ESE-2018 PRELIMS TEST SERIES

Date: 03 December, 2017

CE–TEST 11(OBJECTIVE SOLUTION)...

ANSWERS

1.	(d)	31.	(a)	61.	(b)	91.	(a)	121.	(b)
2.	(c)	32.	(c)	62.	(b)	92.	(b)	122.	(d)
3.	(b)	33.	(d)	63.	(d)	93.	(c)	123.	(d)
4.	(d)	34.	(a)	64.	(b)	94.	(b)	124.	(a)
5.	(a)	35.	(a)	65.	(c)	95.	(d)	125.	(c)
6.	(a)	36.	(a)	66.	(a)	96.	(c)	126.	(c)
7.	(d)	37.	(a)	67.	(c)	97.	(b)	127.	(a)
8.	(c)	38.	(d)	68.	(c)	98.	(a)	128.	(b)
9.	(a)	39.	(a)	69.	(d)	99.	(a)	129.	(a)
10.	(a)	40.	(a)	70.	(c)	100.	(d)	130.	(d)
11.	(c)	41.	(a)	71.	(c)	101.	(b)	131.	(d)
12.	(d)	42.	(b)	72.	(b)	102.	(d)	132.	(b)
13.	(b)	43.	(a)	73.	(b)	103.	(c)	133.	(b)
14.	(d)	44.	(b)	74.	(c)	104.	(b)	134.	(d)
15.	(c)	45.	(b)	75.	(c)	105.	(d)	135.	(a)
16.	(a)	46.	(c)	76.	(d)	106.	(d)	136.	(b)
17.	(d)	47.	(d)	77.	(a)	107.	(a)	137.	(a)
18.	(d)	48.	(d)	78.	(c)	108.	(c)	138.	(c)
19.	(b)	49.	(a)	79.	(c)	109.	(d)	139.	(a)
20.	(b)	50.	(b)	80.	(c)	110.	(c)	140.	(a)
21.	(c)	51.	(d)	81.	(a)	111.	(b)	141.	(a)
22.	(d)	52.	(c)	82.	(d)	112.	(b)	142.	(a)
23.	(b)	53.	(a)	83.	(a)	113.	(d)	143.	(b)
24.	(d)	54.	(b)	84.	(c)	114.	(d)	144.	(b)
25.	(c)	55.	(d)	85.	(a)	115.	(c)	145.	(b)
26.	(b)	56.	(c)	86.	(d)	116.	(c)	146.	(a)
27.	(b)	57.	(d)	87.	(c)	117.	(b)	147.	(d)
28.	(b)	58.	(b)	88.	(d)	118.	(d)	148.	(a)
29.	(a)	59.	(d)	89.	(b)	119.	(a)	149.	(b)
30.	(a)	60.	(c)	90.	(a)	120.	(c)	150.	(a)

1. (d)

1. Creep increases when
   (a) Cement content is high
   (b) w/c ratio is high
   (c) Aggregate content is low
   (d) Air entrainment is high
   (e) Relative humidity is low
   (f) Temperature is high
   (g) Size is small
   (h) loading occurs at early stage.
2. Unlike creep, shrinkage strains are independent of the stress conditions of the concrete.
3. Chemical shrinkage induces internal voids and autogenous shrinkage results in element shortening.
4. In limit state method of design, two factor of safety are used, one to account for uncertainity in load and other to account for uncertainity in material.

2. (c)

1. It has been seen that the compressive (as well as tensile) strength of concrete is reduced by the presence of shear stress. Also shear strength of concrete is enchanced by the application of direct compression (except extreme case of very high compression), whereas it is (expectedly) reduced by the application of direct tension.
2. The code limits the maximum value of f_y to 415, as higher strength reinforcements may be rendered brittle at the sharp bends of the web reinforcement, also a shear compression failure could precede the yielding of the high strength steel.

3. (b)

Beam is subjected to torque = 15 kN-m,

and shear force (factored) = 140 kN.

Calculating equivalent shear force

$$V_e = V_u + \frac{1.6T_u}{B}$$

$$= 140 + \frac{1.6 \times 15}{0.230}$$

$$= 244.348 \text{ kN.}$$

$\therefore$ Additional shear for which the stirrups have to be provided

$$= V_e - (\tau_c)bd$$

$$= (244.348) - (0.48) \times \frac{230 \times 400}{10^3}$$

$$= 200.188$$

$$= 200.19 \text{ kN}$$

$$\approx 200 \text{ kN}$$

4. (d)

1. **Chemical Adhesion:** Due to property in the products of hydration (formed during the making of concrete)
2. **Frictional resistance:** Due to the surface roughness of the reinforcement and the grip exerted by the shrinkage of concrete.
3. **Mechanical interlocking :** Due to surface protrusions or 'ribs' oriented transversely to the bar axis provided in deformed bar.

5. (a)

$$L_d = \frac{\phi \sigma_s}{4\tau_{bd}} = \frac{20 \times 0.87 \times 415}{4 \times 1.6 \times 1.25 \times 1.5}$$

$$= \frac{7221}{12} \text{ mm}$$

$$L_d = 601.75 \text{ mm}$$

$$L_d \approx 602 \text{ mm}$$

6. (a)

Primary (or equilibrium) torsion is associated with twisting moment that are developed in a structural member to maintain static equilibrium with the external load directly applied on member, and are independent of the torsional stiffness of the member.

Secondary (or compatibility) torsion is induced in a member as a secondary effect, by rotation (twist) applied at one or more points along the length of the member through interconnected members, rather than by directly applied load on it.

7. (d)

For simply supported beam

$$\Rightarrow \frac{\text{Span}}{\text{depth}} \not> 20 \times \frac{10}{\text{span}} \times \begin{bmatrix} \text{modification factor for} \\ \text{tension \& compression} \\ \text{reinforcement} \end{bmatrix}$$

$$\Rightarrow \frac{\text{Span}}{\text{depth}} \not> 20 \times \frac{10}{15} \times 0.9 \times 1.1$$

$$\Rightarrow \text{depth} \not< \frac{\text{span}}{20 \times \frac{10}{15} \times 0.9 \times 1.1}$$

$$\Rightarrow \text{depth} \not< 1.136 \text{ m}$$

8. **(c)**

9. **(a)**

Hoyer system is generally used for mass production (like Railways sleeper, poles, etc). The end abutment are kept sufficient distance apart, and several members are casted in a single line. The shuttering is provided at the sides and between the member.

When the level of prestressing is such that the tensile stress under service load is within the cracking stress of concrete, it is called limited prestressing.

10. **(a)**

Area of cross-section = 200 × 250

$= 5 \times 10^4 \text{ mm}^2$

Modular Ratio = 13

Prestressing force,

P = 1200 × 600 = 720 kN.

Stress in concrete at the level of steel

$$\sigma = \frac{P}{A} + \frac{M.y}{I}$$

$$= \frac{720 \times 10^3}{5 \times 10^4} + 0$$

$$\sigma = 14.4 \text{ N/mm}^2$$

Loss of prestress due to elastic shortening of concrete

$$\Delta\sigma = m\sigma = 13 \times 14.4 = 187.2 \text{ N/mm}^2$$

$\therefore$ Stress in wire after loss

$= 1200 - 187.2 \text{ N/mm}^2$

$= 1012.8 \text{ N/mm}^2$

Stress in concrete corresponding to 1200 N/mm^2 Prestress = 14.4 N/mm^2

Stress in concrete corresponding to 1012.8 N/mm^2 Prestress

$$= \frac{14.4}{1200} \times 1012.8$$

$= 12.15 \text{ N/mm}^2$

$\approx 12 \text{ N/mm}^2$

11. **(c)**

1.According to clause 4.7 of IS 4326 – 1993

2.According to clause 4.9 of IS-4326 – 1993

12. **(d)**

In fully rigid design of steel structures, connections are capable of transmitting moments and the angle between members at the joint does not change.

13. **(b)**

In class 4.6 bolt,

(i) 4 denotes $\frac{1}{100^{th}}$ of its ultimate strength in MPa

(ii) 0.6 denotes ratio of yield strength to ultimate strength.

14. **(d)**

15. **(c)**

Pressure at the bottom of tank

$\sigma = 1.75\gamma_w h$

$= 1.75 \times 9.81 \times 27$

$= 463.5 \text{ kN/m}^2$

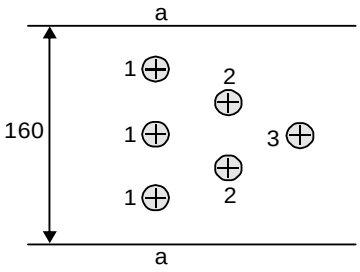
Force per pitch length = $\pi d\sigma \times p$

$= 2.5 \times \pi \times 463.5 \times 50 \times 10^{-3}$

$= 182 \text{ kN}$

16. **(a)**

Critical section for rupture can be



I. a – 1 – 1 – a

$A_{net} = (160 - 3 \times (16 + 2)) \times 8 = 848 \text{ mm}^2$

II. a – 1 – 2 – 1 – 1 – a

$$A_{net} = \left(160 - 4 \times 18 + \frac{2 \times 40^2}{4 \times 25}\right) \times 8$$

$= 960 \text{ mm}^2$

III. a – 1 – 2 – 3 – 2 – 1 – a

$$A_{net} = \left(160 - 5 \times 18 + \frac{4 \times 40^2}{4 \times 25}\right) \times 8$$

$= 1072 \text{ mm}^2$

Hence, the critical most section is I

$A_{net} = 848 \text{ mm}^2$

17. **(d)**

Lug angles are used to reduce the length of joint.

18. (d)

Battens of a built up column are designed for carrying bending moment and shear arising from a transverse shear V

Where $V = \frac{2.5}{100} \times \text{Axial load}$

19. (b)

For compression member maximum allowable slenderness ratio is 180

ratio = 180

$$\frac{l}{r_{min}} = 180$$

$$l = 180 \times r_{min}$$

$$= \frac{180 \times 24}{1000} = 4.32\ \text{m}$$

20. (b)

Given maximum shear force = 56 kN

Shear area = height × thickness of beam of web

= 450 × 6 = 2700 mm^2

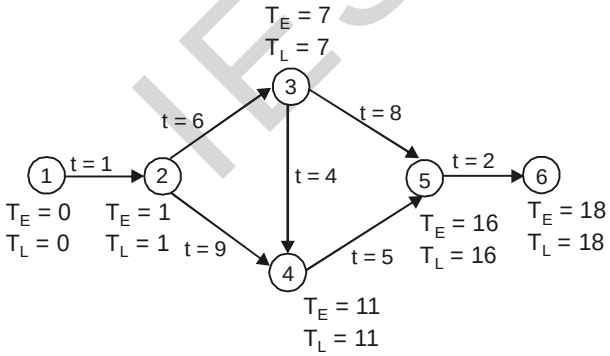
Shear stress = $\frac{56 \times 1000}{2700} = 20.74\ N/mm^2$

21. (c)

22. (d)

Schedule contracts are usually used for maintenance or minor job. They are also used for conventional building construction projects.

23. (b)



(a) 1 – 2 – 3 – 5 – 6 $\Rightarrow$ 17 days

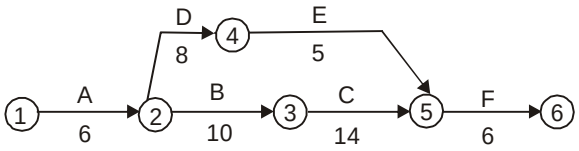
(b) 1 – 2 – 3 – 4 – 5 – 6 $\Rightarrow$ 18 days

(c) 1 – 2 – 4 – 5 – 6 $\Rightarrow$ 17 days

(d) 1 – 2 – 4 – 3 – 5 – 6 $\Rightarrow$ Not valid

Hence critical path is 1 – 2 – 3 – 4 – 5 – 6

24. (d)



Critical path is A – B – C – F with project duration of 36 days. Range of project duration is $T_E \pm 3\sigma$.

Standard deviation of project is calculated along critical path

$$\sigma_{project} = \sqrt{\sigma_A^2 + \sigma_B^2 + \sigma_c^2 + \sigma_F^2}$$

$$\sigma_{project} = \sqrt{1^2 + 2^2 + 2^2 + 0^2}$$

$$\sigma_{project} = 3$$

$\therefore$ Range of project duration

= [36 – 3 × 3] to [36 + 3 × 3]

= (27, 45)

25. (c)

The following are important stages in developing a bar chart.

1. **Breakdown:** The project into its various activities or jobs or operation, each representing manageable unit for planning and control.
2. **Decide:** The method to be employed in execution of the project as well as for each activity or operation or task; also decide above the sequence in which the activities are to be completed.
3. **Assign:** Duration of time for the completion of each activity. Once the activities are seperated and choice of method is made, it is possible to estimate the time required for the completion of each activity.
4. **Represent:** The above information is the bar chart, indicating the relative position of the each activity.

26. (b)

Scheduling is the deciding of the phasing rate of activities. The starting and completion dates and the sequential relationship among the various activities in a project such that work can be carried out in an orderly and effective manner.

27. (b)

For spreading of soil

Area to be covered = $\frac{\text{Volume}}{\text{Thickness}} = \frac{80000}{0.2}$

$= 4{,}00{,}000\ m^2$

Area covered per hour per pass

$= \text{Speed} \times \text{width} \times OF$

$= 4 \times 1000 \times 3 \times \frac{50}{60}$

$= 10{,}000\ m^2$

Total area covered by one grader with 5 passes $= 50{,}000\ m^2$

No. of grader required $= \frac{4{,}00{,}000}{50{,}000} = 8$

28. (b)

Kani's method $\Rightarrow$ Displacement method

29. (a)

$400\Delta = (100 \times 10) + (15 \times 300)$

$\Delta = 13.75$ mm

30. (a)

Stiffness of BC $= k_{BC} = \frac{3EI}{3} = EI$

Stiffness of AB $= k_{AB} = \frac{4EI}{4} = EI$

D.F for AB $= \frac{1}{2}$

D.F for BC $= \frac{1}{2}$

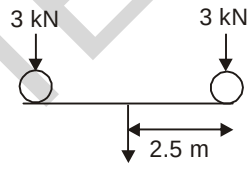
So, moment in $M_{BA} = 20$ kN-m

So, At A moment will be $= \frac{20}{2} = 10$ kN-m

31. (a)

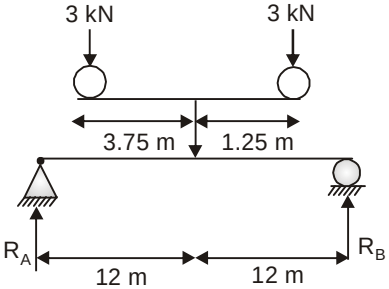
32. (c)

Maximum B.M will occur when centre of the beam lies midway between the load and C.G of the series of load



C.G of load $\Rightarrow \frac{3 \times 5}{6} = 2.5$

For absolute maximum B.M



$R_A + R_B = 6$kN

$\Sigma M_A = 0$

$24\,R_B = 3 \times 8.25 + 3 \times 13.25$

$R_B = 2.6875$ kN

$R_A = 3.3125$ kN

$M_{max} = 2.6875 \times 10.75\ m \Rightarrow 28.89$ kN-m

$\sigma = \frac{M}{z}$

$\sigma = \frac{28.89 \times 10^6\ \text{N-mm}}{16.2 \times 10^3\ mm^3}$

$\sigma = 1783.33\ N/mm^2$

$\sigma = 1.78$ GPa

33. (d)

34. (a)

No. of rotation possible = 3 (m – 1) = 3 (5 – 1) = 12

35. (a)

In plastic region, deformation is caused by slippage of material along oblique surface Thus volume remain constant in this region.

36. (a)

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

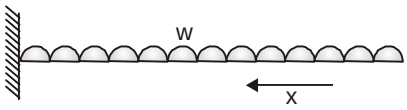
differentiation should be w.r.t 'x' to get SF @ that point

37. (a)

Max. principal stress theory is applicable to brittle material because brittle material fail under tension leading to fracture.

38. (d)

39. (a)



$M_x = \frac{wx^2}{2}$ $\quad z = \frac{bd^2}{6}$

$\Rightarrow \sigma = \frac{wx^2}{2 \times \frac{b \times d_x^2}{6}}$

$\Rightarrow \frac{\sigma \times bd^2x}{3} = wx^2$

$\Rightarrow d_x = \sqrt{\frac{3w}{b\sigma}}\,x$

Hence $d_x \propto x$

40. **(a)**

41. **(a)**

42. **(b)**

Taking moment about hinge (A)

$T \times 0.5 = 300 \times 0.3 + 300 \times 0.9$

$\Rightarrow \quad \boxed{T = 720\ N}$

43. **(a)**

$$\text{Work done} = \frac{1}{2} K_{eq} (\Delta l)^2$$

$$\text{and} \quad K_{eq} = \frac{K_1 K_2}{K_1 + K_2}$$

$$\therefore \quad W_D = \frac{K_1 K_2}{2(K_1 + K_2)} \times (\Delta l)^2$$

$$W_D = \frac{100 \times 200}{600} (\Delta l)^2 = \frac{100}{3} (\Delta l)^2$$

44. **(b)**

For a spring, (K × L) is a constant

$$\therefore \quad K \times L = K' \times \left(\frac{2L}{3}\right)$$

$$\therefore \quad \frac{2L}{3} = \text{Length of longer piece}$$

$$\therefore \quad \boxed{K' = \frac{3}{2} K}$$

45. **(b)**

$$\tau_{allwable} = \frac{103000\ kN/m^2}{2.5} = 41200\ kN/m^2$$

Allowable shear force

$$V = \tau_{all} A = \tau_{allow} = \tau_{allow} \frac{\pi}{4} d^2$$

$$= 41200 \times \frac{\pi}{4} \times 0.0125^2 = 5.056\ kN$$

Force supported by nuts

$F = 2 \times V = 2 \times 5.056 = 10.11\ kN$

46. **(c)**

at C

$$\tau_c = \frac{Tr}{J} = \frac{40 \times 10^6 \times 75}{\frac{\pi \times (150)^4}{32}}$$

$$\sigma_c = \frac{My}{I} = \frac{30\sqrt{2} \times 10^6 \times \frac{75}{\sqrt{2}}}{\frac{\pi}{64} \times 150^4}$$

$$\sigma_{max} = \frac{\sigma_2}{2} \pm \sqrt{\left(\frac{\sigma_c}{2}\right)^2 + \tau_c^2}$$

$\Rightarrow$ 120.72 MPa.

47. **(d)**

Maximum slope will occur at the end where moment is applied. Angle is clockwise so it will be –ve

$$\theta_{max} = \frac{-ML}{3EI} = \frac{-1.13 \times 10^3 \times 0.6}{3 \times 1370 \times 10^6 \times 2.08 \times 10^{-6}}$$

$\Rightarrow$ –0.0793 rad = – 4.54 degree

48. **(d)**

49. **(a)**

$$\sigma_{max} = \frac{My}{I} = \frac{32\,M}{\pi D^3}$$

$$\tau_{max} = \frac{\tau r}{J} = \frac{16T}{\pi D^3}$$

$$\frac{\sigma_{max}}{\tau_{max}} = \frac{2M}{T}$$

50. **(b)**

$$8N = \gamma_m V_m + \gamma_w V_w$$

$$= (13.6)(\gamma_w)(28 \times 10^{-6}) + (\gamma_w)(V_w)$$

$$V_w = \frac{8}{9.81 \times 10^3} - 13.6 \times 28 \times 10^{-6}$$

$$= 4.34 \times 10^{-4}\ m^3$$

$$= 434.69\ cm^3 \simeq 435\ cm^3$$

51. **(d)**

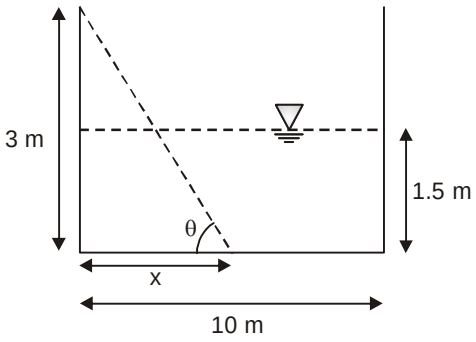
$$\text{For notch } Q = \frac{8}{15} c_D H^{5/2} \sqrt{2g} \tan\left(\frac{\theta}{2}\right)$$

$$\frac{dQ}{Q} = \frac{5}{2} \frac{dH}{H}$$

$$\frac{dQ}{Q} \times 100 = \frac{5}{2} \times \frac{1.5 \times 10^{-3}}{0.5} \times 100 = 0.75\%$$

52. **(c)**

For maximum accleration oil will reach just upto the maximum height of the tank without being spill out and volume of oil will remain the same.



$$\frac{1}{2}\times x\times 3\times 5 = 10\times 1.5\times 5$$

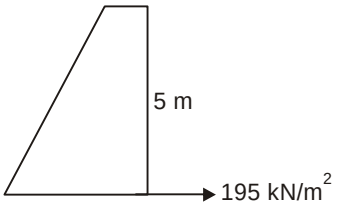
$$x = 10 \text{ m}$$

$$\text{therefore } \tan\theta = \frac{a_x}{g} = \frac{3}{10}$$

$$a_x = 3 \text{ m/s}^2$$

53. (a)

Area of gate = 5 × 3 = 15 m^2



The equivalent height of water which gives a pressure intensity of 195 kN/m^2 at bottom

$$h = \frac{P}{\gamma_w} = 19.87 \text{ m}$$

Centre of pressure $\bar{h} = \bar{x} + \frac{I_a}{A\bar{x}}$

$$\bar{x} = 19.87 - 2.5 = 17.37 \text{ m}$$

$$I = \frac{bd^3}{12}$$

$$\bar{h} = 17.37 + \frac{3\times 5^3}{12\times 14\times 17.37}$$

$$= 17.49 \text{ m}$$

54. (b)

Boundary layer will form on both sides of plate

$$F_D = 2\left(C_D \frac{\rho_w V^2}{2}\right)\times A$$

$$5.31 = 2\times C_D \times \frac{10^3\times 2^2}{2}\times 2\times 1$$

$$C_D = 6.64\times 10^{-4}$$

55. (d)

Since the pipes are connected in parallel hence head loss will be same in both the pipes

$$\frac{fLQ^2}{12.1 d^5} = C$$

$$Q^2 \propto d^5$$

$$\frac{Q_1}{Q_2} = \left(\frac{d_1}{d_2}\right)^{\frac{5}{2}} = (3)^{5/2} = 15.6$$

56. (c)

57. (d)

58. (b)

Entrance length is (0.05 Re)D for laminar flow

$$f = \frac{64}{R_e}$$

59. (d)

Volume of water precipitation

$$= 500\times 10^4 \times 10 \times 10^{-2}$$

$$= 0.5\times 10^6 \text{ m}^3$$

Volume of water from inflow

$$= 5\times 30\times 24\times 3600$$

$$= 12.96\times 10^6 \text{ m}^3$$

Volume of water from outflow

$$= 2\times 30\times 24\times 3600$$

$$= 5.184\times 10^6 \text{ m}^3$$

Volume lost due to evaporation

$$\Rightarrow \quad 500\times 10^4 \times 8\times 10^{-2} = 0.4\times 10^6 \text{ m}^3$$

Increase in depth

$$= \frac{0.5\times 10^6 + 12.96 - 0.4\times 10^6 - 5.184\times 10^6}{500\times 10^4}$$

$$= 1.5752 \text{ m}$$

60. (c)

Muskingum equation is used for channel routing.

Both Saint Venant equation and hydraulic method uses continuity and moment equation. While Hydrological method uses continuity and energy equations.

61. (b)

62. (b)

$$Q = \frac{AS}{T}\ln\left(\frac{S_1}{S_2}\right)$$

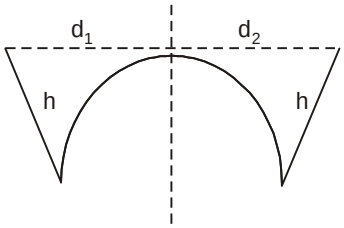
$$= \frac{\frac{\pi}{4}\times(11^2\times 2.5)}{\frac{70}{60}}\ln\left(\frac{2.5}{1.3}\right) = 1.1 \text{ m}^3\text{/hour}$$

63. **(d)**

64. **(b)**

65. **(c)**

From the concept of visible horizon



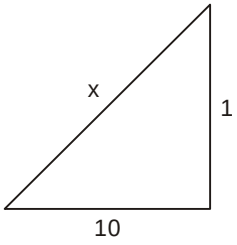
$$d = d_1 + d_2$$

$$d = 2 \times 3.855\sqrt{h}$$

$$20.09 = 2 \times 3.855\sqrt{h}$$

$$h = 6.78 \text{ m}$$

66. **(a)**



Grade 1 in 10

$$= \sqrt{1+10^2} = 10.05$$

$$\text{Fall in 30 m} = \frac{30}{10.05} \times 1 = 2.985$$

Slope correction Cg =

$$-\frac{h^2}{2L} = -\frac{2.985^2}{2 \times 30} = -0.15 \text{m}$$

67. **(c)**

68. **(c)**

69. **(d)**

$$\Delta x = \frac{\Delta E}{S_0 - \bar{S}_F}$$

$$E_1 = y_1 + \frac{V^2}{2g}$$

$$\Rightarrow E_1 = 1 + \frac{10^2}{1^2 \times 2 \times 10} = 6 \text{ m}$$

$$E_2 = 0.85 + \frac{10^2}{0.85^2 \times 2 \times 10} = 7.77 \text{ m}$$

$$\Delta x = \frac{7.77 - 6}{0.003 - \left(\frac{0.015 + 0.02}{2}\right)}$$

$$\Delta x = 122 \text{ m}$$

70. **(c)**

Find the continuity for unsteady flow

$$\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} = 0$$

$$\frac{\partial A}{\partial t} = -\frac{\partial Q}{\partial x}$$

$$\frac{\partial A}{\partial t} = -0.10$$

71. **(c)**

72. **(b)**

For homologous pumps the specific speed is same .

$$N_{SA} = N_{SB}$$

$$N_S = \frac{N\sqrt{Q}}{H^{3/4}}$$

$$\frac{600\sqrt{0.4}}{50^{3/4}} = \frac{600\sqrt{0.3}}{H_B^{3/4}}$$

$$H_B = 41.28 \text{ m}$$

73. **(b)**

74. **(c)**

$$\text{Flow } Q = \frac{x + y}{t_w + t_a}$$

$$x = 200$$

$$y = 10 - 20 = -10$$

$$t_w = t_a = \frac{5}{60} = \frac{1}{12} \text{ hrs}$$

$$Q = \frac{200 - 10}{\frac{1}{12} + \frac{1}{12}} = 1140 \text{ Veh/hr}$$

Flow of vehicles travelling at 80 kmph

$$= 0.4 \times 1140$$

$$= 456 \text{ Veh/hr}$$

Time taken for 5 Km by vehicles of speed 80 Kmph = $\frac{5}{80}$ hrs

So vehicles met by the car when travelling against the flow = $456 \times \left(\frac{5}{80} + \frac{5}{60}\right)$ = 66.5 vehicles.

75. **(c)**

76. **(d)**

CBR of subgrade = 5% and thickness = 50 cm

50 cm = $t_{subbase}$ + t_{base} + $t_{wearing\ course}$

CBR of subbase = 20% and thickness = 20 cm

20 cm = t_{base} + $t_{wearing\ course}$

$t_{wearing\ course}$ = 5 cm

So t_{base} = 20 - 5 = 15 cm

$t_{subbase}$ = 50 – 15 – 5 = 30 cm

So ratio = $\frac{30}{15} = 2$

77. (a)

78. (c)

Ruling gradient = 1 in 150 = 0.67%

Allowable ruling gradient = 1 in 183 = 0.547%

Grade compensation = 0.67 – 0.547 = 0.123%

= 0.04% ×N°

$\Rightarrow$ N° $\simeq 3°$

79. (c)

In sand,

$$d_s = \frac{\gamma_d}{\gamma_w} \times d[F.C. - \phi]$$

$$= 1.5 \times 20 \times \frac{(30-15)}{100} = 4.5\,cm$$

Similarly Clay

$$d_c = 1.2 \times 20 \times \frac{20}{100} = 4.8\,cm$$

$\therefore$ Total moisture storage capacity

= 4.8 + 4.5 = 9.3 cm

80. (c)

Grain dia = 6 cm = 0.06 m [> 6 mm]

$\therefore$ $d \geq 11RS$

$$R_{max} \leq \frac{d}{11S} = \left(\frac{6}{100} \times \frac{1}{11 \times 0.01}\right)$$

R_{max} = 0.544 m or 54.4 cm.

81. (a)

$$T_a = \frac{\text{Water stored in root-zone}(W_s)}{\text{Water delivered to the field}(Ws)} \times 100$$

$$= \frac{110 \times 10^{-3} \times 8 \times 60 \times 60 - 485}{110 \times 10^{-3} \times 8 \times 60 \times 60} \times 100$$

= 84.69%

Closest answer is (a)

82. (d)

When water from higher level is supplied to lower level, by the action of gravity then it is called Flow Irrigation.

If the water is lifted up by some mechanical or manual methods and then supplied for irrigation, it is called lift irrigation.

Natural sub irrigation is caused by leakage of water flowing in channels.

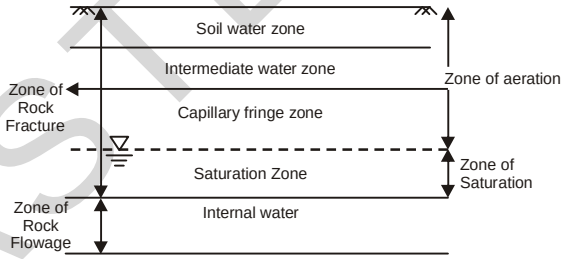
Artificial sub irrigation is very costly. Hence is employed only for cash crops of high value.

83. (a)

The length and width of meander varies as the square root of the discharge i.e. $\sqrt{Q}$

84. (c)

Ground Profile



85. (a)

Nitrogen in the form of ammonia exerts an oxygen demand and can be toxic to fish. Removal of nitrogen can be accomplished either biologically or chemically. The biological process is called nitrification / denitrification. The chemical process is called ammonia stripping.

86. (d)

Sodium hypochlorite, ozone, chlorine dioxide and UV are used as disinfectant. Sodium hypochlorite is handled in liquid form that contains from 5% to 15% available chlorine.

87. (c)

Molecular weight of H_2SO_4

$$= 2 \times 1 + 32 + 4 \times 16 = 98\ g$$

No. of moles of H_2SO_4 in 1 Litre of solution = $\frac{100 \times 10^{-3}}{98 \times 1} = 1.02 \times 10^{-3}$ mole/L

The reaction is $H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

Therefore, $2 \times (1.02 \times 10^{-3})$ mole/L H^+ ion are produced. The pH is

$$pH = -\log(2.04 \times 10^{-3}) = 2.69 \approx 2.7$$

88. (d)

The philosophy for controlling water hammer in pipes is

(i) to minimize the length of the returning water column causing water hammer.

(ii) to dissipate energy of the water column length by air cushion valve.

(iii) to provide a quick opening pressure relief value to relieve any rise in pressure in critical zones.

These objective are achieved by the following three values

1. Zero velocity valve
2. Air cushion valve
3. Opposed poppet valve.

89. (b)

When bacteria are introduced into a synthetic liquid medium, reproduction takes place by binary fission, each cell divides producing two new cells, the increase in population follows geometric progression,

$1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32$, and so forth.

90. (a)

Reaction of chlorine with natural organics such as fulvic and humic acids produce undesirable disinfection by-products (DBPs) such as trihalomethanes (THM), the most predominant of which are chloroform and bromachloromethane. These THMs are suspected carcinogens. Minute quantities of phenolic compounds react with chlorine to create DBPs with severe taste and odour. To prevent the formation of DBPs, the organics in the raw water must be removed before disinfection or if formed, through the use of activated carbon adsorption. The other way is to prevent the formation by avoiding the use of chlorine and substituting chloramines as the disinfectant.

91. (a)

Molecular weight of glutamic acid

$$= 5\times12+9\times1+4\times16+14 = 147$$

Total oxygen used in the reaction

$$= (4.5+2)\times(2\times16) = 208\text{g}$$

147g of glutamic acid requires 208g of oxygen

$$\text{ThOD} = 63\times\frac{208}{147} = 89.14\,\text{mg/L}$$

$$\text{ThOD} \approx 89\ \text{mg/L}$$

92. (b)

The DO sag equation has been developed using oxygen deficit rather than dissolved oxygen concentration, to make it easier to solve the integral equation that results from the mathematical description of the mass balance. The saturation value of dissolved oxygen is heavily dependent on water temperature - it decreases as the temperature increases.

93. (c)

The activated sludge process is controlled by wasting a portion of the microorganisms each day in order to maintain the proper amount of microorganism to efficiently degrade the BODs. Wasting means that a portion of the microorganisms is discarded from the process.

94. (b)

Total weight of filterable residue

$$= (325.57-325.46)\text{gm} = 0.11\ \text{gm}$$

Quantity of filterable residues

$$= \frac{0.11\times10^3}{200\times10^{-3}} = 550\ \text{mg/L}.$$

95. (d)

96. (c)

97. (b)

Compaction decreases compressibility of soil.

98. (a)

$$K_z = \frac{12}{\frac{4}{1\times10^{-4}}+\frac{4}{4\times10^{-5}}+\frac{4}{2\times10^{-5}}}$$

$$= 3.53\times10^{-5}\ \text{mm/sec}$$

Head Causing Flow = Head of water due to artesian pressure – Head of Water due to ground water

[Take top of gravel as datum]

$$\text{Head Causing Flow} = \frac{150}{10}-13 = 2\text{m}$$

$$q = KiA = 3.53\times10^{-5}\times\frac{2}{12}\times1$$

$$= 0.588\times10^{-5}\ \text{mm}^3/\text{sec}/\text{mm}^2.$$

99. (a)

The radius of fictitious circular footing of area equal to the rectangular footing.

$$\pi R_{eq}^2 = 30 \times 12$$

$$R_{eq} \Rightarrow 10.7 \text{ m}$$

σ_Z for circular loaded area

$$\sigma_Z = q\left[1-\left\{\frac{1}{1+\left(\frac{R}{Z}\right)^2}\right\}^{3/2}\right]$$

$$= 1000\left[1-\left\{\frac{1}{1+\left(\frac{10.7}{20}\right)^2}\right\}^{3/2}\right]$$

$$= 1000 \times 0.3145$$

$$\sigma_Z = 314.5 \text{ N/m}^2$$

100. (d)

Tetrahedral $\rightarrow$ Central ion is silicon

Octahedral $\rightarrow$ Central ion is Aluminium.

In octahedral iron or magnesium ions may replace aluminium ions in some units.

When Aluminium is at centre $\rightarrow$ Gibbsite sheet

When Magnesium is at centre $\rightarrow$ Brucite sheet

101. (b)

The unconfined compression strength of the soil is given by

$$\sigma_1 = \frac{P(1-\epsilon)}{A_0}, \text{ where P = 360 N}$$

$$A_0 = \frac{3.14}{4}\times(4)^2 = 12.56\,\text{cm}^2$$

$$\epsilon = \frac{0.8}{8} = 0.1$$

$$\therefore \quad \sigma_1 = \frac{360(1-0.1)}{12.56}$$

$$= 25.8\,\text{N/cm}^2 = 258\ \text{KN/m}^2$$

102. (d)

The effective stress at point A can be then calculated as $\sigma = S + \gamma_1 H_1 + \gamma_2 H_2$

$S + 16\times3 + (16-9.81)\times1 + 5\times(18-9.81)$

= S + 95.14

According to the problem, the maximum effective pressure at point A is equal to 150 KPa.

$\because$ σ = S + 95.14 = 150

S = 54.86 kN/m^2

103. (c)

From this problem, we know the thickness of this soil layer is 3 m. We need to determine the void ratio before and after ultimate consolidation settlement. They can be calculated based on

$$e_0 = \frac{n_0}{1-n_0} = \frac{0.5}{1-0.5} = 1$$

$$e_1 = \frac{n_1}{1-n_1} = \frac{0.45}{1-0.45} = 0.82$$

Based on the equation

Ultimate settlement,

$$S_f = \frac{e_0 - e_1}{1+e_0}\times H = \frac{1-0.82}{1+1}\times 3 = 0.27 \text{ m}$$

104. (b)

$$K_a = \tan^2\left(45-\frac{\phi}{2}\right) = \tan^2(45-15) = \frac{1}{3}$$

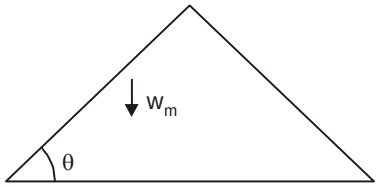
The lateral stress at the base for soil.

$$(\sigma_H) = K_a \times \gamma \times h = \frac{1}{3}\times 100 = 33.3\ \text{KPa}$$

$\therefore$ The lateral force due to soil.

$$P_a = \frac{1}{2}(\sigma_H)\times H = \frac{1}{2}\times 33.3\times 5 = 83.33\ \text{kN/m}$$

105. (d)



When the slope angle θ of the sand cone reaches its maximum, the sand on the slope surface is in equilibrium

$$T_{MOB} = T_{FF}$$

The mobilized shear force along the slope surface is $T_{MOB} = W_M \sin\theta$.

The shearing resistance along the slope surface is " $T_{FF} = W_M \cos\alpha_s \tan\phi$

$\therefore$ $W_M \sin\theta = W_m \cos\theta \tan\phi$

$\therefore$ $\tan\phi = \tan\theta$

$\therefore$ $\theta = \phi = 35°$

106. (d)

Capillarity permeability test is used to determine the coefficient of permeability of unsaturated soil.

Capillary flow analog is a method used for constructing flow Net.

Consolidation test is sometimes used to determine the coefficient of permeability of clayey soil.

107. (a)

108. (c)

Vibrofloatation is used for in-situ densification of loose granular soil.

In graded filter, the filter are provided such that each layer is coarser than the one below.

109. (d)

The timber, which is the sawn or milled wood, has inherent structural characteristics.

110. (c)

The pith nourishes the plant in its young age.

111. (b)

112. (b)

113. (d)

Aggregates are not just inert filler but their properties influence-workability, strength, stiffness, creep, etc. of mortar and concrete.

114. (d)

A 2:1:9 cement lime mortar contains two part of cement, one part of lime and nine parts of sand by volume.

115. (c)

The compressive strength of concrete is governed by its water-cement ratio.

116. (c)

Batching plant operators will have to compute the amount of water to be added by substracting the amount of free-water in aggregate from the amount of design free-water.

117. (b)

118. (d)

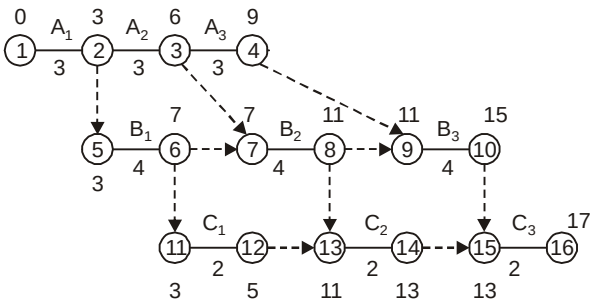
Angular Unconformity : Unconformity by different inclination and structural features.

Parallel Unconformity : Unconformity such that stratas remain parallel.

Non-conformity : Unformity based on geological origin of rock formations.

119. (a)

120. (c)



Alternate:

Modified duration:

$= \text{Max. of given days} + \frac{1}{3}(\text{sum of other})$

$= 12 + \frac{1}{3}(9+6)$

$= 17$ days

121. (b)

Nominal distribution reinforcement should be provided mainly to account for secondary moments due to poisson's effect and possible differential settlement, and also to take care of shrinkage and temperature effects.

122. (d)

Losses in case of pre-tensioned beam is more than losses is post-tensioned beam.

123. (d)

Earthquake load and wind load are not considered together while designing tall building.

124. (a)

125. (c)

Impact factor is used due to dynamic action of moving load. It is multiplied to static load even when gantry girder is effectively restrained laterally.

126. (c)

No stresses are developed in 3-hinge arch due to temperature rise.

127. (a)

128. (b)

129. (a)

We know, flexural stiffness

$$= \frac{\text{Flexural rigidity}}{\text{length}}$$

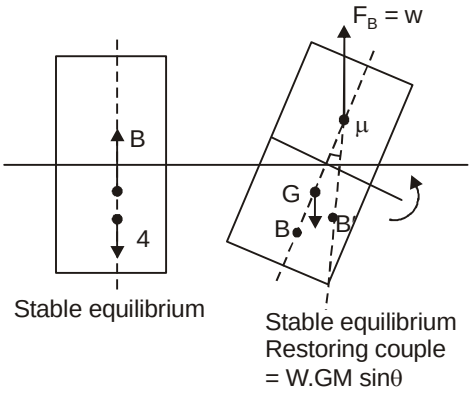
and Flexural rigidity of a beam = EI

where, I = MOI (Moment of Inertia)

130. (d)

131. (d)

132. (b)



133. (b)

134. (d)

Two contour do not intersect each other except in the cases of an overhanging cliff or a cave penetrating a hill side.

135. (a)

Due to introduction of Air vessel the flow condition will become more uniform so the friction losses will reduce and hence the power required will also reduce.

136. (b)

Rutting is a longitudinal depression or groove along the wheel lines.

If rutting is accompanied by adjacent building, it may be a sign of subgrade movement or weak pavement.

137. (a)

Construction R.C.C. through (ducts) involve various joints like expansion joints, contraction joints, sliding joints, construction joints.

To prevent leakage through these joints water bars or water stops made of rubber, PVC galvanized iron etc. are used.

138. (c)

A water logged soil is unsuitable for cultivation, reclamation of saline and alkaline lands is done.

139. (a)

Circular setting basins are circular in plan. Unlike the rectangular basin, circular basins are easily upset by wind, cross current. Because of its rectangular shape, more energy is required to cause circulation in rectangular basin; in contrast the content of the circular basin is conducive to circular stream lining. This condition may cause short circuiting of the flow. For this reason, circular basins are normally designed for diameter not exceeding 30 m.

140. (a)

All the sewer pipes are generally laid starting from their outfall ends, towards their starting ends. The advantage gained in starting from the tail end is the utilization of the tail length even during the initial period of its construction, thus ensuring that the functioning of the sewerage scheme has not to wait till the completion of the entire scheme.

141. (a)

It is preferred to carry out thickening before digestion, since digestion takes longer detention time than thickening. The volume of the digester would be much, much smaller when put after the thickener than when put before thickner.

142. (a)

An important method to control the production of leachate is to eliminate the infiltration of surface water from the landfill which is the major contributor to the total volume of the leachate. For this we use an impervious clay layer over the top of the fill at a descent slope, provided with adequate drainage and surface infiltration.

143. (b)

$$\text{Area ratio} = \frac{D_2^2 - D_1^2}{D_1^2} \times 100$$

D_1 = inside diameter of cutting edge

D_2 = outside diameter of cutting edge

< 20 for stiff clay

< 10 for sensitive clay

Rotary samples are double walled tube samplers with an inner removable liner. They are useful for sampling in firm to hard cohesive soils and rocks.

144. (b)

Negative skin friction acts in the same direction as the applied load hence it reduces the allowable load on piles.

As ground water table lowers, effective stress increases, which can cause consolidation of soil which causes downward drag on piles.

145. (b)

Effect of capillarity in a sand bed is to increase it's effective vertical stress or it's stiffness.

A plate load test is of short duration. Hence reason is also correct but is not the correct explanation of statement 1.

146. (a)

147. (d)

Glass by definition is not a ceramic material because it is an amorphous solid.

148. (a)

149. (b)

The modulus of elasticity of aluminium is 68.9Gpa as compared to 206.7Gpa for steel.

150. (a)