CLASS TEST

Sl. : 02DLSK_CE_ABC_30082026

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REINFORCED CEMENT CONCRETE

CIVIL ENGINEERING

Date of Test : 30/08/2026

ANSWER KEY

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

DETAILED EXPLANATIONS

1. (a)

Over-reinforced section is the one in which the area of tensile steel, is such that, ultimate compressive strain in concrete is reached, however the tensile strain in the reinforcing steel is less than the yield strain (ε_y).

2. (c)

For isolated L-beam

$$(b_{\text{eff}})_f = b_w + \frac{0.5 l_o}{\frac{l_o}{b_f} + 4} \nless b_f$$

Given: $l_o = 6$ m, $b_f = 1000$ mm, $b_w = 300$ mm

$$(b_{eff})_f = 300 + \frac{0.5 \times 6000}{\frac{6000}{1000} + 4} = 600 \text{ mm} \ngtr 1000 \text{ mm} \left(= b_f\right) \qquad \text{(OK)}$$

3. (b)

$$(\text{MOR})_{\text{lim}} = R_{\text{lim}}\, bd^2$$

For Fe 500,

$$R_{\text{lim}} = 0.133\, f_{ck} = 0.133 \times 20 = 2.66$$

$$(\text{MOR})_{\text{lim}} = (2.66 \times 250 \times 500^2) \text{ N-mm} = 166.25 \text{ kN-m}$$

4. (b)

For 50 m^3 of concrete volume, we need to consider 4 number of samples and 12 specimens of cube. Above 50 m^3, one addition sample is required.

$\therefore$ For 206 m^3 concrete,

Number of samples required = 4 + 1 + 1 + 1 + 1
= 8

Number of cube specimens= 8 × 3 = 24 nos.

5. (a)

Effective bending moment due to torsion,

$$M_t = \frac{T_u}{1.7}\left(1 + \frac{D}{b}\right) = 259 \text{ kNm}$$

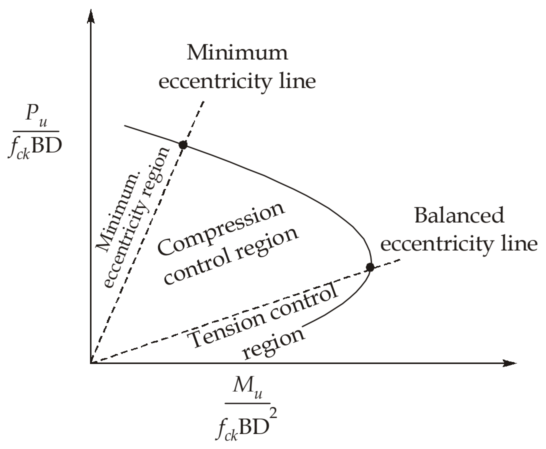
Equivalent bending moment at bottom is,

$$M_e = M_t + M_u = 259 + 200 = 459 \text{ kN-m}$$

6. (b)

Refer table 3, Clause 8.2.2.1 of IS 456 : 2000.

7. **(c)**



8. **(b)**

For solid slabs, to control deflection, span to overall depth ratios are given as:

	Mild steel	HYSD
SS slab	35	28
Continuous slab	40	32

9. **(b)**

$$e_{min} = \max\begin{cases} 20 \text{ mm} \\ \dfrac{\text{Unsupported length}}{500} + \dfrac{\text{Lateral direction}}{30} \end{cases}$$

$\Rightarrow$
$$e_{min} = \max\begin{cases} 20 \text{ mm} \\ \dfrac{2500}{500} + \dfrac{400}{30} = 18.33 \text{ mm} \end{cases}$$

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

10. **(a)**

For slab

$$(A_{st})_{min} = 0.0012 \times A_g \qquad \text{(if Fe415 is used)}$$
$$= 0.0012 \times 150000 = 180 \text{ mm}^2$$

11. **(a)**

$$\text{Required footing area} = \frac{1.1P}{q_u}$$

where P = Column load

Self-weight of footing and backfill soil considered is 10% of column load.

$\therefore$
$$A = \frac{1.1 \times 2000}{210} = 10.48 \text{ m}^2$$

$$\frac{L}{B} = \frac{600}{400} = \frac{3}{2}$$

$\therefore$ $L \times B = 10.48$

$$\Rightarrow \quad \frac{3}{2}B \times B = 10.48$$

$\therefore$ $B = 2.64$ m

and $L = 3.96$ m

Hence, nearest answer is option (a).

12. (b)

$\because$ $D > 400$ mm and column is helically reinforced, so

As per IS 456 : 2000,

$\therefore$ $P_u = [0.4 f_{ck} A_c + 0.67 f_y A_{sc}] \times 1.05$

where A_c = Area of concrete

$= A_g - A_{sc}$

A_{sc} = Area of steel in compression

A_g = gross cross-section area of compression member

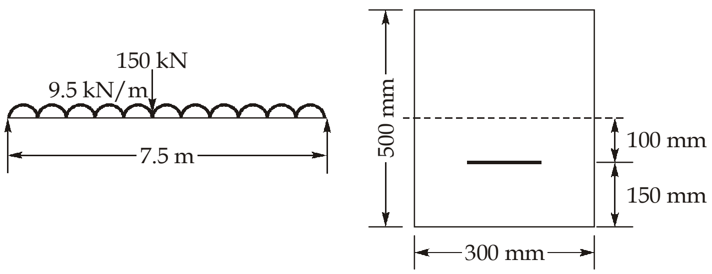
5% increment in load carrying capacity as it is helically reinforced.

$$\therefore \quad P_u = 1.05\left[0.4 \times 25 \times \left(\frac{\pi}{4} \times 500^2 - 8 \times \frac{\pi}{4} \times 20^2\right) + 0.67 \times 500 \times \frac{\pi}{4} \times 8 \times 20^2\right] \times 10^{-3}$$

$\Rightarrow$ $P_u = 1.05\,[1938362.667 + 841946.83] \times 10^{-3}$

$\Rightarrow$ $P_u = 2919.32$ kN $\simeq 2920$ kN (say)

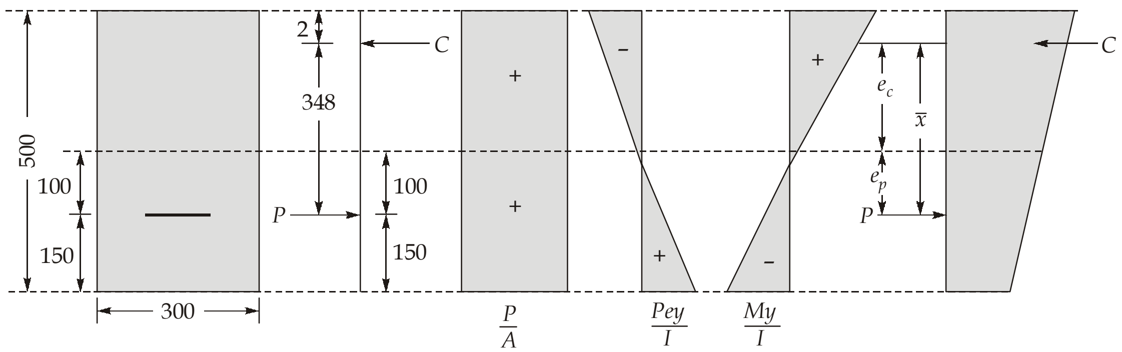
13. (c)



$$M_0 = \frac{Wl^2}{8} + \frac{WL}{4} = \frac{9.5 \times 7.5^2}{8} + \frac{150 \times 7.5}{4} = 348.05 \text{ kN-m}$$

$$\bar{x} = \frac{M}{P} = \frac{348.05 \times 10^6}{1000 \times 10^3} \simeq 348.05 = 348 \text{ mm}$$

$\therefore$ $\bar{x}$ from top $= 500 - 150 - 348 = 2$ mm



(All dimensions are in mm)

14. (b)

$$b = 250 \text{ mm}, d = 450 \text{ mm}, f_{ck} = 20 \text{ MPa}, f_y = 250 \text{ MPa}$$

$$A_{st} = 4 \times \frac{\pi}{4} \times 18^2 = 1017.876 \text{ mm}^2$$

Depth of neutral axis:

$$0.36 \times 20 \times 250 \times x_u = 0.87 \times 250 \times 1017.876$$

$$\Rightarrow \quad x_u = 122.993 \text{ mm} \simeq 123 \text{ mm}$$

For Fe250, $x_{u,max} = 0.53 \times 450 = 238.5$ mm

$$\therefore \quad x_u < x_{u\,max}$$

$\Rightarrow$ Under-reinforced beam section

$$\therefore \quad MOR = 0.87 \times 250 \times 1017.876(450 - 0.42 \times 123) \text{ Nmm}$$

$$= 88.19 \text{ kNm}$$

15. (a)

For depth of neutral axis,

$$0.36 f_{ck}\, b x_u + (f_{sc} - 0.45 f_{ck})A_{sc} = 0.87 f_y A_{st}$$

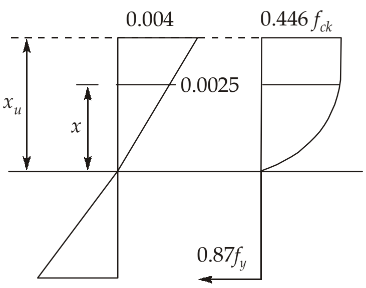
$$\Rightarrow \quad 0.36 \times 20 \times 300 \times x_u + (353 - 0.45 \times 20)700 = 0.87 \times 415 \times 2000$$

$$\Rightarrow \quad x_u = 222.82 \text{ mm}$$

For Fe415, $x_{u,\,max} = 0.48 \times 500 = 240$ mm

$\therefore$ Beam is under-reinforced and depth of neutral axis = 222.82 mm $\simeq$ 222.8 mm

16. (d)



From strain diagram,

$$\frac{0.004}{x_u} = \frac{0.0025}{x}$$

$$\Rightarrow \quad x = \frac{0.0025}{0.004} x_u$$

$$\Rightarrow \quad x = \frac{5}{8} x_u$$

$\therefore$ Total compressive force,

$$C = C_{linear} + C_{parabolic}$$

$$\Rightarrow \quad C = 0.446 f_{ck} \times (x_u - x) \times b + \frac{2}{3} \times 0.446 f_{ck} \times x \times b$$

$$\Rightarrow \quad C = 0.446 f_{ck}\left(x_u - \frac{5}{8}x_u\right) \times b + 0.185 f_{ck} b\left(\frac{5}{8}x_u\right)$$

$\Rightarrow \quad C = 0.167\, f_{ck}\, bx_u + 0.185 f_{ck}\, bx_u$

$\Rightarrow \quad C = 0.352\, f_{ck} bx_u = 0.352 \times 25 \times bx_u$

$\Rightarrow \quad C = 8.8\, bx_u$

17. (a)

$$E_{\text{long}} = \frac{E}{1+\theta}$$

For 28 days, $\theta = 1.6$

$$\therefore \quad E_{\text{long}} = \frac{5000\sqrt{f_{ck}}}{1+\theta}$$

$$\Rightarrow \quad E_{\text{long}} = \frac{5000 \times \sqrt{30}}{1+1.6}$$

$$= 10533.126 \text{ MPa} = 10.5 \text{ GPa}$$

18. (b)

$$V_u = 80 \times 10^3 \text{ kN}$$

$$P_t = \frac{100 \times 4 \times \frac{\pi}{4} \times 12^2}{250 \times 400} = 0.452\%$$

Using the table to get τ_c corresponding to

$$P_t = 0.452\%$$

$$\frac{0.48-0.36}{0.5-0.25} = \frac{0.48-x}{0.5-0.452}$$

$$\Rightarrow \quad x = \tau_c = 0.457 \text{ MPa}$$

$$\tau_v = \frac{80 \times 10^3}{250 \times 400} = 0.8 \text{ MPa}$$

We see that $\tau_c < \tau_v$

$$\therefore \quad V_{us} = V_u - \tau_c bd$$

$$= 80 \times 10^3 - 0.457 \times 250 \times 400 = 34300 \text{ N}$$

Since vertical stirrups,

$$S_v = \frac{0.87 f_y A_{sv}\, d}{V_{us}}$$

$$\therefore \quad 280 = \frac{0.87 \times 250 \times 2 \times \frac{\pi}{4}\phi^2 \times 400}{34300}$$

$$\Rightarrow \quad \phi = 8.38$$

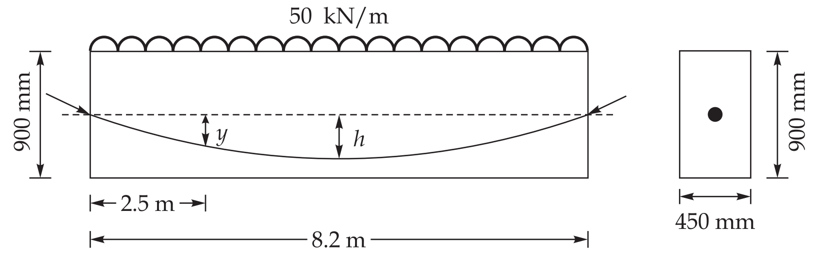
Let us provide 10 mm dia. stirrups.

19. (b)

Shear force along short side

$$F_x = \frac{1}{3}(1.5w\, l_x) = \frac{1}{3} \times 1.5 \times 12 \times 4 = 24 \text{ kN}$$

20. (a)



We know, $$y = \frac{4hx}{l^2}(l-x)$$

where l = Length of beam = 8.2 m

x = Distance of section from either end of beam = 2.5 m from left end

y = Eccentricity of section

h = Maximum dip = $\frac{wl^2}{8P}$

$$\therefore \quad h = \frac{50\times 8.2^2}{8\times 1200} = 0.350 \text{ m}$$

$$\therefore \quad y = \frac{4\times 0.350\times 2.5}{8.2^2}\times(8.2-2.5)$$

y = 0.2967 m i.e., y = 296.7 mm

21. (d)

22. (c)

$$\frac{P_u}{f_{ck}bD} = \frac{810\times 10^3}{20\times 450\times 450} = 0.2$$

From the interaction diagram

For $$\frac{P_u}{f_{ck}bD} = 0.2$$

$$\frac{M_u}{f_{ck}bD^2} = 0.4$$

$$\Rightarrow \quad M_u = 0.4 \times 20 \times 450 \times 450^2 \text{ N-mm}$$

$$= 729 \times 10^6 \text{ N-mm}$$

$$\because \quad e = \frac{M_u}{P_u} = \frac{729\times 10^6}{810\times 10^3} \text{ mm}$$

$$\Rightarrow \quad e = 900 \text{ mm}$$

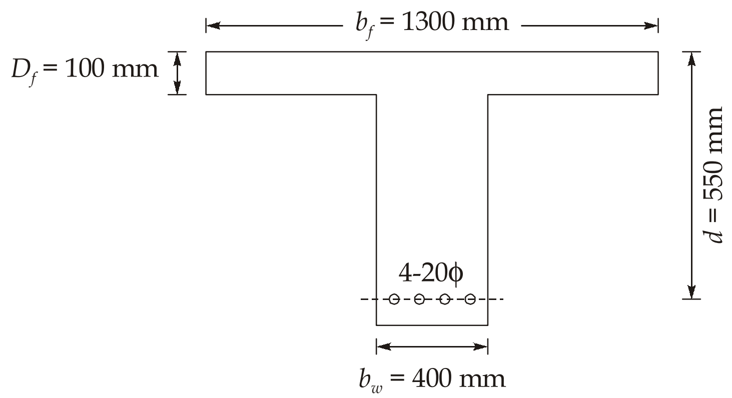
23. (b)

Creep increases when:

- Cement content is high
- Water cement ratio is high
- Aggregate content is low

- Air entrainment is high
- Relative humidity is low
- Temperature is high
- Loading occurs at an early age
- Loading sustained over a long period.

24. (a)



Actual depth of Neutral axial (Assuming $x_u \le D_f$)

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b_f}$$

$$= \frac{0.87 \times 415 \times \left(4 \times \frac{\pi}{4} \times 20^2\right)}{0.36 \times 30 \times 1300}$$

$$= 32.32 \text{ mm} < D_f (= 100 \text{ mm}) \qquad \text{(OK)}$$

For Fe415, $x_{u\,lim} = 0.48 \times d = 0.48 \times 550 = 264 \text{ mm} > x_u$

Thus section is under-reinforced and hence ultimate moment of resistance is given by

$$M_u = 0.36 f_{ck} b x_u (d - 0.42 x_u)$$

$$\Rightarrow \quad M_u = 0.36 \times 30 \times 1300 \times 32.32 (550 - 0.42 \times 32.32) \times 10^{-6} \text{ kNm}$$

$$\Rightarrow \quad M_u = 243.32 \text{ kNm} \simeq 243 \text{ kNm}$$

25. (b)

In post-tensioned prestressed beam

$$\text{Shrinkage strain in concrete, } \in = \frac{2 \times 10^{-4}}{\log_{10}(t+2)} = \frac{2 \times 10^{-4}}{\log_{10}(28+2)}$$

$$= \frac{2 \times 10^{-4}}{\log_{10} 30} = 1.354 \times 10^{-4}$$

$\therefore$ Loss of stress in steel $= E_s \times \in$

$= 1.354 \times 10^{-4} \times 2.1 \times 10^5$

$= 28.43 \text{ N/mm}^2$

26. (b)

Given: $M_{u\,lim} = 190$ kNm

As in the question no information is given about grade of steel and concrete. So assume that beam is designed to carry limiting moment.

$$\therefore \quad M_{u\,lim} = \frac{w_u l^2}{8}$$

$$\Rightarrow \quad 190 = \frac{w_u (6)^2}{8}$$

$$\Rightarrow \quad w_u = 42.22 \text{ kN/m}$$

$$\Rightarrow \quad w = \frac{w_u}{\text{FOS}} = \frac{42.22}{1.5} = 28.15 \text{ kN/m}$$

Self weight of beam $= bD\gamma$

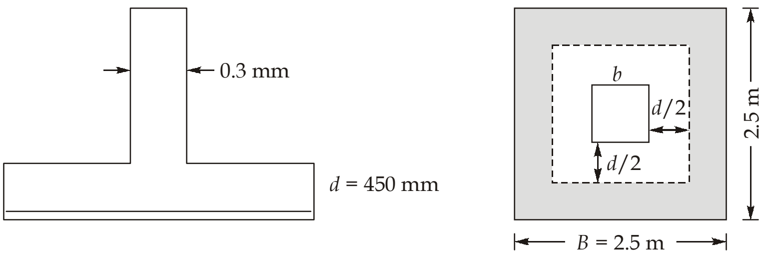
$= 0.25 \times 0.53 \times 25$

$= 3.31$ kN/m

$\therefore$ Net intensity of superimposed load $= 28.15 - 3.31$

$= 24.84$ kN/m

27. (d)



Two way shear $= V_{u2} = w_u [B^2 - (b + d)^2]$

$= 145 \times [2.5^2 - (0.3 + 0.45)^2]$

$= 824.688$ kN

Punching shear stress, $\tau_v = \dfrac{V_u}{b_o d}$

$b_o = 4\,(b + d) = 4\,(0.3 + 0.45)$

$$\therefore \quad \tau_v = \frac{824.688 \times 10^3}{4(0.75) \times 0.45} = 0.611 \text{ MPa}$$

28. (d)

The location of critical section for shear from column line is:

$$x = \frac{\text{width of support}}{2} + d$$

$= 0.25 + 1 = 1.25$ m

$$\text{Design shear force} = \left(\frac{10 \times 10}{2} - 10 \times 1.25\right) \times 1.5 = 56.25 \text{ MN}$$

29. (d)

Slenderness ratio about y-axis,

$$\lambda_y = \frac{l_{ey}}{b} = \frac{5000}{300} = 16.67 > 12$$

$\therefore$ Column is long about y-axis and additional moment need to be considered as per **Cl 39.7.1** of **IS 456:2000.**

$$M_{\text{uay}} = \frac{P_u b}{2000}\left(\frac{l_{ey}}{b}\right)^2$$

$$= \frac{1200 \times 1000 \times 300}{2000}\left(\frac{5 \times 10^3}{300}\right)^2 \text{ Nmm}$$

$$= 50 \text{ kNm}$$

30. (b)

As per IS 456 : 2000

Refer clause 26.2.3.1 and 26.2.3.2

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