Solutions

1. Ans. C.
Given $2x+3y=5$
$3x+py=10$

$$\Rightarrow \begin{bmatrix} 2 & 3 \\ 3 & p \end{bmatrix}\begin{bmatrix} x \\ y \end{bmatrix}=\begin{bmatrix} 5 \\ 10 \end{bmatrix}$$

AX = B

Augmented matrix $[A/B]=\begin{bmatrix} 2 & 3 & 5 \\ 3 & p & 10 \end{bmatrix}$

$$R_2 \rightarrow 2R_2\text{-}3R_1 \begin{bmatrix} 2 & 3 & 5 \\ 0 & 2p\text{-}9 & 5 \end{bmatrix}$$

System will have no solution if $\rho(A/B)\neq\rho(A)$

$\Rightarrow 2p-9=0$

$\Rightarrow p=\frac{9}{2}=4.5$

2. Ans. A.

We know that the approximated value of $\int_a^b f(x)dx$

obtained by trapezoidal rule is always greater than the analytical value.

$\therefore J > I$ where J =approximate value

I =analytical value

3. Ans. B.

$p(x,q)=q \quad \text{if } X=0$

$=1-q \quad \text{if } X=1$

$0 \quad \text{otherwise}$

given $q=0.4$

$\Rightarrow p(x,q)=0.4 \quad \text{if } X=0$

$=0.6 \quad \text{if } X=1$

$=0 \quad \text{otherwise}$

$\Rightarrow$

X	0	1
p (X=x)	0.4	0.6

Required value $=V(X)=E(X^2)-\{E(X)\}^2$

$E(X)=\sum x_i p_i=0\times0.4+1\times0.6=0.6$

$E(X^2)=\sum x_i^2 p_i=0^2\times0.4+1^2\times0.6=0.6$

$V(X)=0.6-(0.6)^2$

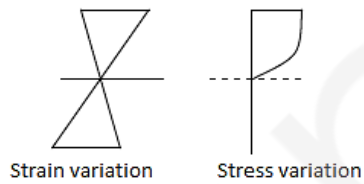
$=0.6-0.36$

$=0.24$

4. Ans. D.
As the slump increases, the Vebe time decreases. In this case statement (i) is incorrect.
Whereas statement (ii) is correct as if Vebe time decreases then compaction factor increases

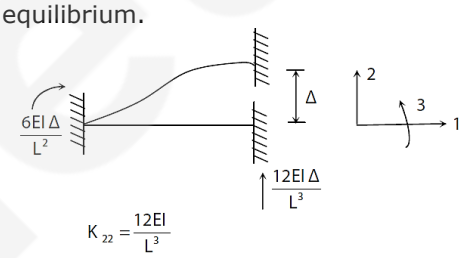
5. Ans. A.
(i) Air-entrainment reduces the water demand for a given level of workability-True
(ii) Use of air-entrained concrete is required in environments where cyclic freezing and thawing is expected.-True

6. Ans. B.
At



Hence, The variation of strain is linear and that of stress is non–linear.
So, Option (B) is correct answer.

7. Ans. B.
The ratio of the force acting on a linear mechanical system, such as a spring, to its displacement from equilibrium.



8. Ans. A.

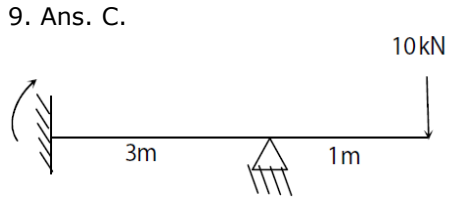
$L_d=\frac{\phi\sigma_s}{4\tau_{bd}}$ But for deformed bars τ_{bd} is increased by 60%.

So,

$$Ld=\frac{\phi\sigma_{st}}{4\times1.6\times\tau_{bd}}=\frac{\phi\sigma_s}{6.4\tau_{bd}}$$

So, k=6.4.

9. Ans. C.



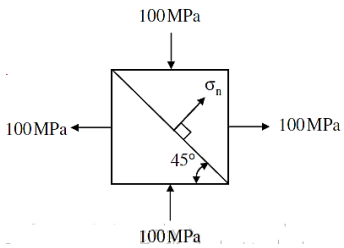
Since, $\frac{F\times D}{2}=\frac{10\times1}{2}=5\text{kN - m}$

So option (C) is correct answer.

10. Ans. A.

$$\sigma_n=\frac{\sigma_x+\sigma_y}{2}+\frac{\sigma_x\text{-}\sigma_y}{2}\cos2\theta$$

$$=\frac{100\text{-}100}{2}+\frac{100\text{-}(\text{-}100)}{2}\cos90=0$$



11. Ans. C.

$I_p = W_L - W_p = 40-28 = 12\%$

$$\text{Activity} = \frac{I_p}{C} = \frac{12}{100-60} = 0.3$$

12. Ans. B.

$V_s = \frac{V}{n} \quad \because$

So, $VS > V$ always

So, seepage velocity (V_S) can never by smaller than discharge velocity.

13. Ans. A.

As thickness of sampler increases, disturbance increases, So, Thinner the sampler wall, lower the degree of disturbance of collected soil sample is true for the above statement.

14. Ans. C.

In the given condition,

$$B = \frac{\Delta U}{\Delta\sigma_3} = \frac{80}{100} = 0.8$$

Where, ΔU = Increase in the pore pressure.

$\Delta\sigma_3$ = difference of cell pressure.

15. Ans. D.

Since, Liquefaction is due to cyclic loads, not due to high hydraulic gradient

So, optionD. is not the correct statement.

16. Ans. C.

Continuity equation

$$\frac{\partial}{\partial x}(\rho Y) + \frac{\partial}{\partial y}(\rho V) = 0$$

$$\Rightarrow \frac{\partial}{\partial x}(x) + \frac{\partial}{\partial y}\left(\frac{1}{x}.V\right) = 0$$

$$\Rightarrow 1 + \frac{\partial}{\partial y}\left(\frac{V}{x}\right) = 0 \Rightarrow \frac{\partial}{\partial y}\left(\frac{V}{x}\right) = -1$$

$$\Rightarrow V = -xy$$

17. Ans. B.

All fluids are compressible - even water - their density will change as pressure changes. Under steady conditions, and provided that the changes in pressure are small, it is usually possible to simplify analysis of the flow by assuming it is incompressible and has constant density. As you will appreciate, liquids are quite difficult to compress - so under most steady conditions they are treated as incompressible. In some unsteady conditions very high pressure differences can occur and it is necessary to take these into account - even for liquids. Gasses, on the contrary, are very easily compressed, it is essential in most cases to treat these as compressible, taking changes in pressure into account.

Hence, the direction of flow for steady incompressible flow through a closed–conduit of uniform cross–section will always be from higher to lower pressure

18. Ans. C.

$$Q = \frac{1}{n}.AR^{\frac{2}{3}}S^{\frac{1}{2}} \Rightarrow Q_{full} = \frac{1}{n}.\frac{\pi}{4}.D^2.\left(\frac{D}{4}\right)^{\frac{2}{3}} s^{\frac{1}{2}}$$

$$Q_{half} = \frac{1}{n}.\frac{\pi D^2}{8}.\left(\frac{D}{4}\right)^{\frac{2}{3}} s^{\frac{1}{2}}$$

$$\frac{Q_{full}}{Q_{half}} = 2$$

19. Ans. B.

P-Gross Command Area=1000 ha
Q-Permanent Wilting Point=0.12
R-Duty of canal water=100 ha/cumec
S-Delta of wheat=40 cm

So, Option (b) is correct answer.

20. Ans. C.

Kjeldahal Nitrogen (TKN) is the sum of organic nitrogen and ammonia in sewage

Total Kjeldahl Nitrogen (TKN) = Ammonia (60%) + Organic Nitrogen (40%)

Hence, Option (c) is correct answer.

21. Ans. A.

Let density of sludge is ρ

$$\frac{c_1 + c_2}{\rho} = \frac{c_1}{\rho_1} + \frac{c_2}{\rho_2}$$

$$\Rightarrow \rho = \frac{100}{\frac{c_1}{\rho_1} + \frac{c_2}{\rho_2}}$$

22. Ans. A.

The correct answer is 80. Because as the temperature rises from 25 to 60 degree Celsius, the viscosity of bitumen decreases and thus the penetration value should be more than 80 mm in any case.

23. Ans. D.

Free flow speed $\rightarrow$ Speed when flow is negligible

$\rightarrow$ Speed when density is negligible

$\rightarrow$ Affected by Geometry, deriver's perception, roadway condition etc.

24. Ans. B.
Mean Sea Level (MSL) is used as reference surface for establishing the vertical control and not horizontal control

25. Ans. D.

$$e = \sqrt{\ell} \qquad \sqrt{(0.3)^5 + (0.4)^2} = 0.5\text{m}$$

Relative precision $= \dfrac{0.5}{1000} = 1:2000$

26. Ans. D.

$$\text{Let } A = \begin{bmatrix} 3 & -2 & 2 \\ 4 & -4 & 6 \\ 2 & -3 & 5 \end{bmatrix}$$

Characteristic equation is

$$|A - \lambda I| = 0$$

$$\Rightarrow \begin{vmatrix} 3-\lambda & -2 & 2 \\ 4 & -4-\lambda & 6 \\ 2 & -3 & 5-\lambda \end{vmatrix} = 0$$

$$\Rightarrow \lambda^3 - 4\lambda^2 + 5\lambda - 2 = 0$$

$$\Rightarrow (\lambda - 1)(\lambda^2 - 3\lambda + 2) = 0$$

$$(\lambda - 1)(\lambda - 1)(\lambda - 2) = 0$$

$$\lambda = 1, 2$$

27. Ans. B.

$$f(x) = x^2 - 4x + 4$$

$$x_0 = 3$$

$$f'(x) = 2x - 4$$

By Newton Raphson method $x_1 = x_0 - \dfrac{f(x_0)}{f'(x_0)}$

$$= 3 - \frac{1}{2} = 2.5$$

For secant method let $x_0 = 2.5$ and $x_1 = 3$

By secant method $x_2 = x_1 - \dfrac{x_1 - x_0}{f(x_1) - f(x_0)} f(x_1)$

$$= 3 - \frac{(3 - 2.5)}{f(3) - f(2.5)} f(3)$$

$$= 3 - \frac{0.5}{1 - (0.25)} \times 1$$

$$= 3 - \frac{0.5}{0.75}$$

$$= 3 - 0.6667$$

$$= 2.333$$

28. Ans. C.
Given D.E

$$x(ydx + xdy)\cos\frac{y}{x} = y(xdy - ydx)\sin\frac{y}{x}$$

$$\Rightarrow x(ydx + xdy)\cos\frac{y}{x} + \left(-\sin\frac{y}{x}\right) y(xdy - ydx) = 0$$

$$\Rightarrow (ydx + xdy)\cos\left(\frac{y}{x}\right) + \left(-\sin\frac{y}{x}\right)\frac{y(xdy - ydx)}{x} = 0$$

$$\Rightarrow (ydx + xdy)\cos\left(\frac{y}{x}\right) + (xy)\left(-\sin\frac{y}{x}\right)\left(\frac{xdy - ydx}{x^2}\right) = 0$$

By observing, the above equation is $d\left((xy)\cos\dfrac{y}{x}\right) = 0$

By integrating, $xy\cos\left(\dfrac{y}{x}\right) = c$

29. Ans. A.

$$f(3) = \frac{9}{(z-1)(z+2)^2}$$

z = 1 is a simple pole
z = -2 is a pole of order 2

$$\left[\text{Res } f(z)\right]_{z=1} = \lim_{z \to 1}(z-1)\frac{9}{(z-1)(z+2)^2} = \frac{9}{9} = 1$$

$$\left[\text{Res } f(z)\right]_{z=2} = \frac{1}{1!}\lim_{z \to -2}\frac{d}{dz}\left[(z+2)^2 . \frac{9}{(z-1)(z+2)^2}\right]$$

$$= \lim_{z \to -2}\frac{-9}{(z-1)^2}$$

$$= \frac{-9}{9} = -1$$

30. Ans. D.

Let $u(x,y,z) = x^2 - 3yz$

$\vec{a} = i + j - 2k$ and $P(2, -1, 4)$

$$\nabla u = i\frac{\partial u}{\partial x} + j\frac{\partial u}{\partial y} + k\frac{\partial u}{\partial z}$$

$$= i2x + j(-3z) + k(-3y)$$

$$\nabla u|_{(2,-1,4)} = 4i - 12j + 3k$$

$$|\vec{a}| = \sqrt{1 + 1 + 4} = \sqrt{6}$$

directional derivative $= \nabla u.\hat{a}$

$$= (4i - 12j + 3k).\frac{(i + j - 2k)}{\sqrt{6}}$$

$$= \frac{4 - 12 - 6}{\sqrt{6}}$$

$$= \frac{-14}{\sqrt{6}} = -5.72$$

31. Ans. C.

$$\frac{M_C}{P_C}+\frac{M_S}{P_S}+\frac{M_a}{P_a}+V_W+V_a=1$$

$$\Rightarrow \frac{368}{3.14\times1000}+\frac{606}{2.67\times1000}$$

$$+\frac{1155}{2.74\times1000}+\frac{184}{1000}+V_V$$

$$=1.0$$

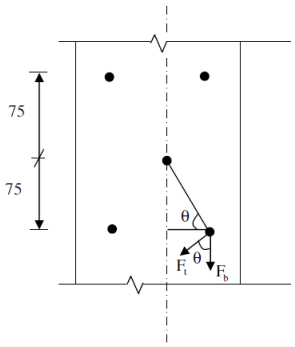
$\Rightarrow 0.117 + 0.227 + 0.421 + 0.184 + V_V = 1.0$

$\Rightarrow V_V = 0.051$

$=0.051\times1000=51\simeq50.32\ 1/m^3$

32. Ans. A.

$$F_D=\frac{P}{n}=\frac{100}{5}=20kN$$



$$F_t=\frac{(P.d)r}{\sum r^2}=\frac{100\times600\times75\sqrt{2}}{4\times\left(75\sqrt{2}\right)^2}=141.42kN$$

$$F_R=\sqrt{F_D^2+F_t^2+2\times F_D\times F_t\cos\theta}$$

$$=\sqrt{(20)^2+(141.42)^2+2\times20\times141.42\times\frac{1}{\sqrt{2}}}$$

$$=156.20kN$$

$$\cos\theta=\frac{1}{\sqrt{2}}$$

$$\Rightarrow\theta=45^\circ$$

33. Ans. C.

$$A_{st}=4\times\frac{\pi}{4}\times(12)^2=453mm^2$$

$$0.36f_{ck}.b.x_u=0.87f_yA_{st}$$

$$\Rightarrow x_v=\frac{0.87f_yA_{st}}{0.36f_{ck}.b}=\frac{0.87\times415\times453}{0.36\times25\times200}$$

$$=90.86mm$$

$x_{v,max}=0.48d$

$=0.4\times300=120mm$

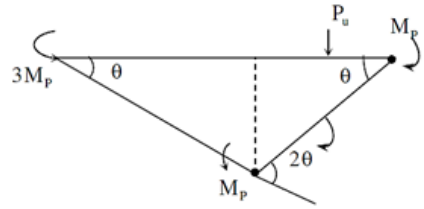
$x_v < x_{v,max}$ So U.R.section

$$M_v=0.87\times f_y\times A_{st}\times(d-0.42x_v)$$

$$=0.87\times415\times453(300-42\times90.86)=42.82kNm$$

34. Ans. A.

Mechanism-I

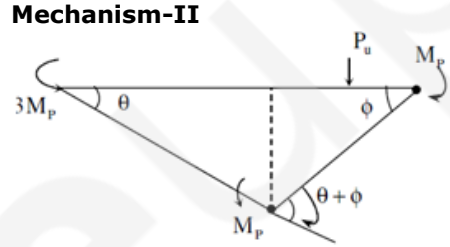


$$3M_p.\theta+M_p(2\theta)+MP.\theta=P_U\times\frac{L}{4}\times\theta$$

$$\Rightarrow 6M_p.\theta=P_U.\frac{L}{4}.\theta$$

$$\Rightarrow P_U=24\frac{M_p}{L}$$

Mechanism-II



$$1.\phi=3.\theta\Rightarrow\phi=3\theta$$

$$3M_p.\theta+M_p(\theta+\phi)+M_p.\phi=P_U\times\frac{L}{4}\phi$$

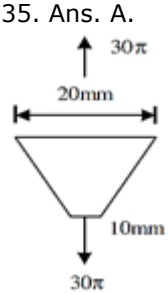
$$\Rightarrow 3M_p\ \theta+M_p(\theta+3\theta)+M_p.3\theta=P_U\times3\theta\times\frac{L}{4}$$

$$\Rightarrow 10M_p.\theta=P_U\times3\theta\times\frac{L}{4}$$

$$\Rightarrow P_U=\frac{40}{3}.\frac{M_p}{L}=13.33\frac{M_p}{L}$$

So, C = 13.33

35. Ans. A.



$$\Delta_1=\frac{4P.L}{\pi d_1d_2\times E}$$

$$=\frac{4\times30\pi\times2\times10^6}{\pi\times20\times10\times2\times10^5}$$

$$=6\ mm$$

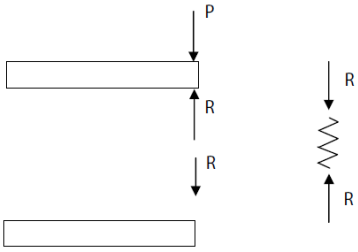
$$\Delta_2 = \frac{P \times L}{A_E}$$

$$= \frac{4 \times 30\pi \times 1.5 \times 10^6}{\pi \times 10 \times 10 \times 2 \times 10^5}$$

$$= 9\text{mm}$$

$$\Delta = \Delta_1 + \Delta_2 = 15\text{mm}$$

36. Ans. A.



$$\Delta = \frac{R}{K}$$

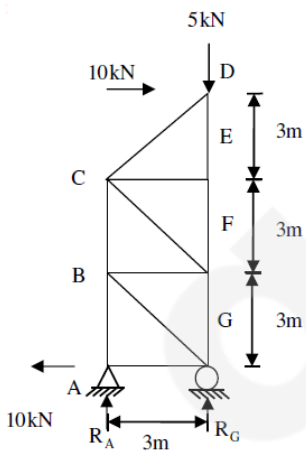
$$= \frac{R}{3EI} \times 2L^3$$

$$\Delta = \frac{2R.L^3}{3EI}$$

$$\frac{PL^3}{3EI} - \frac{RL^3}{3EI} = \frac{2RL^3}{3EI}$$

$$\Rightarrow \frac{PL^3}{3EI} = \frac{3RL^3}{3EI} \Rightarrow R = \frac{P}{3} = 33.33\%$$

37. Ans. A.

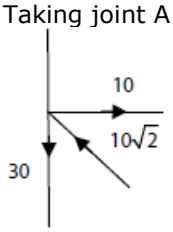


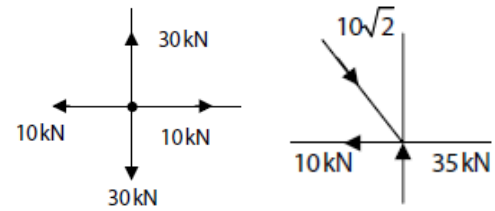
$$R_A \times 3 + 10 \times 9 = 0$$

$$\Rightarrow R_A = -30\text{kN}$$

$$R_G = 35\text{kN}$$

Taking joint A Joint G Joint B





$$F_x = 10\text{kN}$$

$$U = \frac{F^2 \times L}{2A_E} = \frac{10 \times 10 \times 3}{2 \times 30} = 5\text{kN} - \text{m}$$

38. Ans. B.

$$\frac{V}{1+e} = \frac{V_x}{1+e_1} = \frac{V_y}{1+e_2} = \frac{V_z}{1+e_3}$$

$$\gamma_d = \frac{G}{1+e}.\gamma_W \Rightarrow 16 = \frac{2.67}{1+e} \times 10$$

$$\Rightarrow e = 0.67$$

$$\frac{5000}{1.67} = \frac{V_x}{1.6} = \frac{V_y}{1.64} = \frac{V_z}{1.7} \quad \backslash$$

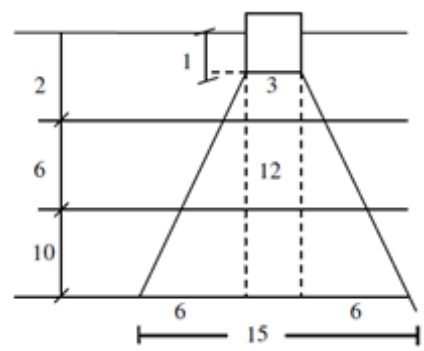
$$\Rightarrow V_x = 4790.42\text{m}^3$$

$$V_y = 4910.18\text{m}^3$$

$$V_z = 5089.82\text{m}^3$$

$C_x = C \times 4790.42 + 2 \times C \times 140$
$= 5070.42C$
$C_y = C \times 4910.18 + 2 \times C \times 80 = 5070.18C$
$C_z = C \times 5089.82 + 2 \times C \times 100 = 5289.82C$

39. Ans. B.



$$\text{Settlement} = \frac{C_C}{1+e_0} H_0 \log\left(\frac{\sigma_0 + \Delta}{\sigma_0}\right)$$

$$\sigma_0 = 15 \times 2 + (18-10) \times 6 + (18-10) * 5$$

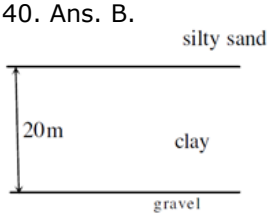
$= 118\text{kN/m}^2$

$$\Delta \quad \frac{1500}{\frac{\pi}{4}(3+6+6)^2} = 8.488 kN/m^2$$

$$\Delta \quad \frac{3}{1+0.7} \times 10 \log_{10}\left(\frac{118+8.488}{118}\right)$$

$= 0.0532\text{m}$
$\Delta H = 53.236\text{mm}$

40. Ans. B.



$$T_U = \frac{003 \times 2 \times 86400 \times 365}{\left(\frac{20}{2} \times 100\right)^2} = 0.189$$

$$\frac{\pi}{4} U^2 = 0.189 \Rightarrow U = 0.49 \le 60\%$$

$$\text{Consolidation} = \frac{30}{0.49} = 61.2.2\text{mm}$$

Degree of consolidation for 50mm settlement

$$U = \frac{50}{61.22} = 0.817 = 81.7\%$$

$$\Rightarrow T_v = 1.784 - 0.933 \log_{10}(100 - U)$$

$$= 0.608 = \frac{C_v \times t}{d^2}$$

$$\Rightarrow t = \frac{0.608 \times H^2}{0.003 \times 10^{-4}} = \frac{0.608 \times (10)^2}{0.003 \times 10^{-4}} S$$

$$= 202666667 \text{ s}$$

$$= 6.43\text{yr}$$

Additional number of years = $6.43 - 2 - 4.43$ years

41. Ans. A.

H_1	**(1)**	**K_1**	**Fine sand**
H_2	(2)	K_2	Silt
H_3	(3)	K_3	clay

$$k_2 = 10k_3 = \frac{1}{10} k_1$$

$$\Rightarrow k_1 = 10k_2$$

$$= 10 \times 10k_3$$

$$k_1 = 100k_3$$

$$k_1 = 10k_2$$

$$H_2 = 2H_1$$

$$H_2 = \frac{2}{3} H_3 \Rightarrow H_3$$

$$= \frac{3}{2} H_2 = \frac{3}{2} \times 2H_1 = 3H_1$$

$$H_3 = 3H_1$$

$$K_x = \frac{K_1H_1 + K_2H_2 + K_3H_3}{H_1 + H_2 + H_3}$$

$$= \frac{K_1H_1 + \frac{1}{10}K_1 \times 2H_1 + \frac{1}{100}K_1 \times 3H_1}{H_1 + 2H_1 + 3H_1}$$

$$K_x = \frac{\left(1 + \frac{2}{10} + \frac{3}{100}\right)K_1H_1}{6H_1} = \frac{123}{100 \times 6} K_1$$

$$K_y = \frac{H_1 + H_2 + H_3}{\frac{H_1}{K_1} + \frac{H_2}{K_2} + \frac{H_3}{K_3}}$$

$$= \frac{6H_1}{\frac{H_1}{K_1} + \frac{2H_1 \times 10}{K_1} + \frac{3H_1 \times 100}{K_1}}$$

$$\frac{K_x}{K_y} = \frac{123}{100 \times 6} \times \frac{321}{6} = 10.967$$

42. Ans. A.

$$q_{safc} = \frac{q_{nu}}{3}$$

$$q_{nu} = cN_c + qN_q + 0.5\gamma BN_\gamma - 8\Delta$$

$$C = 0$$

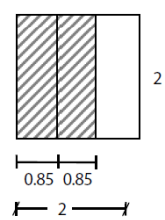
$$q_{nu} = q(N_q - 1) + 0.5\gamma BN\gamma$$

$$q_{ns} = \frac{1}{3}\left(q(N_q - 1)F_{qs} \times F_{qd} + F_{qp} + 0.5\gamma BN_\gamma \times F_{\gamma s} \times F_{\gamma o} \times F_{\gamma p}\right)$$

$$q_{ns} = \frac{1}{3}\left(\begin{array}{l} 18 \times 1(33.3 - 1) \times 1.314 \times 1.113 \times 0.444 + \frac{1}{2} \times 2 \times 18 \times \\ 37.16 \times 1.314 \times 1.113 \times 0.02 \end{array}\right)$$

$$= \frac{397.03}{3} = 132.364 \text{kN/m}^2$$

For one way shear (eccentricity) area to be reduced



Reduced area of footing $= 2 \times 1.7 = 3.4\text{m}^2$

Load carrying capacity $= 132.364 \times 3.4 = 450.\text{kN}$

43. Ans. A.

Total loss = 20 m

$$\Rightarrow 20 = \frac{0.5 \times v^2}{29} + \frac{f \times L}{d} \times \frac{v^2}{2g} + \frac{5.5v^2}{2g} + \frac{v^2}{2g}$$

$$\Rightarrow 20 \times 2 \times 10 = 0.5v^2 + \frac{0.03 \times 930 \times v^2}{0.3} + 5.5v^2 + v^2$$

$$\Rightarrow v^2 = \frac{400}{100} = 4$$

$$\Rightarrow v = 2\text{m/s}$$

$$\theta = \frac{\pi}{4} \times d^2 \times v = \frac{\pi}{4} \times (0.3)^2 \times 2 = 0.1413\text{m}^3/\text{s}$$

44. Ans. A.

$B = 2\text{m},\ y_2 = 0.8\text{m},\ U_2 = 1\text{m/s}$

$$F_2 = \frac{U_2}{\sqrt{g.y_2}} = \frac{1}{\sqrt{10\times 0.8}} = 0.35$$

$$\frac{y_1}{y_2} = -\frac{1}{2} + \frac{1}{2}.\sqrt{1+8F_2^2}$$

$$\Rightarrow \frac{y_1}{0.8} = \frac{-1}{2} + \frac{1}{2}.\sqrt{1+8\times(3.5)^2} = 0.203$$

$$\Rightarrow y_1 = 0.203\times 0.8 = 0.162\text{m}$$

$$Q = B.y_2.V_2 = B.y_1.V_1$$

$$\Rightarrow 0.8\times 1 = 0.162\times V_1$$

$$\Rightarrow V_1 = 4.94\text{m/s}$$

45. Ans. C.

Adverse slope $= -\dfrac{1}{10000}$

$$\theta = 4\text{m}^3/\text{s},\ n = 0.01,\ y = 0.5\text{m}$$

$$\frac{dy}{dx} = \frac{S_0 - S_f}{1 - F_r^2}$$

$$F_r = \frac{V}{\sqrt{gy}} = \frac{Q}{By\sqrt{gy}} = \frac{4}{2\times 0.5\times\sqrt{10\times 5}} = 1.79$$

$$Q = \frac{1}{n}AR^{2/3}\ S_f^{1/2}$$

$$S_f^{1/2} = \frac{Q\times n}{A\times R^{2/3}} = \frac{4\times 0.01}{2\times 0.5\times\left(\frac{2\times 0.5}{2+1}\right)^{2/3}}$$

$$S_f = 6.92\times 10^{-3}$$

$$\frac{dy}{dx} = \frac{\frac{1}{10000} - 6.92\times 10^{-3}}{1-(1.79)^2} = 3.2\times 10^{-3} = 0.0032$$

46. Ans. C.

$\dfrac{\rho v D}{\mu} = \text{Re} \rightarrow$ dimensionless parameter

$\dfrac{F_D\left(kg - m/s^2\right)}{\rho\left(\frac{kg}{m^3}\right)V^2\left(\frac{m^2}{s^2}\right)\times D^2\left(m^2\right)} \rightarrow$ Dimensionless parameter

47. Ans. A.

$$\frac{P_s}{N_s} = \frac{1}{3}\left[\frac{P_p}{N_p} + \frac{P_Q}{N_Q} + \frac{P_R}{N_R}\right]$$

$$\Rightarrow \frac{P_s}{980} = \frac{1}{3}\left[\frac{860}{780} + \frac{930}{850} + \frac{1010}{920}\right]$$

$$\Rightarrow P_s = 1076.20\text{mm}$$

48. Ans. A.

Time	UHO	S-curve Addition	S_A
0	0		0
2	0.6		0.6
4	3.1	0	3.1
6	10	0.6	10.6
8	13	3.1	16.1
10	9	10.6	19.6
12	5	16.1	21.1
14	2	19.6	21.6
16	0.7	21.1	21.8
18	0.3	21.6	21.9
20	0.2	21.8	22
22	0.1	21.9	22
24	0	22	22

Maximum S-curve ordinate is 22.

49. Ans. D.

1 m^3 of air has 30 mg SO^2

10^6 m^3 of air has 30g SO^2

$$= \frac{30}{64}\text{mol SO}^2$$

$$V = \frac{nRT}{P} = \frac{n}{P/RT} = \frac{30/64}{41.6}\frac{\text{mol}}{\text{mol/m}^3}$$

$$= \frac{30}{64\times 41.6} = 0.0113\text{m}^3$$

Concentration of SO^2 in ppm = 0.0113 ppm

50. Ans. B.

$$\%\ \text{removal} = \frac{V_s'}{V_s}\times 100$$

$$V_s' = 0.9V_s$$

$$= \frac{0.9\times 40}{86400}\,\text{m/s}$$

$$\Rightarrow \frac{1}{18}\times d^2\times\frac{g}{\mu}\left(\rho_S-\rho_w\right)=\frac{0.9\times 40}{86400}$$

$$\Rightarrow d=\sqrt{\frac{0.9\times 40\times 18\times V.\rho_w}{86480\left(G_S-1\right)\times\rho_w\times g}}$$

$$\Rightarrow d = 22.58\mu m$$

51. Ans. B.

$$\frac{dV}{dt}=\left(\alpha-\beta V_o\right)e^{-\beta T}$$

$$\int dv=\int\left(\alpha-\beta V_o\right)e^{-\beta T}.dt$$

$$=\frac{\left(\alpha-\beta V_o\right)e^{-\beta T}}{-\beta}$$

$$t=0, V=V_0$$

$$\Rightarrow V_0=\frac{\left(\alpha-\beta V_o\right)}{-\beta}+C$$

$$C=V_0+\frac{\alpha-\beta V_o}{\beta}\Rightarrow C=\frac{\alpha}{\beta}$$

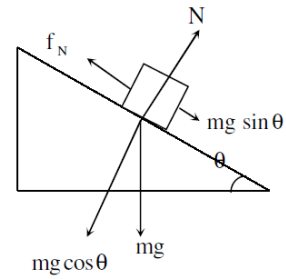
$$\Rightarrow V=\frac{\alpha-\left(\alpha\beta V_o\right)\times e^{-\beta t}}{\beta}$$

$$x=\frac{\alpha t_0}{\beta}+\frac{1.3}{\beta^2\left(e^{-3\beta}\right)}\left(e^{-\beta t_0}-1\right)$$

$$=\frac{2\times 35}{0.05}+\frac{1.3\left(e^{-35\times 0.05}-1\right)}{(0.05)^2\left(e^{-3\times 0.05}\right)}$$

$$=1400-499.17=900.83m$$

52. Ans. A.



$$f_N \geq mg\sin\theta$$

$$\Rightarrow f\left(mg\cos\theta\right)=mg\sin\theta$$

$$\Rightarrow f\geq\tan\theta$$

$$\Rightarrow f\geq e$$

$$\Rightarrow e\leq f$$

53. Ans. A.
For a 6/6 person, driver can see from a distance of 48 m.
For a 6/9 person, driver can see from distance =
The vehicle requires 174 m to show down to 30 km/hr
So, minimum distance,

54. Ans. A.
In Surveying by Law of weights, the weight of sum of two measurements is given as,

$$A + B = \frac{1}{\frac{1}{W_1}+\frac{1}{W_2}}$$

$$\text{Here } X + Y + Z = \frac{1}{\frac{1}{W_X}+\frac{1}{W_Y}+\frac{1}{W_Z}}$$

55. Ans. C.

$$\delta = 2^\circ$$

Magnetic F.B. of AB $= N79^\circ$

Correct FB of OA $= N50^\circ$

∴ Correct B.B of OA $= 129^\circ$

∵ observed F.B. of AO = observed BB of OA

$= 552^\circ$

Error = M.V – T.V $= -2^\circ$

Correction $+2^\circ$

T.B. of FB of AB $= N79^\circ$

$= N84^\circ$

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