CLASS TEST

S.No. : 01JPCE-RCC-11082023

MADE EASY

India's Best Institute for IES, GATE & PSUs

Delhi | Bhopal | Hyderabad | Jaipur | Pune | Bhubaneswar | Kolkata

Web: www.madeeasy.in | **E-mail:** info@madeeasy.in | **Ph:** 011-45124612

CIVIL ENGINEERING

REINFORCED CEMENT CONCRETE

Duration : 1:00 hr. **Maximum Marks : 50**

Read the following instructions carefully

1. This question paper contains **30** objective questions. **Q.1-10** carry one mark each and **Q.11-30** carry two marks each.
2. Answer all the questions.
3. Questions must be answered on Objective Response Sheet (**ORS**) by darkening the appropriate bubble (marked **A**, **B**, **C**, **D**) using HB pencil against the question number. Each question has only one correct answer. In case you wish to change an answer, erase the old answer completely using a good soft eraser.
4. There will be **NEGATIVE** marking. For each wrong answer **1/3rd** of the full marks of the question will be deducted. More than one answer marked against a question will be deemed as an incorrect response and will be negatively marked.
5. Write your name & Roll No. at the specified locations on the right half of the **ORS**.
6. No charts or tables will be provided in the examination hall.
7. Choose the **Closest** numerical answer among the choices given.
8. If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that questions.
9. If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

Q.No. 1 to Q.No. 10 carry 1 mark each

Q.1 A partially prestressed member is one in which :
(a) Tensile stresses and cracking are permitted under service loads.
(b) No tensile stresses are permitted under service loads.
(c) Mild steel is used in addition to prestressing steel
(d) Tensile stresses are permitted but not cracking at service loads.

Q.2 Consider the following statements in a RC structure:
1. The concept of locating the neutral axis in a reinforced concrete flexural member as centroidal axis is applicable in working stress design method, but not in limit state design method.
2. The working stress design method assumes that the structural material behaves in a nonlinear elastic manner and there is strain compatibility in bond between steel and concrete.

Which of the above statement (s) is (are) correct?
(a) 1 only (b) 2 only
(c) both 1 and 2 (d) Neither 1 nor 2

Q.3 The cubes and cylinders are stored under water or placed in constant temperature at 100% relative humidity before testing
(a) to provide proper curing.
(b) to enhance workability.
(c) to increase water cement ratio.
(d) to decrease water cement ratio.

Q.4 Consider the following statements based on response spectra of structure with low value of natural period:
1. Short natural period or high natural frequency indicates a very stiff structure.
2. The maximum relative displacement is nearly zero.

Which of the above statement(s) is/are CORRECT?
(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 nor 2

Q.5 The effective lateral support to a RC compression member is given by transverse reinforcement either in the form of circular rings capable of taking up circumferential tension or by polygonal links (lateral ties) with internal angles not exceeding.
(a) 135° (b) 120°
(c) 90° (d) 150°

Q.6 Minimum nominal cover provided to the column immersed in normal water but not exposed to coastal environment is
(a) 30 mm (b) 40 mm
(c) 45 mm (d) 50 mm

Q.7 Column head is also known as
(a) Drop (b) Shear caps
(c) Panel (d) Capital

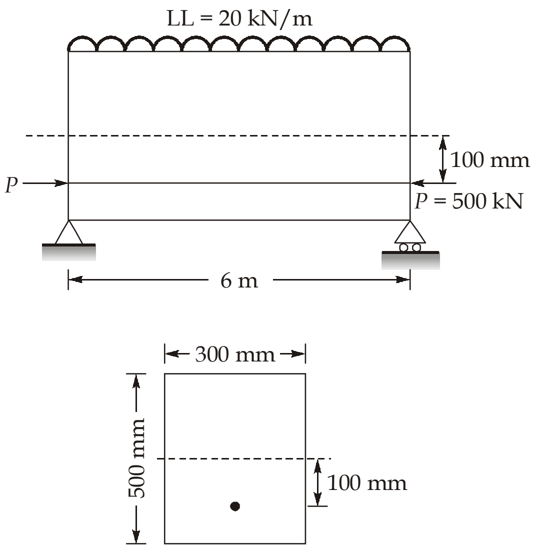
Q.8 If maximum spacing of shear reinforcement for vertical stirrups is k_1 and for inclined stirrups is k_2, then, $\frac{k_1}{k_2}$ is
(a) 0.5 (b) 0.75
(c) 1.34 (d) 1.0

Q.9 In URS beam, flexural collapse occurs due to
(a) Primary compression failure
(b) Primary tension failure
(c) Secondary compression failure
(d) Bond failure

Q.10 As per IS code, purlins provided in industrial building are assumed to be
(a) Simply supported (b) Cantilever
(c) Continuous (d) Fixed

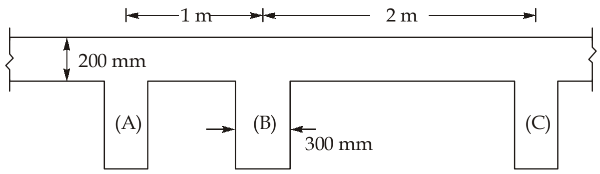
Q.No. 11 to Q.No. 30 carry 2 marks each

Q.11 A prestressed concrete beam as shown in figure is subjected to a LL of 20 kN/m and DL of 10 kN/m. If the net losses are 15% and prestressing force is 500 kN, then the extreme fibre stress at bottom in initial stage (at transfer) at the mid span of the beam is



(a) 3.33 N/mm² (b) 4 N/mm²
(c) –3.6 N/mm² (d) 3.73 N/mm²

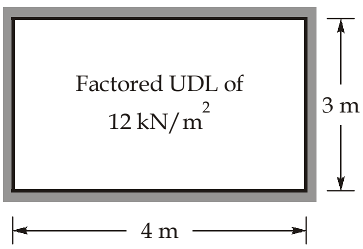
Q.12 Beams of effective span of 6 m supporting a slab are fixed at both ends. Effective width of flange of beam is



(a) 1 m (b) 1.5 m
(c) 1.8 m (d) 2 m

Q.13 If a beam of cross-section (300 × 600) mm² is subjected to a torsional moment of 34 kNm, then it's equivalent hogging bending moment (in kNm) is
(a) 45 (b) 90
(c) 124 (d) 180

Q.14 A slab shown in the figure below, simply supported on all edges is subjected to a udl of 12 kN/m². Ratio of maximum shear force per unit length along larger edge to shorter edge is

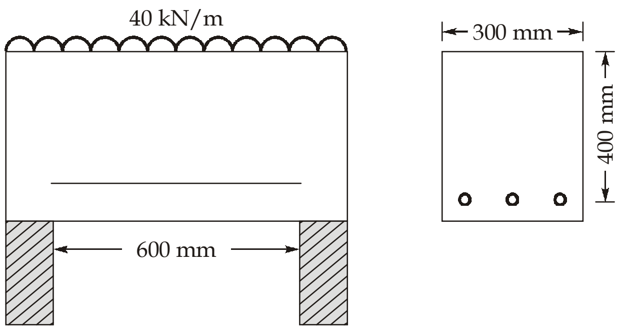


(a) 1.5 (b) 1.2
(c) 0.8 (d) 1.8

Q.15 In case of pre-tensioned PSC beams, which of the following statement(s) is/are true?
1. Loss of friction is significant.
2. Generally Hoyer's method is adopted.
3. Transmission length requirement must be satisfied.
4. Spalling stresses are major concern.

(a) 2 only (b) 3 and 4
(c) 1, 2 and 3 (d) 2 and 3

Q.16 A simply supported RC beam as shown in figure is subjected to a factored udl of 40 kN/m. It has to be designed for shear at critical section. If τ_c = 0.6 N/mm²; then what will be the shear force for which shear reinforcement is to be designed.



(a) 16 kN (b) 104 kN
(c) 72 kN (d) 36 kN

Q.17 Consider the following statements:
1. Reinforcement that is no longer required for flexure beyond a certain section, shall however be extended by d or 12 ϕ, whichever is greater, before being curtailed.
2. Atleast half of the total bars should be bent up at the cut–off point.
3. The shear capacity at cut–off point should atleast be 1.5 times the shear force at that section.

Which of the above statements are CORRECT?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Q.18 A cantilever type retaining wall has a 5.5 m tall stem. It retains earth level with its top. Width of base slab is given as 3.5 m. The total magnitude of vertical load including the weight of soil is 300 kN and distance of the point of application of the resultant force from the heel end is given as 2 m. The extreme pressure intensities at the base length will be nearly:

(a) 122 kN/m^2 and 49 kN/m^2
(b) 100 kN/m^2 and 35 kN/m^2
(c) 49 kN/m^2 and 16 kN/m^2
(d) 136 kN/m^2 and 40 kN/m^2

Q.19 A simply supported rectangular beam of span 24 m is subjected to UDL. The minimum effective depth required to check deflection of this beam, when modification factor for tension and compression are 1.6 and 1.2 respectively, will be ________ mm.

(a) 1200 (b) 625
(c) 1500 (d) 1800

Q.20 The target mean strength for a concrete mix is 36 MPa and standard deviation is 4 MPa. If for the mix, creep coefficient is 1.5, the long-term static modulus of elasticity as per provision of **IS 456 : 2000** is

(a) 10845 MPa (b) 12431 MPa
(c) 89428 MPa (d) 10000 MPa

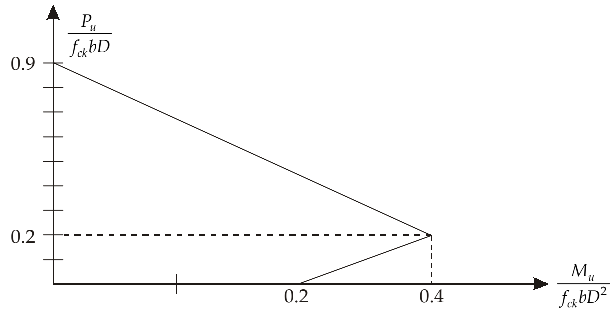
Q.21 The design dead load and live load on a continuous one way slab are 6 kN/m^2 and 3 kN/m^2 respectively. If the effective span is 4.5 m, then the magnitude of B.M. at support next to the end support will be

(a) 17.6 kN-m (b) 18.9 kN-m
(c) 15.4 kN-m (d) 19.5 kN-m

Q.22 The development length in compression for a 18 mm diameter deformed bar of grade Fe415 embedded in concrete of grade M30 whose design bond stress for plain mild steel bars in tension is 1.5 N/mm^2 is ________.

(a) 542 mm (b) 645 mm
(c) 450 mm (d) 510 mm

Q.23 A RC column of square cross-section (450 mm × 450 mm) has its column load-moment interaction diagram as shown in figure below.



What is the maximum eccentricity at which a factored load of P_u = 810 kN can be applied safely? [Take f_{ck} = 20 MPa]

(a) 600 mm (b) 800 mm
(c) 900 mm (d) 1000 mm

Q.24 A RC footing of size 4.5 m × 3 m is reinforced with 16 mm diameter bars in the short direction. If the total reinforcement in this direction is 825 mm^2, then the reinforcement in central band width will be

(a) 550 mm^2 (b) 590 mm^2
(c) 720 mm^2 (d) 660 mm^2

Q.25 A circular column with helical reinforcement was checked as per codal provisions. Diameter of the column is 420 mm and cross-section area of longitudinal steel used is 2100 mm^2. M20 grade concrete and Fe415 grade steel are used. The factored axial load that can be taken by the column is

(a) 1800 kN (b) 1760 kN
(c) 1950 kN (d) 1740 kN

Q.26 In a post-tensioned prestressed beam, if the age of concrete at transfer is 28 days, then the loss of stress in the tendon due to shrinkage of concrete is equal to
(Take E_s = 2.1 × 10^5 N/mm^2)

(a) 26.54 N/mm^2 (b) 27.56 N/mm^2
(c) 28.43 N/mm^2 (d) 30.02 N/mm^2

Q.27 The characteristic compressive strength of concrete required in a project is 20 MPa and the standard deviation in the observed compressive strength expected at site is 4 MPa. The average compressive strength of cubes tested at different water-cement (w/c) ratios using the same material as is used for the project is given in the table below.

w/c(%)	45	50	55	60
Avg. compressive strength (MPa)	35	25	20	15

The water-cement ratio to be used in the mix is ______.

(a) 49.2% (b) 47.5%
(c) 48.5% (d) 52.3%

Q.28 A reinforced concrete beam is made of M25 grade of concrete. After how many days, loading would have applied on this beam if effective modulus of elasticity is found to be 11904.76 N/mm^2 at the time of loading.

Creep coefficient	2.2	1.6	1.1
Time (days)	7	28	365

(a) 7 days (b) 54 days
(c) 28 days (d) 365 days

Q.29 A square column section of size 450 mm × 450 mm is reinforced with four bars of 32 mm diameter and four bars of 16 mm diameter. The minimum transverse reinforcement that should be provided is

(a) 10 mm ϕ @ 180 mm c/c
(b) 6 mm ϕ @ 250 mm c/c
(c) 8 mm ϕ @ 250 mm c/c
(d) 10 mm ϕ @ 250 mm c/c

Q.30 A beam of size 300 mm × 450 mm is subjected to an axial compressive load of 120 kN along with the transverse loading. Maximum shear force in the section is 120 kN and it has flexural tension reinforcement of 1000 mm^2. Corresponding to the given flexural tension reinforcement, the design shear strength of M20 grade concrete is 0.512 N/mm^2. Using the limit state method of design, the design shear strength of concrete is
(Take grade of steel as Fe415)

(a) 0.526 N/mm^2
(b) 0.396 N/mm^2
(c) 0.614 N/mm^2
(d) 0.72 N/mm^2

■■■■

CLASS TEST

S.No. : 01JPCE-RCC-11082023

MADE EASY
India's Best Institute for IES, GATE & PSUs

Delhi | Bhopal | Hyderabad | Jaipur | Pune | Bhubaneswar | Kolkata

Web: www.madeeasy.in | **E-mail:** info@madeeasy.in | **Ph:** 011-45124612

REINFORCED CEMENT CONCRETE

CIVIL ENGINEERING

Date of Test : 11/08/2023

ANSWER KEY

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

Detailed Explanations

1. (a)

In partially prestressed members, tensile stresses are permitted in concrete under service loads with control on the maximum width of crack. The additional reinforcement is required in the cross–section for various reasons such as to resist differential shrinkage, temperature effects and handling stresses.

2. (a)

The working stress method assumes that concrete is elastic and the stress in concrete varies linearly from zero at the neutral axis to a maximum at the extreme fibre. The bond between steel and concrete is perfect within the elastic limit of steel.

3. (a)

Concrete i.e. allowed to dry out quickly undergoes considerable early age shrinkage which can cause shrinkage cracks. Besides curing also ensures the cement hydration reaction to progress steadily producing calcium silicate hydrate gel making the concrete denser thereby decreases the porosity and enhances the physical and the mechanical properties of concrete.

4. (c)

5. (a)

Refer **IS 456 : 2000, Clause 26.5.3.2(a)**

6. (b)

As per IS-456:2000; Table - 3 and table -16, nominal cover $\ngtr$ 30 mm. and according to clause 26.4.2.1 of IS-456 : 2000, nominal cover $\nless$ 40 mm for column any case.

So, here, answer will be 40 mm.

7. (d)

8. (b)

Maximum spacing for vertical stirrups, $k_1 = 0.75d$ and for inclined stirrups, $k_2 = d$

where d is effective depth.

So, $$\frac{k_1}{k_2} = 0.75$$

9. (c)

At failure in URS beam,

$$\text{Strain in steel} >> 0.002 + \frac{0.87 f_y}{E_s}$$

$\therefore$ Failure occurs due to secondary compression failure of concrete.

10. (c)

11. (d)

At initial stage, no losses are considered and only DL is considered.

At mid span, moment due to dead load:

$$M_d = \frac{wl^2}{8} = \frac{10 \times 6^2}{8} = 45 \text{ kNm}$$

Stress at bottom of mid span $= \frac{P}{A} + \frac{Pe}{Z} - \frac{M_d}{Z}$

$$= \frac{500 \times 10^3}{300 \times 500} + \frac{500 \times 10^3 \times 100}{\frac{300 \times 500^2}{6}} - \frac{45 \times 10^6}{\frac{300 \times 500^2}{6}}$$

$= 3.33 + 4 - 3.6 = 3.75 \text{ N/mm}^2$

12. (c)

Here, $L_o = 0.7 \times l_{eff} = 0.7 \times 6 = 4.2$ m

Now, Effective flange width,

$$b_f = \min.\begin{cases} \frac{L_o}{6} + b_w + 6D_f \\ \frac{L_1}{2} + b_w + \frac{L_2}{2} \end{cases} = \min.\begin{cases} 700 + 300 + 1200 \\ 500 + 300 + 1000 \end{cases}$$

$$= \min.\begin{cases} 2200 \text{ mm} \\ 1800 \text{ mm} \end{cases}$$

$b_f = 1800$ mm

13. (b)

Given: $d = 600$ mm, $N = 300$ mm

$$M_{Tu} = \frac{T_u}{1.7}\left(1 + \frac{D}{B}\right) = \frac{1.5 \times 34}{1.7}\left(1 + \frac{600}{300}\right) = 90 \text{ kNm}$$

Equivalent sagging moment, $M_{ue1} = M_{Tu} + M_u$

$= 0 + 90 = 90$ kNm

Equivalent hogging moment, $M_{ue2} = M_u - M_{Tu}$

[Only applicable when $M_{Tu} > M_u$]

$M_{ue2} = 0 - 90$ kNm

$= -90$ kNm $= 90$ kNm [Hogging Bending Moment]

14. (b)

$$r = \frac{l_y}{l_x} = \frac{4}{3}$$

Maximum shear force along larger edge,

$$F_L = \frac{w_u l_x \times r}{2+r} = \frac{12 \times 3 \times \frac{4}{3}}{2 + \frac{4}{3}} = \frac{48 \times 3}{10} = 14.4 \text{ kN/m}$$

Maximum shear force along shorter edge,

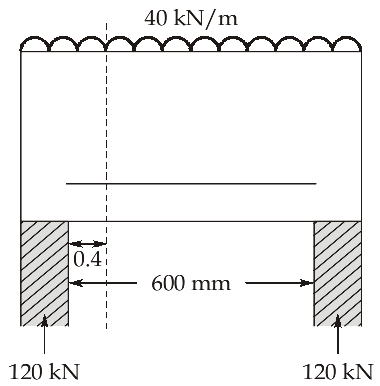
$$F_S = \frac{w_u l_x}{3} = \frac{12 \times 3}{3} = 12 \text{ kN/m}$$

$$\frac{F_L}{F_S} = \frac{14.4}{12} = 1.2$$

15. (d)

Spalling stresses are major concern for post-tensioned PSC members.

16. (d)



At critical section, $V_u = 120 - (40 \times 0.4) = 140$ kN

Shear strength of concrete, $V_c = \tau_c \times bd = 0.6 \times 300 \times 400$

$= 72$ kN

Design shear force, $V_s = V_u - V_c = 104 - 72 = 32$ kN

17. (b)

Refer IS 456 : 2000 Cl. 26.2.3.1 and 26.2.3.2

18. (a)

Total vertical load, $W = 300$ kN

Distance of point of application of the resultant force from the heel end = 2 m

hence, Distance of point of application of the resultant force from the toe end = 3.5 – 2 = 1.5 m

So, eccentricity, $e = \frac{b}{2} - \bar{x} = \frac{3.5}{2} - 1.5$

$= 0.25$ m

$$\frac{b}{6} = \frac{3.5}{6} = 0.583 \text{ m}$$

$\therefore$ $e < \frac{b}{6}$

Extreme pressure intensity at the base,

$$= \frac{W}{b}\left[1 \pm \frac{6e}{b}\right]$$

$$= \frac{300}{3.5}\left[1 \pm \frac{6 \times 0.25}{3.5}\right]$$

$= 122.449\ kN/m^2$ and $48.98\ kN/m^2$

or, $\simeq 122\ kN/m^2$ and $49\ kN/m^2$

19. (c)

For simply supported, $\left(\frac{l}{d}\right)_{basic} = 20$

For span > 10 m

$$\left(\frac{l}{d}\right)_{basic} = 20 \times \frac{10}{24}$$

$$\therefore \quad \left(\frac{l}{d}\right)_{max} = \left(\frac{l}{d}\right)_{basic} k_t\, k_c$$

$$\therefore \quad d_{min} = \frac{24000}{\frac{200}{24} \times 1.6 \times 1.2} = 1500 \text{ mm}$$

20. (a)

$$\because \quad E_\theta = \frac{5000\sqrt{f_{ck}}}{1+\theta}$$ (Refer Cl. 4.1 of **IS 456 : 2000**)

$\because \quad f_{ck} = f_m - 1.65\sigma = 36 - 1.65 \times 4 = 29.4$ MPa

$$E_\theta = \frac{5000 \times \sqrt{29.4}}{1+1.5} = 10844.35 \text{ MPa} \approx 10845 \text{ MPa}$$

21. (b)

B.M. at support next to the end support $= \frac{1}{10} w_d L^2 + \frac{1}{9} \times w_l l^2$ (Table 12 of **IS 456 : 2000**)

$$= \frac{1}{10} \times 6 \times 4.5^2 + \frac{1}{9} \times 3 \times 4.5^2$$

$= 18.9$ kN-m

22. (a)

Given $\phi = 18$ mm

$\tau_{bd} = 1.5\ N/mm^2$ and Fe415 grade steel

$$L_d = \frac{0.87 f_y \phi}{4\tau_{bd}}$$

$\because$ Bars are in compression and HYSD bars are used, so increase bond stress by 25% and 60% respectively.

$\because \quad L_d = \dfrac{0.87 \times 415 \times 18}{4 \times 1.5 \times 1.25 \times 1.6} = 541.575 \text{ mm} \approx 542 \text{ mm}$

23. (c)

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

From the interaction diagram

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

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

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

$= 729 \times 10^6$ N-mm

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

$\Rightarrow \quad e = 900$ mm

$$L_d = \frac{0.87 \times 415 \times 18}{4 \times 1.6 \times 1.25 \times 1.5} = 541.575 \text{ mm} \simeq 541.58 \text{ mm}$$

24. (d)

$\because \quad \dfrac{\text{Reinforcement in central band width}}{\text{Total reinforcement in short direction}} = \dfrac{2}{\beta + 1}$

where $\quad \beta = \dfrac{\text{Long side}}{\text{Short side}} = \dfrac{4.5}{3} = 1.5$

$\therefore \quad$ Reinforcement in central band width $= \dfrac{2}{1.5+1} \times 825 = 660 \text{ mm}^2$

25. (b)

Factored load, $P_u = 1.05\left(0.4 f_{ck} A_c + 0.67 f_y A_{sc}\right)$

$$= 1.05\left[0.4 \times 20 \times \left(\frac{\pi}{4} \times 420^2 - 2100\right) + 0.67 \times 415 \times 2100\right] \text{N}$$

$= 1759.23$ kN ≈ 1760 kN

26. (c)

In post-tensioned prestressed beam

Shrinkage strain in concrete,

$$\in = \frac{2 \times 10^{-4}}{\log_{10}(t+2)} = \frac{2 \times 10^{-4}}{\log_{10}(28+2)} = \frac{2 \times 10^{-4}}{\log_{10} 30} = 1.354 \times 10^{-4}$$

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

$= 1.354 \times 10^{-4} \times 2.1 \times 10^5 = 28.43 \text{ N/mm}^2$

27. (a)

Target mean strength $= f_{ck} + 1.65\ \sigma$

$= 20 + 1.65 \times 4$

$= 26.6$ MPa

Water content required $= 50 - \frac{50-45}{35-25} \times (26.6 - 25) = 49.2$

28. (d)

$\because \quad E_s = \frac{E}{1+\theta}$

$\Rightarrow \quad 11904.76 = \frac{5000 \times \sqrt{25}}{1+\theta}$

$\Rightarrow \quad \theta$ = Creep coefficient = 1.1

From table, t = 365 days

29. (c)

As per **Clause 26.5.3.2** of IS 456 : 2000, diameter of transverse/lateral ties is

$$\max \begin{cases} (i) & \frac{d_{\max}}{4} = \frac{32}{4} = 8 \text{ mm} \\ (ii) & 6 \text{ mm} \end{cases}$$

So, diameter of tie = 8 mm

Spacing, $S_v = \min \begin{cases} \text{(i) Least lateral dimeniosn} = 450 \text{ mm} \\ \text{(ii) } 16 \times \text{smallest dia. of longitudinal reinforcement} = 16 \times 16 = 256 \text{ mm} \\ \text{(iii) } 300 \text{ mm} \end{cases}$

$\therefore$ Provide spacing of 250 mm c/c (< 256 mm)

Hence provide 8 mm ϕ ties @ 250 mm c/c as transverse reinforcement.

30. (c)

Given: $A_{st} = 1000 \text{ mm}^2$

$A_g = B \times D = 300 \times 450 = 135000 \text{ mm}^2$

As per Cl. 40.2.2 of IS 456 : 2000, for a beam subjected to axial compression, the design shear strength is multiplied by a factor

$$\delta = 1 + \frac{3P_u}{A_g\, f_{ck}} \quad \text{but} \not> 1.5$$

$$\therefore \quad \delta = 1 + \frac{3 \times 1.5 \times 120 \times 10^3}{135000 \times 20}$$

$= 1.2 < 1.5$ (OK)

$\therefore$ Design shear strength concrete $= 1.2 \times 0.512 = 0.614 \text{ N/mm}^2$

■■■■