 + \frac{10H}{75}\right) \times 37.5 + H \times 12.5 + 5 \times \frac{37.5^2}{2} = 0$$

$$H = 468.75 \text{ kN}$$

End of Solution

- Q.109** Consider the following statements related to merits of construction in structural steel:
1. Structural steel has high strength per unit weight as compared to RCC.
 2. The steel members are slender or small in size as compared to RCC.
 3. The steel structures are useful in construction of tall buildings, long-span bridges and airplane hangars.

Which of the above statements are correct?

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

Ans. (c)

End of Solution

- Q.110** For a laced column, the minimum width of the lacing bars when using 20 mm nominal diameter rivets is
- (a) 65 mm (b) 60 mm
(c) 55 mm (d) 50 mm

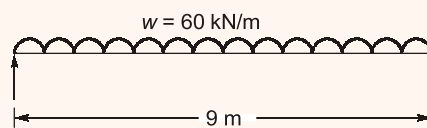
Ans. (b)

Minimum width = $3 \times \text{nominal diameter of rivet} = 3 \times 20 \text{ mm} = 60 \text{ mm}$

End of Solution

- Q.111** A beam simply supported over an effective span of 9 m, carries a uniformly distributed load of 60 kN/m, inclusive of its own weight. What is the section modulus of the beam, if $f_y = 250 \text{ N/mm}^2$ and $E = 2 \times 10^5 \text{ N/mm}^2$? (Assume width of support is 200 mm)
- (a) $2612 \times 10^3 \text{ mm}^3$ (b) $3682 \times 10^3 \text{ mm}^3$
(c) $4682 \times 10^3 \text{ mm}^3$ (d) $5124 \times 10^3 \text{ mm}^3$

Ans. (b)



$$w = 60 \text{ kN/m (DL + LL)}$$

$$f_y = 250 \text{ N/mm}^2$$

$$E = 2 \times 10^5 \text{ N/mm}^2$$

$$M = \sigma_{bt} Z_e$$

$$M = \frac{wL^2}{8} = \frac{60 \times 9^2}{8} = 607.5 \text{ kNm}$$

$$Z_e = \frac{M}{\sigma_{bt}} = \frac{607.5 \times 10^6 \text{ Nmm}}{0.66 \times 250 \text{ N/mm}^2}$$
$$= 3681.818 \times 10^3 \text{ mm}^3$$

End of Solution

Q.112 Consider the following statements related batten plates:

1. These normally consist of flat plate connecting the components of built-up columns in two parallel planes.
2. These are used for triaxial loading.
3. The design of batted columns and design of battens are usually governed by IS code requirements.

Which of the above statements are correct?

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

Ans. (a)

End of Solution

Q.113 Consider the following statements related to design of tension member with single structural shapes and plates:

1. The common single structural shapes are angle sections, tee sections, channel sections.
2. Single angles are not used for bracing, for light truss tension members.
3. Occasionally, I sections are also used as tension members as they have more rigidity.

Which of the above statements are correct?

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

Ans. (a)

End of Solution

Q.114 Consider the following statements regarding the advantages of a good organization:

1. It increases cooperation and a feeling of freedom.
2. It prevents duplication of work.
3. It makes communication easier.
4. It increases the likelihood of run-arounds.

Which of the above statements are correct?

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

Ans. (a)

End of Solution

Q.115 For design of a roof truss, if the design wind velocity is 20 m/s, what is the design wind pressure?

- | | |
|--------------------------|--------------------------|
| (a) 400 N/m ² | (b) 240 N/m ² |
| (c) 40 N/m ² | (d) 200 N/m ² |

Ans. (b)

$$p_z = 0.6 (V_d)^2 = 0.6 (20)^2 = 240 \text{ N/m}^2$$

End of Solution

Q.116 Consider the following statements:

1. The working stress design is based on explicit consideration of the various conditions under which the structure may cease to fulfil its intended function.
2. In case of working stress design, structure will directly take into consideration the various relevant modes of failure.
3. In working stress method, regulatory bodies or classification societies usually specify the value of the allowable stress as some fraction of the mechanical properties of a materials.

Which of the above statements is/are correct?

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

Ans. (d)

End of Solution

- Q.119** Consider the following for local capacity of section:
1. Local section failure is usually encountered in the case of short stocky beam-columns with relatively smaller axial compression ratio and beam-columns bent in reverse curvature.
 2. The strength of end section reached under combined axial force and bending, governs the failure.
 3. The strength of the section may be governed by plastic buckling of plate elements in the case of plastic, compact and semi-compact sections.

Which of the above statements is/are correct?

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

Ans. (c)

End of Solution

- Q.120** A tension member of a roof truss carries a factored load of 430 kN. By considering the strength in yield, what is the gross area required to carry this load? (Consider Fe250 grade steel)
- (a) 1892 mm² (b) 1978 mm²
(c) 1903 mm² (d) 2150 mm²

Ans. (a)

$$430 \text{ kN} = \frac{A_g \times f_y}{\gamma_{m0}}$$

$$A_g = \frac{430 \times 10^3 \times 1.1}{250} = 1892 \text{ mm}^2$$

End of Solution

- Q.121** Stirrup area in excess of that required shear and torsion is provided along each terminated bar over a distance from the cut-off point equal to
- (a) three-fourth the effective depth of the member
(b) one-third the effective depth of the member
(c) two-third the effective depth of the member
(d) one-fourth the effective depth of the member

Ans. (a)

As per IS-456-Pr. 26.2.3.2

"Stirrup area in excess of that required for shear and torsion is provided along each terminated bar over a distance from the cut off point equal to:

$\frac{3}{4}$ the effective depth of the member.

End of Solution

Q.122 Which one of the following is not a type of mortar?

- (a) Lime surkhi mortar (b) Cement sand mortar
(c) Cement stone chips mortar (d) Cement lime mortar

Ans. (c)

As per Pr. 3.2.1 | IS 1905 Table-1 | There is no such type of mortar.

End of Solution

Q.123 The grade of concrete and reinforcement M-20 and Fe-250 respectively. Consider 25 mm diameter bars and τ_{bd} is 1.2. What is the development length at support for a simply supported beam of a rectangular section?

- (a) 1133 mm (b) 1033 mm
(c) 1321 mm (d) 1232 mm

Ans. (a)

Development length

$$\begin{aligned}L_d &= \frac{\phi \cdot 0.87 \cdot f_y}{4 \cdot \tau_{bd}(\text{per})} \\ &= \frac{25 \times 0.87 \times 250}{4 \times 1.20} \\ &= 1132.8 \text{ mm} = 1133 \text{ mm}\end{aligned}$$

End of Solution

Q.124 In a singly reinforced beam, for given grade of concrete, permissible bond stress in deformed bars

- (a) is lesser than that of plain bars.
(b) is equal to that of plain bars.
(c) may be greater than or smaller than that of the plain bars.
(d) is greater than that of plain bars.

Ans. (d)

Permissible Bond stress in deformed bars

$$= 1.6 \times \tau_{bd} \text{ (for plain bars)}$$

End of Solution

Q.125 The safe load carried by the helically reinforced column is

- (a) 1.05 times the load carried by the similar column with ties.
(b) 2.15 times the load carried by the similar column with ties.
(c) 1.15 times the load carried by the similar column with ties.
(d) 2.05 times the load carried by the similar column with ties.

Ans. (a)

End of Solution

Q.126 Nominal cover to reinforcement is provided to

1. protect reinforcement against corrosion.
2. provide shear resistance.
3. protect reinforcement against fire.
4. develop sufficient bond strength along surface area of reinforcement bars.

Which of the above statements are correct?

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

Ans. (c)

Nominal cover is provided to all steel reinforcement to

1. Protect reinforcement against corrosion.
2. Protect reinforcement against fire.
3. Develop sufficient Bond strength along surface area of reinforcement bars, as concrete is required all around the reinforcement for some particular thickness to develop bond strength.

End of Solution

Q.127 In slab design, ratio of maximum diameter of reinforcing bars to the total thickness of slab should not be more than

- (a) $\frac{1}{12}$ (b) $\frac{1}{6}$
(c) $\frac{1}{8}$ (d) $\frac{1}{7}$

Ans. (c)

As per Clause 26.5.2.2 of IS: 456- 2000

Dia of bars for slab $\leq \frac{1}{8}$ slab thickness.

End of Solution

Q.128 To prevent cracking of edges, the corners in two way slabs are provided with

- (a) shear reinforcement (b) torsion reinforcement
(c) tensile reinforcement (d) compression reinforcement

Ans. (b)

To prevent cracking of edges torsion reinforcement are provided as per clause D1.8 to D1.10, of IS : 456 -2000.

End of Solution

- Q.129 Critical section for two way shear in case of isolated footing design is at
- (a) the face of column
 - (b) effective depth from the face of column
 - (c) half of the effective depth from the face of column
 - (d) two-third of the effective depth from the face of column

Ans. (c)

At $\frac{d}{2}$ distance from face of column.

As per clause 34.2.4.1, 31.6, of IS : 456 -2000.

End of Solution

- Q.130 Accepted relationship between tread and riser in case of staircase design is
- (a) Riser \times Tread = 60,000 mm²
 - (b) 2 \times Riser + Tread = 600 mm
 - (c) Riser + Tread = 600 mm
 - (d) 2 \times Tread + Riser = 600 mm

Ans. (b)

End of Solution

- Q.131 Loss of pre-stress is not directly related to
- (a) creep of concrete
 - (b) shrinkage of concrete
 - (c) grade of concrete
 - (d) slipping of steel tendons from concrete

Ans. (c)

Loss of prestress will depend on grade of concrete also but it is not directly related to grade of concrete.

End of Solution

- Q.132 Which one of the following statements is the disadvantage of post tensioning method?
- (a) The loss of pre-stress is less as compared to pre-tensioning system.
 - (b) Post-tensioning method is costly as compared to pre-tensioning method.
 - (c) Post-tensioning can be done in factories and at the site also.
 - (d) Post-tensioning method is used for large spans and heavily loaded structures.

Ans. (b)

End of Solution

- Q.133 What is the main limitation of bar chart?
- (a) It does not help in material and labour planning.
 - (b) It does not show all the activities of a project.
 - (c) It does not indicate critical activities of a project.
 - (d) Project duration cannot be estimated.

Ans. (c)

End of Solution

- Q.134 Graders are not suitable for
- | | |
|-------------------------------|----------------------|
| (a) levelling of earthwork | (b) cutting ditches |
| (c) working on steeper slopes | (d) heavy excavation |

Ans. (d)

Bulldozers and motor graders are both highly versatile pieces of construction equipment. Many times they can be used interchangeably.

Graders are a narrow multipurpose construction equipment used to flatten a surface during grading projects.

- Motor graders play an essential role in performing accurate grading and levelling of earthwork.
- It is used for following:
 - i. Create the base for paved roads.
 - ii. Set the foundation for a large building.
 - iii. Create an incline.
 - iv. Create drainage ditches.
 - v. Ditch cutting
 - vi. High bank cutting

For Projects: (i) Road construction.

(ii) Road maintenance and repair.

Motor graders have limited traction because they use rubber tires rather than tracks. They are also not suitable for moving heavy loads like a bulldozer due to moldboard location. They are too large for small projects.

End of Solution

- Q.135 Line of Balance technique is
- | |
|---|
| (a) modified bar chart. |
| (b) planning of repetitive activities of a project. |
| (c) modified form of PERT. |
| (d) used for planning milestones of a project. |

Ans. (b)

The line of balance is also known as the repetitive scheduling method (RSM).

A line of balance diagram comprises a series of inclined lines which represent the rate of work between repetitive operations in a construction sequence.

The purpose of the LOB method is to ensure that the many activities of a repetitive production process stay "in balance" that is they are producing at a pace which allows an even flow of the items produced.

End of Solution

- Q.136** Which one of the following statements is not correct in respect of drawing network?
- (a) No activity can start until its tail event has occurred.
 - (b) An event cannot occur twice.
 - (c) Length of arrow should be in proportion to the time consumed by that activity.
 - (d) The number of arrows should be equal to the number of activities in the project

Ans. (c)

Length of arrow have no significance, it is taken only according to better pictorian representation.

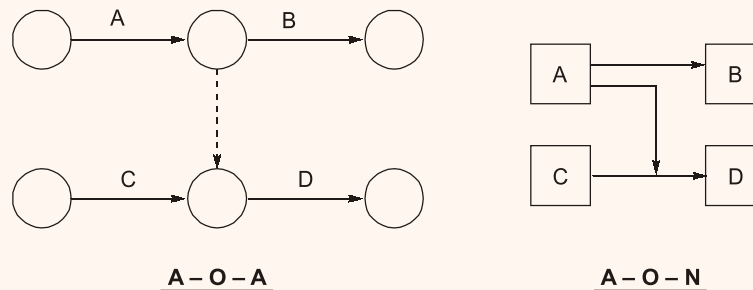
End of Solution

- Q.137** A-O-N system of network

- (a) completely eliminates the use of dummy activities.
- (b) requires judicious use of dummy activities.
- (c) does not distinctly show pre-operation and post-operation of the activities.
- (d) is not suitable for projects with number of activities.

Ans. (a)

No rule of dummy is in A-O-N network however their relationship has been maintained by arrow.



End of Solution

- Q.138** Which one of the following types of cost contracts allows the amount of reimbursement to increase if the contractor cost increase?
- (a) Cost-plus award fee contract
 - (b) Cost-plus incentive fee contract
 - (c) Cost-plus fixed fee contract
 - (d) Cost-plus percentage fee contract

Ans. (c)

In cost plus fixed fee contract, the cost of project is unnecessarily increased because of purchase of materials of higher price and engaging costly labour in an attempt to reduce the project time.

End of Solution

Q.139 Number of bricks required for 15 cu.m on brickwork is approximately

- (a) 6750 (b) 7200
(c) 7500 (d) 6000

Ans. (c)

$$\text{No. of bricks} = \frac{15}{0.2 \times 0.1 \times 0.1} = 7500$$

End of Solution

Q.140 The plinth area of a building does not include area of

- (a) the walls at the floor levels
(b) internal shaft for sanitary installations upto 2 sq.m area
(c) lifts
(d) cantilevered porches

Ans. (d)

Plinth area is the covered built-up area measured at the floor level of any storey or at the floor level of the basement. Plinth area is also called as built-up area and is the entire area occupied by the building including internal and external walls. Plinth area is generally 10-20% more than carpet area.

Plinth area means the built-up covered area measured at the floor level of the basement or of any storey including balconies but excluding ducts/ services and lift shaft (except in the lowest floor of lift shaft) and open cut-out areas.

Generally, the plinth area is calculated by taking the external dimensions of the building at the floor level. Whereas while calculating the floor area the internal measure is mandatory to lay the carpet which does not include the thickness of the walls and an internal measure.

Porch is included. In plinth area veranda, balconies and parapets is included, if these area is secured by projections, in plinth area full area is included, if the area of veranda, balconies and parapets etc. in unsecured by projections then 50% of the area is included.

End of Solution

Q.141 Which one of the following statements is not correct?

- (a) The circulation area of any floor includes entrance halls
(b) Floor area of a building includes area of sills of doors and other openings
(c) Cube rate estimate of a building is more accurate as compared to plinth area estimate
(d) The preliminary estimate for water supply and sewerage project can be prepared on the basis of per head of population served.

Ans. (b)

End of Solution

Q.142 Consider the following statements regarding the advantages in line or military organization of management technique:

1. The command and control is very effective.
2. It is simple to work and easily understood by the employees.
3. Responsibilities in all levels are definite and fixed.
4. The organization is rigid.

Which of the above statements are correct?

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

Ans. (c)

According to this type of organization, the authority flows from top to bottom in a concern.

- It is most simplest form of organism.
- Line of authority flows from top to bottom.
- Specialized supportive services do not take place in the organization.

Merits:

Flexibility: There is coordination between the top most authority bottom line authority. Since the authority relationships are year, line officials are independent can flexibly take the decision.

End of Solution

Q.143 Project management audit consists of which of the following?

1. Project work-breakdown structure verification and the relevance.
2. Risk identification, cost, levels and security.
3. Measurements of risk impacts.

Select the correct answer using the code given below:

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

Ans. (c)

End of Solution

Q.144 Consider the following statements regarding inspection and quality control:

1. Coefficient of variation is a relative measure of dispersion.
2. Standard deviation is the root mean square of the deviation of all the results.
3. Standard deviation is relative measure of dispersion.
4. Lower value of standard deviation indicates low degree of uniformity of observations.

Which of the above statements are correct?

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

Ans. (c)

The variability of quality is measured by standard deviation(σ) and coefficient of variation (C_v).

A small standard deviation means a high degree of uniformity and homogeneity of quality, while a large value means just the opposite. Hence statement (4) is wrong.

End of Solution

Directions : Each of the next six (06) items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

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 a 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.

Q.145 Statement (I): The theoretical strength of concrete as per Gel-Space ratio theory is less than the actual strength of concrete.

Statement (II): In the Gel-Space ratio theory, it has been assumed that the concrete is perfectly homogeneous and flawless.

Ans. (d)

The limitation of Gel-Space theory is that the theoretical strength of concrete is much more than actual strength of concrete, as it has been assumed in this theory that concrete is perfectly homogeneous and flawless.

End of Solution

Q.146 Statement (I): Spur length is kept longer than 1.5 to 2 times the depth of flow.

Statement (II): Shorter spur length in deeper rivers induces swirling motion on both the upstream and downstream sides of the spur.

Ans. (d)

End of Solution

Q.147 Statement (I): Both the Empirical formulae given by American Insurance Association and Buston for the determination of fire demand of water are not suitable for Indian conditions.

Statement (II): Kuchling's formula estimates lesser value fire water demand.

Ans. (d)

End of Solution

Q.148 Statement (I): For the design of slender column, additional moments are required to be considered.

Statement (II): Lateral deflection of slender columns, under axial load, is substantial and causes additional moments.

Ans. (a)

Both statements are correct and statement II is correct explanation of statement I. As per IS 456 : 2000 clause 39.7, recommend to add additional moment for long (slender) columns.

End of Solution

Q.149 Statement (I): To achieve maximum value for minimum radius of gyration of compression members, without increasing the area of the section number of elements are placed away from principal axis using suitable lateral systems.

Statement (II): Batten shall be placed at 40° to 70° to the axis of built-up members.

Ans. (c)

End of Solution

Q.150 Statement (I): Chain surveying is that type of surveying which only linear measurements are made in the field.

Statement (II): Traversing is that type of survey in which number of connected survey lines from framework and the directions and length the survey lines are measured with the help of and angle measuring instrument and a respectively.

Ans. (b)

End of Solution

