S.No. : 04 **IG1_CE_D_220819**

Reinforced Cement Concrete

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Date of Test : 22/08/2019

ANSWER KEY ➤ Reinforced Cement Concrete

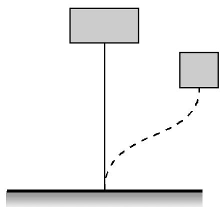
1.	(d)	7.	(a)	13.	(c)	19.	(d)	25.	(b)
2.	(b)	8.	(d)	14.	(d)	20.	(c)	26.	(b)
3.	(d)	9.	(c)	15.	(a)	21.	(d)	27.	(d)
4.	(b)	10.	(b)	16.	(a)	22.	(d)	28.	(b)
5.	(a)	11.	(b)	17.	(a)	23.	(c)	29.	(a)
6.	(a)	12.	(a)	18.	(a)	24.	(d)	30.	(d)

DETAILED EXPLANATIONS

5. (a)

$$M_u = 0.36\, f_{ck}\, x_u B(d - 0.42\, x_u)$$
$$M_u = 1.5\, M_w$$
$$M_u = 150 \text{ kNm.}$$
$$150 \times 10^6 = 0.36 \times 30\, x_u \times 300\,(450 - 0.42\, x_u)$$
$$0.42 x_u^2 - 450\, x_u + 46296.3 = 0$$
$$\Rightarrow \quad x_u = 115.28 \text{ mm}$$

7. (a)

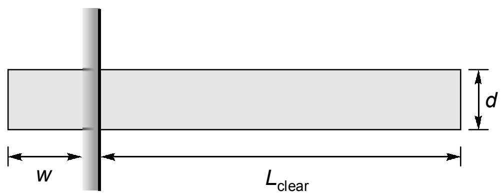


$$L_{eff} = 1.5 \text{ L}$$
$$L_{eff} = 1.5 \times 5 = 7.5 \text{ m}$$

Option (a) is correct.

9. (c)
As per **IS 456: 2000**

$$L_{eff} \text{ of continues beam} = l_{clear} + \frac{d}{2}$$



10. (b)

$$\frac{\text{Permissible shear stress in LSM}}{\text{Permissible shear stress in WSM}} = \frac{0.25\sqrt{f_{ck}}}{0.16\sqrt{f_{ck}}} = \frac{25}{16} = 25:16$$

11. (b)
Maximum spacing of shear reinforcement
(i) d for inclined shear reinforcement
0.75 d for vertical shear reinforcement
(ii) 300 mm.

So, $$\text{spacing} = \min\begin{cases} 375 \text{ mm} \\ 300 \text{ mm} \end{cases}$$
$$\text{spacing} = 300 \text{ mm}$$

12. (a)

$$V_u \text{ at support} = wl = 2 \times 4 = 8 \text{ kN}$$

$$M_u \text{ at support} = \frac{wl^2}{2} = \frac{2\times4\times4}{2} = 16 \text{ kNm}$$

$$\text{Design } V_u = V_u - \frac{M_u}{d}\tan\beta$$

$$= 8 - \frac{16}{0.4}\times\frac{(400-200)}{4000} = 6 \text{ kN}$$

$$w = \frac{\text{Design } V_u}{Bd} = \frac{60\times10^3}{150\times400} = 0.1 \text{ N/mm}^2$$

14. (d)

$$\text{Initial stress in wire} = \frac{400\times10^3}{200} = 2000 \text{ N/mm}^2$$

(a) For pre-tensioned beam

$$\text{Loss of stress} = E_s \times 3 \times 10^{-4}$$

$$= 210 \times 10^3 \times 3 \times 10^{-4}$$

$$= 63 \text{ N/mm}^2$$

$$\%\text{ Loss} = \frac{63}{2000}\times100 = 3.15\%$$

(b) For post-tensioned beam

$$\text{Loss of stress} = E_s \times \frac{2\times10^{-4}}{\log_{10}(t+2)} = \frac{210\times10^{-3}\times2\times10^{-4}}{\log_{10}(8+2)}$$

$$= 42 \text{ N/mm}^2$$

$$\%\text{ Loss} = \frac{42}{2000}\times100 = 2.1\%$$

15. (a)

For simply supported beam

$$L_{\text{eff}} = \text{Minimum} \begin{cases} L_{\text{clear}} + d \\ L_{\text{clear}} + w \end{cases}$$

$$= \text{Minimum of} \begin{cases} 6+0.4 \\ 6+0.25 \end{cases}$$

$$L_{\text{eff}} = 6.25 \text{ m}$$

$$\text{Permissible deflection} = \frac{L_{eff}}{350} \text{ or } 20 \text{ mm}, \text{ whichever is less}$$

$$= \frac{6250}{350} = 17.857 \text{ mm}$$

16. (a)

Pressure line is the locus of resultant compressive force in the beam.

Cable line is the actual location of cable in the beam.

17. (a)

Let

$$\text{Let inclination angle} = \theta$$

$$\text{upward force} = 2\,P\sin\theta \simeq 2\,P\tan\theta$$

$$= 2P\frac{h}{l/2} = \frac{4Ph}{l}$$

To balance load W,

$$\frac{4Ph}{l} = W$$

$$\Rightarrow \quad h = \frac{Wl}{4P}$$

18. (a)

$$\text{Equivalent area} = BD + (m-1)A_s = 400\times 600 + (6-1)\times 6\times\frac{\pi}{4}\times 6^2$$

$$= 240848.23\text{ mm}^2$$

$$\text{Applied prestressing force} = 6\times\frac{\pi}{4}\times 6^2\times 1500$$

$$= 254.47\text{ kN}$$

$$\text{Eccentricity,}\quad e = \frac{600}{2} - 100 = 200\text{ mm}$$

$$\text{Stress at soffit} = \frac{P}{A} + \frac{Pl}{Z}$$

$$= \frac{254.47\times 10^3}{240848.23} + \frac{254.47\times 10^3\times 200}{400\times\dfrac{600^2}{6}}$$

$$= 1.056 + 2.12 = 3.176\text{ N/mm}^2$$

19. (d)

$$M_{eq} = M_u + M_{Tu}$$

if,

$$M_{Tu} > M_u$$

$$M_{eu_2} = M_{Tu} - M_u$$

$$M_{Tu} = \frac{T_u}{1.7}\left[1+\frac{D}{B}\right] = \frac{35}{17}\left[1+\frac{450}{250}\right]$$

$$M_{Tu} = 57.647\text{ kNm} > M_u$$

$$M_{eu_2} = M_{Tu} - M_u = 57.647 - 50 = 7.647\text{ kNm}$$

20. (c)

As per **IS 456 : 2000**

$$\text{Diameter} = \begin{cases}\dfrac{\phi_{main}}{4}\text{(Maximum.diameter)}\\ 6\text{ mm}\end{cases}$$

$$\text{Diameter} = \begin{cases}\dfrac{25}{4} = 6.25\text{ mm}\\ 6\end{cases}$$

So provide tie bars of 8 mm diameter.

24. (d)

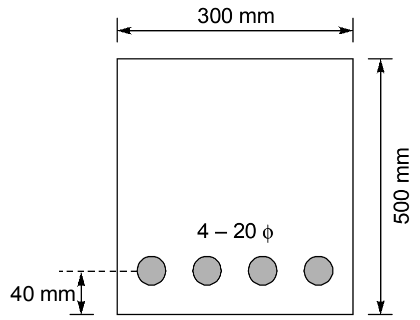
All statements are correct assumptions of steel beam theory.

25. (b)

$$LL = 2 \text{ kN/M}$$
$$DL = 0.3 \times 0.53 \times 25 = 3.975 \text{ kN/m} \quad \text{(Assume effective cover of 30 mm)}$$
$$w = 5.975 \text{ kN/m}$$
$$w_u = 1.5\, w = 8.9625 \text{ kN/m}$$
$$V_u = w_u L_{clear}$$
$$\left[\begin{array}{l} L_{eff} = L_{clear} + \dfrac{d}{2} \\ 4000 = L_{clear} + \dfrac{500}{2} \\ L_{clear} = 3750 \text{ mm} \end{array}\right]$$
$$V_u = 8.9625 \times 3.75 = 33.61 \text{ kN}$$
$$\tau_v = \frac{V_u}{Bd} = \frac{33.61 \times 10^3}{300 \times 500}$$
$$= 0.224 \text{ N/mm}^2$$

26. (b)

For M30 concrete, Fe 500 steel



$$0.36\, f_{ck}\, x_u B = 0.87\, f_y A_{st}$$
$$0.36 \times 30 \times x_u \times 300 = 0.87 \times 500 \times 4 \times \frac{\pi}{4} \times 20^2$$
$$x_u = 168.715 \text{ mm} < x_{u,\,lim} \; (x_{u,\,lim} = 0.46 \times 460 = 211.6 \text{ mm})$$
$$M_R = 0.36\, f_{ck}\, x_u\, B(d - 0.42\, x_u)$$
$$M_R = 0.36 \times 30 \times 168.715 \times 300 \times (460 - 0.42 \times 168.715)$$
$$M_R = 212.718 \text{ kNm}$$

The maximum applied moment is equal to moment of resistance of beam.

$$\Rightarrow \quad w_u \frac{l^2}{8} = M_R$$
$$w_u = \frac{212.718 \times 8}{6^2} = 47.27 \text{ kN/m}$$
$$\text{Service load} = \frac{47.27}{1.5} = 31.513 \text{ kN/m}$$
$$\text{Self weight of beam} = 0.3 \times 0.5 \times 25$$

$$= 3.75 \text{ kN/m}$$

$$\text{Permissible imposed service load} = 31.513 - 3.75$$

$$= 27.763 \text{ kN/m}$$

27. (d)

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

$$0.36 \times 30 \times x_u \times 400 = 0.87 \times 415 \times 3 \times \frac{\pi}{4} \times 20^2$$

$$x_u = 78.768 \text{ mm} < x_{u,\lim} = 264 \text{ mm}$$

So,

$$M_u = 0.36\, f_{ck}\, x_u\, B(d - 0.42\, x_u)$$

$$= 0.36 \times 30 \times 78.768 \times 400 \times (550 - 0.42 \times 78.768) \times 10^{-6}$$

$$M_u = 175.8955 \text{ kNm}$$

$$\text{Working moment} = \frac{M_u}{1.5} = \frac{175.8955}{1.5}$$

$$M_u = 117.263 \text{ kNm}$$

28. (b)

When jacking is done from both ends

$$\text{Maximum loss at } x = \frac{l}{2}$$

and

$$\alpha = \frac{4h}{l}$$

$$\alpha = \frac{4 \times 200}{8000} = \frac{1}{10}$$

$$p_x = p_0(kx + \mu\alpha) = 1500\left(0.0015 \times 4 + 0.4 \times \frac{1}{10}\right)$$

$$P_x = 69 \text{ N/mm}^2$$

$$\text{Percentage loss} = \frac{69}{1500} \times 100 = 4.6\%$$

29. (a)

Self weight = $0.4 \times 0.6 \times 25 = 6$ kN/m

$$I_C = 400 \times \frac{600^3}{12} = 7.2 \times 10^9 \text{ mm}^4$$

$$\delta = \frac{P(e_1 + e_2)L^2}{12 E_c I_c} - \frac{Pe_1}{8 E_c I_c} + \frac{5wL^4}{384 E_c I_c}$$

$$\delta = \frac{1000 \times 10^3 \times (80 + 150) \times 8000^2}{12 \times 32000 \times 7.2 \times 10^9} - \frac{1000 \times 10^3 \times 80 \times 8000^2}{8 \times 32000 \times 7.2 \times 10^9} + \frac{5 \times 6 \times 8000^4}{384 \times 32000 \times 7.2 \times 10^9}$$

$$\delta = 5.324 - 2.78 + 1.389$$

$$\delta = 3.933 \text{ mm}$$

30. (d)

$$l_{\text{eff}} = 0.65 \times 3.6 \text{ m} = 2.34 \text{ m}$$

$$\frac{l_{eff}}{D} = \frac{2340}{500} = 4.68 < 12 \qquad \text{[short column]}$$

$$e_{\min} = \frac{3600}{500} + \frac{500}{30}$$

$$= 23.8667 \text{ mm} < 0.05\, D\, (= 25 \text{ mm})$$

$$k_u = 1.05[0.4\, f_{ck}\, A_c + 0.67\, f_y\, A_s]$$

$$1.5 \times 2500 \times 10^3 = 1.05\left[0.4 \times 30 \times \left(\frac{\pi}{4} \times 500^2 - A_s\right) + 0.67 \times 415 \times A_s\right]$$

$$\Rightarrow \quad A_s = 4567.7 \text{ mm}^2$$

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