(viii) What is the maximum outstand of stiffeners? t_q = Thickness of stiffeners.
(a) $20t_q\varepsilon$ (b) $30t_q\varepsilon$ (c) $40t_q\varepsilon$ (d) $50t_q\varepsilon$.

(ix) What horizontal traction force acts along the rails of a gantry girder due to applying brakes of the crane girder?
(a) 20 percent of all static wheel loads
(b) 15 percent of all static wheel loads
(c) 10 percent of all static wheel loads
(d) 5 percent of all static wheel loads.

(x) What is the maximum effective slenderness ratio for a member carrying compressive loads resulting from dead loads and imposed loads?
(a) 250 (b) 180 (c) 300 (d) 400.

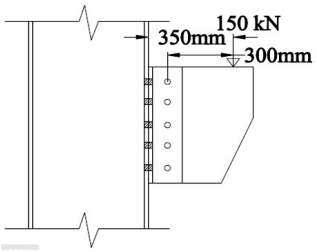
Group – B

2. (a) An ISA 60×60×6 transmits 150 kN factored load and is welded to a 10 mm thick gusset plate. Design a fillet weld connection. The properties of ISA 60 × 60 × 6 are given as follows:
Sectional area (a) = 6.84 cm^2, weight per meter (w) = 5.4 kg/m, centre of gravity, $C_{xx} = C_{yy}$ = 1.69cm, minimum size of the weld = 3mm. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2.

(b) Explain the failure modes that may control the strength of a bolted joint?

8 + 4 = 12

3. Design a bracket connection to transfer a factored load of 150 kN as shown in figure. Consider 20 mm 4.6 grade bolts. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2.

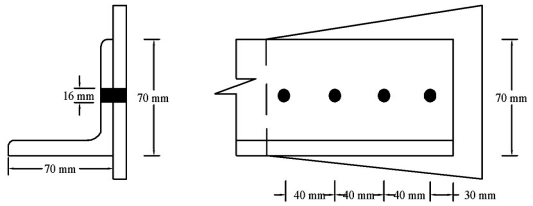


12

Group – C

4. (a) Find out the compressive resistance of a 6.0 m long column containing 2 - ISMB 350 @ 52.4 kg/m spaced 200 mm apart from each other. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2, sectional area (A) of I – section = 66.71 cm^2, I_{xx} = 13630.3 cm^4, I_{yy} = 537.7 cm^4, width of flange (b_f) = 140 mm, thickness of flange (t_f) = 14.2 mm, thickness of web (t_w) = 8.1 mm.

(b) Find out the tensile strength of an ISA 70 × 70 × 6 considering "Gross Section Yielding", "Net Section Rupture" and "Block Shear Failure" for the arrangement of bolts shown in the following figure. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2. Gross area of the angle is 8.06 cm^2.



6 + 6 = 12

5. A 6 m long column, fixed at base and hinged at top, is subjected to 500 kN axial compressive load at top, 100 kNm moment at the base and 3 kN lateral shear acting at the base of column. All the given loads and moments contain their factored values. The column is fabricated using ISMB 450 @ 72.4 kg/m. Design a suitable base plate for the column. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2, sectional area (A) of each I – section = 92.27 cm^2, I_{xx} = 30390.8 cm^4, I_{yy} = 834.0 cm^4, width of flange (b_f) = 150 mm, thickness of flange (t_f) = 17.4 mm, thickness of web (t_w) = 9.4 mm.

12

Group – D

6. Calculate the moment capacity of a laterally supported beam made of ISMB 225 @ 31.2kg/m under applied factored shear 300kN. The properties of ISMB 225 @ 31.2kg/m are given as follows: Sectional area(a) = 39.72cm^2 , Depth of section (h) = 225mm, Width of flange (b) = 110mm, Thickness of flange (t_f) = 11.8mm, Thickness of web (t_w) = 6.5mm, Raddi of Gyration (r_z) = 9.31cm, (r_y) = 2.34cm, Section Modulus (Z_{ez}) = 305.9cm^3, Plastic modulus (Z_{pz}) = 348.27cm^3.

12

7. A laterally supported beam of clear span 8.0 m is subjected to factored load 60 kN/m uniformly distributed load for the entire span. The width of supports are 200 mm at each end and the depth of the beam is limited to 400 mm. The beam is fabricated using ISMB 350 @ 52.4 kg/m with 16 mm thick flange plates attached at the top and bottom of the beam. Check the adequacy of the section and suggest necessary curtailment of the flange plates. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, E = 2 × 10^5 N/mm^2, sectional area (A) of I – section = 66.71 cm^2, I_{xx} = 13630.3 cm^4, I_{yy} = 537.7 cm^4, width of flange (b_f) = 140 mm, thickness of flange (t_f) = 14.2 mm, thickness of web (t_w) = 8.1 mm.

12

Group – E

8. A welded gantry girder is fabricated using 400 mm × 25 mm plate as top flange, 650 mm × 8 mm plate as web and 300 mm × 25 mm plate as bottom flange. Two 100 mm × 12 mm plates are attached to the top flange as stiffeners. The crane girder has two wheels on the gantry girder. Load on each wheel of the crane girder is 120 kN. Assume selfweight of the gantry girder as 2.67 kN/m and spacing of truss column as 4 m. Check safety of the gantry girder against shear force caused by vertical loads only. Perform necessary bearing and intermediate stiffeners design also. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, $E = 2 \times 10^5$ N/mm^2.

12

9. A gantry column, 8 m long, is fixed at base and hinged at top. The length of the crane leg is 6 m and that for roof leg is 2 m. The axial compression on roof leg is 10 kN and that on crane leg is 300 kN. The crane leg has 2-ISMB 250 @ 37.3 kg/m with 650 mm spacing between the columns. The roof leg uses ISMB 250 @ 37.7 kg/m. Check the safety of the gantry column for axial compression only. Consider f_y = 250 N/mm^2, f_u = 410 N/mm^2, $E = 2 \times 10^5$ N/mm^2, sectional area (A) of each I – section = 47.55 cm^2, I_{xx} = 5131.6 cm^4, I_{yy} = 334.5 cm^4, width of flange (b_f) = 125 mm, thickness of flange (t_f) = 12.5 mm, thickness of web (t_w) = 6.9 mm.

12

DESIGN OF STEEL STRUCTURES
(CIVL 3201)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Effective length of fillet weld should not be less than
(a) two times the weld size (b) four times the weld size
(c) six times the weld size (d) size of weld.

(ii) Lacing bars in a steel compound column should be designed to resist
(a) bending moment due to 2.5% of axial load on column
(b) shear force due to 2.5% of the column load
(c) 2.5% of the column load
(d) both (a) and (b).

(iii) The thickness t of a single flat lacing should not be less than
(a) 1/30th length between inner end bolts
(b) 1/40th length between inner end bolts
(c) 1/50th length between inner end bolts
(d) 1/60th length between inner end bolts.

(iv) In the cross-section of a weld, throat is the
(a) minimum dimension (b) maximum dimension
(c) average dimension (d) mean dimension.

(v) As per IS: 800 – 2007, the partial factor of safety for material resistance governed by yielding (γ_{m0}) is,
(a) 1.20 (b) 1.10 (c) 1.30 (d) 1.40.

(vi) Considering serviceability requirements, what is the limiting depth to thickness ratio (d/t_w) of a girder without any transverse stiffeners?
(a) 100ε (b) 2 00ε (c) 300ε (d) 400ε.

(vii) What is the value of the imperfection factor (α) for buckling class 'c'?
(a) 0.21 (b) 0.49 (c) 0.34 (d) 0.76.