BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E., 6TH SEMESTER (CE) FINAL EXAMINATIONS, 2012
Design of Steel Structures (CE-601)

Full Marks: 70 **Time: 3 hours**

*Use separate answer script for each half. Use of IS:800-2007 is allowed in the examination hall. Answer any **six** questions, taking **three from each half**. All questions are of equal value. Two marks are reserved for neatness in each half. Assume any data reasonably, if required. All the notations used have their usual meanings. Consider E250 (Fe410) steel conforming to IS 2062. E=200 GPa.*

First Half

1. Calculate the safe compressive and tensile load carried by a single angle welded discontinuous truss member made with ISA 90x60x6 (a=8.65 cm^2, C_{zz}=2.87 cm, C_{yy}=1.39 cm, I_{zz}= 70.6 cm^4, I_{yy}=25.2 cm^4, r_{zz}=2.86 cm, r_{yy}=1.71 cm, g= 50 mm, r_1= 7.5 mm) with longer leg connected to 8 mm thick gusset plate. Consider the maximum connection length as 100 mm. Check for block shear failure and design of connection are not asked.

2. Determine the design strength in flexure and shear of ISMB 350 @ 0.514 kN/m (a= 66.70 cm^2, I_{zz}=13630.3 cm^4, I_{yy}= 537.7 cm^4, r_{zz}= 14.32 cm, r_{yy}=2.84 cm, Z_{pz}=889.57 cm^3, Z_{ez}=779 cm^3, t_w=8.1 mm, t_f=14.2 mm, b_f=140 mm, r_1=14 mm) used in 4 m simply supported laterally unsupported span. The ends are restrained from rotation, but free to warp. Use formulae. Do not use table 14 of IS:800-2007.

3. A Laced column of effective length 5 m, consists of 2-ISMC 300, placed back-to-back. The column carries a factored axial force of 350 kN. The properties of 1 –ISMC 300 @ 351.21N/m are a=45.64 cm^2, b_f =90 mm, t_f=13.6 mm, t_w=7.6 mm, C_{yy}=23.6 mm, I_{zz}=6362.6 cm^4, I_{yy}= 310.8 cm^4, r_{zz}= 11.81 cm, r_{yy}=2.61 cm, g=50 mm.

a) Determine the spacing between the two channel sections. Check for overall load carrying capacity is not asked.

b) Design a suitable single lacing system for the above column. Check whether the lacing bars are safe from axial tension and compression. Design of connection and check for block shear failure are not asked.

4. Design a welded connection for a beam-column joint (Beam: ISMB 400 with b_f=140 mm, t_f=16.0 mm, t_w =8.9 mm, r_1=14 mm; Column: ISWB 550 with b_f= 250 mm) which will transfer a factored bending moment of 80 kN-m and factored shear force of 50 kN. Use field weld.

5. Check the adequacy of a 5.2 m beam column made with ISHB 300 @ 618 N/m (a=80.25 cm^2, b_f=250 mm, t_f=10.6 mm, t_w=9.4 mm, I_{zz}=12950.2 cm^4, I_{yy}=2246.7 cm^4, r_{zz}=12.7 cm, r_{yy}=5.29 cm, Z_{pz}=962.18 cm^3, Z_{ez}=836.3 cm^3) which is subjected to a factored axial force of 400 kN. The factored bending moment is linearly varying from 110 kN-m at top and 0.0 at bottom. Given data: i) $k_z = 1.0, k_y = 0.8$, ii) the section is semi-compact. iii) There is no reduction due to shear force, Check for shear buckling is not asked.

Second Half

6. Calculate the safe compressive load carried by a double angle discontinuous bolted truss member composed of 2- ISA 100 65 6 (a=9.55 cm^2, C_{zz}=3.19 cm, C_{yy}=1.47 cm, I_{zz}= 96.7 cm^4 , I_{yy}=32.4 cm^4, r_{zz}=3.18 cm, r_{yy}=1.84 cm, g= 60 mm, r_1= 8 mm,) with longer legs back to back connected to

opposite side of a 8 mm thick gusset plate. Consider 4 nos. 16 mm diameter bolts placed in a single row. Edge distance and pitch are 30 mm and 50 mm, respectively.
Also, check for block shear failure under direct tension.

7. A simply supported laterally supported beam of span 4 m is carrying a total factored load of 10 kN/m. Check whether ISMB 250 @37.3 kg/m (a= 47.55 cm^2, b_f=125 mm, t_f=12.5 mm, t_w=6.9 mm, I_{zz}=5131.6 cm^4, Z_{ez}=410.5 cm^3, Z_{pz}= 465.71 cm^3, r=13 mm) is adequate for the beam in i) flexure, ii) flexural shear, iii) deflection, and v) web buckling. Given, Allowable deflection= L/300.

8. Check adequacy of ISMC 150 @ 0.16 kN/m (a= 20.88 cm^2, Z_{pz}=119.82 cm^3, Z_{ez}=103.9 cm^3, Z_{py}=31.1 cm^3, Z_{ey}=19.4 cm^3, t_w=5.4 mm, t_f=9.0 mm, b_f=75 mm, r_1=10 mm) as a purlin section for an industrial building roof for the following data: distance between c/c of trusses=4 m, distance between c/c of purlins =1.4 m, inclination of the roof surface to the horizontal =20^0, weight of GI sheets =133.1 N/mm^2, unfactored wind load normal to the roof =1.1 kN/m^2. Checks for lateral torsional buckling and deflection are not required.

9. A gantry girder of simply supported span 8.0 m is composed of ISWB 600 and ISMC 300. ISMC 300 is placed over the top flange of ISWB 600 with the web of channel connected to the top flange of ISWB 600. Check the adequacy of the section in flexure and flexural shear for the following data: i) Static wheel load=160 kN, ii) Wheel base =2.5 m, iii) Height of rail =150 mm, iv) f_{bd} =170 MPa, v) Z_{pz} of overall section =4768 cm^3, vi) Z_{py}=824 cm^3 for top flange of overall section, vii)Z_{ez}= 3765 cm^3 of overall section, viii) Z_{ey}= 581 cm^3 for top flange of overall section, ix) Lateral surge=8 kN per wheel, x) longitudinal surge = 5 kN per wheel.

   Consider the section to be plastic. Assume 2 kN/m for weight of rail and gantry girder. Calculations and checks for longitudinal drag force, local capacity, weld design, web buckling, web bearing, deflection and fatigue are not asked.

10. Calculate the safe load P for the bracket connection shown in Fig. Q.10.The column section is ISWB 400 (b_f=200 mm, t_f=13.0 mm). The load is acting at an eccentricity of 450 mm from the C.G. of the connection. Assume 16 mm bolts of grade 4.6.

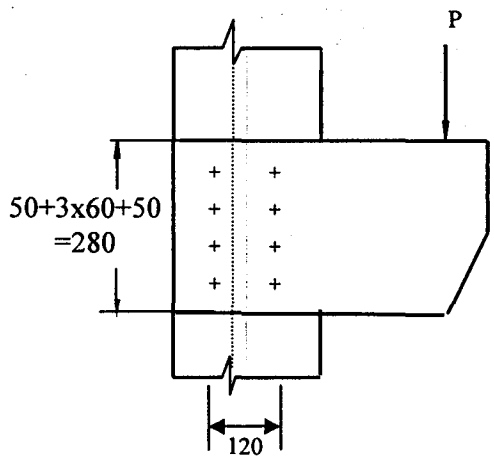

Fig. Q.10

All dimensions are in mm