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(Set-A)

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Branch	**Gen**	**OBC**	**SC**	**ST**	**Branch**	**Gen**	**OBC**	**SC**	**ST**
CE	210-220	205-215	170-180	170-180	**CE**	188	185	143	159
ME	245-255	245-255	210-220	210-220	**ME**	187	187	166	169
EE	225-235	215-225	195-205	195-205	**EE**	221	211	191	172
E&T	235-245	225-235	185-195	185-195	**E&T**	226	221	176	165

Civil Engineering Paper
Analysis : ESE 2020 Prelims Exam

Sl.	Subjects	No. of Qs.
1	Building Materials	15
2	Strength of Materials	18
3	Structural Analysis	06
4	Design of Steel Structures	13
5	RCC & Prestress Concrete	10
6	Construction Practice, Planning & Management	12
7	Fluid & Hydraulic Machines + OCF	12
8	Engineering Hydrology	02
9	Irrigation Engineering	08
10	Environmental Engineering	13
11	Geo-technical Engineering	14
12	Surveying and Geology	13
13	Transportation Engineering	06
14	Railway Engineering	08

UPSC ESE/IES Prelims 2020

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1. When the deposit of efflorescence is more than 10% but less than 50% of the exposed area of the brick, the presence of efflorescence is

(a) Moderate (b) Slight
(c) Heavy (d) Serious

Ans. (a)

NIL negligible
SLIGHT ≤ 10%
MODERATE 10 – 50%
HEAVY/HIGH > 50%
SERIOUS > 50% and accompanied by powdering or flacking of exposed surface.

End of Solution

2. Mohs scale is used for stones to determine

(a) Flakiness index (b) Durability
(c) Strength (d) Hardness

Ans. (d)

End of Solution

3. Which of the following conditions are recommended for using sulphate resisting cement?

1. Concrete to be used in foundation and basement, where soil is not infested with sulphates.
2. Concrete used for fabrication of pipes which are likely to be buried in marshy region or sulphate bearing soils.
3. Concrete to be used in the construction of sewage treatment works.

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

Ans. (a)

End of Solution

4. Which one of the following cements is a deliquescent?

(a) Quick setting Portland cement (b) White and Coloured cement
(c) Calcium Chloride cement (d) Water Repellent cement

Ans. (c)

End of Solution

5. Consider the following data for concrete with mild exposure

Water-cement ratio = 0.50
Water = 191.6 litre

The required cement content will be

(a) 561 kg/m^3 (b) 472 kg/m^3
(c) 383 kg/m^3 (d) 294 kg/m^3

Ans. (c)

$$\frac{W}{C}\text{ (By mass)} = 0.5$$

$$C = \frac{W}{0.5}$$

Volume of water = 191.6 litre = 0.1916 m^3

Mass of water = 0.1916×10^3 = 191.6 kg

$$C = \frac{191.6}{0.5} = 383.2 \text{ kg}$$

End of Solution

6. The strength of a fully matured concrete sample is 500 kg/cm^2. When cured at an average temperature of 20°C in day, 10°C in night, datum temperature T_0 is –11°C. If Plowman constants A is 32 and B is 54, the strength of identical concrete at 7 days will be nearly

(a) 333 kg/cm^2 (b) 312 kg/cm^2

(c) 272 kg/cm^2 (d) 243 kg/cm^2

Ans. **(a)**

$$M = (20 - (-11)) \times 12 \times 7 + (10 - (-11)) \times 12 \times 7$$
$$= 2604 + 1764$$
$$= 4368°C - \text{Hrs}$$

Strength, $f = a + b \log_{10}(M \times 10^{-3})$

$$= 32 + 54 \log_{10}(4368 \times 10^{-3})$$
$$= 66.57\%$$

Strength of concrete at 7 days = 0.6657×500

$$= 332.85 \text{ kg/cm}^2$$
$$= 333 \text{ kg/cm}^2$$

End of Solution

7. A sample of concrete is prepared by using 500 g of cement with water cement ratio of 0.55 and 240 N/mm^2 intrinsic strength of gel. The theoretical strength of concrete on full hydration will be nearly

(a) 148 N/mm^2 (b) 126 N/mm^2

(c) 104 N/mm^2 (d) 82 N/mm^2

Ans. **(c)**

Weight of cement = 500 gm

$$\frac{W}{C} = 0.55$$

Weight of water = 500×0.55 = 275 gm

Volume of water = 275 ml

$$\text{Gel space ratio} = \frac{0.657C}{0.319C + W} = \frac{0.657 \times 500}{0.319 \times 500 + 275} = \frac{328.5}{434.5} = 0.756$$

Theoretical strength of concrete = $240\ (0.756)^3$ = 103.71 N/mm^2

End of Solution

8. The cement and water slurry coming on the top and setting on the surface is called
(a) Crazing
(b) Efflorescence
(c) Sulphate deterioration
(d) Laitance

Ans. (d)

End of Solution

9. Polymer concrete is most suitable for
(a) Sewage disposal works
(b) Mass concreting works
(c) Insulating exterior walls of an air-conditioned building
(d) Road repair works

Ans. (a)

End of Solution

10. Which one of the following limes will be used for finishing coat in plastering and white washing?
(a) Semi Hydraulic lime
(b) Kankar lime
(c) Magnesium/Dolomitic lime
(d) Eminently Hydraulic lime

Ans. (c)

End of Solution

11. Which one of the following light weight element will be added to enhance the protective properties for X-ray shielding mortars?
(a) Sodium
(b) Potassium
(c) Lithium
(d) Calcium

Ans. (c)

End of Solution

12. Which one of the following stone is produced by moulding a mixture of iron slag and Portland cement?
(a) Imperial stone
(b) Garlic stone
(c) Ransom stone
(d) Victoria stone

Ans. (b)

End of Solution

13. When a round bar material with diameter of 37.5 mm, length of 2.4 m, Young's modulus of 110 GN/m^2 and shear modulus of 42 GN/m^2 is stretched for 2.5 mm, its Bulk modulus will be nearly
(a) 104 GN/m^2
(b) 96 GN/m^2
(c) 84 GN/m^2
(d) 76 GN/m^2

Ans. (b)

$$E = \frac{9KG}{3K + G}$$
$$3KE + EG = 9KG$$
$$9KG - 3KE = EG$$
$$K = \frac{EG}{9G - 3E} = \frac{110 \times 42}{9 \times 42 - 3 \times 110} = 96.25 \text{ GN/m}^2$$

End of Solution

14. A punch of 20 mm diameter is used to punch a hole in 8 mm thick plate. If the force required to create a hole is 110 kN, the average shear stress in the plate will be nearly

(a) 410 MPa (b) 320 MPa
(c) 220 MPa (d) 140 MPa

Ans. **(c)**

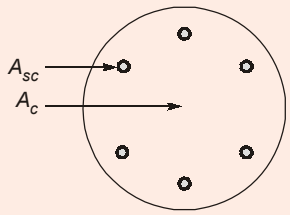
$$\text{Shear stress, } \tau = \frac{P}{A} = \frac{P}{\pi dt}$$
$$= \frac{110 \times 10^3}{\pi \times 20 \times 8} = 219 \text{ MPa} \simeq 220 \text{ MPa}$$

End of Solution

15. A reinforced concrete circular section of 50,000 mm^2 cross-sectional area carries 6 reinforcing bars whose total area is 500 mm^2. If the concrete is not to be stressed more than 3.5 MPa and modular ratio for steel and concrete is 18, the safe load the column can carry will be nearly

(a) 225 kN (b) 205 kN
(c) 180 kN (d) 160 kN

Ans. **(b)**



$A_g = 50000 \text{ mm}^2$
$A_{sc} = 500 \text{ mm}^2$
$A_c = 50000 - 500 = 49500 \text{ mm}^2$
$P = A_c \cdot \sigma_{cc} + A_{sc} \cdot \sigma_{sc}$
$= A_c \cdot \sigma_{cc} + A_{sc} \cdot m \cdot \sigma_{cc}$
$= 49500 \times 3.5 + 500 \times 18 \times 3.5$
$= 204750 \text{ N}$
$= 204.75 \text{ kN}$
$= 205 \text{ kN (say)}$

End of Solution

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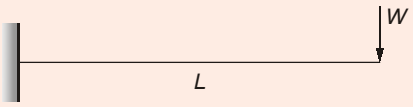
16. The strain energy U stored due to bending of the cantilever beam due to point load at the free end will be

(a) $\frac{W^2l^3}{6EI}$ (b) $\frac{W^2l^2}{6EI}$

(c) $\frac{W^3l^3}{36EI}$ (d) $\frac{W^2l^3}{36EI}$

where : W = Concentrated load
l = Length of a cantilever
EI = Flexural rigidity

Ans. **(a)**



$$U = \int_0^L \frac{(M_x)^2\,dx}{2EI} = \int_0^L \frac{W^2x^2dx}{2EI} = \frac{W^2L^3}{6EI}$$

End of Solution

17. A steel bar 2 m long, 20 mm wide and 15 mm thick is subjected to a tensile load of 30 kN. If Poisson's ratio is 0.25 and Young's modulus is 200 GPa, an increase in volume will be

(a) 160 mm^3 (b) 150 mm^3

(c) 140 mm^3 (d) 130 mm^3

Ans. **(b)**

$$\text{Axial stress, } \sigma = \frac{P}{A} = \frac{30\times10^3}{20\times15} = 100 \text{ MPa}$$

$$\text{Volumetric strain, } \varepsilon_v = \frac{\sigma}{E}(1-2\mu)$$

$$\therefore \quad \Delta V = \frac{100}{200\times10^3}(1-0.5)\times20\times15\times2000$$

$$= 150 \text{ mm}^3$$

End of Solution

18. A bolt is under an axial thrust of 9.6 kN together with a transverse force of 4.8 kN. If factor of safety is 3, yield strength of bolt material is 270 N/mm^2 and Poisson's ratio is 0.3, its diameter as per maximum principal stress theory will be nearly

(a) 13 mm (b) 15 mm

(c) 17 mm (d) 19 mm

Ans. **(a)**

$$\text{Axial stress, } \sigma = \frac{9.6\times10^3}{\frac{\pi}{4}d^2} = \frac{12.23\times10^3}{d^2} \text{ N/mm}^2$$

$$\text{Shear stress, } \tau = \frac{4.8\times10^3}{\frac{\pi}{4}d^2} = \frac{6.115\times10^3}{d^2} \text{ N/mm}^2$$

Maximum principal stress,

$$\sigma_1 = \frac{\sigma}{2} + \sqrt{\left(\frac{\sigma}{2}\right)^2 + \tau^2}$$

$$= \frac{6115}{d^2} + \sqrt{\left(\frac{6115}{d^2}\right)^2 + \left(\frac{6115}{d^2}\right)^2}$$

$$= \frac{1}{d^2}[6115 + 8647.916]$$

$$= \frac{14762.9}{d^2} \text{ N/mm}^2$$

According to maximum principal stress theorem,

$$\sigma_1 \le \frac{\sigma_y}{\text{FOS}}$$

$$\frac{14762.9}{d^2} \le \frac{270}{3}$$

$\therefore \quad d \ge 12.81$ mm

End of Solution

19. In a material the principal stresses are 60 MN/m^2, 48 MN/m^2 and –36 MN/m^2. When the values of E = 200 GN/m^2 and $\frac{1}{m}$ = 0.3, the total strain energy per unit volume will be nearly

(a) 43.5 kNm/m^3 (b) 35.5 kNm/m^3
(c) 27.5 kNm/m^3 (d) 19.5 kNm/m^3

Ans. (d)

Strain energy per unit volume

$$= \frac{1}{2E}[\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - 2\mu(\sigma_1\sigma_2 + \sigma_2\sigma_3 + \sigma_3\sigma_1)]$$

$$= \frac{1}{2\times200\times10^9}[60^2 + 48^2 + 36^2 - 0.6(60\times48 - 48\times36 - 60\times36)]\times10^{12}$$

$$= \frac{10^{12}}{4\times10^{11}}[7200 - 0.6(2880 - 1728 - 2160)]$$

$$= \frac{10}{4}(7200 + 604.8)$$

$$= 19.51 \text{ kNm/m}^3$$

End of Solution

20. At a point in a two dimensional stress system, the normal stress on two mutually perpendicular planes are σ_{xx} and σ_{yy} and shear stress is τ_{xy}. One of the principal stresses will become zero when the value of shear stress τ_{xy} is

(a) $\pm(\sigma_{xx}\sigma_{yy})$ (b) $\pm\sqrt{\sigma_{xx}-\sigma_{yy}}$

(c) $\pm\sqrt{\sigma_{xx}+\sigma_{yy}}$ (d) $\pm\sqrt{\sigma_{xx}\sigma_{yy}}$

Ans. **(d)**

$$\sigma_1 = \frac{\sigma_{xx}+\sigma_{yy}}{2} + \sqrt{\left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)^2 + \tau_{xy}^2} = +\text{ve} \neq 0$$

$$\therefore \quad \sigma_2 = 0$$

$$\frac{\sigma_{xx}+\sigma_{yy}}{2} - \sqrt{\left(\frac{\sigma_{xx}-\sigma_{yy}}{2}\right)^2 + \tau_{xy}^2} = 0$$

$$\tau_{xy}^2 = \sigma_{xx}\cdot\sigma_{yy}$$

$$\therefore \quad \tau_{xy} = \pm\sqrt{\sigma_{xx}\cdot\sigma_{yy}}$$

End of Solution

21. The deflection δ of the closed coil helical spring is

(a) $\frac{WR^2n}{8Cd^3}$ (b) $\frac{64WR^3n}{Cd^4}$

(c) $\frac{128WR^3n}{Cd^2}$ (d) $\frac{64WR^2n}{Cd^2}$

where : W is the axial load
R is the radius of the coil
n is the number of turns of coil
C is the modulus of rigidity
d is the diameter of the wire of the coil

Ans. **(b)**

$$\text{Strain energy in spring} = \frac{T^2L}{2GJ}$$

$$= \frac{P^2R^2(2\pi Rn)}{2G\frac{\pi}{32}d^4}$$

$$= \frac{32P^2R^3n}{Gd^4}$$

By Castigliano's theorem,

$$\delta = \frac{\partial U}{\partial P} = \frac{\partial}{\partial P} = \frac{32P^2R^3n}{Gd^4}$$

$$\delta = \frac{64PR^3n}{Gd^4}$$

$G = C$ = Modulus of rigidity

End of Solution

22. A closely-coiled helical spring of round steel wire 5 mm in diameter having 12 complete coils of 50 mm mean diameter is subjected to an axial load of 100 N. If modulus of rigidity is 80 GPa, the deflection of the spring will be

(a) 36 mm (b) 32 mm
(c) 28 mm (d) 24 mm

Ans. **(d)**

$$\Delta = \frac{64PR^3n}{Gd^4} = \frac{64\times100\times25^3\times12}{80\times10^3\times5^4}$$

$\Delta = 24$ mm

End of Solution

23. A hollow shaft of external and internal diameters as 100 mm and 40 mm respectively is transmitting power at 120 rpm. If the shearing stress is not to exceed 50 MPa, the power the shaft can transmit will be

(a) 100 kW (b) 120 kW
(c) 140 kW (d) 160 kW

Ans. **(b)**

$$\tau_{max} = \frac{16T}{\pi d_0^3\left[1-\left(\frac{d_i}{d_o}\right)^4\right]}$$

$$50 = \frac{16T}{\pi\times100^3\left[1-\left(\frac{40}{100}\right)^4\right]}$$

$T = 9.56 \times 10^6$ Nmm

$\therefore$ $$P = \frac{2\pi NT}{60}$$

$$= \frac{2\pi\times120\times9.56\times10^3}{60}$$

$= 120$ kW

End of Solution

24. A circular beam of 100 mm diameter is subjected to a shear force of 30 kN. The maximum shear stress will be nearly

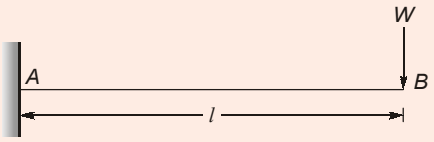
(a) 5.1 MPa (b) 6.3 MPa
(c) 7.5 MPa (d) 8.7 MPa

Ans. (a)

$$\tau_{max} = \frac{4}{3}\cdot\frac{F}{A} = \frac{4}{3}\times\frac{30\times10^3}{\frac{\pi}{4}(100)^2} = 5.08 \text{ MPa}$$

End of Solution

25. A cantilever beam *AB* as shown in figure is subjected to a point load of 12 kN over a span of 6 m with $E = 2 \times 10^5$ N/mm^2 and $I_{XX} = 6 \times 10^7$ mm^4. The deflection at the free end will be



(a) 80 mm (b) 72 mm
(c) 64 mm (d) 56 mm

Ans. (b)

$$\Delta = \frac{PL^3}{3EI} = \frac{12\times10^3\times6000^3}{3\times2\times10^5\times6\times10^7} = 72 \text{ mm}$$

End of Solution

26. A floor has to carry a load of 12 kN/m^2. The floor is supported on rectangular joists each 100 mm wide, 300 mm deep and 5 m long. If maximum stress in the joists should not exceed 8 MN/m^2, the centre to centre distance of joists will be

(a) 430 mm (b) 400 mm
(c) 360 mm (d) 320 mm

Ans. (d)

Let *h* is the distance between two joists.

$$\therefore \quad \frac{12\times l\times h}{l} = w$$

$$w = 12h \text{ kN/m}$$

Now $$\sigma_{max} = \frac{M_{max}}{z}$$

$$8 = \frac{wl^2}{8\times\frac{bd^2}{6}}$$

$$8 = \frac{6wl^2}{8bd^2}$$

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$$\frac{64\times100\times300^2}{6\times(5000)^2} = w$$

$\therefore$ $w = 3.84$ N/mm

$12h = 3.84$

$h = 0.32$ m

$= 320$ mm

End of Solution

27. A simply supported wooden beam 100 mm wide, 250 mm deep and 3 m long is carrying a uniformly distributed load of 40 kN/m. The maximum shear stress will be

(a) 2.4 MPa (b) 2.8 MPa

(c) 3.2 MPa (d) 3.6 MPa

Ans. (d)

Maximum S.F., $S = \frac{wL}{2} = \frac{40\times3}{2} = 60$ kN

$$\tau_{max} = 1.5\ \tau_{avg} = 1.5\times\frac{60\times10^3}{100\times250} = 3.6 \text{ MPa}$$

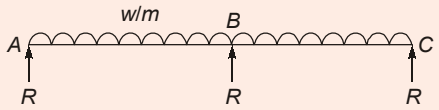
End of Solution

28. A simply supported beam of span 8 m carries a uniformly distributed load of 24 kN/m run over the whole span. The beam is propped at the middle of the span. The values of $E = 200 \times 10^6$ kN/m^2 and $I = 20 \times 10^{-5}$ m^4. The amount by which the prop should yield in order to make all three reactions equal will be nearly

(a) 20 mm (b) 15 mm

(c) 10 mm (d) 5 mm

Ans. (b)



$3R = 24 \times 8$

$R = 64$ kN

$$\Delta_B = \frac{5}{384}\frac{wL^4}{EI} - \frac{RL^3}{48EI}$$

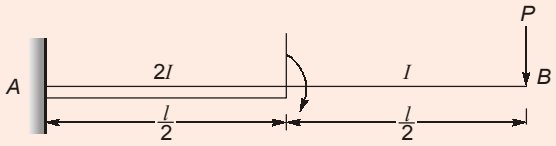
$$= \frac{1}{EI}\left[\frac{5}{384}\times24\times8^4 - \frac{64\times8^3}{48}\right]$$

$$= \frac{1}{200\times10^9\times20\times10^{-5}}[1280 - 682.666]$$

$= 14.9$ mm

End of Solution

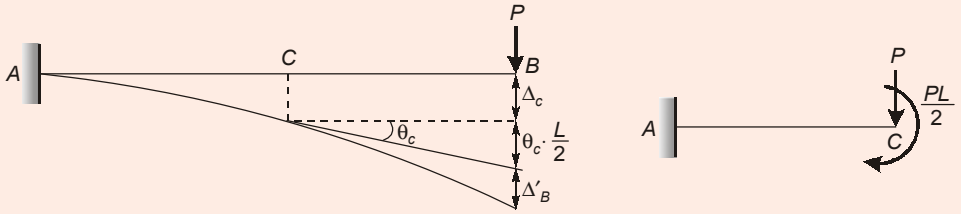
29. A cantilever beam *ACB* has end *A* fixed and subjected to a point load *P* at free end *B*. The point *C* is mid-point of *AB* and the moment of inertia of *AC* is twice that of *CB*. the deflection at the free end will be



(a) $\frac{Pl^3}{3EI}$ (b) $\frac{Pl^3}{48EI}$

(c) $\frac{5Pl^3}{96EI}$ (d) $\frac{9Pl^3}{48EI}$

Ans. (d)



$$\theta_C = \frac{\frac{PL}{2}\cdot\left(\frac{L}{2}\right)}{2EI} + \frac{P\left(\frac{L}{2}\right)^2}{4EI}$$

$$= \frac{PL^2}{8EI} + \frac{PL^2}{16EI} = \frac{3PL^2}{16EI}$$

$$\Delta_C = \frac{\frac{PL}{2}\cdot\left(\frac{L}{2}\right)^2}{4EI} + \frac{P\left(\frac{L}{2}\right)^3}{6EI}$$

$$= \frac{PL^3}{32EI} + \frac{PL^3}{48EI} = \frac{5PL^3}{96EI}$$

$\therefore$ $$\Delta_B = \Delta_C + \theta_C\cdot\frac{L}{2} + \Delta'_B$$

$$= \frac{5PL^3}{96EI} + \frac{3PL^3}{32EI} + \frac{PL^3}{24EI}$$

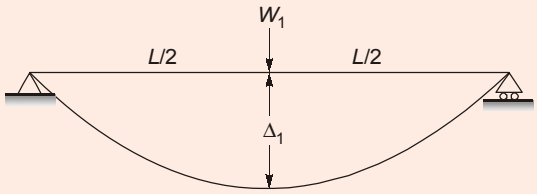
$$= \frac{9PL^3}{48EI}$$

End of Solution

30. A beam of uniform cross-section simply supported at ends carries a concentrated load *W* at midspan. If the ends of the beam are fixed and only load *P* is applied at the midspan such that the deflection at the centre remains the same, the value of the load *P* will be

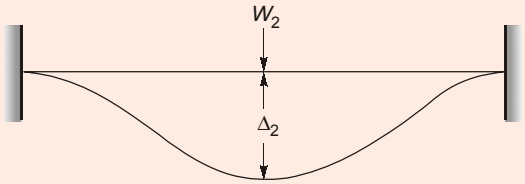
(a) 6 W (b) 4 W
(c) 2 W (d) W

Ans. (b)



$$\Delta_1 = \frac{W_1 L^3}{48EI}$$

For fixed beam



$$\Delta_2 = \frac{W_2 L^3}{192EI}$$

For $\Delta_1 = \Delta_2$

$$\frac{W_1 L^3}{48EI} = \frac{W_2 L^3}{192EI}$$

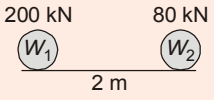
$$\therefore \quad W_2 = 4W_1$$

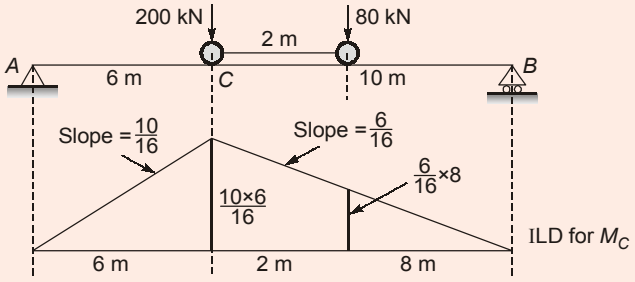
End of Solution

31. Two wheel loads 200 kN and 80 kN spaced at 2 m apart move on the span of girder of 16 m. If any wheel load can lead the other, the maximum bending moment that can occur at a section of 6 m from the left end will be

(a) 1050 kNm (b) 990 kNm
(c) 870 kNm (d) 750 kNm

Ans. (b)





For maximum B.M. at '*C*' place 200 kN at Section-C, and the load of 80 kN should be placed to the right of Section-C because the slope of '*BC*' is less. So ordinate will be more.

$$\therefore \quad M_{max} = \left(200 \times \frac{10 \times 6}{16}\right) + \left(80 \times \frac{6}{16} \times 8\right)$$

$$= 990 \text{ kNm.}$$

End of Solution

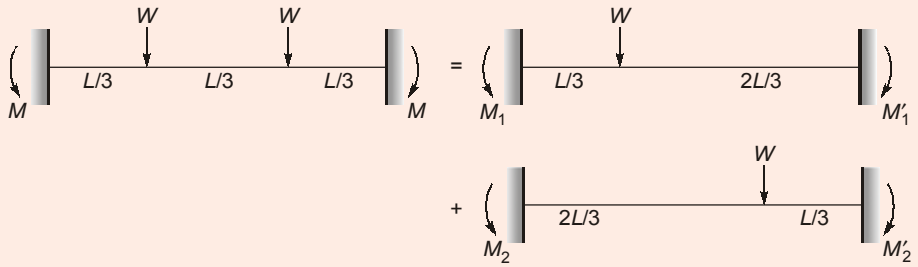
32. A beam of length l is fixed at its both ends and carries two concentrated loads of W each at a distance of $\frac{l}{3}$ from both ends. The fixed end moment at A will be

(a) $\frac{-Wl}{3}$ (b) $\frac{-2Wl}{9}$

(c) $\frac{-6Wl}{15}$ (d) $\frac{-4Wl}{27}$

Ans. **(b)**

Method 1 : By Principle of Superposition

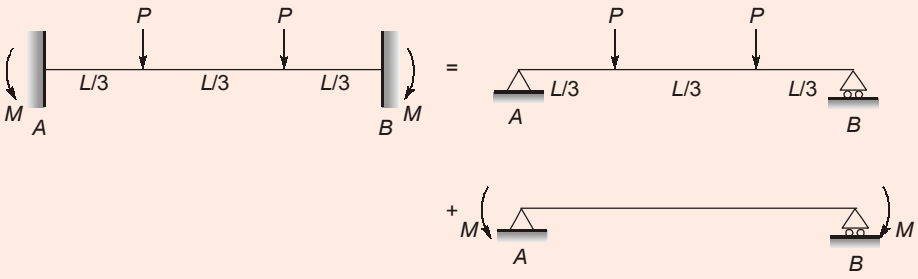


$$M = M_1 + M_2$$

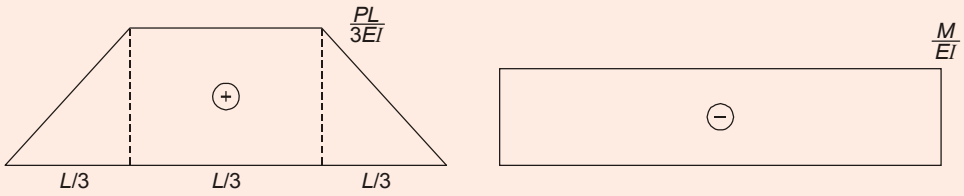
$$= \frac{W\left(\frac{l}{3}\right)\left(\frac{2l}{3}\right)^2}{l^2} + \frac{W\left(\frac{2l}{3}\right)\left(\frac{l}{3}\right)^2}{l^2}$$

$$= W\left[\frac{4l}{27} + \frac{2l}{27}\right] = \frac{2Wl}{9} \text{ (Hogging) or } \frac{-2Wl}{9}$$

Method 2 : By Moment Area Method



Net $\frac{M}{EI}$ diagram by superposition.



From moment area theorem

$$\theta_{AB} = 0$$

$$\Rightarrow \quad = \left\{\frac{1}{2}\times\left(\frac{Pl}{3EI}\right)\times\frac{l}{3}\times 2\right\}+\left\{\left(\frac{Pl}{3EI}\right)\times\frac{l}{3}\right\}-\frac{Ml}{EI}$$

$$\Rightarrow \quad M = \frac{2Pl}{9} \text{ (Hogging) or } \frac{-2Pl}{9}$$

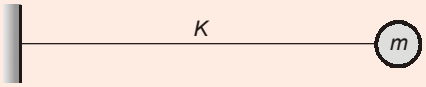
End of Solution

33. The natural frequency of a mass *m* at the end of the cantilever beam of negligible mass with usual notations will be

(a) $\frac{1}{2\pi}\left(\frac{3EI}{mL^3}\right)^{1/2}$ (b) $\frac{1}{\pi}\left(\frac{6EI}{mL^3}\right)^{1/2}$

(c) $\frac{1}{2\pi}\left(\frac{6EI}{mL^3}\right)^{1/2}$ (d) $\frac{1}{2\pi}\left(\frac{3EI}{mL^3}\right)^{1/2}$

Ans. (a)



Stiffness of beam (K) = $\frac{3EI}{L^3}$

Natural frequency (f) = $\frac{1}{2\pi}\sqrt{\frac{K}{m}}$

$= \frac{1}{2\pi}\sqrt{\frac{3EI}{mL^3}}$

End of Solution

34. The simple oscillator under idealized conditions of no-damping, once excited will oscillate indefinitely with constant amplitude at its natural frequency *f* will be

(a) $\frac{1}{2\pi}\sqrt{\frac{m}{k}}$ (b) $\frac{1}{\pi}\sqrt{\frac{k}{m}}$

(c) $\frac{1}{2\pi}\sqrt{\frac{k}{m}}$ (d) $\frac{1}{\pi}\sqrt{\frac{m}{k}}$

Ans. (c)

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$$f = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$$

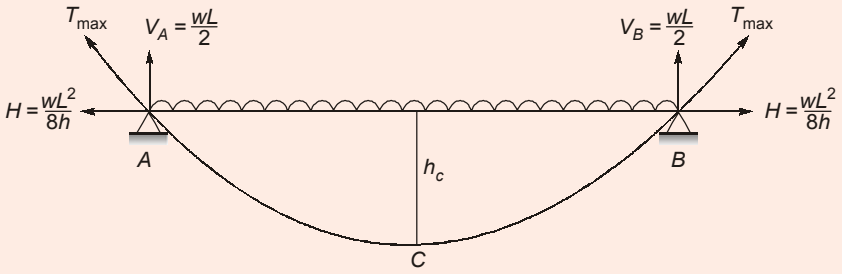
End of Solution

35. A cable carrying a load of 10 kN/m run of horizontal span is stretched between supports of 100 m apart. If the supports are at same level and central dip of 8 m, the ratio of greatest and least tensions in the cable will be

(a) 1.05 (b) 1.35

(c) 1.65 (d) 1.95

Ans. (a)



$$T_{max} \text{ at supports} = \sqrt{\left(\frac{wL}{2}\right)^2 + \left(\frac{wL^2}{8h}\right)^2}$$

$$T_{min} \text{ at mid-span} = H = \frac{wL^2}{8h}$$

$$\therefore \quad \frac{T_{max}}{T_{min}} = \frac{\frac{wL^2}{8h}\left(1+\frac{16h^2}{L^2}\right)^{1/2}}{\frac{wL^2}{8h}}$$

$$\Rightarrow \quad \frac{T_{max}}{T_{min}} = \left(1+\frac{8h^2}{L^2}\right) \qquad \left(\because \frac{h^2}{L^2} << 1\right)$$

$$\therefore \quad \frac{T_{max}}{T_{min}} = \left(1+8\times\frac{8^2}{100^2}\right)$$

$$= 1.0512$$

End of Solution

36. A cable is suspended between two points 75 m apart at the same level. It carries a uniformly distributed load of 12.5 kN per horizontal meter. If the maximum tension in the cable is limited to 1000 kN, the minimum central dip will be nearly

(a) 14 m (b) 12 m

(c) 10 m (d) 8 m

Ans. (c)

$$T_{max} = \sqrt{\left(\frac{wL^2}{8h}\right)^2 + \left(\frac{wL}{2}\right)^2}$$

Neglecting the magnitude of $\frac{wL}{2}$ as compared to $\frac{wL^2}{8h}$.

$$\therefore \quad T_{max} \simeq \frac{wL^2}{8h}$$

$$\frac{wL^2}{8h} \le 1000 \text{ kN}$$

$$\Rightarrow \quad h \ge \frac{12.5 \times 75^2}{8 \times 1000} = 8.789 \text{ m}$$

Take $h = 10$ m

End of Solution

37. A tie bar 50 mm × 8 mm is to carry a load of 80 kN. A specimen of the same quality steel of cross-sectional area is 250 mm^2. For a maximum load of 125 kN carried by the specimen, the factor of safety in the design will be

(a) 3.0 (b) 2.5

(c) 2.0 (d) 1.5

Ans. **(b)**

$$\text{Yield strength of steel} = \frac{\text{Maximum Load}}{\text{Cross-Section Area}}$$

$$= \frac{125 \times 10^3}{250} = 500 \text{ N/mm}^2$$

$$\text{Working stress} = \frac{80 \times 1000}{50 \times 8} = 200 \text{ N/mm}^2$$

$$\text{FOS} = \frac{\text{Yield Strength}}{\text{Working Stress}} = \frac{500}{200} = 2.5$$

End of Solution

38. Hanger connections are made when

(a) Beam as well as girder is meeting at different level. A plate or hanger is interposed between the beam and the girder and finally interconnected by means of angle cleats or bolts and rods.

(b) Beam as well as girder is meeting at same level. A plate is interposed between the beam and the girder.

(c) The beams are meeting at different levels. A hanger is interposed between the beams and finally interconnected by means of angle cleats or bolts and rods.

(d) The girders are meeting at same level. A plate is interposed between the girders and finally interconnected by means of bolts and rods.

Ans. **(a)**

End of Solution

39. The splicing of a column becomes necessary, where
(a) The available length of structural steel section is less than the required length of the column.
(b) Section remains same throughout at all floors.
(c) Only riveted columns are to be designed.
(d) Splices should be designed to carry axial loads only.

Ans. **(a)**

End of Solution

40. A tie bar 50 mm × 8 mm is to carry a load of 80 kN. A specimen of same quality steel of cross-sectional area is 250 mm^2. If the maximum load carried by the specimen is 125 kN, the gauge length will be
(a) 133 mm (b) 126 mm
(c) 113 mm (d) 106 mm

Ans. **(c)**

$$\text{Gauge length} = 5.65\sqrt{A_o}$$

$$= 5.65\sqrt{50 \times 8} = 113 \text{ mm}$$

End of Solution

41. The strength of a column depends on which of the following imperfections?
1. The material being isotropic and homogeneous.
2. Geometric variations of column.
3. Eccentricity of load.

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

Ans. **(b)**

End of Solution

42. Which of the following types of failures occur in the beam-column connections?
1. Failure by lateral-torsional buckling.
2. Failure by combined instability in both the principal directions.
3. Failure by combined twisting and bending on the torsionally weak sections.
4. Failure by combined twisting and bending when plane of bending does not contain the shear centre.

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

Ans. **(b)**

The following categories of combined bending and axial load, along with the likely mode of failure exist
1. Axial compression and bending about one axis; Failure by instability in plane of bending without twisting.

2. Axial compression and bending about the strong axis : Failure by lateral-torsional buckling.
3. Axial compression and biaxial bending (torsionally stiff sections): Failure by instability in one of the principal directions.
4. Axial compression and biaxial bending (thin walled sections) : Failure by combined twisting and bending on these torsionally weak sections.
5. Axial compression, biaxial bending, and torsion: Failure by combined twisting and bending when plane of bending does not contain the shear centre.

End of Solution

43. In a design of beam columns, the values of plastic section ratio $\beta_b = 1$, the plastic sectional modulus $Z_{pz} = 3948812\ mm^3$, the yield stress $f_y = 250\ N/mm^2$ and critical moment of $M_{cr} = 16866 \times 10^6\ N/mm$. The non-dimensional lateral torsional slenderness ratio will be nearly

(a) 0.141 (b) 0.242
(c) 0.323 (d) 0.424

Ans. **(b)**

$$\lambda_{LT} = \sqrt{\frac{\beta_b Z_p f_y}{M_{cr}}}$$

$$= \sqrt{\frac{1 \times 3948812 \times 250}{16866 \times 10^6}}$$

$$= 0.242$$

End of Solution

44. As per Indian Railway Board, the impact factor i (also known as coefficient of dynamic augment, CDA) in steel girders for single track span is

(a) $\left[0.15 + \frac{8}{6+L}\right] \geq 1.0$ (b) $\left[0.75 + \frac{6}{8+L}\right] \geq 1.0$

(c) $\left[0.15 + \frac{6}{8+L}\right] \geq 1.0$ (d) $\left[0.75 + \frac{8}{6+L}\right] \geq 1.0$

where : L is span.

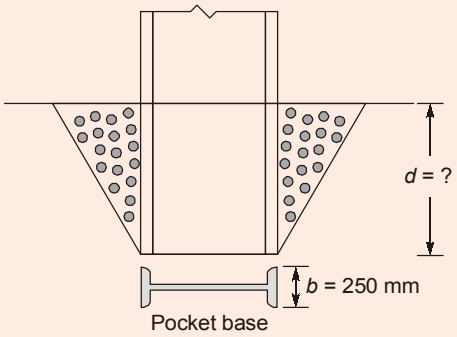
Ans. **(a)**

End of Solution

45. An ISHB 300 with plastic section modulus of $921.68 \times 10^3\ mm^3$, flange width of 250 mm, the yield stress of $250\ N/mm^2$ is embedded in a pocket base to develop its strength with M25 concrete in design of beam-column. The required depth will be nearly

(a) 475 mm (b) 425 mm
(c) 375 mm (d) 325 mm

Ans. **(a)**



For plastic section,

$$\text{Depth, } d = \sqrt{\frac{f_y z_p}{0.164 f_{ck} b}}$$

$$= \sqrt{\frac{250 \times 921.68 \times 10^3}{0.164 \times 25 \times 250}} = 474.1 \simeq 475 \text{ mm}$$

End of Solution

46. In beam-columns or eccentric loaded columns, an elastic critical stress in compression f_{cc} is

(a) $\frac{\pi E}{\lambda}$ (b) $\frac{\pi^2 E}{\lambda^2}$

(c) $\frac{\pi E}{\lambda^2}$ (d) $\frac{\pi^2 E}{\lambda}$

where : E = Modulus of elasticity of steel

λ = Slenderness ratio in the plane of bending

Ans. (b)

$$P_e = \frac{\pi^2 EA}{\lambda^2}$$

$$\sigma_c = \frac{\pi^2 E}{\lambda^2}$$

End of Solution

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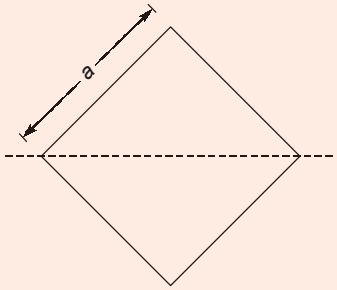
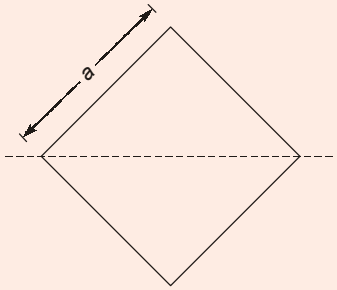
47. A square of side *a* is placed such that its diagonal is horizontal. The shape factor of the square will be



(a) 3.2 (b) 2.0
(c) 1.5 (d) 1.0

Ans. **(b)**



$$\text{Shape factor} = \text{S.F} = \frac{Z_p}{Z_e}$$

$$Z_p = \frac{A}{2}(\bar{y}_1 + \bar{y}_2)$$

$$= \frac{1}{2} \times \frac{a}{\sqrt{2}} \times \sqrt{2}a\left(\frac{a/\sqrt{2}}{3} + \frac{a/\sqrt{2}}{3}\right)$$

$$Z_p = \frac{a^3}{3\sqrt{2}}$$

$$Z_e = \frac{I_{xx}}{y_{max}} = \frac{a^4/12}{a/\sqrt{2}}$$

$$= \frac{a^3}{6\sqrt{2}}$$

$$\text{Shape factor} = \frac{a^3/3\sqrt{2}}{a^3/6\sqrt{2}} = 2$$

End of Solution

48. Which one of the following is the correct assumption made in evaluation of fully plastic moment?

(a) The upper and lower yield stresses and the modulus of elasticity have different values in compression and tension.
(b) The material is homogeneous and isotropic in both the elastic and plastic states.
(c) There will be resultant axial force on the beam.
(d) Some layers of the material are not free to expand and contract longitudinally and laterally under stress.

Ans. (b)

End of Solution

49. As per IS-456 : 2000, cracking of concrete in tension zone cannot be avoided but can be limited by

1. Adhering to the codal requirements of minimum steel area
2. Proper and prolonged curing of concrete
3. Increasing water cement ratio to increase workability

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

Ans. (a)

Increasing water cement ratio will reduce the strength of concrete. This may lead to cracking of concrete on tension side.

End of Solution

50. Which of the following assumptions are made with respect to Euler's theory applied to columns?

1. The section of the column is uniform.
2. The length of the column is very large compared to the lateral dimensions.
3. The direct stress is large when compared with the bending stress.

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

Ans. (d)

The direct stress is small compared to bending stress.

End of Solution

51. A rectangular beam with b = 200 mm and effective depth d = 300 mm is subjected to limit state shear of 80 kN and torsional moment of 6 kNm. The equivalent value of shear will be

(a) 128 kN
(b) 116 kN
(c) 104 kN
(d) 92 kN

Ans. (a)

$$V_{ue} = V_u + \frac{1.6T_u}{B}$$

$$= 80 + \frac{1.6 \times 6}{0.20} = 128 \text{ kN}$$

End of Solution

52. As per IS-456 : 2000, the value of maximum compression strain in concrete in axial compression for limit state of collapse is

(a) 0.001 (b) 0.002

(c) 0.003 (d) 0.004

Ans. **(b)**

As per IS 456 - Pr. No. 39.1 (a) maximum compression strain in axial compression is 0.002.

End of Solution

53. The positive bending moment coefficient at the middle of the end-span of a continuous one way slab is

(a) $\left(\frac{w_l}{10} + \frac{w_d}{12}\right)L^2$ (b) $\left(\frac{w_l}{9} + \frac{w_d}{10}\right)L^2$

(c) $\left(\frac{w_l}{12} + \frac{w_d}{16}\right)L^2$ (d) $\left(\frac{w_l}{9} + \frac{w_d}{12}\right)L^2$

where : w_l = Live load

w_d = Dead load

Ans. **(a)**

As per table 12 | IS 456

$$\text{Coefficient of DL} = \frac{1}{12}$$

$$\text{Coefficient for LL} = \frac{1}{10}$$

At middle of end span

$$\text{So maximum BM} = \left(\frac{W_L}{10} + \frac{Wd}{12}\right)L^2$$

End of Solution

54. Which of the following are the general design requirements of retaining wall?

1. The factor of safety against sliding should be at least 1.5.
2. The factor of safety against over-turning should be at least 2.0.
3. The bearing pressure at toe should be less than the bearing capacity of the soil.
4. The length of retaining wall to be cast in one go should not exceed 10 m otherwise cracks may develop.

(a) 1, 2 and 3 only (b) 1, 3 and 4 only

(c) 1, 2 and 4 only (d) 2, 3 and 4 only

Ans. **(b)**

As per **IS 456:2000 Clause 20.1**

1. Factor of safety against sliding = 1.50.
2. Factor of safety against overturning = 1.5
3. Bearing pressure at toe should be < BC of soil.
4. Length of RW ≯ 10 m in one go.

End of Solution

55. Which of the following are the desirable properties for efficient functioning in design for movement joint of water tank?

1. The joint should accommodate repeated movement of the structure without loss of water-tightness.
2. The design should provide for exclusion of grit and debris which would prevent the closing of the joint.
3. The material used in the construction of movement joints should not slump unduly in hot weather or become brittle in cold weather.

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

Ans. **(a)**

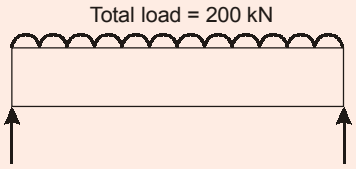
Provision No. 10.2 IS 3370 - Part II/P-6.

End of Solution

56. A simply supported beam having 200 mm width and 450 mm effective depth supports a total uniformly distributed load of 200000 N. The nominal shear stress will be nearly

(a) 0.8 N/mm^2 (b) 1.1 N/mm^2
(c) 1.8 N/mm^2 (d) 2.2 N/mm^2

Ans. **(b)**



$$\text{Maximum shear force} = \frac{wL}{2} = \frac{200}{2}$$

$$V = 100 \text{ kN}$$

$$\text{Nominal shear stress, } \tau_v = \frac{V}{Bd} = \frac{100 \times 1000}{200 \times 450}$$

$$= 1.11 \text{ N/mm}^2$$

End of Solution

57. Which of the following are correct for cover to reinforcement?

1. The reinforcement shall have a minimum clear cover of 20 mm or diameter of such bar whichever is more.
2. At each end of reinforcing bar not less than 25 mm nor less than twice the diameter of such bar.
3. Increased cover thickness may be provided when surface of concrete exposed to the action of harmful chemicals.

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

Ans. **(a)**

As per 4.1/ (a)/ P-29/ SP - 34

End of Solution

58. A beam of size 250 mm width and 460 mm effective depth is subjected to limit state moment of 146 kNm. If M20 grade concrete and Fe415 steel are used, the area of steel required will be

(a) 435 mm^2 (b) 935 mm^2
(c) 1100 mm^2 (d) 1235 mm^2

Ans. **(c)**

$B = 250\,mm$ [M20/Fe415]

$d = 460\ mm$

$M_u = 146\ kN\text{-}m$

$M_{u,lim} = Q.Bd^2$

$= 0.138 \times 20 \times 250 \times \frac{460^2}{10^6}$

$= 146\ kN\text{-}m$ Balanced section

$$A_{st} = \frac{M_u}{0.87 f_y jd} = \frac{146 \times 10^6}{0.87 \times 415 \times 0.80 \times 460}$$

$= 1099\ mm^2$

$= 1100\ mm^2$ (say)

Alternatively,

$$A_{st} = \frac{0.5 f_{ck}}{f_y}\left[1 - \sqrt{1 - \frac{4.6 M_u}{f_{ck} Bd^2}}\right] \times Bd$$

$$= \frac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \frac{4.6 \times 146 \times 10^6}{20 \times 250 \times 460^2}}\right] \times 250 \times 460$$

$= 1096.43\ mm^2$ say $1100\ mm^2$

End of Solution

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59. Air permeability method is used to determine

(a) Soundness of cement (b) Setting time

(c) Fineness of cement (d) Resistance of cement

Ans. **(c)**

Air permeability method is used to find fineness of cement.

End of Solution

60. Which of the following assumptions are correct for the lateral torsional buckling of an I-section beam?

1. The beam is initially distorted.
2. Its behaviour is elastic.
3. It is loaded by equal and opposite end moments in the plane of the web.

(a) 1 and 2 only (b) 2 and 3 only

(c) 1 and 3 only (d) 1, 2 and 3

Ans. **(b)**

End of Solution

61. In an excavation of 3000 cub.mtr of common earth for a canal project, 6 men can be effectively employed on the job. If an output of a man is taken as 100 cub.mtr per day, the duration of excavation activity will be

(a) 5 days (b) 6 days

(c) 7 days (d) 8 days

Ans. **(a)**

$$\text{Duration for excavation} = \frac{3000\ m^3}{6 \times 100\ m^3/day}$$

$$= 5 \text{ days}$$

End of Solution

62. The project plan for construction:

1. Clearly defines project's scope of work. It breaks down project objectives into clear, identifiable, attainable and verifiable goals.
2. Identifies critical activities, thus enabling management of projects by exceptions.
3. Provides the basis for co-ordinating the efforts of clients, consultants, architects, designers, quality surveyors, specialists, suppliers, contractors and project staff.

(a) 1 and 2 only (b) 1, 2 and 3

(c) 1 and 3 only (d) 2 and 3 only

Ans. **(c)**

Planning is the most important phase of project management planning involves defining the objectives of a project, listing of tasks, or jobs that must be performed, determining gross requirement for material, manpower and preparing estimate of costs and durations for various activities to bring about satisfactory completion of project.

End of Solution

63. Which one of the following techniques is not covered in Project Network Analysis?

(a) Critical Path Method
(b) Program Evaluation and Review Techniques
(c) Procedure Network Analysis
(d) Measurement Book

Ans. (d)

End of Solution

64. Which of the following statements are correct for Network Critical Path?

1. The path of critical activities, which links the start and end events is critical path.
2. It is the path of activities having zero float.
3. It is the path of events having zero slack.
4. The sum of the duration of the critical activities along a critical path gives the duration of the project.

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

Ans. (a)

End of Solution

65. Independent float is an amount of time by which the start of an activity may be delayed without affecting

1. the preceding or the following activity.
2. the start of a following activity.
3. the completion of the project.

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

Ans. (d)

Independent float gives the idea about excess time that exist if the preceeding activity completed as late as possible and the succeeding activity start as early as possible.

End of Solution

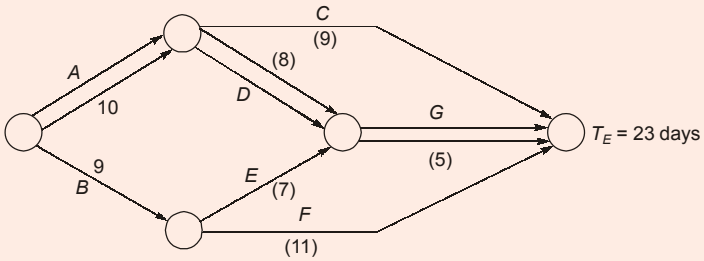
66. Consider the following activity for the total project:

Activity	Immediate Predecessors	Duration (Days)
A	–	10
B	–	9
C	A	9
D	A	8
E	B	7
F	B	11
G	D, E	5

The total project duration for the critical path will be

(a) 25 days
(b) 23 days
(c) 21 days
(d) 19 days

Ans. **(b)**



Critical path is = A – D – G and project duration = 23 days

End of Solution

67. By performing which of the following functions the construction manager can achieve the project goals?

1. Envisioning the task ahead.
2. Setting targets and monitoring performance.
3. Motivating the work force.
4. Building the line supervisors team.

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

Ans. **(d)**

End of Solution

68. The cost of the machine is ₹20,00,000 and if it is purchased under installment basis; the company has to pay 25% of the cost at the time of purchase and the remaining amount in 10 annual equal installments of ₹2,50,000 each. If rate of interest is 18%, compounded annually the present worth of the machine will be

(a) ₹17,01,000 (b) ₹16,22,500
(c) ₹15,43,000 (d) ₹14,64,500

Ans. **(b)**

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

$$= 250000\left[\frac{(1+0.18)^{10} - 1}{0.18(1.18)^{10}}\right] = ₹1123521$$

Now initially payment = 25% of 2000000 = ₹500000

∴ Present worth of machine = 500000 + 1123521 = ₹1623521

End of Solution

69. Which of the following relations are correct for determining different components of a bid price?

1. Bid price = Direct cost + Indirect cost + Mark up amount
2. Direct cost = Project overheads + Common plant and equipment cost + Common work men cost
3. Mark up amount = Profit + Contingency + Allowances for risks + General overheads

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

Ans. (c)

Project overhead is indirect cost.

End of Solution

70. Resources smoothing is

(a) An optimization and economical utilization of resources.
(b) An adjustment of resources without affecting project duration.
(c) A gradual increase in resources.
(d) A gradual decrease in resources.

Ans. (b)

End of Solution

71. In PERT technique, the time estimate of activities and probability of their occurrence follow

(a) Binomial distribution (b) Normal distribution
(c) Poisson distribution (d) β-distribution

Ans. (d)

All activities will follow β-distribution of frequency and project as a whole is assumed to follow normal distribution of frequency according to central limit theorem.

End of Solution

72. Indirect cost due to accidents includes

(a) Legal charges
(b) Medical expenses for the injured
(c) Compensation amount to the injured
(d) Over time payment to make up the loss of time

Ans. (b)

End of Solution

73. An oil of specific gravity 0.9 contained in a vessel. At a point the height of oil is 40 m and for the density of water = 1000 kg/m^3, the corresponding height of water at the point will be

(a) 28 m (b) 32 m
(c) 36 m (d) 40 m

Ans. (c)

Pressure due to oil column height = Pressure due to water column height

$$(900)g \cdot 40 = (1000)gh$$

$$h = 36 \text{ m of water column}$$

End of Solution

74. When speed changes in case of centrifugal pump, which of the following points are correct?

1. The shape of the velocity triangle will remain same.
2. Various angles will remain same.
3. Magnitude of velocities will change proportionately.

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

Ans. (d)

End of Solution

75. Which one of the following is the use of flow net analysis in fluid mechanics?

(a) To determine the streamlines and equipotential lines.
(b) To determine, downward lift pressure above hydraulic structure.
(c) To determine the viscosity for given boundaries of flow.
(d) To design the hydraulic structure.

Ans. (d)

End of Solution

76. A jet propelled aircraft is flying at a speed of 1100 km/hour at $t = 20°C$, $k = 1.4$ and $R = 287$ J/kgK. The Mach number at a point on the jet will be nearly

(a) 0.3 (b) 0.5
(c) 0.7 (d) 0.9

Ans. (d)

For adiabatic process

$$K = \gamma P$$

$$C = \sqrt{\frac{K}{\rho}}, \qquad P = \rho RT$$

$$= \sqrt{\gamma RT}$$

$$= \sqrt{1.4(287)(273+20)}$$

$$= 343.114 \text{ m/s}$$

$$M_a = \frac{V}{C} = \frac{1100 \times \frac{5}{18}}{343.114}$$

$$= 0.89$$

End of Solution

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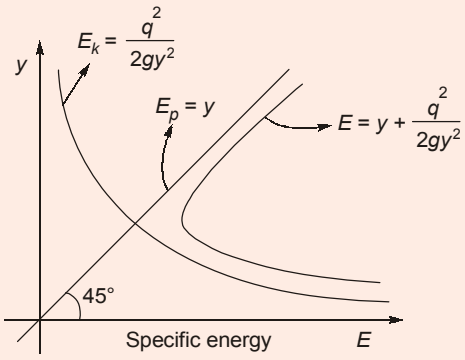
77. When the drag force becomes equal to the weight of the body, the acceleration ceases and the net external force acting in the body becomes.
(a) Zero and the body will move at constant speed.
(b) Light and the body will move forward
(c) Zero and the body will move fast.
(d) High and the body will move at constant speed.

Ans. (a)

End of Solution

78. Which one of the following statements is correct regarding flow in open channel?
(a) The curve for kinetic energy is a parabola
(b) The curve for potential energy is a parabola
(c) Specific energy is asymptotic to the vertical axis
(d) At critical depth the specific energy is maximum

Ans. (a)



Consider a rectangular channel,

$$\text{Specific energy } (E) = y + \frac{q^2}{2gy^2} \qquad \ldots q = \text{Discharge per unit width}$$

$$E = E_p + E_k$$

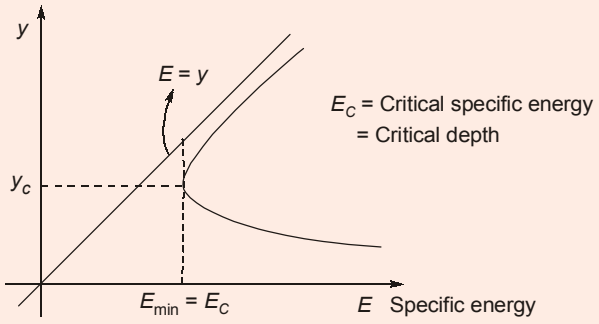
$\therefore$ The curve of kinetic energy $\left(E_k = \frac{q^2}{2gy^2}\right)$ is parabolic while the curve of potential energy ($E_p = y$) is a straight line making an angle 45°.
Specific energy curve is asymptotic to $E_p = y$ line and horizontal axis (E-axis).

End of Solution

79. Which one of the following statement is correct regarding critical state of flow through a channel section?
(a) Specific energy is a minimum for a given discharge
(b) Specific energy is a maximum for a given discharge
(c) The Froude number is greater than two
(d) The discharge is a minimum for a given specific force

Ans. (a)

For a given discharge specific energy is minimum when the flow is critical.



End of Solution

80. Which one of the following statement is correct regarding centrifugal pumps?

(a) The discharge is fluctuating and pulsating

(b) It is used for large discharge through smaller heads

(c) The efficiency is low

(d) It runs at low speed

Ans. (b)

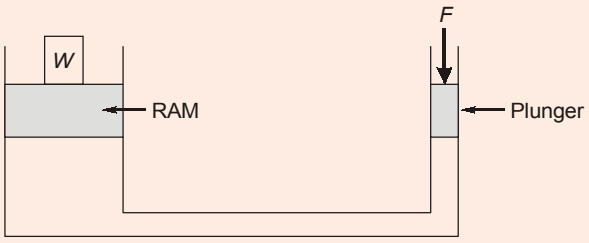
End of Solution

81. A hydraulic press has a ram of 300 mm diameter and a plunger of 45 mm diameter. When the force applied at the plunger is 50 N, the weight lifted by the hydraulic press will be nearly

(a) 2133 N (b) 2223 N

(c) 2316 N (d) 2406 N

Ans. (b)



According to Pascal law,

$$\frac{W}{A} = \frac{F}{a} \quad ; \quad A = \text{Area of Ram, } a = \text{Area of plunger}$$

$$\frac{W}{\frac{\pi}{4}\times(0.3)^2} = \frac{50}{\frac{\pi}{4}\times(0.045)^2}$$

$$W = 2222.22 \text{ N}$$

End of Solution

82. Hydraulic efficiency of Francis turbine is

(a) Directly proportional to velocity of whirl at inlet and inversely proportional to net head on turbine.

(b) Directly proportional to velocity of whirl at inlet and net head on turbine.

(c) Inversely proportional to velocity at inlet and net head on turbine.

(d) Inversely proportional to velocity of whirl at inlet and directly proportional to net head on turbine.

Ans. (a)

End of Solution

83. A turbine develops 7225 kW power under a head of 25 m at 135 rpm. The specific speed of the turbine will be nearly

(a) 245 rpm (b) 225 rpm

(c) 205 rpm (d) 185 rpm

Ans. (c)

$$N_s = \frac{N\sqrt{P}}{H^{5/4}}$$

$$= \frac{135\sqrt{7225}}{(25)^{5/4}} = 205.27 \text{ (SI units)}$$

End of Solution

84. Which one of the following is an example of bodies where both drag and lift forces are produced?

(a) Hydrofiles (b) A tall chimney exposed to wind

(c) Flow of water past a bridge pier (d) Motion of aeroplanes, submarines, torpedoes

Ans. (d)

End of Solution

85. The relative humidity h is a measure of air's capacity, at its existing temperature, to absorb further moisture, and is defined by the relation

(a) $\frac{e}{e_s} \times 100$ (b) $\frac{e_s}{e} \times 100$

(c) $\frac{2e_s}{e} \times 100$ (d) $\frac{2e}{e_s} \times 100$

Where: e = Vapour pressure, e_s = Saturation vapour pressure

Ans. (a)

$$\text{Relatively humidity} = \frac{e_a}{e_s} \times 100 \text{ or } \frac{e}{e_s} \times 100$$

Here, e or e_a = Actual vapour pressure of air in mm of Hg

e_s = Saturation vapour pressure of air in mm of Hg

End of Solution

86. Which one of the following is not a major deterrent in water harvesting through water tanks?
(a) Deforestation mainly due to population pressure in the catchments of tank systems
(b) Siltation
(c) Lack of maintenance and repairs and breaches of tank embankments
(d) Shallow depth of water tanks

Ans. (d)

End of Solution

87. Which one of the following is not a basic requirement for any well screen?
(a) Resistance to corrosion, incrustation and deterioration
(b) Enough structural strength to prevent collapse
(c) Suitability for excessive movement of sand into the well
(d) Minimum resistance to flow of water into the well

Ans. (c)

End of Solution

88. Which one of the following methods is not the category of Geophysical methods of sub-surface investigation?
(a) Electrical resistivity method
(b) Electric logging
(c) Gamma-ray logging
(d) Electrical response surveying

Ans. (d)

- Electric resistivity method : It is based on the difference in the electrical conductivity or the electrical resistivity of different soil.
- Electric logging : This technique can be used in geotechnical investigations to assess the variation with depth of geologic materials and associated fluids.
- Gamma-Ray logging : This is a method of measuring naturally occurring gamma radiation to characterize the rock or sediment in a borehole or drill hole.

End of Solution

89. In which one of the following industries, the water requirement in kilo litres per unit of production is very high?
(a) Paper industry
(b) Steel industry
(c) Sugar industry
(d) Fertilizer industry

Ans. (a)

End of Solution

90. In drip irrigation system, which one of the following emitters is not based on definitions by American Society of Agricultural Engineers (ASAE)?
(a) Emitter
(b) Pulsating emitter
(c) Long path emitter
(d) Multi-outlet emitter

Ans. (b)

End of Solution

91. A Persian wheel with an average discharge of 230 litre/minute irrigates 1 hectare wheat crop in 50 hours. The average depth of irrigation will be nearly

(a) 4 cm (b) 5 cm
(c) 6 cm (d) 7 cm

Ans. **(d)**

$$\text{Volume supplied} = \text{Discharge} \times \text{Time}$$

$$V = 230\,\frac{l}{\text{min}} \times 50\ \text{hr}$$

$$= \frac{230 \times 10^{-3}\text{m}^3 \times 50 \times 60\ \text{min}}{\text{min}}$$

$$= 690\ \text{m}^3$$

$$\text{Area irrigated} = 1\ \text{ha}$$

$$A = 10^4\ \text{m}^2$$

$$\text{Depth of irrigation} = \frac{\text{Volume}}{\text{Area}}$$

$$= \frac{690}{10000}\ \text{m}$$

$$= 0.069\ \text{m}$$

$$= 6.9\ \text{cm} \simeq 7\ \text{cm}$$

End of Solution

92. Which one of the following is not the main cause for soil salinity and sodicity?

(a) Irrigation mismanagement
(b) Poor land levelling
(c) Use of heavy machinery, resulting in no soil compaction
(d) Leaching without adequate drainage

Ans. **(c)**

Heavy machinery usage will result only in the change in physical properties of soil but there will not be any change in chemical properties so salt concentration of soil will remain unaffected.

End of Solution

93. Which one of the following is not the major factor influencing seepage from a canal?

(a) Characteristics of the soil traversed by the canal system
(b) Area wetted by the canal
(c) Location of the canal
(d) Frequencies of canal usage

Ans. **(a)**

End of Solution

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94. Which of the following are the causes of failure of weirs?
1. Rupture of floor due to uplift.
2. Rupture of floor due to suction caused by standing wave.
3. Scour on the upstream and downstream of the weir.

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

Ans. (c)

Rupture of floor due to uplift:
If the weight of floor is insufficient to resist the uplift pressure, the floor may burst and fail due to rupture.
Rupture of floor due to suction caused by standard wave.
The standing wave or hydraulic jump formed at the d/s of the weir causes suction which also acts in the direction of uplift pressure. If floor thickness is insufficient then it may fail due to rupture.
Scour on the upstream and downstream of the weir.
If the natural water way of a river is contracted, the water may scour the bed both at upstream and downstream of the structure. The scour holes so formed may progress towards the structure causing its failure.

End of Solution

95. Which of the following are the principal factors influencing the choice of a particular method of lining?
1. Availability and cost of the material at the site or within easy reach.
2. Velocity of flow in the channel.
3. Cost of maintenance.

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

Ans. (c)

That type of lining is preferred for which material required is easily available within small distance.
If alignment of area if such that slope is very high then velocity of canal will also be high hence in such core stronger material for lining such or concrete lining should be used.
To have better benefit - cost ratio that type of lining should be used in which cost of maintenance is less.

End of Solution

96. Which of the following are the objectives for river training?
1. High flood discharge may pass safely and quickly through the reach.
2. To make the river course stable and reduce bank erosion to minimum.
3. To check flow through canal.
4. To provide a sufficient draft for navigation as well as good course for it.

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

Ans. (c)

Objectives of river training are high water training : So that high flood discharge may pass safely.

Mean water training : To have efficient disposal of sediments.

Low water training : To provide sufficient depth of navigation during low weather season.

To reduce bank erosion and make the river course stable.

End of Solution

97. The transition region between unsaturated zone and saturated zone is called

(a) Capillary fringe
(b) Water table
(c) Yadose water zone
(d) Confining bed

Ans. (a)

Between the unsaturated zone and the saturated zone (water table), transition zone is present called as the capillary fringe.

In this zone the voids are saturated or almost saturated with water that is held in place by capillary forces.

End of Solution

98. Which of the following chemical parameters are associated with the organic content of water?

1. Biological Oxygen Demand (BOD).
2. Chemical Oxygen Demand (COD).
3. Total Organic Carbon (TOC) and Total Oxygen Demand (TOD).

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

Ans. (d)*

* BOD stands for biochemical oxygen demand not biological oxygen demand.

End of Solution

99. When chlorine is dissolved in water, it reacts to form hypochlorous acid and hypochlorite ions. At pH < 5, chlorine exists in water as

(a) Elemental or molecular chlorine
(b) Remains in the form of hypochlorous acid
(c) Remains in the form of hypochlorite ions
(d) Remains in the form of both hypochlorous acid and hypochlorite ions

Ans. (a)

End of Solution

100. Reactive substances are

(a) Unstable under normal conditions. They can cause explosions and/or liberate toxic fumes, gases, and vapors when mixed with water.
(b) Easily ignited and burn vigorously and persistently.

(c) Liquids with pH less than 2 or greater than 12.5, the those that are capable of corroding metal containers.
(d) Harmful or fatal when ingested or absorbed.

Ans. (a)

Reactive substance are solids, liquids or gaseous substances, mixture of substances, as well as substances that occur in combinations of such state, which upon contact with water, at their pressure, temperature or other chemical properties represent a risk of dangerous reaction explosion or emission of dangerous gas, vapour, dust or mist.

End of Solution

101. The noise value of sound waves depends upon:
1. The frequency of sound waves.
2. The intensity of sound waves.
3. The time of exposure of sound waves.

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

Ans. (a)

End of Solution

102. Which one of the following type of treatments will be used for neutralization of alkaline effluent?

(a) Lime stone treatment
(b) Caustic lime treatment
(c) Carbon dioxide treatment
(d) Hydrochloric acid treatment

Ans. (d)

End of Solution

103. Flocculation is the process of
(a) Gently mixing the water and coagulant allowing the formation of large particles of floc.
(b) Removing relatively large floating and suspended debris.
(c) Flow, which is slowed enough so that gravity will cause the floc to settle.
(d) Mixture of solids and liquids collected from the settling tank are dewatered and disposed of.

Ans. (a)

Flocculation in a process of contact and cohesion whereby the particles of a dispersion form larger size clusters in the pressure of coagulants.

End of Solution

104. In solid waste management, waste utilization is achieved by
(a) Recover, Reclamation and Reproduce
(b) Reuse, Reclamation and Recycling
(c) Recover, Recycling and Reproduce
(d) Reuse, Reproduce and Recycling

Ans. (*)

3R's stands for Reduce, Reuse and Recycle. None of the option is matching.

End of Solution

105. The frequency range for hearing the sound by a human ear is in the range of

(a) 20 Hz - 200 kHz
(b) 10 Hz - 20 kHz
(c) 20 Hz - 20 kHz
(d) 10 Hz - 20 Hz

Ans. (c)

End of Solution

106. Physiological response accompanying response and other noise exposures include:

1. A vascular response characteristic by peripheral vasoconstriction, changes in heart beat rate and blood pressure.
2. Various glandular charges such as increased output of adrenaline evidenced by chemical changes in blood.
3. Slow, deep breathing.

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

Ans. (d)

Physiological response accompanying response and other noise exposures include:

1. A vascular response characteristic by peripheral vasoconstriction, changes in heart beat rate and blood pressure.
2. Various glandular charges such as increased output of adrenaline evidenced by chemical changes in blood.
3. Slow, deep breathing.
4. A change in the electrical resistance of skin with changes in activity of sweat glands.

End of Solution

107. Electrostatic precipitators are used for removal of

1. Gaseous contaminants
2. Liquid contaminants
3. Particulate contaminants

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

Ans. (c)

End of Solution

108. Which one of the following type of ecology is dealt with autecology?

(a) Synecology
(b) Community ecology
(c) Ecosystem ecology
(d) Individual species ecology

Ans. (d)

End of Solution

109. A soil sample has porosity of 40%, and the specific gravity of solids is 2.70. If the soil is 50% saturated, the unit weight will be nearly

(a) 22 kN/m^3 (b) 20 kN/m^3

(c) 18 kN/m^3 (d) 16 kN/m^3

Ans. **(c)**

$$\text{Bulk unit weight, } \gamma_b = \frac{(G+Se)\gamma_w}{1+e}$$

$$\text{Void ratio, } e = \frac{n}{1-n} = \frac{0.4}{1-0.4} = \frac{2}{3}$$

$$\therefore \quad \gamma = \left\{\frac{2.7+0.5\times\frac{2}{3}}{1+\frac{2}{3}}\right\}9.81$$

$$= 17.85 \text{ kN/m}^3$$

End of Solution

110. Oven dry mass of a pat of clay is 10.8 gm and mass of mercury displaced on immersion is 84.2 gm. If the specific gravity of solids is 2.72 and the density of the mercury is 13.6 g/cm^3, the shrinkage limit of the soil will be nearly

(a) 12% (b) 15%

(c) 18% (d) 21%

Ans. **(d)**

Dry mass of clay = 10.8 gm

Volume of mercury displaced = Total volume of soil mass

$$= \frac{\text{Mass of mercury}}{\text{Unit weight of mercury}}$$

$$= \frac{84.2}{13.6} = 6.1911 \text{ cc}$$

Dry unit weight of soil,

$$\rho_d = \frac{M_{dry}}{V_T} = \frac{10.8}{6.1911} = 1.744$$

$$\text{Shrinkage ratio, } R = \frac{\rho_d}{\rho_w} = \frac{1.744}{1} = 1.744$$

$$\text{Shrinkage limit, } w_s = \frac{1}{R} - \frac{1}{G}$$

$$w_s = \frac{1}{1.744} - \frac{1}{2.72} = 0.2056$$

$$= 20.56\%$$

Alternatively

Weight of solids (W_s) = 10.8 gm

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3 AIR Rohit Khanna

4 AIR Garima Gupta

5 AIR Ayush Jham

6 AIR Raj Hemant Z.

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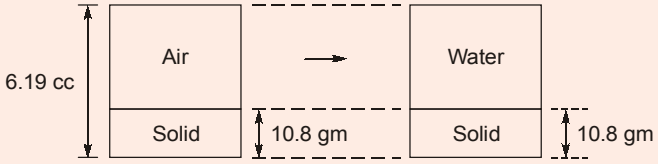
$G_s = 2.72$

Density of mercury (ρ_m) = 13.6 g/cc

Volume of mercury displaced (V) = $\frac{84.2}{13.6}$ = 6.19 cc

$\therefore$ Volume of soil = V = 6.19 cc



at shrinkage limit soil is just saturated

$\therefore$ Volume of water = Volume of void in dry state

$$= 6.19 - \frac{10.8}{2.72} = 2.22 \text{ cc}$$

So, shrinkage limit (w_s) = $\frac{W_w}{W_s} = \frac{2.22 \times 1}{10.8} \times 100\%$

$$= 20.55\% \simeq 21\%$$

End of Solution

111. The suitability number of a backfill for D_{50} = 1 mm, D_{20} = 0.5 mm and D_{10} = 0.08 mm will be nearly

(a) 16 (b) 18

(c) 20 (d) 22

Ans. (d)

$$\text{Suitability Number} = 1.7\sqrt{\frac{3}{(D_{50})^2} + \frac{3}{(D_{20})^2} + \frac{1}{(D_{10})^2}}$$

$$= 1.7\sqrt{\frac{3}{(1)^2} + \frac{3}{(0.5)^2} + \frac{1}{(0.08)^2}}$$

$$= 21.72$$

End of Solution

112. The porosity of a soil n is

(a) $\frac{e}{1+e}$ (b) $\frac{e}{1-e}$

(c) $\frac{e+1}{e}$ (d) $\frac{e-1}{e}$

Where e = void ratio

Ans. **(a)**

$$n = \frac{e}{1+e}$$

$$n = \frac{V_V}{V} = \frac{\frac{V_V}{V_S}}{\frac{(V_S + V_S)}{V_S}} \quad \ldots\ldots \left(e = \frac{V_V}{V_S}\right)$$

$$n = \frac{e}{1+e} \text{ proved}$$

End of Solution

113. A coarse-grained soil has a void ratio of 0.78 and specific gravity as 2.67. The critical gradient at which a quick sand condition occurs will be

(a) 0.62 (b) 0.74

(c) 0.82 (d) 0.94

Ans. **(d)**

Critical hydraulic gradient,

$$i_c = \frac{G-1}{1+e} = \frac{2.67-1}{1+0.78}$$

$$= 0.938$$

End of Solution

114. Which of the following assumptions of the Rankine theory of lateral earth pressure are correct?

1. The soil mass is semi-infinite, homogeneous, dry and cohesionless.
2. The ground surface is a plane which may be horizontal or inclined.
3. The wall yields about the base and thus satisfies the deformation condition for plastic equilibrium.

(a) 1 and 2 only (b) 1 and 3 only

(c) 1, 2 and 3 (d) 2 and 3 only

Ans. **(c)**

End of Solution

115. The ratio of the horizontal stress to the vertical stress is called coefficient of

(a) Active earth pressure (b) Passive earth pressure

(c) Earth pressure (d) Plastic earth pressure

Ans. **(c)**

$$\frac{\text{Horizontal stress}}{\text{Vertical stress}} = \frac{\sigma_h}{\sigma v} = K$$

K = Earth pressure coefficient.

End of Solution

116. A bed consists of compressible clay of 4 m thickness with pervious sand on top and impervious rock at the bottom. In a consolidation test on an undisturbed specimen of clay from this deposit 90% settlement was reached in 4 hours. The specimen was 20 mm thick. The time for the building founded over this deposit to reach 90% of its final settlement will be

(a) 91 years (b) 82 years
(c) 73 years (d) 64 years

Ans. **(c)**

By taking single drainage in field slab,

In lab, $(T_V)_{90} = C_V \frac{t}{d^2}$

$$\frac{(T_V)_{90}}{C_V} = \frac{4 \text{ hrs}}{\left(20 \times 10^{-3}\right)^2}$$

In field, $(T_V)_{90} = C_V \frac{t}{d^2}$

$$t = \frac{(T_V)_{90}}{C_V} \times d^2 = \frac{4}{\left(20 \times 10^{-3}\right)^2} \times 4^2$$

$$t = 18.26 \text{ years}$$

Note : Answer is not matching, hence try assuming double drainage in laboratory.

In lab, $(T_V)_{90} = C_V \frac{t}{d^2} = C_V \times \frac{4 \text{ hrs}}{\left(10 \times 10^{-3}\right)^2}$

In field, $(T_V)_{90} = C_V \frac{t}{(4\text{m})^2}$

$$t = \frac{(T_V)_{90}}{C_V} \times (4 \text{ m})^2 = \frac{4}{\left(10 \times 10^{-3}\right)^2} \times 4^2$$

$$= 73.059 \text{ years}$$

Alternatively,

$$t \propto H^2$$

$$\frac{t_{field}}{t_{lab}} = \left(\frac{H_{field}}{H_{lab}}\right)^2$$

$$H_{lab} = \frac{20}{2} = 10 \text{ mm}$$

$$\therefore \quad t_{field} = \left(\frac{4 \times 10^3}{10}\right)^2 \times \frac{4}{24 \times 365} = 73 \text{ years}$$

End of Solution

117. A 30 cm square bearing plate settles by 8 mm in the plate load test on cohesionless soil when the intensity of loading is 180 kN/m^2. The settlement of a shallow foundation of 1.5 m square under the same intensity of loading will be nearly

(a) 30 mm (b) 26 mm
(c) 22 mm (d) 18 mm

Ans. **(c)**

$$B_f = 1.5 \text{ m. } B_P = 0.3 \text{ m, } S_P = 8 \text{ mm}$$

For cohesionless soil,

$$\frac{S_f}{S_p} = \left\{\frac{B_f(B_P + 0.3)}{B_P(B_f + 0.3)}\right\}^2$$

$$S_f = 8\left\{\frac{1.5(0.3+0.3)}{0.3(1.5+0.3)}\right\}^2$$

$$= 22.22 \text{ mm}$$

End of Solution

118. When the observed value of N exceeds 15, the corrected penetration number N_c as per Terzaghi and Peck recommendation in the silty fine sands will be

(a) $15 - \frac{1}{2}(N_R - 15)$ (b) $15 - \frac{1}{2}(N_R + 15)$
(c) $15 + \frac{1}{2}(N_R - 15)$ (d) $15 + \frac{1}{2}(N_R + 15)$

where : N = Penetration number, and
N_R = Recorded value

Ans. **(c)**

End of Solution

119. A canal of 4 m deep has side slopes of 1 : 1. The properties of the soil are c = 15 kN/m^2, $\phi = 15°$, $e = 0.76$ and $G = 2.7$. Taylor's stability number for that sudden drawdown = 0.136. The factor of safety with respect to cohesion in the case of sudden drawdown will be

(a) 0.64 (b) 1.43
(c) 2.22 (d) 3.01

Ans. **(b)**

In case of sudden drawdown γ_{sat} should be used in stability No.

$$\gamma_{sat} = \left(\frac{G+e}{1+e}\right)\gamma_w = \left(\frac{2.7+0.76}{1+0.76}\right)9.81$$

$$= 19.28 \text{ kN/m}^2$$

$$s_n = \frac{C}{\gamma H_c} = \frac{C}{\gamma_{sat}(\text{FOS})H}$$

$$0.136 = \frac{15}{19.28(FOS)4}$$
$$FOS = 1.43$$

End of Solution

120. The stability or shear strength of fine grained soils can be increased by draining them with the passage of direct current through them. This process is known as
(a) Electro-osmosis (b) Zeta potential
(c) Electro-chemical hardening (d) Consolidation

Ans. **(a)**
Electro-osmosis is a method of drainage of cohesive soil in which a direct current (DC) is passed through a saturated soil between a positive electrode (anode) and a negative electrode (cathode), as a result pore water migrates to cathode.
The cathode is a well point which collects the water drained from the soil.
As the water is drained out, the consolidation process can be upto a hundred times faster rate than mechanical consolidation that is why substantial improvement in the shear strength of soil is achieved quickly.

End of Solution

121. The combined correction for curvature and refraction for a distance of 3400 m will be nearly
(a) 0.2 m (b) 0.4 m
(c) 0.6 m (d) 0.8 m

Ans. **(d)**
$$\text{Combined correction (C)} = -0.06735d^2$$
$$= -0.0673 \times 3.4^2$$
$$= 0.77798 \text{ m}$$
$$\approx 0.8 \text{ m}$$

End of Solution

122. A 100 m tape is suspended between the ends under a pull of 200 N. If the weight of the tape is 30 N, the correct distance between the tape ends will be nearly
(a) 100.5 m (b) 100.3 m
(c) 100.1 m (d) 99.9 m

Ans. **(d)**
$$\text{Sag correction } (C_s) = \frac{w^2 l}{24P_m^2}$$
$$C_s = \frac{30^2 \times 100}{24 \times 200^2}$$
$$= \frac{30 \times 30 \times 100}{24 \times 200 \times 200}$$

$$= \frac{9}{24\times2\times2} = \frac{9}{48\times2} = 0.09375 \approx 0.1 \text{ (negative)}$$

Measured length of tape = 100 m

Correct length of tape = 100 – 0.1

= 99.9 m

End of Solution

123. In horizontal distance measurement, the basic formula for distance in stadia tacheometry has an additive constant. An anallatic lens is inserted in the tacheometer to make this additive constant zero. This lens is

(a) Convex lens inserted between object glass and diaphragm.

(b) Plano-convex lens between object glass and diaphragm.

(c) Plano-convex lens between diaphragm and eye piece.

(d) convex lens inserted between diaphragm and eye piece.

Ans. **(a)**

End of Solution

124. If the LMT is $8^h\ 12^m\ 16^s$ AM at 38° 45′ W longitude, the GMT will be

(a) $11^h\ 12^m\ 16^s$ AM (b) $10^h\ 47^m\ 16^s$ AM

(c) $9^h\ 29^m\ 46^s$ AM (d) $5^h\ 29^m\ 46^s$ AM

Ans. **(b)**

Local mean time at 38°45′W

= 8 hour 12 minute 16 seconds

Difference of degree from GMT (0°) longitude

= 38° 43′

Time difference = 38 × 4 minute + 45 × 4 seconds

= 152 min. + 3 min. = 155 min.

= 2 hr. 35 min.

Time at GMT = LMT + Time difference

= 8 hr. 12 min. 16 sec. + 2 hr. 35 min.

= 10 hr. 47 min. 16 sec.

End of Solution

125. A section line *AB* appears to be 10.16 cm on a photograph for which the focal length is 16 cm. The corresponding line measures 2.54 cm on a map, which is to a scale $\frac{1}{50{,}000}$. The terrain has an average elevation of 200 m above mean sea level. The flying altitude of the aircraft above mean sea level during photograph will be

(a) 1800 m (b) 2000 m

(c) 2200 m (d) 2400 m

Ans. **(c)**

Length of a line on a map

= 2.54 cm

$$\text{Scale} = \frac{1}{50{,}000}$$

Actual length on ground

$$= 50{,}000 \times 2.54 \text{ cm}$$

Length of same line on photo

$$= 10.16 \text{ cm}$$

then, $$\text{Scale of photo} = \frac{10.16}{50{,}000 \times 2.54}$$

$$= \frac{4}{50{,}000} = \frac{1}{12500}$$

$$\text{Scale of photo} = \frac{f}{H-h}$$

$$\frac{16 \times 10^{-2}}{H-200} = \frac{1}{12500}$$

$$\Rightarrow \quad 16 \times 10^{-2} \times 12500 = H - 200$$

$$\Rightarrow \quad 16 \times 125 + 200 = H$$

$$\Rightarrow \quad 2000 + 200 = H$$

$$\text{Scale of photo} = \frac{f}{H-h}$$

$$\frac{16 \times 10^{-2}}{H-200} = \frac{1}{12500}$$

$$\Rightarrow \quad 16 \times 10^{-2} \times 12500 = H - 200$$

$$\Rightarrow \quad 16 \times 125 + 200 = H$$

$$\Rightarrow \quad 2000 + 200 = H$$

$$\Rightarrow \quad H = 2200$$

End of Solution

126. If backsight and foresight distances are balanced

1. The difference in elevation between two points can be directly calculated by taking difference of the two readings.
2. No corrections for the inclination of the line of sight is necessary.

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

Ans. **(c)**

Due to balancing of sight, error due to non-parallism of sight is eliminated.

End of Solution

127. A railway curve of 1350 m radius is to be set out to connect two tangents. If the design speed is 110 kmph and the rate of change of acceleration is 0.3 m/s^3, the shift of the circular curve will be nearly

(a) 0.18 m (b) 0.16 m
(c) 0.14 m (d) 0.12 m

Ans. **(b)**

$$R = 1350 \text{ m}$$
$$V = 110 \text{ kmph}$$
$$L_T = \frac{V^3}{CR} = \left(\frac{110^3 \times \frac{5^3}{18^3}}{0.3 \times 1350} \right) = 70.41 \text{ m}$$
$$\text{Shift} = \frac{LT^2}{2MR}$$
$$= \frac{70.41^2}{24 \times 1300} = 0.159 \approx 0.16 \text{ m}$$

End of Solution

128. A theodolite is called a transit theodolite, when its telescope can be revolved thrugh a complete revolution about its

(a) Vertical axis in an inclined plane (b) Horizontal axis in an inclined plane
(c) Vertical axis in a horizontal plane (d) Horizontal axis in a vertical plane

Ans. **(d)**

Transiting = Revolution of telescope about horizontal axis (Trunion axis) in vertical plane.

End of Solution

129. Stalactites and stalagmites are features of

(a) Stream erosion developed in limestone region by specific chemical reaction.
(b) Ground water deposition in caves formed by precipitation from dripping water rich in calcium carbonate.
(c) Marine erosion and deposition formed along coastal regions by selective erosion followed by deposition by waves.
(d) A centripetal drainage in which streams from different directions flow towards a common central basin.

Ans. **(b)**

End of Solution

130. Which of the following statements with reference to isogonic line are correct in magnetic declination?

1. It is drawn through the points of same declination.
2. It does not form complete great circle.
3. It radiates from north and south magnetic regions and follow irregular paths.

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

Ans. **(d)**

End of Solution

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Selections from Classroom Course 32 out of 40 (80%)	Selections from Classroom Course 62 out of 78 (80%)	Selections from Classroom Course 323 out of 465 (70%)

Civil Engineering

10 in Top 10

216 Selections out of 233 vacancies

93% of Total Selections are from MADE EASY

1 AIR — ABUZAR GAFFARI — Classroom T. S.

2 AIR — Pramit Debmallik — Classroom Course

3 AIR — Amarjeet — Classroom Course

4 AIR — Aman Gulia — Classroom Course

5 AIR — Ayush Chandra Dwivedi — Postal Course

6 AIR — Kabil Bhargava — Online T. S.

7 AIR — Abhishek Kumar — Classroom Course

8 AIR — Yogesh Kumar — Classroom Course

9 AIR — Ankit Kumar — Classroom Course

10 AIR — Tushar Garg — Classroom Course

Mechanical Engineering

10 in Top 10

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98% of Total Selections are from MADE EASY

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2 AIR — Sahil Goyal — Interview Course

3 AIR — Kumar Chandan — Classroom Course

4 AIR — Saurav Kumar — Classroom Course

5 AIR — Himanshu Verma — Classroom Course

6 AIR — Ch. Pushpak Pramod — Classroom Course

7 AIR — Manish Rajput — Classroom Course

8 AIR — Hemant Kumar Singh — Online T. S.

9 AIR — Sabapara D. Manishbhai — Interview Course

10 AIR — Sumit Bhamboo — Classroom Course

Electrical Engineering

10 in Top 10

79 Selections out of 86 vacancies

92% of Total Selections are from MADE EASY

1 AIR — KARTIKEYA SINGH — Classroom Course

2 AIR — Shambhavi Tripathi — Classroom Course

3 AIR — Abhishek Anand — Classroom Course

4 AIR — Ankit Tayal — Classroom Course

5 AIR — Kumar Mayank — Classroom Course

6 AIR — Ritesh Lalwani — Classroom Course

7 AIR — Kartikey Singh — Online T. S.

8 AIR — Anshuman Mitra — Classroom T. S.

9 AIR — Deepita Roy — Classroom Course

10 AIR — Ankita Sharma — Classroom Course

E&T Engineering

10 in Top 10

85 Selections out of 88 vacancies

97% of Total Selections are from MADE EASY

1 AIR — RAJAT SONI — Classroom Course

2 AIR — Ankush Mangla — Classroom Course

3 AIR — Rohit Kumar Singhal — Classroom Course

4 AIR — Amir Khan — Classroom Course

5 AIR — Y. Naga Rahul — Classroom Course

6 AIR — Janga Srinivasa Reddy — Classroom Course

7 AIR — Rahul Jain — Classroom Course

8 AIR — Kuldeep Kumar — Classroom Course

9 AIR — Shubham Karnani — Classroom Course

10 AIR — Gaurav Srivastava — Classroom Course

131. Mountains resulting from the depression or elevation of blocks of the earth crust on a large scale due to faulting and these elevated structures are commonly called

(a) Fault block mountains (b) Volcanic mountains
(c) Relict mountains (d) Residual mountains

Ans. (a)

End of Solution

132. A little gap is left between the head of the glaciated valley and the mass of the glacier ice. This gap is known as

(a) Bergs-chrund (b) Arete
(c) Horn (d) Cirque

Ans. (a)

End of Solution

133. The sight distance available on a road to a driver at any instance depends on

1. Features of the road ahead
2. Height of the driver's eye above the road surface
3. Height of the object above the road surface

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

Ans. (d)

End of Solution

134. Consider the following data :
Design speed = 96 kmph
Speed of overtaken vehicle = 80 kmph
Reaction time for overtaking = 2 sec
Acceleration = 2.5 kmph/sec
The safe overtaking sight distance on a two-way traffic road will be nearly

(a) 646 m (b) 556 m
(c) 466 m (d) 376 m

Ans. (a)

$$S = (0.2V_B + 6) = 0.2 \times 80 + 6 = 22 \text{ m}$$

$$T = \sqrt{\frac{45}{9}} = \sqrt{\frac{4 \times 22}{0.694}} = 11.26 \text{ sec}$$

$$V_A = V_C = 96$$

$$V_B = 80 \text{ kmph}$$

$$\text{OSD} = d_1 + d_2 + d_3$$

$$\text{OSD} = (0.278 \times 80 \times 2) + (0.278 \times 80 \times 11.26 + 2 \times 22) + (0.278 \times 96 \times 11.26)$$

$$= 639 \text{ m}$$

End of Solution

135. Which one of the following statements is correct?
(a) The ratio of load on wheel to contact area or area of imprint is called as contact pressure.
(b) The ratio of load on wheel to contact pressure is called as rigidity factor.
(c) The value of rigidity factor is more than three for an average tyre pressure of 7 kg/cm^2.
(d) Rigidity factor does not depend upon the degree of tension developed in walls of tyres.

Ans. (a)

End of Solution

136. Which one of the following is **not** the correct type of critical load position in pavement slab design for the load on the pavement surface?
(a) Interior loading
(b) Edge loading
(c) Eccentric loading
(d) Corner loading

Ans. (c)

End of Solution

137. Which of the following statements are correct regarding Westergaard's concept for temperature stresses?
1. During the day, the top of the pavement slab gets heated under the sun light when the bottom of the slab becomes hot.
2. During summer season as the mean temperature of the slab increases, the concrete pavement expands towards the expansion joints.
3. Due to frictional force at the interface, compressive stress is developed at the bottom of the slab as it tends to expand.

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

Ans. (b)

End of Solution

138. Which of the following advantages are correct regarding Poly-centric shape tunnel?
1. It can be conveniently used for road and railway traffic.
2. The number of centres and lengths of radii cannot be fixed.
3. It can resist external and internal pressure due to its arch action.

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

Ans. (c)

Poly-centric Tunnel :
- This tunnel section consist number of centers.
- The base of tunnel is flat enough for traffic hence can be used for radius and railways.
- The number of centers and length of roads can be fixed as per the local conditions hence required greater skilled persons.
- The tunnel can resist effectively external and internal pressure.

End of Solution

139. Which one of the following statement is correct regarding Journal friction?
(a) Caused due to the wave action of rails.
(b) The amount does not depend upon the type of bearing.
(c) For roller bearings, it varies from 0.5 to 1.0 kg per tonne.
(d) For coupled boxes, it lubricates by hard grease from 0.5 kg to 1.0 kg per tonne.

Ans. (c)

End of Solution

140. For the construction of a 640 m long B.G. railway track by using a sleeper density of $M + 5$, and the length of each rail is 12.8 m, the number of sleepers required will be
(a) 1000 (b) 900
(c) 800 (d) 700

Ans. (b)

$$\text{Number of sleepers} = \frac{640}{M} \times (M + 5)$$

$$= \frac{640}{12.8} \times (12.8 + 5)$$

$$= 890 \approx 900$$

End of Solution

141. Which one of the following statement is correct regarding ballast used for railway tracks?
(a) The minimum depth of ballast for B.G. section is 20 cm – 25 cm.
(b) The quantity of stone ballast required for one metre length of track is 0.53 m^3 for B.G. section.
(c) For M.G. section the width of ballast is 1.83 m.
(d) The minimum depth of ballast for N.G. section is 10 cm.

Ans. (a)
Standard depth of ballast for B.G. section is 20 cm – 25 cm.

End of Solution

142. Which one of the following statement is correct?
(a) The radius of transition raises from infinity to a selected minimum in order to attain full super-elevation and curvature gradually.
(b) The compound curve is an arc of circle.
(c) The radius of transition curve is constant for entire length.
(d) The horizontal curves are provided whenever there is a change in gradient.

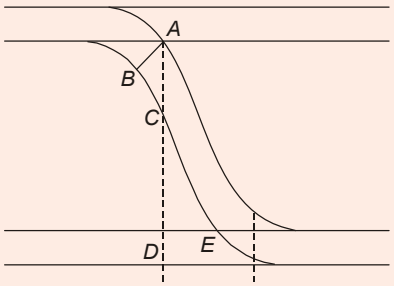
Ans. (a)

End of Solution

143. A cross-over occur between two Metre Gauge parallel tracks of same crossing number 1 in 12 with straight intermediate portion between the reverse curves and the distance between the centres of tracks is 3.5 m. If the value of *G* is 1 m, the intermediate straight distance will be nearly

(a) 12 m (b) 15 m
(c) 18 m (d) 21 m

Ans. (c)



Length of intermediate straight :

$$DE = (D - G)N - G\sqrt{1+N^2}$$

$$= (3.5 - 1.0) \times 12 - 1\times\sqrt{1+12^2}$$

$$\approx 2.5 \times 12 - 12$$

$$= 1.5 \times 12 = 18 \text{ m}$$

End of Solution

144. Which one of the following is the correct standard for provision of curves on railway track?

(a) Cant excess on B.G. shall not be allowed to exceed 105 mm.
(b) Minimum radius of vertical curves for group *A*, Broad Gauge track is 4,000 m.
(c) The minimum value of super-elevation according to Railway Board is $\frac{1}{10}$ th of gauge.
(d) The speed potential of curve is given by formula $E = \frac{V^2}{127R}$ where, *E* is superelevation in mm.

Ans. (b)

End of Solution

Directions : Each of the next Six (06) items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. 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 tru'e; 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

145. **Statement (I) :** Finer grinding of cement results in early development of strength.
Statement (II) : the finer the cement, the higher is the rate of hydration.

Ans. (a)

End of Solution

146. **Statement (I) :** Pozzolana is added to cement to increase early strength.
Statement (II) : It reduces the heat of hydration.

Ans. (d)
(i) Initial strength of Pozzolana cement is generally less. So statement is wrong.

End of Solution

147. **Statement (I) :** Coarser the particles, less is optimum moisture content.
Statement (II) : The specific surface area of coarser particle is less.

Ans. (a)
Coarser the grains, the lesser is the specific surface area, so lesser is the amount of water required to make the soil grains wet at maximum dry density.

End of Solution

148. **Statement (I) :** A reverse curve consists of two arcs with their centres of curvature on opposite sides of the curve.
Statement (II) : Superelevation can be provided conveniently at the intersection point of the two arcs.

Ans. (c)

End of Solution

149. **Statement (I) :** The counter interval depends upon the nature of the ground – whether it is undulating or flat.
Statement (II) : In a hilly terrain or undulating ground a smaller interval is adopted, otherwise the contours will come too close for plotting due to the steep slope.

Ans. (c)
Statement II is wrong. Bigger contour interval is adopted in hilly terrain.

End of Solution

150. **Statement (I) :** Geodetic survey cannot be done for works requiring high precision.
Statement (II) : The curvature of earth is accounted for measurements in Geodetic survey.

Ans. (d)
Geodetic survey is done for high precision works.

End of Solution