



## ANSWERS

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

1. (b)  
2. (b)  
3. (a)

Dilatant materials have  $\mu > 0.5$  and undergoes increase in volume when compressed.

For all engineering materials it is (+ve) and hence lies between -0 to 0.5.

4. (a)

**Chemical stability** : Significant for durability of all types of structures specially subjected to chemical stability.

**Grading** : Economises cement content and improves workability.

**Deleterious substance** : Organic impurities and coatings interface with hydration of cement.

**Bulk density** : As check on the uniformity of aggregates grading.

5. (d)

6. (d)

$$(y_{\max})_I = \frac{a}{2} (y_{\max})_{II} = \frac{b}{\sqrt{2}}$$

$$(I)_I = \frac{a^4}{12}, (I)_{II} = \frac{b^4}{12}$$

$$\Rightarrow \sigma_y = \left( \frac{M_I \cdot y}{I} \right)_I = \left( \frac{M_{II} \cdot y}{I} \right)_{II}$$

$$\frac{M_I}{M_{II}} = 4$$

$$\Rightarrow \frac{a/2}{a^4/12} = \frac{4b\sqrt{2}}{b^4/12}$$

$$\Rightarrow b = 1.414 a$$

$$\% \text{ extra material} = \frac{b^2 - a^2}{a^2}$$

$$= 100\%$$

7. (a)

$n \rightarrow$  increase  
 $\downarrow$   
 number of nodes will increase  
 $\downarrow$   
 Radius of curvature will decrease  
 $\downarrow$   
 Hence curvature will increase.

8. (d)

$$F_r^2 = \frac{Q^2 T}{g A^3}$$

$$\Rightarrow F_r^2 = \frac{3^2 \times (2 \times 1)}{9.81 \times (1)^3} = 1.83$$

$$F_r = 1.35$$

i.e. flow is supercritical ( $F_r > 1$ )

It is also known as shooting or fast flow.

9. (c)

$$a = 1.7 \text{ kg}$$

$$b = 2.6 \text{ kg}$$

$$c = 2.4 \text{ kg}$$

$$\text{specific gravity} = \frac{c}{b-a}$$

$$= \frac{2.4}{(2.6-1.7)} = 2.66$$

Apparent specific gravity

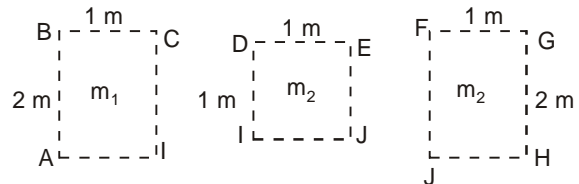
$$= \frac{c}{c-a} = \frac{2.4}{2.4-1.7} = 3.43$$

Water absorption

$$= \frac{b-c}{c} \times 100\% = 8.33\%$$

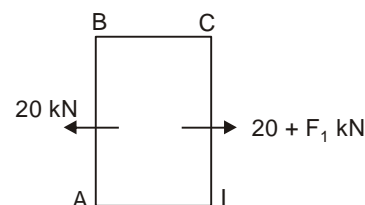
10. (d)

11. (c)



$$\text{Here, } m_1 = 2m_2 = m_3$$

FBD of ABCI



$$F_1 = \frac{(100-20)}{(m_1+m_2+m_3)} \times m_1 = 32 \text{ kN}$$

So, stress on face DI:

$$= \frac{(32+20)}{2 \times 1} \times 10^3 = 26 \text{ kN/m}^2$$

12. (a)

Softwood species tend to have dark coloured knots, so they are easily visible but in many hardwoods, the knots are virtually the same colour as the parent wood and less noticeable and may only be noticed once a stain and clear finish is applied.

13. (a)

$$F_r = \frac{13.5}{\frac{(0.9)(3)}{\sqrt{10 \times 0.9}}}$$

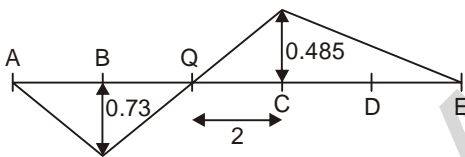
$$= \frac{S}{3} = 1.67$$

Since  $F_r > 1$ , the flow is supercritical and a hydraulic jump will occur at a downstream section.

14. (b)

15. (d)

ILD for member CF



Maximum tension in member CF occurs when load is in region E to Q.

$$(P_{CF})_{\max} = \frac{1}{2} \times 0.485 \times 12 \times 25$$

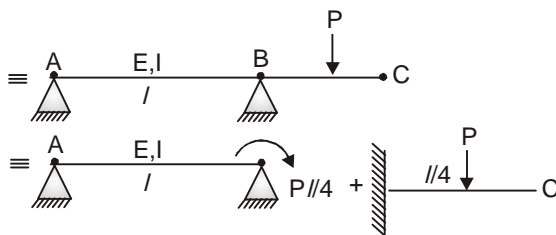
$$= 72.75 \text{ kN (tension)}$$

Maximum compression in member CF occurs when load is in region A to Q.

$$(P_{CF})_{\max} = \frac{1}{2} \times 0.73 \times 8 \times 25$$

$$= 73.0 \text{ kN (compression)}$$

16. (a) Using concept of symmetry at C there will be no reaction:



$$\delta_c = \frac{Ml}{3EI} \times \frac{l}{2} + \frac{P(l/4)^3}{3EI} + \frac{P(l/4)^2}{2EI} \times \frac{l}{4}$$

$$= \frac{(P/4) \cdot l}{3EI} \times \frac{l}{2} + \frac{P(l/4)^3}{3EI} + \frac{P(l/4)^2}{2EI} \cdot \frac{l}{4}$$

$$= \frac{7 P^3}{128 EI} (\downarrow)$$

17. (c)

Tangential shrinkage is in the direction parallel or tangential to the growth rings. It is always larger than the shrinkage in the radial direction because radial shrinkage is partly restrained by medullary rays fibers that extend perpendicular to the growth rings.

18. (d)

The transitional depth is defined as the depth at which the normal discharge  $Q_n$  is equal to the critical discharge  $Q_c$  and the slope of the gradually varied flow profile is horizontal. For such a situation,

$$\frac{dy}{dx} = S_0$$

19. (a)

$$r = 7$$

number of extra equation of conditions

$$c = 2$$

Total number of external indeterminacy

$$= 7 - (3 + 2) = 2$$

$$m = 3 \quad r = 7 \quad j = 4 \quad c = 2$$

$$I_D = (3m + r) - (3j + c)$$

$$= (3 \times 3 + 7) - (3 \times 4 + 2)$$

$$= 16 - 14 = 2$$

Degree of internal indeterminacy

$$= 2 - 2 = 0$$

20. (a)

21. (c)

Here maximum tensile stress will be developed at mid point of bar and maximum shear stress will be developed due to combination of this tensile stress.

$$\sigma_{\max} = \frac{P}{\frac{\pi}{4} \left(\frac{3d_1}{2}\right)^2} = \frac{16P}{9\pi d_1^2}$$

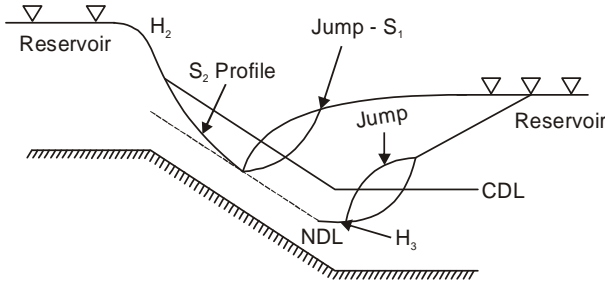
and  $\tau_{\max} = \frac{\sigma_{\max}}{2} = \frac{8P}{9\pi d_1^2}$

22. (c)

Wooden beams should be sawn in such a

way that they do not contain pith in their cross section. This can be best achieved by sawing the timber first through the pith thus dividing it into two halves.

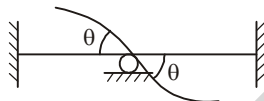
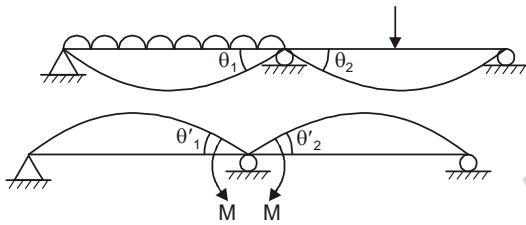
23. (a)



2 possibilities

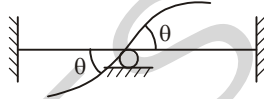
- (i)  $H_2 - S_2 - \text{Jump} - S_1$
- (ii)  $H_2 - S_2 - H_3 - \text{Jump}$

24. (a)



$$\theta = \theta'_1 - \theta_1 = \theta_2 - \theta'_2$$

$$\theta_1 + \theta_2 = \theta'_1 + \theta'_2$$

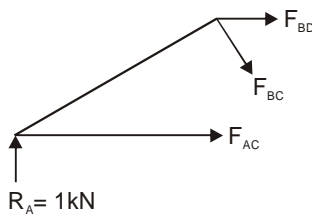


$$\theta = \theta_1 - \theta'_1 = \theta'_2 - \theta_2$$

$$\Rightarrow \theta_1 + \theta_2 = \theta'_1 + \theta'_2$$

25. (a)

The truss is cut in such way as to pass through member BC but through no other inclined member. The free body of the remaining portion of the truss is



$$\Sigma F_v = 0$$

$$R_A = F_{BC} \sin 60^\circ$$

$$1 = F_{BC} \sin 60^\circ$$

$$F_{BC} = 1.15 \text{ kN (T)}$$

26. (d)

$$\theta = \frac{\partial V}{\partial T} = \frac{T.L}{4.Am^2G} \sum \left( \frac{dS}{t} \right)$$

$$= \frac{T.L}{4(a^2)^2G} \cdot \frac{4a}{t} = \frac{T.L}{Ga^3t}$$

27. (c)

Seasoning alone is not always sufficient to protect timbers. Protection is effectively achieved by preservative treatments with certain chemicals.

28. (b)

For a rectangular channel,

$$F_2 = \frac{0.313}{\sqrt{9.81 \times 1.0}} = 0.1$$

Froude no. of flow after the jump

$$\frac{y_1}{y_2} = \frac{1}{2} \left[ -1 + \sqrt{1 + 8F_2^2} \right]$$

$$y_1 = 0.02 \text{ m}$$

29. (b)

Statement I and IV are correct

30. (b)

$$R_E = R_A = 5 \text{ kN}$$

Taking a section perpendicular to AF at C and balancing moments.

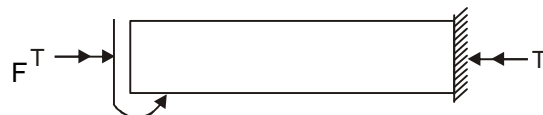
$$\Sigma M_C = 0$$

$$\Rightarrow -5(4) + 4(2) + f_{HG} (4 \sin 60^\circ) = 0$$

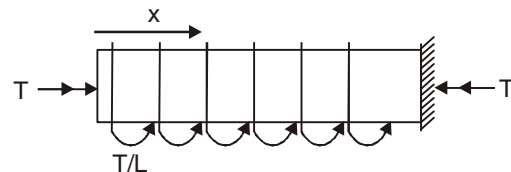
$$f_{HG} = 3.46 \text{ kN (compressive)}$$

31. (c)

Case 1:



$$\phi_1 = \frac{TL}{GJ}$$

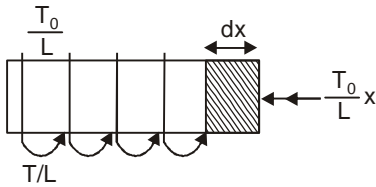


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**Case 2:**

$$d\phi = \frac{Tdx}{GJ}$$

$$d\phi = \frac{T}{L} x dx \frac{1}{GJ}$$



$$\phi = \frac{T/L}{GJ} \int_0^L x dx$$

$$\phi_2 = \frac{TL}{2GJ}$$

Now,  $\frac{\phi_1}{\phi_2} = \frac{TL/GJ}{TL/2GJ} = 2$  Ans.

**32. (d)**

**33. (a)**

Spatially varied flow (SVF) with increasing discharges finds considerable practical applications. Flows in side-channel spillway, wash water troughs in filter plants, roof gutters, highway gutters are some of the typical instances. The lateral flow enters the channel normal to the channel - flow direction causing considerable turbulence. It is difficult to assess the net energy imparted to the flow and as such the energy equation is not of much use in developing the equation of motion. Therefore, momentum equation are applied to get differential equation of SVF with increasing discharge.

**34. (b)**

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

$$v = \int_0^L \frac{m^2 dx}{2EI}$$

$$= \int_0^L \frac{w^2 x^4 dx}{4 \times 2EI}$$

$$= \frac{w^2}{8EI} \left[ \frac{x^5}{5} \right]_0^L$$

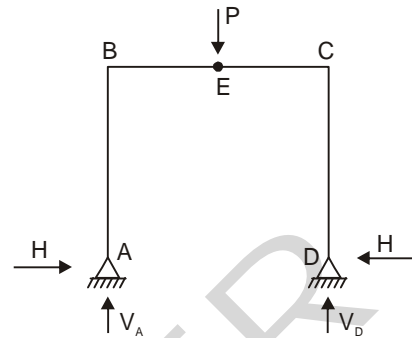
$$= \frac{w^2 L^5}{40EI}$$

**35. (c)**

From the loading given

$$V_A = V_D = \frac{P}{2}$$

$$H_A = H_D = H$$



Taking moment about the hinge E

$$V_A \times \frac{L}{2} = H \times h$$

$$\Rightarrow H = \frac{\frac{P}{2} \times \frac{L}{2}}{h} = \frac{PL}{4h}$$

$$M_B = H \times h$$

$$= \frac{PL}{4h} \times h = \frac{PL}{4}$$

**36. (c)**

$$y_{\max} = -\frac{5PL^3}{48EI} \leq -0.006$$

$$E > \frac{-5PL^3}{(-0.006) 48I}$$

$$= \frac{5 (100 \text{ kN}) (2\text{m})^3}{(0.006 \text{ m}) (48)(0.0002 \text{ m}^4)}$$

$$E > 70 \text{ GPa}$$

**37. (c)**

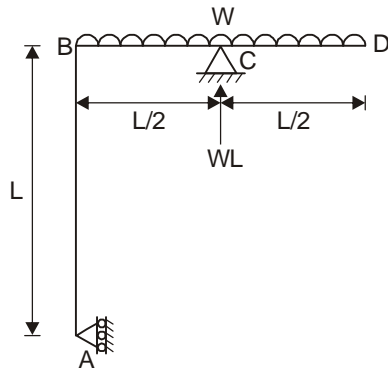
The standard dimensions of modular brick as recommended by BIS are length x width x thickness = 190x90x90 mm including the thickness of mortar, the effective size of brick becomes 200x100x100mm.

**38. (a)**

A tidal bore is a rare natural phenomenon in which an incoming tide creates a wave of water that travel up along a river or a narrow bay causing water to flow against river current.

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39. (d)



$$\sum M_A = 0$$

$$W \times L \times \frac{L}{2} - WL \times \frac{L}{2} + H_C \times L = 0$$

$$H_C = 0$$

$$H_A = 0$$

40. (a)

$$N_s = \frac{N\sqrt{Q}}{(H)^{3/4}} = \frac{600\sqrt{50}}{(64)^{3/4}}$$

$$= 187.5$$

41. (c)

$$\frac{1}{R} = \frac{M}{EI}$$

$$\Rightarrow I = \frac{RM}{E} = \frac{(10)(400) \times 10^3}{200 \times 10^6}$$

$$I = 17.28 \times 10^6 \text{ mm}^4$$

$$I = \frac{bh^3}{12} = \frac{\lambda^4}{12}$$

$$\lambda = (12I)^{1/4}$$

$$= 120 \text{ mm}$$

42. (d)

43. (c)

Since the channel is horizontal, at the downstream end of channel, where water spills out, critical flow will occur.

For a rectangular channel, the critical depth

$$y_c = \left( \frac{Q^2}{gB^2} \right)^{1/3}$$

$$= \left( \frac{2.4^2}{9.8 \times 2.4^2} \right)^{1/3} = 0.46 \text{ m}$$

44. (d)

$$FEM_{AB} = \frac{-W}{12L^2} (L^4 - b^3(4L - 3b))$$

$$= \frac{-10}{12 \times 5^2} (5^4 - 2^3(4 \times 5 - 3 \times 2))$$

$$= -17.1 \text{ kN-m}$$

45. (b)

46. (c)

$$\text{axial stress } \sigma = \frac{f}{A}$$

$$\Rightarrow A = \frac{f}{\sigma} = \frac{400}{14.4} = 27.77 \text{ m}^2$$

$$A = \frac{\pi}{4} (d_2^2 - d_1^2) \Rightarrow d_1 = 8.04$$

$$t = \frac{d_2 - d_1}{2} = \frac{10 - 8.04}{2}$$

$$= 0.98 = 1 \text{ m (say)}$$

47. (b)

48. (c)

Energy head

$$H = Z + y \cos \theta + \alpha \frac{V^2}{2g}$$

$$= 0.33 + 0.65 \times \cos(17.50) +$$

$$1.2 \times \frac{\left( \frac{1.95}{0.65} \right)^2}{2 \times 9.81}$$

$$= 0.33 + 0.62 + 0.55$$

$$= 1.5 \text{ m}$$

49. (c)

50. (b)

$$600 = \frac{600\sqrt{Q}}{(H)^{3/4}}$$

$$1 = \frac{\sqrt{27}}{H^{3/4}}$$

$$H = (27)^{2/3}$$

$$= 9 \text{ m}$$

No. of impellers required

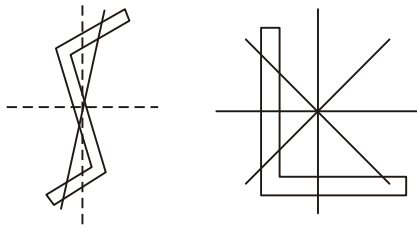
$$= \frac{60}{9} = 6.67$$

$$= 7 \text{ impellers}$$

51. (d)

The asymmetric section have the principle axis other than the geometric orthogonal axis that creates the maximum and minimum stresses along those axis. In fact those principle axis represents their main axis. All calculation should be given along

those principle axis.



52. (d)

Generally, white cement is ground finer than the grey cement i.e. it is of higher strength and sets rapidly.

53. (\*) Marks to All

$$q = 10 \text{ m}^3/\text{s-m},$$

$$S = 0.0025,$$

$$n = 0.015$$

$$Q = \frac{A}{n} R^{2/3} S_0^{1/2}$$

For wide rectangular channel

$$R = y_n$$

$$q = \frac{1}{n} y_n (y_n)^{2/3} \times \sqrt{S_0}$$

$$\frac{10 \times 0.015}{\sqrt{0.003}} = y_n^{5/3}$$

$$\Rightarrow y_n = 1.96 \text{ m}$$

Critical depth of flow

$$y_c = \left(\frac{q^2}{g}\right)^{1/3} = \left(\frac{10^2}{9.81}\right)^{1/3}$$

$$y_c = 2.16 \text{ m}$$

$$y_c > y_n$$

Hence the slope is steep.

**Note :** This question is difficult to solve without calculator's help.

54. (b)



$$M_{AB} = FEM_{AB} +$$

$$\frac{2 \times EI}{L} \left( 2\theta_A + \theta_B + \frac{3\Delta_1}{L} + \frac{3\Delta_2}{L} \right)$$

$$= \frac{2 \times 80,000}{4} \left( \frac{3(6+8)}{4 \times 1000} \right)$$

$$= 420 \text{ kN-m}$$

$$M_{BA} = 420 \text{ kN-m}$$

$$R_A = \frac{M_{AB} + M_{BA}}{4} = 210 \text{ kN} \downarrow$$

55. (a)

Static indeterminate by

$$\begin{aligned} D_s &= 3C - R' \\ &= (3) (4) - (1 + 2 + 3) \\ &= 6 \end{aligned}$$

Kinetic undetermined

$$\begin{aligned} D_k &= (3)(9) - (2 + 2 + 1) + (4 - 1) - 10 \\ &= 14 \end{aligned}$$

56. (\*) Marks to All

$$\begin{aligned} I &= \frac{bh^3}{12} = \frac{50 \times 300^3}{12} \\ &= 112.5 \times 10^6 \text{ mm}^4 \end{aligned}$$

$$M = \frac{PL}{4}, \quad M = \sigma z = \frac{PL}{4}$$

$$P = \frac{4\sigma z}{L} = 21600 \text{ N}$$

57. (d)

58. (b)

Given:

$$H_s = 3 \text{ m}, \quad H_{am} = 10.1 \text{ m}, \quad H_{vp} = 0.3 \text{ m}$$

$$h_{LS} = 0.4 \text{ m}, \quad \text{NPSHR} = 5 \text{ m}$$

$$\begin{aligned} \text{NPSHA} &= H_{am} - H_s - h_{LS} - H_{vp} \\ &= 10.1 - 3 - 0.4 - 0.3 = 6.4 \text{ m} \end{aligned}$$

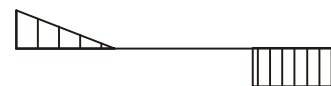
$$\begin{aligned} \text{Margin} &= \text{NPSHA} - \text{NPSHR} \\ &= 6.4 - 5 = 1.4 \text{ m} \end{aligned}$$

59. (c)

60. (c)

61. (d)

Moment diagram is the integration of shear diagram, we find that the maximum occurs where the shear is zero by drawing its sketch for the shear diagram it is found that shear is minimum around centre, so let's find shear between C and D



Make a section between C and D

$$\Sigma F_y = 0; R_A - wa + v = 0;$$

$$V = -R_A \quad wa = 2 \times 3 - 6 = 0$$

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Therefore the maximum moment occurs between C and D.

62. (b)

Carbonation has two effects it increases mechanical strength of concrete but it also decreases alkalinity which is essential for corrosion prevention of the reinforcement steel.

63. (a)

Change moment of momentum = Torque  
=  $T = 15915 \text{ N-m}$

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 600}{60} = 20\pi$$

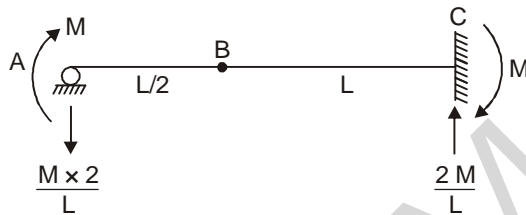
$$= 62.3 \text{ rad/s}$$

Power developed

$$P = T \times \omega$$

$$= \frac{15915 \times 62.3}{10^3} = 999.46 \text{ kW}$$

64. (b)



$$M_C - \frac{2M}{L} \times L = 0$$

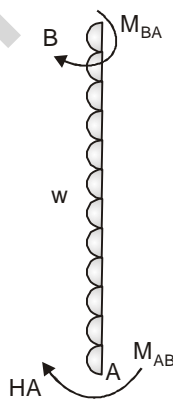
$$M_C = 2M$$

65. (d)

Shear equation will be

$$H_A + H_D + wh_1 = 0$$

where  $H_A$  and  $H_D$  are reaction at A and D in right hand direction.



Taking moment about B

$$H_A h_1 - M_{AB} - M_{BA} + \frac{wh_1^2}{2} = 0$$

$$H_A = \frac{M_{AB} + M_{BA}}{h_1} - \frac{wh_1}{2}$$

Similarly

$$H_D = \frac{M_{CD} + M_{DC}}{h_2}$$

i.e. shear equation will be

$$\frac{M_{AB} + M_{BA}}{h_1} + \frac{M_{CD} + M_{DC}}{h_2} + \frac{wh_1}{2} = 0$$

66. (a)

The force F acting on point E will transfer on point C as a concentrated load, therefore the shear diagram has a jump at point C.

Using the fact that shear diagram is integration of load diagram, we can find that shear diagram on part AB is an inclined line. And constant between B and C.

Therefore, the shear diagram is inclined at AB and decreases at Point C, so A is correct.

67. (c)

Most concrete blocks have one or more hollow cores inside to reduce weight of block or insulation.

68. (a)

$$\text{Discharge} = Q = \pi D_2 B_2 V_{f_2}$$

$$= \pi \times 4 \times 0.8 \times 3 = 30.16 \text{ m}^3/\text{s}$$

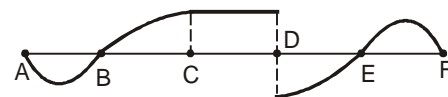
$$\rho = \eta \gamma QH$$

$$= (0.851)(30.16)(9.81)(10)$$

$$= 2517 \text{ kW}$$

69. (d)

70. (b)



71. (a)

From the fact that shear diagram is the integration of load. the shear diagram is an inclined line, so the loading should be uniformly distributed load. The slope of shear diagram shows that shear is zero at point A. Uniform load is distributed on full length.

Upward jump at C shows that an upward concentrated load is applied at C.

Therefore the shear diagram represents by beam A.

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72. (a)

Quartzite is a non foliated metamorphic rock which was originally sandstone.

73. (a)

$$u = k_n \sqrt{2gh}$$

$$= 2\sqrt{2 \times 9.81 \times 35} = 52.41 \text{ m/s}$$

$$u = \frac{\pi DN}{60} = \frac{\pi \times 2 \times N}{60} = 52.41$$

$$N = 500.48 \text{ rpm}$$

74. (c)

$$K_{AB} = \frac{1}{2} \times \frac{4EI}{5} = \frac{2EI}{5}$$

$$K_{AE} = \frac{4EI}{3}$$

$$D.F_{AB} = \frac{\frac{2EI}{5}}{\frac{2EI}{5} + \frac{4EI}{3}} = \frac{3}{13}$$

$$D.F_{AE} = \frac{10}{13}$$

75. (c)

$$\text{Specific force} = \frac{P + M}{\gamma_e}$$

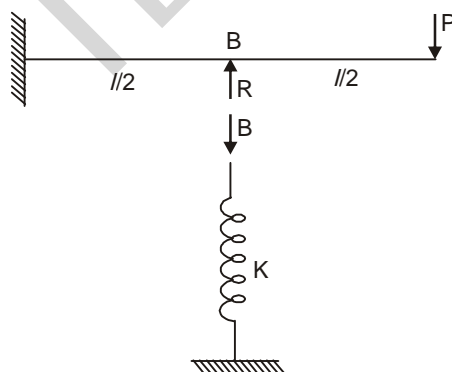
$$= \frac{\frac{1}{2} \gamma_e y^2 B + \rho QV}{\gamma_e}$$

$$= \frac{1}{2} y^2 B + \frac{Q^2}{fA}$$

$$= \frac{1}{2} (1.5)^2 (3) + \frac{10^2}{9.81 \times 3 \times 1.5}$$

$$= 5.64 \text{ m}^3$$

76. (b)



At point B

$$\frac{P(l/2)^3}{3EI} + \frac{(P(l/2)(l/2)^2)}{2EI} - \frac{R(l/2)^3}{3EI} = \Delta$$

$$\frac{P}{24} + \frac{P}{16} - \frac{R}{24} = \Delta$$

$$\frac{5P}{48} = \Delta \left(1 + \frac{K}{24}\right)$$

$$\Delta = \frac{5 \times 192}{48 \times 2} = 10$$

77. (c)

78. (d)

$$\frac{N_1 D_1}{\sqrt{H_1}} = \frac{N_2 D_2}{\sqrt{H_2}}$$

$$D_1 = D_2$$

$$H_2 = \left(\frac{N_2}{N_1}\right)^2 x_1 = \left(\frac{2000}{1000}\right)^2 \times 10 = 40 \text{ m}$$

$$\text{Power} \frac{P_1}{N_1^3 D_1^5} = \frac{P_2}{N_2^3 D_2^5}$$

$$P_2 = \left(\frac{N_2}{N_1}\right)^3 P_1 = \left(\frac{2000}{1000}\right)^3 \times 1 = 8 \text{ kW}$$

79. (a)

$$\Delta h = \left(\frac{l^2 + 4h^2}{4h}\right) \alpha \Delta T$$

$$= \frac{(100)^2 + 4 \times 20^2}{4 \times 20} \times 12 \times 10^{-6} \times 35$$

$$= 60.9 \text{ mm}$$

80. (d)

For a circular section, using manning's equation for maximum velocity

$$\frac{d}{R} = 1.626$$

and  $\frac{d}{D} = 0.81$

i.e.  $d = (0.81) \times 2 = 1.62 \text{ m}$

$$R = \frac{d}{1.626} = 0.99 \text{ m}$$

$$\approx 1 \text{ m}$$

81. (c)

For ductile material plastic deformation is more prominent upto 1.8% strain as compared to elastic deformation (0.12%).

82. (c)

The ceramic tiles produced from recycled glass offer the same quality as traditionally manufactured tiles but require substantially less energy to manufacture.

83. (c)

$$\text{Manometric efficiency} = \frac{g_{Hm}}{V_{w_2} u_2}$$

$$\text{Manometric head } \eta_m = \frac{\eta V_{w_2} u_2}{g}$$

Since it does not depend on density of liquid, it will remain same.

84. (d)

85. (c)

$$\begin{aligned} A &= By + my^2 \\ &= (3)(2) + (1.5)(2)^2 \\ &= 12 \text{ m}^2 \end{aligned}$$

$$P = B + 2y \sqrt{m^2 + 1}$$

$$= 3 + \frac{4\sqrt{13}}{2}$$

$$= 2\sqrt{13} + 3$$

$$R = \frac{A}{P} = 1.175 \text{ m}$$

$$\begin{aligned} \tau &= 0.75 \gamma RS \\ &= (0.75) (9.81 \times 10^3) (1.175) (0.001) \\ &= 43.23 \text{ N/m}^2 \end{aligned}$$

**Note :** As no option is matching, nearest answer is (c).

86. (b)

87. (c)

Stabilisers and antioxidants are added to protect the product against aging, light or biological agents.

88. (a)

89. (d)

90. (b)

$$y_1 = 1.5 \text{ m}$$

$$y_2 = y_1 + \Delta y = 1.7 \text{ m}$$

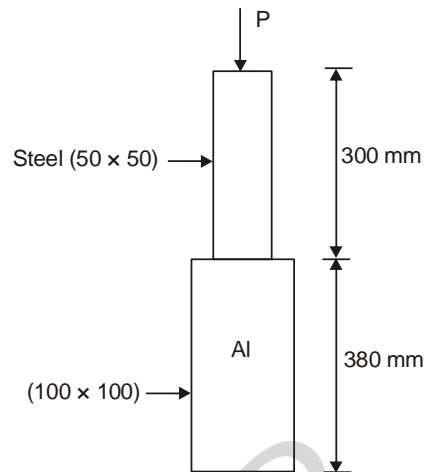
$$C = \sqrt{\frac{1}{2} g \frac{y_2}{y_1} (y_1 + y_2)}$$

$$= \sqrt{\frac{1}{2} \times 9.81 \times \frac{1.7}{1.2} (1.7 + 1.2)}$$

$$= 4.49 \text{ m/sec}$$

$$= 4.5 \text{ m/sec}$$

91. (\*) Marks to All



$$\begin{aligned} \text{Area of steel bar} &= A_s \\ &= 50 \times 50 = 2500 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \text{Area of aluminium bar} &= A_a \\ &= 100 \times 100 = 10^4 \text{ mm}^2 \end{aligned}$$

Total change in length

$$\frac{P l_s}{A_s E_s} + \frac{P l_a}{A_a E_a} = \Delta$$

$$\Rightarrow P \left[ \frac{300}{2500 \times 2.1 \times 10^5} + \frac{380}{10000 \times 0.7 \times 10^5} \right] = 0.25$$

$$\Rightarrow P \times 0.11143 \times 10^{-5} = 0.25$$

$$\Rightarrow P = 224356 \text{ N}$$

$$= \boxed{224.35 \text{ kN}}$$

92. (d)

Compared to copper, aluminium has about 65% of the electrical conductivity by volume, although 200% by weight.

93. (b)

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

The range of values of specific speed is distinctly different for different types of turbines. The specific speed to be used extensively as an aid in selection of appropriate turbines for a specific hydropower development work. It represents performance of a turbine.

94. (c)

95. (a)

The test assumes uniform distribution of tensile stress, but concrete has a non-linear stress-strain distribution. This is considered as limitation of test.

96.(a)

97. (d)

Pig iron is used to make wrought iron or steel.

98. (c)

d (distance of centroid A to shear centre)

$$\begin{aligned} &= \frac{b^2 h^2 t}{4I_N} \\ &= \frac{45^2 \times 90^2 \times 10}{4 \times 2.46 \times 10^6} \\ &= 16.67 \text{ mm} \end{aligned}$$

99. (b)

100. (d)

Le Chatelier method is used to determine soundness of cement.

101. (b)

It is a symmetrical H section. Hence shear centre will lie at its centre of gravity.  $P_1$  and  $P_2$  both acts on the shear centre. Hence both  $P_1$  and  $P_2$  will not cause any twisting in the cross-section.

102. (d)

Bessemer Process is used for bulk steel production.

103. (b)

Specific Speed

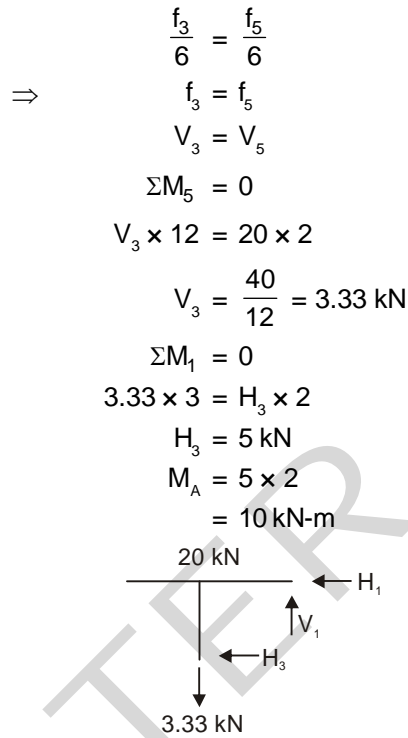
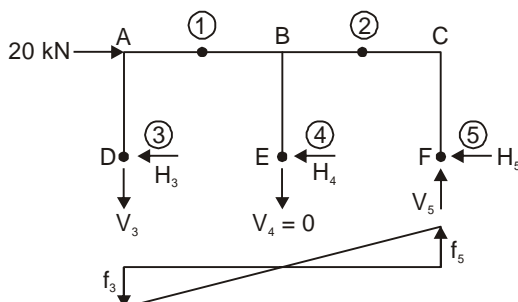
$$\begin{aligned} N_s &= \frac{N\sqrt{P}}{H^{5/4}} \\ N_s &\propto \frac{1}{H^{5/4}} \end{aligned}$$

Kaplan turbine - low head and  $N_s$  in range (260 to 900)

Francis - medium head and  $N_s$  in range (90 to 1000)

104. (b)

$$\begin{aligned} V_3 &= f_3 \times A \\ V_5 &= f_5 \times A \end{aligned}$$



105. (c)

Upset indicate wood fibres injured during crushing and compression.

Druxiness is indicated by white decayed spots which are formed by fungi.

106. (c)

The radial pressure is maximum inside and zero outside.

The hoop stress (due to internal pressure) is maximum inside and minimum outside.

The hoop stress (due to external pressure) is maximum inside and minimum outside.

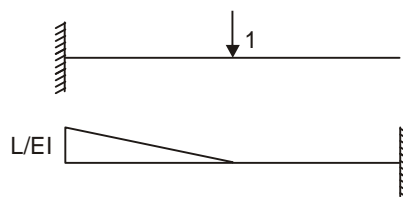
107. (b)

108. (c)

Flow entering the whirl chamber the guide vanes creates a free vortex in the whirl and runner chambers where the velocity is inversely proportional to the radius.

$$V_w r_1 = \text{constant}$$

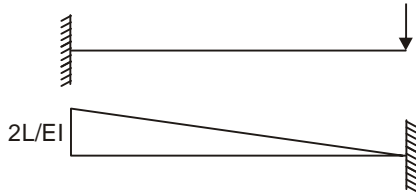
109. (b)



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$$\delta_{11} = \frac{1}{2} \times \frac{L}{EI} \times L \times \frac{2}{3} L = \frac{L^3}{3EI}$$

$$\delta_{21} = \frac{1}{2} \times \frac{L}{EI} \times L \times \left(2L - \frac{L}{3}\right) = \frac{5L^3}{6EI}$$



$$\delta_{12} = \frac{L}{EI} \times L \times \frac{L}{2} + \frac{1}{2} \times \frac{L}{EI} \times L \times \frac{2L}{3} = \frac{5L^3}{6EI}$$

$$\delta_{22} = \frac{1}{2} \times 2L \times \frac{2L}{EI} \times \left(\frac{2}{3} \times 2L\right) = \frac{8L^3}{3EI}$$

**110. (\*) Marks to All**

The given figure was for timber.

**111. (b)**

$$\frac{\phi}{2} = \frac{\epsilon_x - \epsilon_y}{2}$$

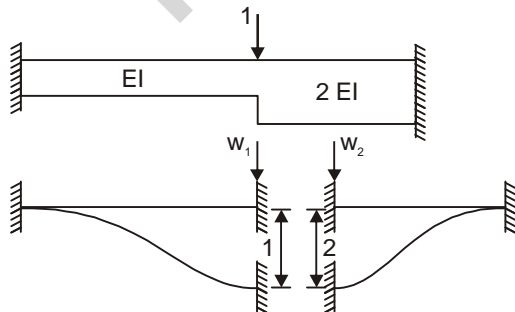
$$\Rightarrow \phi = 8 \times 10^{-3}$$

**112. (b)**

**113. (d)**

Fly ash consists of spherical glassy particles ranging from 1 to 150 μm, most of which passes through a 45 μm sieve. More than 40% of the particles, which are under 10 μm contribute to early age strength (7 and 28 days). Particles of sizes 10 to 45 μm reacts slowly and are responsible for gain in strength from 28 days to 1 year.

**114. (a)**



$$K_{11} = w_1 + w_2 = \frac{12 \times EI}{(2L)^3} + \frac{12E \times 2I}{L^3}$$

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$$= \frac{12EI}{L^3} \left[ \frac{1}{8} + 2 \right]$$

$$= \frac{51EI}{2L^3}$$

**115. (b)**

The fibre reinforced concrete has 5 to 10 times more impact strength than plain concrete depending on the volume of fibre used.

Modular of electricity of FRC increases slightly with increase in fibre content. It is found than 1% increase in fibre content results in 3% increase in elastic modulus.

**116. (b)**

**117. (b)**

**118. (c)**

- Slaked lime is alkaline in nature. It reacts with acids to form salt, thus increases acid resistance.
- Calcium carbonate precipitates when CO<sub>2</sub> passes through lime mortar thus sealing the minor cracks.
- It should be stored in airtight container as it hardens when exposed in air by reacting with CO<sub>2</sub>.
- CaO + H<sub>2</sub>O → Ca(OH)<sub>2</sub> + Heat ↑

**119. (b)**

Steady state is independent of initial conditions and transient state is almost always neglected in engineering applications as it is very difficult to determine initial conditions (initial velocity & amplitude of the structure)

**120. (a)**

As k (stiffness & spring)

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

$$R' = 2R$$

$$n' = \frac{n}{2}$$

(Modified stiffness)

$$k' = \frac{Gd^4 \cdot 2}{64 \times 8R^3 n}$$

$$k' = \frac{k}{4}$$

121. (c)

Cast iron is a brittle material and when subjected to torsion it does hence a helicoidal fracture. Begin a brittle material cast iron is good in compression but weak in tension. Hence reason is wrong.

122. (a)

123. (c)

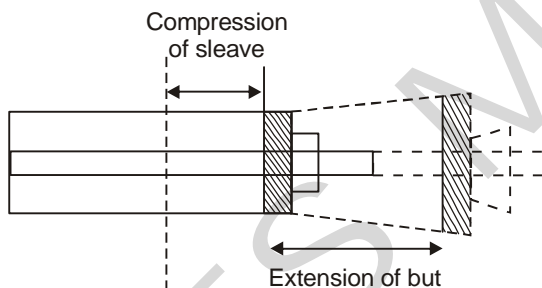
In beams and frames deflection the contribution of shear is very negligible in comparison to bending moment. Reason is wrong.

124. (d)

Shear stress-strain diagram also have initial portion linear for values of shear stress that does not exceed proportional limit in shear we can write  $\tau_{xy} = G \times \gamma_{xy}$  for homogeneous and isotropic material.

125. (d)

Because of tightening of nut, the bolt come under tension and take come under compression

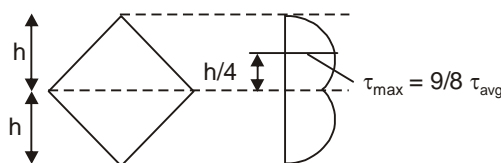


126. (d)

Viscous material have both viscous and elastic property and exhibits time dependent strain. Thus assertion is wrong.

127. (d)

In diamond section  $\tau_{max} = \frac{9}{8} \tau_{avg}$



128. (a)

129. (a)

130. (a)

Since the hydroxides and carbonates of lime and magnesium have no cementing property, they are termed as inert substances.

131. (c)

Aggregates from igneous rocks are satisfactory because they are normally hard, tough and dense. However the metamorphic rock which exhibits foliated structure is not suitable as aggregate.

132. (b)

The preferred range of water cement ratio for most shotcretes is 0.30 to 0.45.

133. (a)

134. (b)

When heated to a higher temperature of the order 340 °C they char. Thus, the new inert material formed during moulding does not melt on subsequent heating but is destroyed and thus can not be recycled.

135. (b)

Aluminium can withstand sub zero temperatures whereas structural steel become brittle and do not perform properly.

136. (a)

137. (b)

138. (d)

In practice the most economical section is not always adopted.

The main reason for not choosing is the steep side slope of the channel with sharp edge.

139. (a)

140. (b)

Turbines are installed according to the head and flow available at the location of the installation. Pelton turbines are for high head; francis turbines are for medium head and kaplan - turbines are for lower head.

141. (c)

The air vessels reduce the acceleration head.

142. (c)

Reflux valve prevent backflow from the line into the pump and consequently save pump from damage.

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143. (b)

At high velocity  $F_r > 1$ , a small disturbance can not travel upstream, as the wave velocity  $C_v$  being less than flow velocity  $V$ , the wave is washed downstream with a velocity  $V - C_o$  with respect to a stationary ground.

144. (d)

In an impulse turbine, the pressure of water does not change while flowing through the rotor of machine.

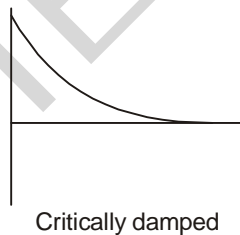
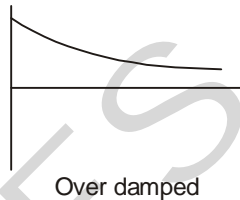
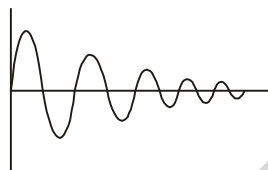
145. (b)

146. (a)

147. (a)

148. (d)

Hydraulic dampers are critically damped in order to shut the door in one time period and without slamming the door, as if the system is overdamped the door will not close quickly and if it is underdamped it will slam repeatedly before closing.



$$\text{Decrement} = \frac{x_2}{x_1}$$

$$= \frac{X_0 e^{-\xi\omega_n t_1} \cos(\omega_n t_1 - \phi_1)}{X_0 e^{-\xi\omega_n t_2} \cos(\omega_n t_2 - \phi_2)} = e^{\xi\omega_n T}$$

(When  $x_1$  and  $x_2$  are across one time period  $T$ )

$$\delta = \ln \frac{x_1}{x_2} = \xi\omega_n T = \frac{2\pi\xi}{(1-E^2)^{1/2}}$$

⇒

$$\xi \approx \frac{\delta}{2\pi}$$

149. (d)

Clapeyron's 3 moment theorem gives consistent result and is not an approximate method.

150. (b)

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