

# CLASS TEST

S.No. : 01 SK1\_CE\_C\_270519

Reinforced Cement Concrete



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# CLASS TEST 2019-2020

## CIVIL ENGINEERING

### Reinforced Cement Concrete

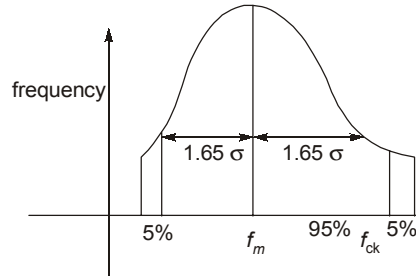
Date of Test : 27/05/2019

#### *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)



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

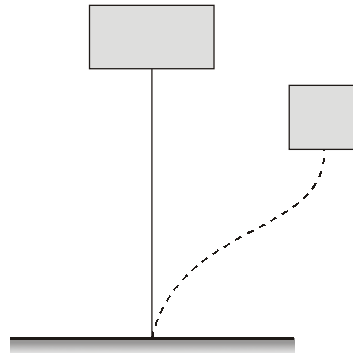
6. (b)

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

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

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

7. (a)



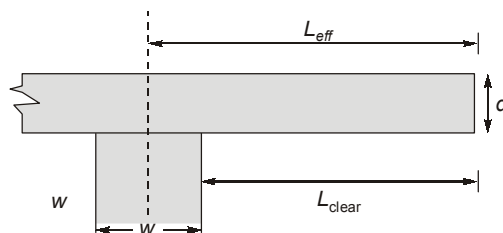
$$L_{\text{eff}} = 1.2 L$$

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

9. (c)

As per IS 456

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



11. (b)

$$V_u \text{ at } xx = \frac{5 \times 12}{2} - 5 \times 3 = 15 \text{ kN}$$

$$M_{u,xx} = 30 \times 3 - \frac{5 \times 3 \times 3}{2} = 67.5 \text{ kNm}$$

$$d_{xx} = 200 + \frac{400 - 200}{6} \times 3 = 300 \text{ mm}$$

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

$$\tau_v = \frac{V_{u \text{ design}}}{Bd_{xx}} = \frac{7.5 \times 10^3}{250 \times 300} = 0.1 \text{ N/mm}^2$$

12. (a)

$$\begin{aligned} \text{Design moment} &= \max \begin{cases} 1.5(DL + LL) \\ 1.5(DL + EQL) \\ 1.2(DL + LL + EQL) \end{cases} \\ &= \max \begin{cases} 1.5(50 + 40) = 135 \text{ kNm} \\ 1.5(50 + 10) = 90 \text{ kNm} \\ 1.2(50 + 40 + 10) = 120 \text{ kNm} \end{cases} = 135 \text{ kNm} \end{aligned}$$

14. (d)

$$\text{Initial stress in steel wires} = \frac{200 \times 10^3}{200} = 1000 \text{ N/mm}^2$$

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

stress in concrete at the level of prestress wire

$$= \frac{P}{A} + \frac{Pe}{I} = \frac{200 \times 10^3}{150 \times 300} + \frac{200 \times 10^3 \times 50^2}{150 \times \frac{300^3}{12}}$$

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

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

$$\text{Loss of stress} = m \cdot F_c = 6 \times 5.926 = 35.56 \text{ N/mm}^2$$

$$\% \text{ loss} = \frac{35.56}{1000} \times 100 = 3.556\%$$

15. (a)

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

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

16. (d)

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

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

So balance load  $w_x$ 

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

 $\Rightarrow$ 

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

17. (a)

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

18. (b)

$$\text{Case:1 } x_u < D_f \quad 0.36 f_{ck} B x_u = 0.87 f_y A_{st}$$

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

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

Case:2

$$x_u > D_f > 3/7 x_u$$

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

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

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

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

$$x_u = 102.11 \text{ m}_m > D_f$$

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

So,

$$x_u = 102.11 \text{ mm}$$

20. (c)

As per IS 456 : 2000

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

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

So provide,  $S = 250 \text{ mm}$ .

21. (a)

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

where,

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

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

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

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,

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

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

⇒

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

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

⇒

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

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

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

26. (b)

M30/Fe415

**Case-I**

Consider neutral axis within flange

$$0.36 F_{ck} x_u B = 0.87 f_y A_{st}$$

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

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

So, our assumption was correct.

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

$$M_R = 0.36 \times 30 \times (105.025 \times 400 \times (500 - 0.42 \times 105.25))$$

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

27. (c)

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

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

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

∴ Doubly reinforced section is required.

Design shear strength of concrete,

$$\tau_c = 0.8092 \text{ N/mm}^2$$

[From table for  $\rho_t = 2.24\%$ ]

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

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

∴ Spacing of vertical shear stirrups,

$$\begin{aligned} S_v &= \frac{0.87 f_y A_{sv} d}{(\tau_v - \tau_c) bd} \\ &= \frac{0.87 \times 415 \times 226.19}{(2.19 - 0.8092) \times 300} \simeq 197 \text{ mm} \quad (< 0.75d = 273.75 \text{ mm}) \end{aligned}$$

28. (a)

When jacking is done from one end.

$$\text{Maximum loss at } x = L$$

and

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

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

$$\rho_x = \rho_0 (kx + \mu\alpha)$$

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

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

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

29. (b)

$$\text{Dead load} = 0.5 \times 0.7 \times 25 = 8.75 \text{ kN/m}$$

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

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

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

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

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

30. (d)

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

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

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

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

⇒

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

