ACE Engineering Academy
Head Office : Sree Sindhi Guru Sangat Sabha Association, # 4-1-1236/1/A, King Koti, Abids, Hyderabad - 500001.
Ph: 040-23234418, 040-2324419, 040-2324420, 040-24750437
Hyderabad | Kukatpally | Kothapet | Delhi | Bhopal | Patna | Pune | Bhubaneswar | Lucknow | Bengaluru | Chennai | Vijayawada | Vizag | Tirupati | Kolkata | Ahmedabad

ESE- 2020 (Prelims) - Offline Test Series **Test- 22**

CIVIL ENGINEERING

FULL LENGTH MOCK TEST-2 (PAPER-II) SOLUTIONS

01. Ans: (c)

Sol: The bearing capacity of a footing on a clayey soil does not change with increase in the width of the footing.

02. Ans: (a)

Sol: Pycnometer method can be used for determining the water content of soil only if specific gravity of that soil is known.

03. Ans: (b)

Sol: Representative samples can be both disturbed and undisturbed in nature.

04. Ans: (c)

Sol: $q_u = 2\ C_u \tan \alpha_f$

$90 = 2\ C_u \tan 60^o$

$90 = 2 \times C_u \times 1.732$

$C_u = 25.98 \simeq 26\ kN/m^2$

05. Ans: (b)

Sol: CNS layer refers to a cohesive non swelling layer.

06. Ans: (b)

Sol: Permeate is considered as incompressible.

07. Ans: (d)

Sol: Below the clay,

$\sigma = 20\ (7 - y)$

$u = 10\ (4)$

$\sigma' = \sigma - u$

If $\sigma' = 0$, heave occurs

$\therefore\ 0 = 20\ (7 - y) - 10 \times 4$

$y = 5$ m

08. Ans: (a)

Sol: Critical void ratio depends on cell pressure in triaxial test.

09. Ans: (b)

Sol: $F = \frac{i_c}{i} \Rightarrow i = \frac{i_c}{F} = \frac{(G-1)(1-n)}{F}$

$$= \frac{(2.80-1)(1-0.60)}{3} = 0.24$$

10. Ans: (d)

Sol: $V_s = \frac{V}{n}$

$$= \frac{19\times10^{-6}}{0.65} \simeq 3 \times 10^{-5} \text{ m/s}$$

11. Ans: (d)

12. Ans: (a)

Sol: $Q_{design} = \frac{Q_{mean}}{c_f t_f} = \frac{2.5}{0.8\times0.75}$

$= 4.16$ cumec ≈ 4.2 cumec

13. Ans: (b)

Sol: $y_{supplied} = 240$ mm

$y_{reqd} = S\times d \times [FC - mc]$

$$= \frac{1600}{1000} 0.8\left[\frac{35-20}{100}\right] = 0.192 \text{ m}$$

$= 192$ mm

$$\% \text{ water wasted } = \frac{240-192}{240}\times100 = 20\%$$

14. Ans: (b)

Sol: Rabi

$$Q = \frac{Ad_w}{t} = \frac{3600 \times 10^4 \times 13.5 \times 10^{-2}}{4 \times 7 \times 24 \times 60 \times 60} = 2 \text{ cumec}$$

Khariff

$$Q = \frac{Ad_w}{t} = \frac{1400 \times 10^4 \times 19 \times 10^{-2}}{2.5 \times 7 \times 24 \times 60 \times 60}$$

$= 1.76$ cumec

Greater value = 2 cumec

15. Ans: (b)

Sol: $f = \frac{dw}{C_u} = \frac{0.75\ Sd[FC - PWP]}{C_u}$

$$= \frac{0.75 \times 1.3(700)}{12}\left(\frac{30-11}{100}\right)$$

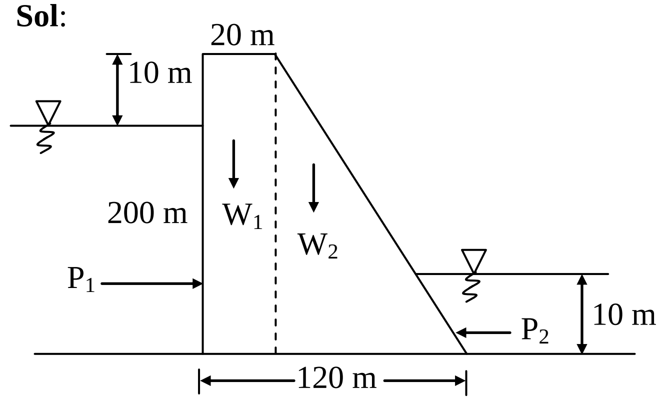
= 10.8 days = 11 days

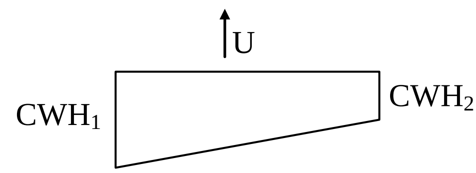
16. Ans: (c)

Sol: Evapotranspiration can not be completely eliminated, which is impossible. Other factors are true.

17. Ans: (d)

Sol:





$$\sum M_R = W_1x_1 + W_2x_2 + P_2\frac{H_2}{3}$$

$= (25 \times 20 \times 210)\ (110)$

$$+\left(25 \times \frac{1}{2} \times 210 \times 100\right)\left(\frac{2}{3} \times 100\right) + \frac{10(10)^3}{6}$$

$\Sigma M_R = 29.05 \times 10^6$ N-mm

$$\sum M_O = P_1\frac{H_1}{3} + Ux_u$$

$$= \frac{10(200)^3}{6} + \left(\frac{120}{2} \times 10(200+10)\right)\left(\frac{2(200)+10}{200+10}\right)\left(\frac{120}{3}\right)$$

$\Sigma M_O = 23.17 \times 10^6$ N-mm

$$FSOT = \frac{\sum M_R}{\sum M_O} = \frac{29.05 \times 10^6}{23.17 \times 10^6} = 1.25$$

18. Ans: (c)

Sol: Canal above drain Type - I

Drain under pressure

$\therefore$ Siphonic action

$\Rightarrow$ siphon aqueduct

19. Ans: (c) **20. Ans: (c)**

21. Ans: (d) **22. Ans: (a)**

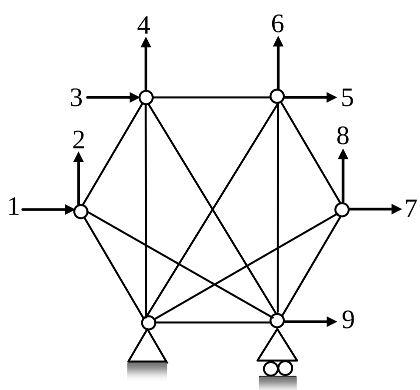
23. Ans: (a) **24. Ans: (c)**

25. Ans: (b)

Sol: Number of joints, j = 6

Number of independent external reaction components r = 2 + 1 = 3

$$D_k = 2 \times 6 - 3 = 9$$



26. Ans: (c)

Sol: Let L = 2 l

Span AB treated as fixed beam collapse mechanism $W_c = \dfrac{8M_p}{\ell}$

Span BC treated as fixed beam collapse mechanism

$$W_c = \frac{16M_p}{L^2} \Rightarrow W_c = w_c XL = \frac{16M_p}{L}$$

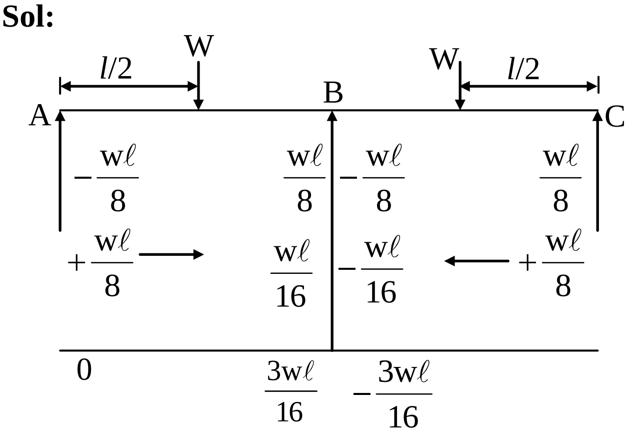
$$W_c = \frac{16M_p}{2\ell} = \frac{8M_p}{\ell}$$

Since both the spans have got same collapse load valves they will both collapse at a time

27. Ans: (c)

28. Ans: (a)

Sol:



Moment at $B = \dfrac{3w\ell}{16}$

Free moment in AB = $\dfrac{w\ell}{4}$

Moment at B = $\dfrac{3}{4}\left(\dfrac{w\ell}{4}\right)$

$= \dfrac{3}{4}$ moment in AB

= 0.75 moment in AB

29. Ans: (d)

30. Ans: (b)

Sol: $L = \frac{10}{0.92} \times 10 = 108.7 \text{ m}$

$B = \frac{8}{0.92} \times 10 = 86.96 \text{ m}$

31. Ans: (d)

Sol: Limiting length of offset (or)

maximum length of an offset (l) = $\frac{0.25 \times S}{\sin\theta}$

Given S = 1000 mm, $\theta = 1.5^o$

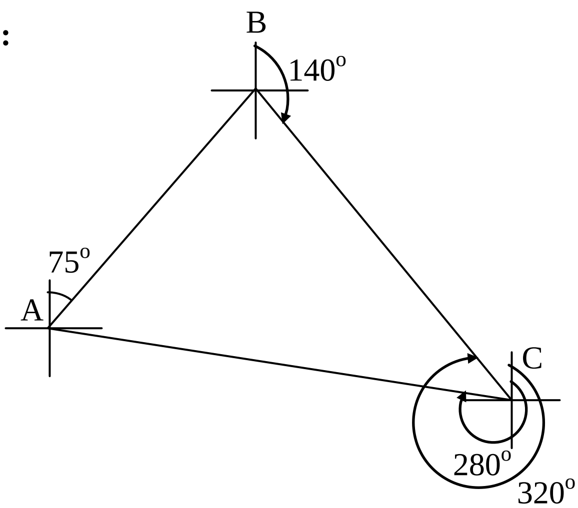
$\ell = \frac{0.25 \times 1000}{\sin(1.5^o)}$

= 9550 mm = 9.55 m

32. Ans: (c)

33. Ans: (c)

Sol:



Angle at C = $320^o - 280^o$

$= 40^o$

34. Ans: (b)

Sol: Since P is free from local attraction

$FB_{PQ} = 40^o$

$BB_{PQ} - FB_{PQ} = 181^o \neq 180^o$

$\therefore$ Station Q is effected by 1^o

Apply correction -1^o at station B

$\therefore$ $FB_{QR} = 102^o - 1^o = 101^o$

Bearing of RQ = $101^o + 180^o = 281^o$

35. Ans: (d)

Sol: Displacement of point = 200 mm

Scale, 1 cm = 20 m

$RF = \frac{1 \text{cm}}{20 \text{ m}} = \frac{1 \text{cm}}{20 \times 100 \text{ cm}} = \frac{1}{2000}$

Displacement of a point from its true position

$= 200 \times \frac{1}{2000} = 0.1 \text{ mm}$

36. Ans: (b)

Sol: $\alpha = \frac{S}{nD}(206265)$

$= \frac{(1.55 - 1.45)}{3 \times 200}(206265) = 34.38 \text{ sec}$

37. Ans: (a)

Sol: Total error, e = $-\frac{1}{2}[(h_a - h_b) - (H_a - H_b)]$

$e_{col} = e - e_{cur} + e_{ref}$

$e_{col} = e$ ($\because$ d = 0)

$e = -\frac{1}{2}[(1.52 - 2.32) - (1.54 - 2.26)]$

= 0.04 m

38. Ans: (a)

Sol: True difference in elevation between A and B

$= (2.225 - 0.06735 \times 1.475^2) - 0.455$

$= 1.624$ m

39. Ans: (c)

Sol:

BS	IS	FS	Rise	Fall	RL
0.750					100.50
	1.65			–0.9	
	2.35			–0.7	
1.95		3.55		–1.2	
2.15		2.65		–0.7	
		3.75		–1.6	95.40

$$\text{Gradient} = \frac{100.50 - 95.40}{150}$$

$= 1$ in 29.4

40. Ans: (a)

41. Ans: (b)

Sol: In full face method since tunneling is done in one operation large equipment is required.

In Drift method since tunneling is carried in smaller section, speed of construction is slow.

42. Ans: (a)

Sol: Primecoat is an application of low viscous cutback bitumen to granular bases

Base course is composed of crushed stone or crushed slag etc

Binder course consists of aggregates with less asphalt.

Sub grade is a compacted layer of natural soil.

43. Ans: (c)

Sol: Actuated signal timing is completely depends on traffic volumes, and it is detected through sensors at all the approaches. Actuated signals are used to reduce vehicle delay. It is flexible and can accommodate the small fluctuations (minor changes) in traffic flow. It provides frequent operation under the low density conditions. These systems are very effective only at multiple phase intersections. This system will lead to increased capacity.

44. Ans: (d)

Sol: Time delay studies are carried by

(a) Floating car method

(b) License plate method

(c) Elevator observer method

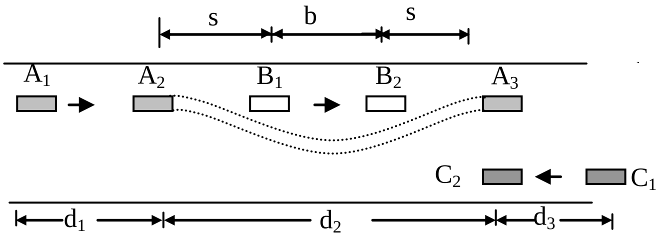
(d) Maximum car method

(e) Photographic method

(f) Moving vehicle method

45. Ans: (a)

Sol:



Distance travelled by vehicle B during the overtaking operation is from B_1 to B_2 and is given by d = $v_b T$

$$T = \sqrt{\frac{4S}{a}} = \sqrt{\frac{4\times16}{1}} = 8\text{sec}$$

d = 0.278 × 40 × 8 = 88.96m

46. Ans: (a)

Sol: 30/40 implies penetration value is in the range of 30 to 40. For hot climates low penetration value is preferred. Hence 30/40 is suitable.

47. Ans: (a)

Sol: With increase in the bitumen content

- Flow value increases
- Stability value increases, reaches maximum and then decreases
- Unit weight increases, reaches maximum and then decreases

48. Ans: (d)

Sol: Radius of taxiway

$$= \frac{V^2}{125f} = \frac{120^2}{125\times0.13} = 886.15\,\text{m}$$

Friction coefficient is considered as 0.13

49. Ans: (d)

Sol: The land surface along the coast line must be fully hard so that frequent repairs are not required. If the coast is sandy, intermittent repairs to docks and port buildings will have to be carried out frequently making the maintenance more expensive.

50. Ans: (b)

Sol: Since there are no turning movements, number of phases = 2

Lost time per phase = amber time + inter green time + start delay

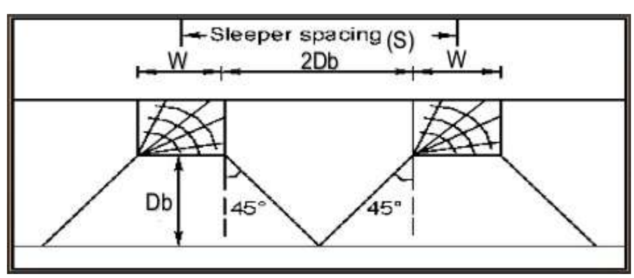
= 4 +2+3 = 9sec

Total lost time per cycle = 2×9 = 18sec.

51. Ans: (a)

Sol: Assuming the load distribution as 45° as shown in the figure, clear Spacing between the sleepers = 2(depth of ballast)

Depth of the ballast required = 60/2 = 30cm



52. Ans: (c)

Sol: Since friction is neglected

$$e = \frac{V^2}{127R} = \frac{80^2}{127 \times 800} = 0.063$$

e = 0.063

Raise of outer edge w.r.t inner edge

= 0.063 × 7.5 = 0.4725m = 47.25cm

53. Ans: (b)

Sol:

T(hr)	0-0.5	0.5-1	1-1.5	1.5-2	2-2.5	2.5-3	3-3.5
i(mm/hr)	25	40	30	45	85	120	45
P = i×t, mm	12.5	20	15	22.5	42.5	60	22.5

$P_e = 20 + 22.5 + 42.5 + 60 + 22.5 = 167.5$

$$\phi\text{-index} = \frac{P_e - R}{t_e} \qquad \because t_e = 2.5 \text{ hr}$$

$$35 = \frac{167.5 - R}{2.5}$$

R = 80 mm

54. Ans: (c)

55. Ans: (b)

Sol: 2, 3 and 4 are correct

Coefficient of Transmissibility is also constant at all places and at all time

56. Ans: (b)

Sol: Volume of water evaporated = $A \times C_p \times E_p$

$\because$ IS pan assume, $C_p = 0.8$

$= (100 \times 10^6) \times 0.8 \times \frac{150}{100}$

= 12000 ha-m

$= 1.2 \times 10^4$ ha- m

57. Ans: (b)

Sol:

- Torsional effects of ground motion are predominant in long narrow rectangular blocks. Therefore, it is desirable to restrict the length of a block to three times its width. If longer lengths are required two separate blocks with sufficient separation in between should be provided. Hence statement I is wrong.
- A building with properly interconnected walls acts like a rigid box since the earthquake strength which long walls derive from transverse walls increases as their length decreases. Therefore structurally it is better to have separately enclosed rooms rather than one long room. For unframed walls of thickness ‘t’ and wall spacing of ‘a’, the maximum permissible ratio of a/t is 40.
- For preventing hammering or pounding damage in large building with several blocks, a physical separation of (3 to 4 cm for 3 storeyed building) throughout the height above the plinth level is

preferred. The separation section can be treated just like expansion joint or it may be filled or covered with a weak material which would easily crush and crumble during earthquake shaking

58. Ans: (b)

Sol: Minimum thickness of shear wall in any zone is 150 mm.

59. Ans: (b)

Sol: The stress in the tendon of a post-tensioned member attains the prestress at the anchorage block. There is no requirement of transmission length or development length

60. Ans: (d)

Sol: Loss due to anchorage slip

$= \Delta Es/L$

$= 5 \times 2 \times 10^5 / (10 \times 1000)$

$= 100$MPa

61. Ans: (d)

Sol: In doubly reinforced sections it is assumed that plane section remains plane before and after bending. Hence strain variation is linear.

Since reinforcement is provided in compression side also, deflections due to shrinkage are reduced and section remains safe under reversal of stresses due to wind, seismic forces etc.

62. Ans: (b)

Sol: For balanced section ; in Fe 415 steel depth of neutral axis = 0.48d

$0.36\, f_{ck}\, bx_u = 0.87\, f_y\, A_{st}$

$0.36\, f_{ck} b\, (0.48d) = 0.87\, f_y\, A_{st}$

$$\frac{A_{st}}{bd} = \frac{0.36 f_{ck} \times 0.48}{0.87 f_y} = \frac{0.36 \times 20 \times 0.48}{0.87 \times 415}$$

$$\frac{A_{st}}{bd} \times 100 = \frac{0.36 \times 20 \times 0.48}{0.87 \times 415} \times 100 = 0.96\%$$

63. Ans: (a)

Sol: Assuming the development of bond stress (u_{avg}) as uniform over the length L,

$\pi \phi L u_{avg} = \frac{\pi}{4} \phi^2 f_s$ (f_s = maximum stress at critical section = $0.87 f_y$)

$$u_{avg} = \frac{\phi f_s}{4L} = \frac{16 \times 0.87 \times 500}{4 \times 750} = 2.32 \text{ MPa}$$

64. Ans: (c)

Sol: As per IS 456, for a column braced against sideway, both ends fixed rotationally effective length is $0.65\, l = 0.65 \times 4 = 2.6$m

65. Ans: (b)

Sol: In case of toe slab, the forces acting are

- self weight of the concrete in toe slab
- gross soil pressure acting upwards

Hence the net loading is acting upwards .

In case of heel slab, the forces acting are

- self weight of the concrete in heel slab
- gross soil pressure acting upwards
- downward pressure due to retained soil

Hence the net loading is acting downwards .

The stem of retaining wall is designed to support the retained soil. It is designed as vertical cantilever fixed at base. Hence the tension is produced on the soil face of the wall. So, the reinforcement is placed near soil face of the wall

66. Ans: (b)

Sol: Shear strength/Resistance = μ.T

$= 0.4 \times 900$

$= 360$ kN

67. Ans (a) **68. Ans: (a)**

69. Ans: (d)

Sol: A member normally acting as a tie in a roof truss or a bracing system, when is subjected to possible reversal of stresses resulting from the action of wind (or) earth forces, the maximum slenderness ratio is 350.

$$r_{min} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{\frac{\pi}{64}.d^4}{\frac{\pi}{4}.d^2}} = \frac{d}{4}$$

$$r_{min} = \frac{18}{4} = 4.5 \text{ mm}$$

$$\lambda = \frac{L_{max}}{r_{min}}$$

$L_{max} = 4.5 \times 350 = 1575$ mm

70. Ans: (c)

71. Ans: (a)

Sol: $d_o = 16 + 2 = 18$ mm

$A_n = (B - nd_o).t$

$= (320 - 1 \times 18) \times 10$

$= 3020 \text{ mm}^2$

72. Ans: (a) **73. Ans: (c)**

74. Ans: (d)

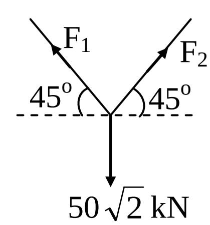
Sol: Let F_1 , F_2 be the forces in AB, BC

For equilibrium:

(i) $\Sigma F_x = 0$

$\Rightarrow F_1 \cos 45^o = F_2 \cos 45^o$

$\therefore F_1 = F_2$



(ii) $\Sigma F_y = 0$

$\Rightarrow F_1 \sin 45^o + F_2 \sin 45^o = 50\sqrt{2}$

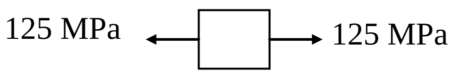
$$\Rightarrow \quad \frac{2F_1}{\sqrt{2}} = 50\sqrt{2}$$

$\Rightarrow \quad F_1 = 50 \text{ kN} = F_2$

Average normal stress in AB

$$= \frac{F_1}{A} = \frac{50 \times 1000}{20 \times 20} = 125 \ \text{MPa}$$

Stress condition:



Since no shear stress is present, this corresponds to principal stress i.e., σ_1 = 125 MPa ; σ_2 = 0 MPa

75. Ans: (c)

Sol: For bars connected in parallel, equivalent Young's Modulus

$$= \frac{A_1E_1 + A_2E_2}{A_1 + A_2}$$

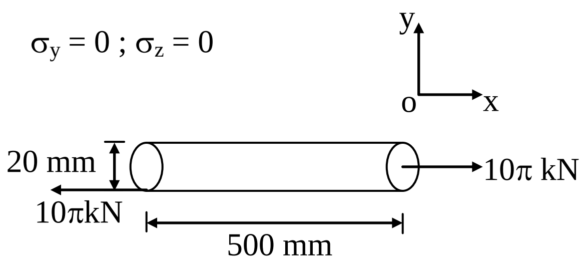
$$= \frac{(2\times2\times100)+(4\times4\times200)}{(2\times2)+(4\times4)}$$

= 180 GPa

76. Ans: (d)

Sol: $\sigma_x = \dfrac{10\pi\times10^3}{\frac{\pi}{4}\times20^2} = 100 \ \text{MPa}$

$\sigma_y = 0$; $\sigma_z = 0$



Volumetric strain

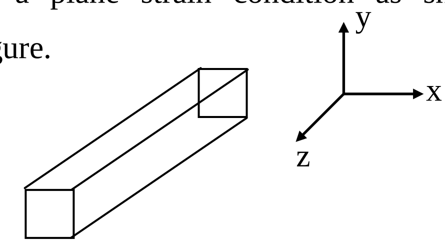
$$= \frac{(\sigma_x + \sigma_y + \sigma_z)}{E}\times(1-2\mu)$$

$$= \frac{(100+0+0)}{200\times10^3}\times(1-2\times0.25)$$

$= 0.25 \times 10^{-3}$

77. Ans: (b)

Sol: In a plane strain condition as shown in figure.



$\varepsilon_z = 0$

$$\Rightarrow \frac{\sigma_z}{E} - \mu\left(\frac{\sigma_x+\sigma_y}{E}\right) = 0$$

$\Rightarrow \sigma_z = \mu\,(\sigma_x + \sigma_y)$

78. Ans: (a)

Sol: For equilibrium

(i) $\Sigma F_y = 0$

$\Rightarrow R_A + R_B - 40 - 20 = 0$

$\Rightarrow R_A + R_B = 60$ kN

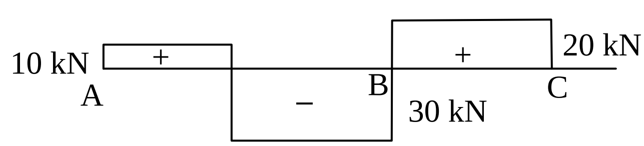
(ii) $\Sigma M_A = 0$

$\Rightarrow 40\,(2) + 20\,(6) - R_B\,(4) = 0$

$\Rightarrow \quad R_B = 50$ kN

$\therefore R_A = 10$ kN

SFD:



Maximum shear force = 30 kN

Average shear stress = $\frac{30\times10^3}{a^2}$

Maximum shear stress = $\frac{1.5\times30\times10^3}{a^2}\le0.5$

$$\Rightarrow a^2=\frac{1.5\times30\times10^3}{0.5}$$

$$\Rightarrow \quad a = 300\text{ mm}$$

79. Ans: (b)

Sol: $\sigma_1 = \sigma_x = \sigma$;

$\sigma_2 = \sigma_y = \sigma$;

$\sigma_3 = \sigma_z = -\sigma$;

From maximum principal strain theory

$\varepsilon<\frac{\sigma_y}{E}$ for no failure

$$\varepsilon_x=\frac{\sigma_x-\mu(\sigma_y+\sigma_z)}{E}=\frac{\sigma}{E}$$

$$\varepsilon_y=\frac{\sigma_y-\mu(\sigma_x+\sigma_z)}{E}=\frac{\sigma}{E}$$

$$\varepsilon_z=\frac{\sigma_z-\mu(\sigma_x+\sigma_y)}{E}$$

$$=\frac{-\sigma-0.25(\sigma+\sigma)}{E}$$

$$=\frac{-1.5\sigma}{E}$$

$$\therefore\frac{1.5\sigma}{E}<\frac{\sigma_y}{E}$$

$$\therefore\sigma_{MPST}<\frac{\sigma_y}{1.5}\qquad -----(1)$$

From maximum shear stress theory:

$\tau_{max}<\frac{\sigma_y}{2}$ for no failure

$$\tau_{max}=\max\left(\frac{\sigma_x-\sigma_2}{2}.\frac{\sigma_2-\sigma_3}{2},\frac{\sigma_1-\sigma_3}{2}\right)$$

$$\frac{\sigma-(-\sigma)}{2}\le\frac{\sigma_y}{2}$$

$$\Rightarrow\frac{\sigma-(-\sigma)}{2}=\frac{\sigma_y}{2}$$

$$\therefore\sigma_{MSST}<\frac{\sigma_y}{2}\qquad -----(2)$$

$$\frac{\sigma_{MPST}}{\sigma_{MSST}}=\frac{\frac{\sigma_y}{1.5}}{\frac{\sigma_y}{2}}=1.33$$

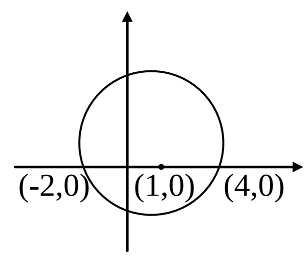
80. Ans: (c)

Sol: Stress invariant = sum of normal stresses on any two mutually perpendicular planes

$= \sigma_1 + \sigma_2$

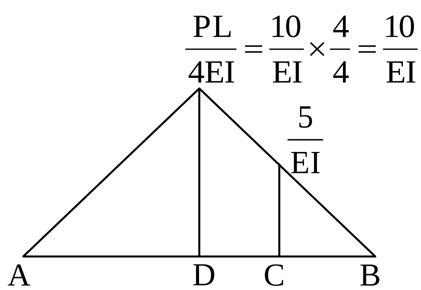
$= 4 - 2$

$= 2$ units



81. Ans: (d)

Sol:



Tangent at 'D' is horizontal

Using moment area theorem (1)

Slope at c = area of $\frac{M}{EI}$ diagram b/w 'D' & 'C'

$$= \frac{1}{2} \times 1 \times \left(\frac{10}{EI} + \frac{5}{EI}\right)$$

$$= \frac{7.5}{EI}$$

82. Ans: (b)

Sol: Vertical deflection at 'C' = Vertical deflection at B

$$= \frac{M\ell^2}{2EI}$$

$$= \frac{(10 \times 0.1) \times 4^2}{2 \times 2 \times 10^{12} \times 10^{-9}}$$

= 0.004 m = 4 mm

83. Ans: (a)

Sol: Eulers buckling stress is valid only upto proportional limit σ = 250 MPa

Buckling stress = $\frac{\pi^2 E}{\lambda_{eff}^2}$

$$\Rightarrow 250 = \frac{\pi^2 \times 200 \times 10^3}{\lambda_{eff}^2}$$

$$\Rightarrow \lambda_{eff}^2 = \frac{\pi^2 \times 200 \times 10^3}{250} \qquad (\pi^2 \approx 10)$$

$$\Rightarrow \lambda_{eff}^2 = \frac{4}{5} \times 10^4 \Rightarrow \lambda_{eff} = 89$$

84. Ans: (c)

Sol: $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{\ell}$

$$\therefore \quad \tau = \frac{TR}{J}$$

At point on the shaft ($R = \frac{40}{2} = 20$ mm)

$$\therefore \tau = \frac{2\pi \times 10^6 \times 20}{\pi \times \frac{40^4}{32}} = 500 \text{ MPa}$$

$\sigma_x = \sigma_y = 0$

$$\therefore \sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

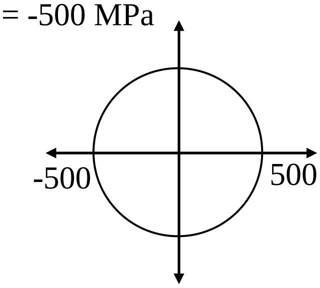
$$= \pm \tau_{xy}$$

$\therefore \sigma_1$ = 500 MPa ; σ_2 = -500 MPa

$\therefore$ Mohr's circle

Centre = (0, 0)

Radius = 500 units



85. Ans: (b)

Sol: Couple $= 10\text{kN} \frac{(100 + 100)}{1000}$

= 10 × 0.2 kN-m

= 2 kN-m

Maximum bending moment = 2kN-m

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

$$\Rightarrow \sigma = \frac{M}{I} \times y = \frac{2 \times 10^6 \times 200}{\left(\frac{200 \times 400^3}{12}\right)}$$

= 0.375 MPa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86. Ans: (c)

Sol: Due to the presence of internal hinges, the reaction at A, E are zero. Hence BD is a simply supported beam with span of 2 m.

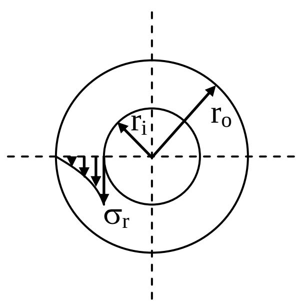
Deflection at c = $\frac{WL^3}{48EI}$

$$= \frac{48\times 2^3}{48EI} = \frac{8}{EI}$$

87. Ans: (b)

Sol: In a thick cylinder, under internal pressure, the radial stress distribution is

$$\sigma_r = \frac{P}{\left(\frac{r_o^2}{\eta^2}-1\right)}\left(1-\frac{r_o^2}{r_1^2}\right)$$



i.e., at $r = r_i$; $\sigma_r = -p$

$r = r_o$; $\sigma_r = 0$

i.e. atmospheric

88. Ans: (c)

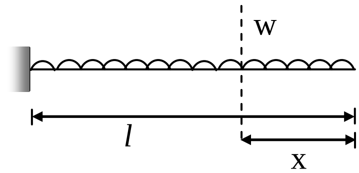
Sol: Work done on spring = $\frac{1}{2}W\delta$

$$= \frac{1}{2}\times W\times\frac{64WR^3n}{Gd^4}$$

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

89. Ans: (c)

Sol:



Strain energy = $\int_0^L \frac{M_x^2dx}{2EI}$

$$M_x = \frac{-wx^2}{2}$$

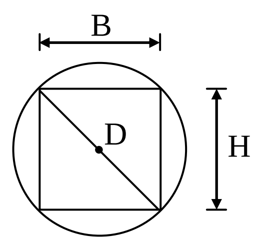
$$\therefore\ U = \frac{1}{2EI}\int_0^L\left(\frac{wx^2}{2}\right)^2 dx$$

$$= \frac{1}{2EI}\times\frac{w^2}{4}\times\frac{x^5}{5}\Big]_0^L$$

$$= \frac{w^2L^5}{40EI}$$

90. Ans: (c)

Sol:



$B^2 + H^2 = D^2$

$\Rightarrow H^2 = D^2 - B^2$

For maximum moment of resistance, section modulus is maximum

$$Z = \frac{BH^2}{6} = \frac{B\left(D^2-B^2\right)}{6}$$

$$\frac{dZ}{dB} = 0$$

$$\Rightarrow \frac{D^2}{6} - \frac{3B^2}{6} = 0$$

$$\Rightarrow B = \frac{D}{\sqrt{3}}$$

$$\therefore H^2 = D^2 - \frac{D^2}{3} = \frac{2D^2}{3}$$

$$\therefore \ H = D\sqrt{\frac{2}{3}}$$

$$\therefore \frac{B}{H} = \frac{\frac{D}{\sqrt{3}}}{D\sqrt{\frac{2}{3}}} = \frac{1}{\sqrt{2}}$$

91. Ans: (d)

Sol: In mass concrete structures, to reduce shrinkage cracks Low Heat Cement is preferred over Sulphate Resistant Cement (Sulphate Resistant Cement has heat of hydration similar to that of OPC). Both High Alumina Cement and Rapid Hardening Cement can be used in cold weather conditions. Since High Alumina Cement is very costly, generally Rapid Hardening Cement is preferred in such situations.

92. Ans: (d)

Sol: Bricks, Tiles, Stoneware and Earthenware are examples of clay ceramics. Glass is a made primarily from silica, not clay.

93. Ans: (a)

Sol: In the hydration of C_3S and C_2S, $Ca(OH)_2$ is released which has a major role in sulphate attack process. Hence, C_3S and C_2S have an indirect role in sulphate attack.

94. Ans: (b)

Sol: Both in English Bond and Flemish Bond, queen closers are generally used at the ends to keep the vertical joint staggered.

95. Ans: (b)

Sol: Both Hydration of cement and Slaking of lime are exothermic reactions.

96. Ans: (a)

Sol: As per IS code, for the manufacturing of Portland Pozzolana Cement, Fly ash or Fly ash + Calcined Clay must be used, not any other Pozzolana Material.

97. Ans: (d)

Sol: Strength of concrete is directly proportional to the size of coarse aggregate.

98. Ans: (a)

Sol: Due to rapid decrease in moisture content, timber seasoned with electrical seasoning gives very poor-quality timber. Best quality timber is obtained using natural seasoning.

99. Ans: (a)

Sol: From Bauxite, Aluminium is manufacturing using two processes. The first process is called Bayer's process, which is used to get pure alumina from the ore. The second process is called Hall Heroult's process, where this purified alumina is smelted into Aluminium metal.

100. Ans: (d)

Sol: Type C fly ash has cementitious properties; hence it is used for Soil Stabilization. Type F fly ash has no cementitious properties. It has only pozzolanic properties.

101. Ans: (c)

Sol: Flaky and Elongated aggregates decrease the workability as well as strength of concrete.

102. Ans: (c)

Sol: PVC is a thermoplastic while Epoxy is a thermosetting plastic.

103. Ans: (b)

Sol: Workability of concrete and Vee-Bee seconds are inversely proportional. That is, more the time taken for the concrete surface to become horizontal, less is its workability.

104. Ans: (d)

Sol: Smith's test is used to determine the presence of soluble matter in a stone while Acid test is used to determine the presence of calcium carbonate in a stone.

105. Ans:(d)

106. Ans:(d)

Sol: Given, A= 25ml

B = 200-25 = 175ml

$$\text{TON} = \frac{A+B}{A} = \frac{200}{25} = 8$$

107. Ans: (d)

Sol: L = 60 m, H = 3m Q = 1 m^3/sec

For 100% removal } $\frac{H}{V_s} \le \frac{L}{V_H} \Rightarrow \frac{H}{V_s} = \frac{L}{V_H}$

$$\Rightarrow V_s = V_H \times \frac{H}{L} = \frac{0.3}{60} \times \frac{3}{60}$$

$$V_s = \frac{1}{20 \times 200}\, \text{m/sec}$$

For 100% removal

$$V_o = V_s = \frac{1}{20 \times 200}\, \text{m/sec}$$

$$\text{Surface area} = \frac{Q}{V_o} = \frac{1}{\frac{1}{20 \times 200}} = 20 \times 200$$

=

4000 m^2

108. Ans: (b)

Sol: Break point Cl_2 dose

$= Cl_2$ dose – Free Cl_2 residual

$= 2 - 0.2 = 1.8$ mg/l

109. Ans: (c)

Sol:

$$Q_{max} = \frac{AIR}{360} = \frac{360 \times 1 \times \frac{1.2 \times 10}{24}}{360} = 0.5 m^3/sec$$

110. Ans: (b)

Sol: Manhole $\rightarrow$ Inspection and maintenance

Inlet $\rightarrow$ Admit storm water in to sewer

Eject $\rightarrow$ To transfer sewage from house sewer to street sewer

Trap $\rightarrow$ Water seal

111. Ans: (a)

Sol: BOD_5 = DO depletion × DF = $6 \times \frac{100}{2}$

= 300 mg/l

112. Ans: (b)

Sol: $X_V = 10000$ mg/l

$$SVI = \frac{10^6}{10000} = 100 \text{ m}l\text{/gm}$$

113. Ans: (a)

Sol: $P_1 = 98\%$, $P_2 = 98 - 2 = 96\%$

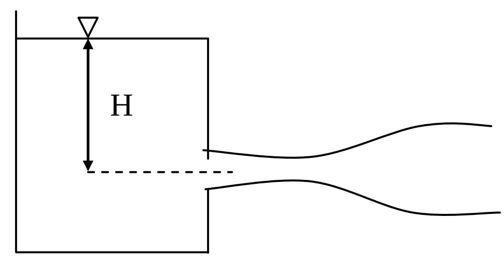
$$V_2 = \frac{100 - P_1}{(100 - P_2)} \times V_1$$

$$= \frac{100 - 98}{100 - 96} \times 16 \text{ m}^3 = \frac{2}{4} \times 16 = 8 \text{ m}^3$$

114. Ans: (d)

115. Ans: (d)

Sol:

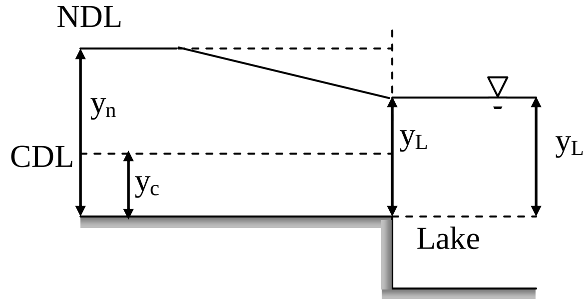


Convergent - divergent mouth pieces is made convergent upto vena contracta of jet and beyond that is made divergent according to profile of expanding jet.

* Due to sudden expansion, no loss of head & co-efficient of discharge is unity.

116. Ans: (a)

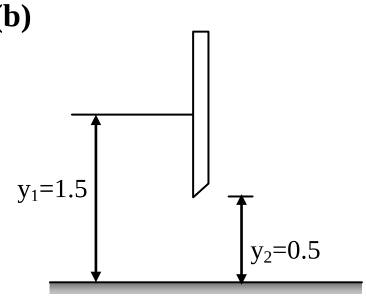
Sol:



Depth of flow in canal at outlet is "y_L" itself.

117. Ans: (b)

Sol:



As channel bottom is horizontal, assume frictionless and specific energy's are same

$$\therefore \frac{q^2}{g} = \frac{2y_1^2y_2^2}{y_1+y_2}$$

$$\frac{q^2}{10} = \frac{2\times1.5^2\times0.5^2}{15+0.5}$$

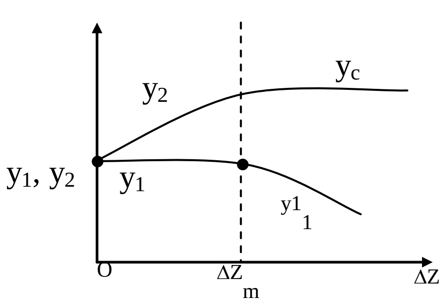
$$\therefore \frac{q^2}{10} = \frac{2.25}{4}$$

$\therefore$ q = 2.37 m^2/s, nearest answer is 2.5 m^2/s

118. Ans: (c)

119. Ans: (d)

Sol: If hump is provided beyond Δz_m ($\Delta z > \Delta z_m$), the downstream remain as critical and surge travel towards up stream by changing water surface to fall.



120. Ans: (c)

Sol:

- All the turbines have adjustable guide vanes.
- Except Kaplan turbine all the turbine have fixed runner vanes.
- Fourneyron turbine is radially outward flow reaction turbine which is obsolete now.

121. Ans: (b)

Sol: For backward vane pump, $\beta_2 < 90°$.

The velocity vectors must satisfy relation,

$\vec{V} = \vec{V}_{r2} + \vec{u}_2$

Only option (b) satisfies both the conditions.

122. Ans: (a)

Sol: $F = P_{CG}\,A$

$= (100\times10^3 + 1000\times10\times1)\times(2\times4)$

= 880 kN

Note: In order to get net force P_{atm} should be first subtracted from both sides.

123. Ans: (c)

Sol: $C_d = \frac{Q}{Q_{th}} = \frac{a.V}{a_{th}\,V_{th}} = \frac{a}{a_{th}}\times\frac{V}{V_{th}}$

$C_d = C_c \times C_v$

$0.88 = C_c \times 0.96$

$C_c = 0.92$

124. Ans: (d)

Sol: $V_1 = \frac{Q}{A_1} = \frac{4000}{20}$ = 200 cm/s = 2 m/s

$V_2 = \frac{Q}{A_2} = \frac{4000}{10}$ = 400 cm/s = 4 m/s

From Beruoulli's equation,

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2$$

$$P_1 - P_2 = \frac{\rho}{2}\left(V_2^2 - V_1^2\right) + \rho g\left(Z_2 - Z_1\right)$$

$$= \frac{1000}{2}\left(4^2 - 2^2\right) + 1000 \times 10(-0.5) = 1 \text{ kPa}$$

125. Ans: (b)

Sol: From the given data, it can be concluded that,

Pessimistic time, t_P = 50 minutes

Optimistic time, t_o = 30 minutes

Most likely time, t_m = 40 minutes

$$\sigma = \sqrt{\left(\frac{t_P - t_o}{6}\right)^2} = \sqrt{\left(\frac{50-30}{6}\right)^2} = 3.33 \text{ minutes}$$

126. Ans: (a)

Sol: The longest path through the network is called critical path and this occurs at events 1, 3, 5, 7, 8 and 9. Hence critical path is along 1 – 3 – 5 – 7 – 8 – 9.

127. Ans: (d)

Sol: Standard deviation $\sigma = \sqrt{16} = 4$

For 60% probability, $Z \approx 0.25$

$Z(40) = Z(60) - 0.5$

$Z(40) = 0.25 - 0.5 = -0.25$

Than 40% probability, Z = – 0.25

$\therefore$ TS = σZ + TE

= 4 × (– 0.25) + 50 = 49 weeks

128. Ans: (c)

Sol: $D = \frac{c-s}{n} = \frac{12000 - 2000}{5} = 2000$ Per year

B.V = 12000 – 2 × 2000 = Rs. 8000/-

129. Ans: (b)

130. Ans: (a)

Sol: Free float cannot be negative.

131. Ans: (d)

Sol: $EOQ = \sqrt{\frac{2QC_o}{C_c}}$

$Q' = 2Q$; $C_o' = \frac{C_o}{2}$; $C_c' = 2C_c$

EOQ′ =?

D = Annual demand

C_o = ordering cost/order

C_c = carrying cost/unit/year

$$EOQ' = \sqrt{\frac{2(2Q)(C_o/2)}{2C_c}} = \frac{1}{\sqrt{2}} \times \sqrt{\frac{2QC_o}{C_c}}$$

$$EOQ' = \frac{1}{\sqrt{2}} EOQ$$

132. Ans: (a)

Sol: Interference float will affect the succeeding activities in the network.

133. Ans: (a) **134. Ans: (a)**

135. Ans: (c)

136. Ans: (a)

Sol: If rotameter is installed in horizontal position then the drag exerted by flowing fluid on rotameter cannot be balanced by other fluid.

137. Ans: (d)

Sol: For Newtonain fluid viscosity is constant for any value of velocity gradient.

i.e., $\tau \propto \frac{du}{dy}$

$$\mu = \frac{\tau}{\left(\frac{du}{dy}\right)} = \text{constant.}$$

though they are not on same streamline.

138. Ans: (a) **139. Ans: (a)**

140. Ans: (c)

Sol: Smaller the particle size, larger the specific surface area. Montomorillonite clay particles are smaller in size compared to Illite minerals.

141. Ans: (a)

Sol: Both are True, Statement II is the correct explanation for Statement I

142. Ans: (b)

Sol: Rail wear is due to various factors like impact of moving loads, lateral forces, braking forces, effects of weather conditions etc.

In tunnels and coastal areas due to humidity and weather effects, rail wear is significant.

143. Ans: (c)

Sol: Statement I: True

Statement II: False

Orographic precipitation is caused by lifting of air over mountain barriers.

144. Ans: (a)

Sol: Both statements are true and statement 2 is correct explanation of statement 1

For Ephemeral stream $\rightarrow$ Bass flow value = 0

145. Ans: (b)

Sol: Shrinkage in concrete is due to loss of moisture by evaporations which leads to reduction in the volume. Hence shrinkage strains are independent of the loading conditions.

Due to alternate wet and dry conditions shrinkage strains are reversible .

146. Ans: (b)

Sol: When the carbon content is low, steel is ductile and with increase in carbon content the brittleness increases.

Also, at lower temperature material becomes harder and more brittle. With increase in temperature the material become softer and more ductile.

147. Ans: (a)

Sol: Under plastic yielding conditions, there is no change in volume.

i.e volumetric strain is zero

Hence bulk modulus is infinite.

Also $K = E/(3*(1-2\mu))$

For infinite bulk modulus, poissons ratio = 0.5. Hence $\mu=0.5$ is used under plastic yielding conditions

148. Ans (a)

Sol: In Ion exchange process hardness causing cations Ca & Mg are exchanged with less hardness causing cations Na. Yield zero hardness water.

149. Ans: (d)

Sol: High dosage of coagulant cause charge reversal.

150. Ans: (b)