S.No. : 08 **IG_CE_F_180919**

Reinforced Cement Concrete

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CLASS TEST 2019-2020

CIVIL ENGINEERING

Reinforced Cement Concrete

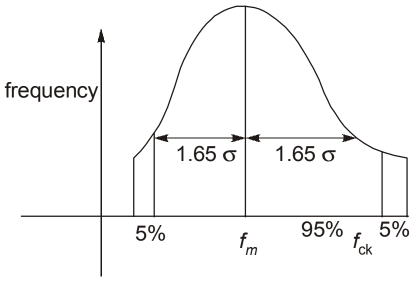
Date of Test : 18/09/2019

Answer Key

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

DETAILED EXPLANATIONS

4. (c)



$$f_{ck} = f_m + 1.65\sigma$$

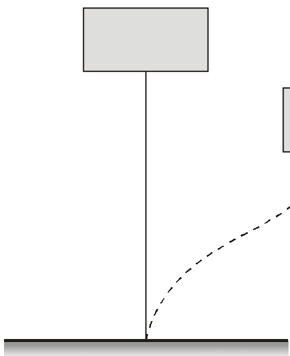
6. (b)

$$e_{min} = \left.\begin{matrix} \frac{L}{500} + \frac{D}{30} \\ 20 \text{ mm} \end{matrix}\right\} \text{Max}$$

$$e_{min} = \left.\begin{matrix} \frac{3500}{500} + \frac{350}{30} = 18.67 \text{ mm} \\ 20 \text{ mm} \end{matrix}\right\} \text{max}$$

$$e_{min} = 20 \text{ mm}$$

7. (a)



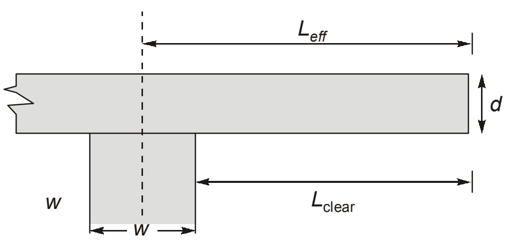
$$L_{eff} = 1.2\text{ L}$$

$$L_{eff} = 1.2 \times 6 = 7.2 \text{ m}$$

9. (c)

As per IS 456

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



11. (b)

$$V_u \text{ at } xx = \frac{5\times12}{2} - 5\times3 = 15 \text{ kN}$$

$$M_{uxx} = 30\times3 - \frac{5\times3\times3}{2} = 67.5 \text{ kNm}$$

$$d_{xx} = 200 + \frac{400-200}{6}\times3 = 300 \text{ mm}$$

$$V_u \text{ design} = V_u - \frac{M_u}{d}\tan\beta = 15 - \frac{67.5}{0.3}\times\frac{200}{6000} = 7.5 \text{ kN}$$

$$\tau_v = \frac{V_{udesign}}{Bd_{xx}} = \frac{7.5\times10^3}{250\times300} = 0.1 \text{ N/mm}^2$$

12. (a)

$$\text{Design moment} = \max\begin{cases}1.5(DL+LL)\\1.5(DL+EQL)\\1.2(DL+LL+EQL)\end{cases}$$

$$= \max\begin{cases}1.5(50+40) = 135 \text{ kNm}\\1.5(50+10) = 90 \text{ kNm}\\1.2(50+40+10) = 120 \text{ kNm}\end{cases} = 135 \text{ kNm}$$

14. (d)

$$\text{Initial stress in steel wires} = \frac{200\times10^3}{200} = 1000 \text{ N/mm}^2$$

$$e = \frac{300}{2} - 100 = 50 \text{ mm}$$

stress in concrete at the level of prestress wire

$$= \frac{P}{A} + \frac{Pe}{I}e = \frac{200\times10^3}{150\times300} + \frac{200\times10^3\times50^2}{150\times\frac{300^3}{12}}$$

$$F_c = 5.926 \text{ N/mm}^2$$

$$m = \frac{E_s}{E_c} = \frac{210}{35} = 6$$

$$\text{Loss of stress} = m\,.\,F_c = 6\times5.926 = 35.56 \text{ N/mm}^2$$

$$\%\text{ loss} = \frac{35.56}{1000}\times100 = 3.556\%$$

15. (a)

$$L_{eff} = L_{clear} + \frac{d}{2} = 4 + \frac{0.40}{2} = 4.2 \text{ m}$$

$$\text{final deflection as per IS : 456} = \frac{L_{eff}}{250} = \frac{4200}{250} = 16.8 \text{ mm}$$

16. (d)

$$\tan\theta = \frac{h}{l/3} = \frac{3h}{l}$$

$$\text{So upward force} = P\sin\theta = \frac{3Ph}{l}$$

So balance load w_x

$$\frac{3Ph}{l} = w$$

$$\Rightarrow \quad h = \frac{wl}{3P}$$

17. (a)

Permissible bearing stress in footing as per LSM is 0.45 f_{ck}.

18. (b)

Case:1 $x_u < D_f$

$$0.36 f_{ck} Bx_u = 0.87 f_y A_{st}$$

$$0.36 \times 25 \times x_u \times 1000 = 0.87 \times 415 \times 8 \times \frac{\pi}{4} \times 20^2$$

$$x_u = 100.824 \text{ mm} > D_f$$

Case:2

$$x_u > D_f > 3/7\, x_u$$

$$y_f = 0.15\, x_u + 0.65\, D_f = 0.15\, x_u + 65$$

$$0.36 f_{ck} x_u bw + 0.45 f_{ck}(B_f - b_w)\, y_f = 0.87 f_y A_{st}$$

$$0.36 \times 25 \times x_u \times 250 + 0.45 \times 25(1000 - 250)[65 + 0.15\, x_u] = 0.87 \times 415 \times 8 \times \frac{\pi}{4} \times 20^2$$

$$2250\, x_u + 1265.625\, x_u + 548437.5 = 90787.622$$

$$x_u = 102.11\, m_m > D_f$$

$$\frac{3}{7} x_u = 43.76 \text{ mm} < D_B$$

So, $x_u = 102.11$ mm

20. (c)

As per IS 456 : 2000

$$\text{spacing} = \min \begin{cases} \text{Least lateral dimension} \\ 16\phi_{main}(\text{min}) \\ 300 \text{ mm} \end{cases}$$

$$\text{Diameter} = \min \begin{cases} 400 \\ 16 \times 16 = 256 \\ 300 \text{ mm} \end{cases}$$

So provide, $S = 250$ mm.

21. (a)

$$T_{up}(\text{LSM}) = k_B 0.25\sqrt{f_{ck}}$$

where,

$$k_B = \left(0.5 + \frac{b}{a}\right) \ngtr 1 = 0.5 + \frac{2}{5} = 0.9 \ngtr 1$$

$$T_{up} = 0.9 \times 0.25 \times \sqrt{25}$$

$$T_{up} = 1.125 \text{ N/mm}^2$$

22. (a)

$m = 8,\ j = 6,\ r = 4$

$$D_s = m - (2j - r) = 8 - (6 \times 2 - 4) = 0$$

So truss is stable and determinate.

23. (d)

$$\text{Long term, } E = \frac{5000\sqrt{f_{ck}}}{1+\theta}$$

$$\theta(\text{for 28 days loading}) = 1.6$$

$$E = \frac{500\sqrt{25}}{1+1.6} = 9615.4 \text{ N/mm}^2$$

25. (c)

For simply supported beam,

$$l_{eff} = \left.\begin{matrix} L_{clear} + d \\ L_{clear} + w \end{matrix}\right\} \text{min.}$$

$$6000 = \left.\begin{matrix} L_{clear} + 450 \\ L_{clear} + 200 \end{matrix}\right\} \text{min.}$$

$\Rightarrow$ $$L_{clear} = 5800 \text{ mm}$$

$$w = 4 \text{ kN/m}$$

$\Rightarrow$ $$w_u = 1.5\text{ w} = 1.5 \times 4 = 6 \text{ kN/m}$$

$$v_u = \frac{w_u L_{clear}}{2} = \frac{6 \times 5.8}{2} = 17.4 \text{ kN}$$

$$w = \frac{V_u}{Bd} = \frac{17.4 \times 10^3}{250 \times 450} = 0.154 \text{ N/mm}^2$$

26. (b)

M30/Fe415

Case-I

Consider neutral axis within flange

$$0.36\ F_{ck}\ x_u\ B = 0.87 \text{ fy Ast}$$

$$0.36 \times 30 \times x_u \times 400 = 0.87 \times 415 \times 4 \times \frac{n}{4} \times 202$$

$$x_u = 105.025 \text{ mm} < 120 \text{ mm}$$

So, our assumption was correct.

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

$$M_R = 0.36 \times 30 \times (05.025 \times 400 \times (500 - 0.42 \times 105.25)$$

$$M_R = 229.526 \text{ kNm}$$

27. (c)

$$\text{Effective depth, } d = 400 - 35 = 365 \text{ mm}$$

$$\text{Percentage tension steel, } p_t = \frac{100\ A_{st}}{bd} = \frac{100 \times 5 \times \frac{\pi}{4} \times 25^2}{300 \times 365}$$

$$= 2.24\% > p_{t\lim}\left(= 41.61 \frac{f_{ck}}{f_y} \cdot \frac{x_{u\lim}}{d} = 41.61 \times \frac{20}{415}(0.48) = 0.96\% \right)$$

$\therefore$ Doubly reinforced section is required.

Design shear strength of concrete,

$$\tau_c = 0.8092 \text{ N/mm}^2 \qquad \text{[From table for } p_t = 2.24\%]$$

$$\text{Nominal shear stress, } \tau_v = \frac{V_u}{bd} = \frac{240 \times 10^3}{300 \times 365} = 2.19 \text{ N/mm}^2$$

$$\text{Area of shear stirrups, } A_{sv} = 2 \times \frac{\pi}{4} \times 12^2 = 226.19 \text{ mm}^2$$

∴ Spacing of vertical shear stirrups,

$$S_v = \frac{0.87 f_y A_{sv} d}{(\tau_v - \tau_c) bd}$$

$$= \frac{0.87 \times 415 \times 226.19}{(2.19 - 0.8092) \times 300} \simeq 197 \text{ mm} \quad (< 0.75d = 273.75 \text{ mm})$$

28. (a)

When jacking is done from one end.

Maximum loss at $x = L$

and

$$\alpha = 2\theta = \frac{8R}{L}$$

$$\alpha = \frac{8 \times 150}{6000} = \frac{1}{5}$$

$$p_x = p_0 (kx + \mu\alpha)$$

$$p_x = 1000\left(0.002 \times 6 + 0.3 \times \frac{1}{5}\right)$$

$$p_x = 72 \text{ N/mm}^2$$

$$\% \text{ loss} = \frac{72}{1000} \times 100 = 7.2\%$$

29. (b)

Dead load = 0.5 × 0.7 × 25 = 8.75 kN/m

$$I = \frac{500 \times 700^3}{12} = 1.43 \times 10^{10} \text{mm}^4$$

$$\delta = \frac{5P(e_1 + e_2)L^2}{48E_c I_c} - \frac{P_{e_1} L^2}{8E_c I_C} + \frac{5wl^4}{384E_c I_c}$$

$$\delta = \frac{5 \times 1500 \times 10^3 \times (50 + 200) \times 10000^2}{48 \times 35000 \times 1.43 \times 10^{10}} - \frac{1500 \times 10^3 \times 50 \times 10000^2}{8 \times 35000 \times 1.43 \times 10^{10}} + \frac{5 \times 8.75 \times 10000^4}{384 \times 35000 \times 1.43 \times 10^4}$$

$$\delta = 7.8047 - 1.873 + 2.2763 = 8.208 \text{ mm}$$

$$\delta = 8.208 \text{ mm}$$

30. (d)

$$P = C_r[\sigma_{cc} A_c + \sigma_{sc} A_{sc}]$$

$$\frac{l_{eff}}{B} = \frac{0.8 \times 9000}{500} = 14.4 > 12 \text{ long column}$$

$$C_r = 1.25 - \frac{l_{eff}}{48B} = 1.25 - \frac{7200}{48 \times 500} = 0.95$$

$$2500 \times 10^3 = 0.95[8 \times (500 \times 500 - A_{sc}) + 190 \times A_{sc}]$$

$$\Rightarrow \quad A_{sc} = 3470.2 \text{ mm}^2$$

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