22607

22232

4 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions : (1) All Questions are *compulsory.*

(2) Answer each next main Question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

(6) Use of Non-programmable Electronic Pocket Calculator is permissible.

(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following : 10

(a) State the criterias to decide design strength of tension member. State the formula for any one.

(b) State maximum values of slenderness ratio for any two conditions of compression member.

(c) State any two conditions where in doubly reinforced section is to be used.

(d) State the expression for effective width of flange for Tee beam and L beam with meaning of each term.

(e) State the expression to calculate self-weight of waist slab in staircase.

(f) Draw sketch of part of folded plate stair flight showing rise, tread and main steel.

(g) Write I.S. specifications for

(i) Minimum and maximum % of compression steel in column

(ii) Minimum no. & diameter of bars

2. Attempt any THREE of the following : 12

(a) A tension member consists of 2 ISA 90 × 90 × 8 mm connected back to back same side of 10 mm thick gusset plate. Calculate its net area if 20 mm diameter bolts are used for connection.

(b) Determine the moment of resistance of a T-beam having (i) bf = 1500 mm (ii) Df = 150 mm (iii) effective depth of beam d = 640 mm (iv) width of web bw = 300 mm (v) reinforcement 8-20 mm dia. bars. (vi) M20 grade of concrete and Fe415 steel.

(c) Calculate the safe load carrying capacity of a column of diameter 500 mm reinforced with 6 bars of 20 mm dia. M20 concrete and Fe415 steel are used. Check the column for minimum eccentricity if effective length 4.50 m.

(d) Determine the area of longitudinal steel for short circular column of diameter of 450 mm with length 5.0 m which is held in position at both ends but not restrained against rotation. Column has to carry a factored load of 1500 kN. Use M20 concrete and Fe500 steel.

3. Attempt any TWO of the following : 12

(a) An inclined truss member consists of 2 ISA 100 × 75 × 10 mm connected back to back (with longer leg) to gusset plate of 12 mm thick. 20 mm dia. 3 bolts of grade 4.6 are used in one row for connection with 70 mm pitch and 40 mm edge distance. Calculate the design tensile strength of member considering block shear only.

(b) Design a tie member using single unequal angle section to carry a tensile load of 340 kN. Assume single row of 20 mm bolted connection. The length of member is 2.4 M. Take f_u = 410 MPa, α = 0.80, f_y = 250 MPa. (Check for block shear not expected).

Section Available	**Area in mm^2 (A_g)**
ISA 100 × 75 × 8	1336
ISA 125 × 75 × 8	1538
ISA 150 × 75 × 8	1748

(c) A single angle discontinuous strut ISA 70 × 70 × 6 mm of a roof truss is 1.2 m long. It is connected by two bolts at each end. Determine the design load this strut can carry.

KL/γ	40	50	60	70	80	90	100	110
fcd MPa	198	183	168	152	136	121	107	94.6

for given angle A_g = 806 mm^2 r_{vv} = 13.5 mm.

4. Attempt any TWO of the following : 12

(a) A discontinuous compression member consists of 2 ISA 90 × 90 × 10 mm connected back to back on opposite sides of 12 mm thick gusset plate. Taking rivets are provided along the length along with one bolt at each end. Determine the design strength of the member. The center to center distance of connections is 3m.

For single ISA 90 × 90 × 10 mm, A = 1703 mm^2, f_x = 27.3 mm, $C_x = C_y$ = 25.9 mm, $I_x = I_y = 12.67 \times 10^5$ mm^4.

KL/γ	80	90	100	110	120	130
fcd (MPa)	136	121	107	94.6	83.7	74.4

(b) Design double angle section back to back on each side of gusset plate of 8 mm thick for the continuous principal rafter of a truss to carry factored load of 250 kN. Center to center length of member between centroids of connection is 2.5 m.

Angle Section (mm)	**'A'mm^2**	**f_{yy} (mm)**	**$I_{xx} = I_{yy}$**	**$C_{xx} = C_{yy}$**
ISA 70 × 70 × 8	1058	21.0	47.4×10^4	20.2
ISA 75 × 75 × 8	1138	22.8	59.0×10^4	21.4
ISA 80 × 80 × 8	1221	24.4	72.5×10^4	22.7

(c) A doubly reinforced section 230 × 500 mm deep to the center of 4-16 mm dia. tension reinforcement. It is also reinforced with 4-12 mm bars in compression zone. Determine the ultimate moment of resistance of the section considering M20 grade of concrete d'/d as 0.10 with stress in compression steel as 353 N/mm^2 (for f_y 415 steel).

5. Attempt any TWO of the following : 12

(a) A RCC beam 250 × 550 mm carries a factored moment of 248.5 kNm. Find the steel required for the beam if M20 concrete and Fe415 steel is used. Assume effective cover to reinforcement as 50 mm.

d'/d	0.05	0.10	0.15	0.20
fsc in MPa	355	353	342	329

(b) A rectangular RC section is 200 mm × 600 mm overall depth and is reinforced with 2-20 mm dia. bars in compression. If the concrete is M20 and steel is Fe500, determine the area of the tension steel needed to make the fully effective. Take effective cover to reinforcement as 50 mm. Take f_{sc} as 410 N/mm^2.

(c) Determine the area of tensile reinforcement for a singly reinforced flanged beam having following data :

(i) Clear span – 6.5 m

(ii) Overall depth of beam – 500 mm

(iii) c/c spacing of T-beam ribs is 2.75 m

(iv) Live load on slab is 4 kN/m^2

(v) Slab thickness is 100 mm

(vi) Concrete M20

(vii) Steel Fe415

(viii) Assume eff. cover to steel as 40 mm.

6. Attempt any TWO of the following : 12

(a) A hall measuring 30 m × 8 m provided with floor consisting of slab and beam cast monolithically. T-beam has following details :

(i) Effective span = 8 m

(ii) Slab thickness = 120 mm

(iii) Effective depth = 600 mm

(iv) Width of Ribs = 300 mm

(v) Reinforcement on tension side 8-20 mm dia.

(vi) Materials are M20 & Fe415

Determine the design u.d. load the beam can carry.

(b) Design a flight of a dog-legged staircase for the following data :

(i) No. of risers per flight = 10

(ii) Rise = 150 mm

(iii) Trade = 300 mm

(iv) Landing width = 1000 mm

(v) Assume landing spanning along the flight

(vi) Live load on staircase is 3 kN/m^2

Use M20 & Fe415 materials.

(c) Design an RC column footing for uniform depth with the following data :

(i) Size of column – 450 mm × 450 mm

(ii) SBC = 180 kN/m^2

(iii) Load on column = 1500 kN

(iv) Materials are M20 & Fe415

(v) Depth of footing is for BM criteria & one way shear only.

Clause 10.3.3 $V_{nsb} = (fu/\sqrt{3})(n_n A_{nb} + n_s A_{sb})$ $V_{dsb} = V_{nsb}/\gamma_{mb}$

Clause 10.3.4 $V_{npb} = 2.5 k_b\, d\, t\, f_u$ $V_{dpb} = V_{npb}/\gamma_{mb}$

k_b is smaller of $e/3d_o$, $[(p/3d_o) - 0.25]$, f_{ub}/f_u, 1.0

Clause 6.2 $T_{dg} = \dfrac{A_g f_y}{\gamma_{m0}}$

Clause 6.3.3 $T_{dn} = \dfrac{0.9 A_{nc} f_u}{\gamma_{m1}} + \beta \dfrac{A_{go} f_y}{\gamma_{m0}}$ $\beta = 1.4 - 0.076\,(w/t)\,(f_y/f_u)\,(b_s/L_c) \leq (f_u \gamma_{mo}/f_y \gamma_{m1})$

≥ 0.7

$$T_{dn} = \frac{\alpha A_n f_u}{\gamma_{m1}}$$

Clause 6.4.1 $T_{db1} = \dfrac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \dfrac{0.9 A_{tn} f_u}{\gamma_{m1}}$ $T_{db2} = \dfrac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \dfrac{A_{tg} f_y}{\gamma_{m0}}$

Clause 7.1.2.1 $f_{cd} = \chi \dfrac{f_y}{\gamma_{m0}}$ $\chi = \dfrac{1}{\phi + \sqrt{\phi^2 - \lambda_e^2}}$ $\phi = 0.5[1 + \alpha(\lambda_e - 0.2) + \lambda_e^2]$

Clause 7.5.1.2. $\lambda_e = \sqrt{k_1 + k_2 \lambda_{vv}^2 + k3 \lambda_\varphi^2}$

$$\lambda_{vv} = \frac{\left(\dfrac{l}{r_{vv}}\right)}{\varepsilon \sqrt{\dfrac{\pi^2 E}{250}}} \quad \text{and} \quad \lambda_\varphi = \frac{(b_1 + b_2)/2t}{\varepsilon \sqrt{\dfrac{\pi^2 E}{250}}}$$
