22607

23124

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

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

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

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

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

Marks

1. Attempt any FIVE of the following : 10

(a) Draw neat sketches of any four steel sections used as tension member.

(b) Calculate effective length of a 6 m long column with both ends are fixed.

(c) State the conditions of formation of Flanged beams.

(d) Enumerate any two types of staircase, spanning longitudinally.

(e) State live load on staircase of different types of buildings as per IS code.

(f) Calculate effective span of a flight of a dog-legged stair supported by 230 mm wide beams at the end of landings. Rise is 150 mm while tread width is 300 mm. Width of landing is 1 m.

(g) State IS recommendations about pitch of spiral ties in a circular column.

2. Attempt any THREE of the following : 12

(a) Explain with sketches three modes of failure of an axial tension member.

(b) Calculate effective flange width for a T beam if clear span of beam is 5.75 m, width of supports = 300 mm each, spacing of beams 2.5 m c/c, width of web = 250 mm and slab thickness = 100 mm.

(c) Draw neat sketch of a circular column having spiral tie. State IS provisions regarding pitch of spiral.

(d) State reasons for designing any column considering certain minimum eccentricity. State expression to calculate e_{min}.

3. Attempt any TWO of the following : 12

(a) A single angle of 100 × 100 × 10 tie member is connected to a 12 mm thick gusset plate with 4 bolts of 18 mm diameter (with pitch of 60 mm and gauge of 40 mm). Determine block shear strength only of given tension member. Take $f_y = 250$ MPa and $f_u = 410$ MPa.

(b) Design a suitable angle section as a tie member in a truss to carry factored load of 250 kN. Use double angle section connected back to back on both sides of 10 mm thick gusset plate by means of 4 bolts of 18 mm dia. in one line. (check of block shear not required)

Given $\alpha = 0.8$, $f_y = 250$ MPa, $f_u = 410$ MPa

Available Sections	**Gross Area (mm^2)**
ISA 90 × 60 × 6	865
ISA 100 × 75 × 6	1014
ISA 120 × 80 × 8	1550

(c) In a roof truss, a discontinuous strut of 2.5 m long consists of a Double angle section 100 × 100 × 6 mm back to back on same sides of 8 mm thick gusset plate connected with 2 bolts of 16 mm diameter. Calculate safe load carried by strut.

Assume – Properties of ISA 100 × 100 × 6 mm is as ; Area = 1167 mm^2

$C_{xx} = C_{yy} = 26.7$ mm, $I_{xx} = I_{yy} = 111 \times 10^4$ mm^4, $f_y = 250$ N/mm^2

KL/r :	80	90	100	110	120	130
f_{cd} (N/mm^2) :	136	121	107	94.6	83.7	74.6

4. Attempt any TWO of the following : 12

(a) State the functions of lacing and battening. Draw diagram showing double lacing system. Also state general requirements for lacing as per IS 800.

(b) Design a discontinuous rafter using double angle on opposite sides of G.P. to carry factored compressive load of 300 kN. c/c length is 2.35 m between welds on 12 mm thick gusset plate. Available sections are as follows :

Section	**Area (mm^2)**	**I_{yy}(mm^4)**	**C_{yy}(mm)**
ISA 90 × 60 × 8	1137	32×10^4	14
ISA 80 × 50 × 10	1202	75×10^4	13
ISA 90 × 60 × 10	1401	111×10^4	15

(c) Calculate the ultimate moment capacity of a beam 250 × 350 mm (effective) if it is reinforced with 4 – 16 mm diameter bars in tension zone and 3 – 12 mm diameter bars in compression zone, each at an effective cover of 40 mm. Assume M25 concrete and Fe500 steel is used. Take $f_{sc} = 355$ N/mm^2.

5. Attempt any TWO of the following : 12

(a) A simply supported beam having effective span 5 m is to carry working UDL of 62 kN/m. Limiting section of RCC beam is 300 mm × 400 mm (effective). Calculate area of steel required. Use M20 concrete and Fe415 steel. Assume $f_{sc} = 335$ N/mm^2.

(b) Draw strain and stress block diagram for a doubly reinforced RC beam. Mark all important parameters and corresponding lever arms.

(c) Calculate ultimate moment of resistance of a T beam having flange width 1100 mm, depth of slab 120 mm, effective depth of beam 500 mm, width of web 230 mm. Beam is reinforced with 4 numbers of 12 mm diameter bars. Assume M20 concrete and Fe415 steel.

6. Attempt any TWO of the following : 12

(a) A simply supported singly reinforced flanged beam having effective span 6 m with flange width 2.2 m embedded in slab of 125 mm thick carries total working load of 60 kN/m. Calculate area of reinforcement at tension side. Assume effective depth of beam as 450 mm. M25 concrete and Fe415 steel are used.

(b) Design dog legged stair case for residential building for floor to floor height 3 m, rise 150 mm, tread 250 mm with 1 m landings on both side. Assume M20 concrete and Fe415 steel. Flight is supported by beams at the end of landing.

(c) Design a RC column footing for an axially loaded square column 450 mm × 450 mm.

It carries a factored load of 1500 kN. Safe bearing capacity of soil is 250 kN/m^2. Use bending moment criteria only. Use M20 grade concrete & Fe415 steel.

IS : 800-2007 Equations (Formula Sheet)

$V_{nsb} = \left(\frac{f_u}{\sqrt{3}}\right)(n_n A_{nb} + n_s A_{sb}),$ $V_{dsb} = \frac{V_{nsb}}{\gamma_{mb}},$ $V_{dpb} = \frac{V_{npb}}{\gamma_{mb}},$

$T_{dg} = \frac{A_g f_y}{\gamma_{m0}},$ $V_{npb} = 2.5 k_b d\, t\, f_u$

$T_{dn} = \frac{0.9 A_{nc} f_u}{\gamma_{m1}} + \beta \frac{A_{go} f_y}{\gamma_{m0}}$ where $\beta = 1.4 - 0.076 (w/t)(f_y/f_u)(bs/Lc) \leq (f_u \gamma_{m0} / f_y \gamma_{m1})$ ≥ 0.7

$T_{dn} = \frac{\alpha A_n f_u}{\gamma_{m1}},$ $T_{db1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 A_{tn} f_u}{\gamma_{m1}},$ $T_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$

$P_d = A_e f_{cd},$ $P_z = 0.6 V_z^2,$ $V_z = V_b k_1 k_2 k_3$

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

$\lambda_e = \sqrt{k_1 + k_2 \lambda_{vv}^2 + k_3 \lambda_\varphi^2}$

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

$t_s = \sqrt{[2.5w(a^2 - 0.3b^2)\gamma_{m0}/fy]} > t_f$

Values of χ and fcd (N/mm^2) for different values of KL/r_{min} as per buckling curve 'c'

KL/r_{min}	10	20	30	40	50	60	70	80	90
χ	1.000	0.987	0.930	0.870	0.807	0.740	0.670	0.600	0.533
fcd	227	224	211	198	183	168	152	136	121

KL/r_{min}	100	110	120	130	140	150	160	170	180
χ	0.471	0.416	0.368	0.327	0.291	0.261	0.234	0.212	0.192
fcd	107	94.6	83.7	74.3	66.2	59.2	53.3	48.1	43.6