August 2021

DESIGN OF STEEL STRUCTURE

Time Allowed: 1.5 Hours *Full Marks: 70*

Answer to Question No. 1 is compulsory and Answer <u>any two</u> questions from the rest.
Use of IS: 800-2007, SP-6(1) and Steel tables are permitted
Assume all necessary data as per required.

1. Answer the following questions:- (any twenty): 20 x 2

<u>Choose the correct answer:</u>

i) The Indian standard code deals with steel structures is-
a. IS: 456 b. IS: 800 c. IS: 1343 d. IS : 1893

ii) The diameter of the Hot Rivet is-
a. Nominal diameter b. Gross diameter c. Standard diameter d. Effective diameter

iii) Generally High strength bolts transfer load by-
a. Bearing b. Shear c. Tension d. Friction

iv) The yield tensile strength of the bolt of grade 4.6 is-
a. 210 N/mm^2 b. 240 N/mm^2 c. 300 N/mm^2 d. 350 N/mm^2

v) For design of Tension member effective area of outstanding leg is-
a. equal to gross area b. Less than gross area c. More than gross area d. None of these

vi) Web crippling generally occurs at the point where-
a. Bending moment is maximum c. Shear Force is maximum
b. Concentrated loads acts d. deflection is maximum

vii) As per IS codal provision, the effective length of a column fixed at one end and free at other end is (L = Length of the column)-
a. 0.65 L b. 0.85 L c. 1.2 L d. 2 L

viii) The minimum pitch for the tacking bolts should not exceed (whichever is less)-
a. 12t or 200 mm b. 32t or 300 mm c. 48t or 300 mm d. 60t or 200 mm

<u>Fill in the blanks:</u>

ix) As per IS – 1367, the ratio of net tensile area at the root of the threads to the nominal plain Shank area of the bolt is _____.

x) The allowable bearing strength in concrete is assumed to be _____ in Limit State Method.

xi) The load factor for the combination of (DL+LL+SL) is _____.

xii) The efficiency of a welding joint is _____ than that of bolted joint.

xiii) The maximum deflection in beam should not exceed _____.

xiv) Hanger connection is a type of _____ connection.

xv) The design tensile strength of a steel section due to gross-section yielding T_{dg} is given by _____.

xvi) The Shape factor of Circular Section is generally _____.

State True or False:

xvii) The most preferred beam section as a column is ISHB.

xviii) In the cross section of a fillet weld, the throat thickness is the minimum dimension.

xix) The partial safety factor of material resistance governed by yielding (γ_{mo}) is 1.25.

xx) The minimum pitch distance between the holes should be 1.5d.

xxi) In a cantilever truss subjected to Dead load, the top chord member is always subjected to compressive load.
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xxii) If the acting moment on beam is very high, the gantry girder can be designed.

xxiii) A beam when free to buckle tends to buckle about its major axis.

xxiv) Load factor is the ratio of working load to collapse load.

2. a. What are the advantages and disadvantages of use of steel as a structural material? 4+4+4+3
   b. What is the difference between slip type connection and slip critical connection?
   c. State the assumption used in the analysis of welded joints.
   d. How the approximate size of the weld is selected?

3. Determine the strength of 20 mm diameter bolt of grade 4.6 for the following condition:- 15
   a. Lap Joint
   b. Single cover butt joint with 10 mm thick cover plate.
   c. Double cover butt joint with 8 mm thick cover plates.

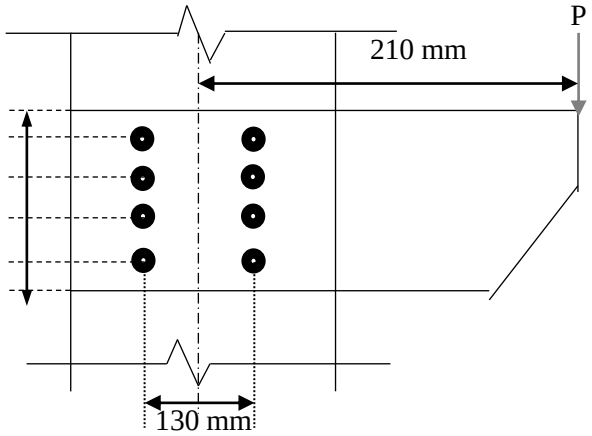
   The main plates can be joined are 14 mm thick. Use Fe-410 grade steel. Assume the shear plane is through the threaded plate.

4. An ISA 90 x 60 x 8 mm of steel of grade Fe-410 is connected to a 12 mm gusset plate and is used as a tension member. Design the weld if 15
   a. The weld is to be provided on upper and lower edges of connected legonly.
   b. The welding can be done on the three sides of the angle section.

   Take Partial factor of safety due to shop welding – 1.25.
   (Specification for ISA 90 x 60 x 8:- Gross area = 1137 mm^2, C_{zz} = 29.6 mm, C_{yy} = 14.8 mm)

5. A column section ISHB 450 @ 859 N/m is subjected to an axial compression load of 485 kN including its self-weight. Use M30 concrete for the pedestal. Design the base plate. Use Fe-410 steel. Assume the projection of base plate beyond the column flanges = 150 mm.
   (Section Properties for ISHB 450 @859 N/m: -Depth of the section = 450 mm, Flange width = 250 mm, Flange thickness = 13.7 mm, web thickness = 9.8 mm.) 15

6. Find the safe load 'P' that can be carried by the bracket connection as shown in the figure below. The bolts are of 20 mm diameter of grade 4.6. The thickness of the flange of I-section is 13.7 mm and that of bracket plate is 16 mm. Use Fe-410 grade steel. (Assume the Pitch and edge distance of bolts are 90 mm and 50 mm respectively). 15



7. An unequal angle ISA 90 x 60 x 6 is connected to a 10 mm gusset plate at the end with 4 numbers – 16 mm diameter bolts. The angle is to be used as a tension member. Find the design tensile strength of the angle if-
   a. 90 mm leg is connected to the gusset plate (g = 50 mm).
   b. 60 mm leg is connected to the gusset plate (g = 30 mm).

   Use Fe-410 grade steel.
   (Specification for ISA 90 x 60 x 6:- Gross area = 865 mm^2) 15

8. Design a single angle section to carry a compression of 100 kN. The centre to centre distance between end connections is 2m. Assume that the end connection is done by at least two bolts. The grade of the steel is E250. The angle belongs to the buckling class 'C'. Available sections are given in the table.
   Assume $K_1 = 0.20$, $K_2 = 0.35$, $K_3 = 20$, $\alpha = 0.49$. 15

Section (ISA)	Weight (kg/m)	Area (mm^2)	Breadth (mm)	Thickness (mm)	Distance of centroid $C_z = C_r$ (mm)	I_z or I_y (mm^4)	$r_z = r_y$ (mm)	R_{vv} (mm)
80 x 80 x 8	9.6	1220	80	8	23	72.5 x 10^4	24.4	15.5
90 x 90 x 8	10.8	1380	90	8	25	104 x 10^4	27.5	17.5
100 x 100 x 8	12.1	1540	100	8	28	145 x 10^4	30.7	19.5

9. Check the safety of the purlin section ISMC 125 for (DL+LL) case only with the following data:- 15
   a. Spacing of the truss = 6.0 m
   b. The purlins have effective length 2.0 m about y-axis.
   c. The pitch of truss = 1:3
   d. Live load intensity = 580 N/mm^2
   e. Spacing of Purlin = 1.4 m
   f. Purlins are two span continuous
   g. The sheeting above has a unit weight of 175 N/mm^2
   h. Property of ISMC-125: w = 127 N/m, A = 1619 m^2, h = 125 mm, b_f = 65 mm, t_w = 5.1 mm, t_f = 8.1 mm, C_y (distance of centroid from back) = 19.5 mm, I_z = 425 x 10^4 mm^4, I_y = 61.1 x 10^4 mm^4, r_z = 50.5 mm, r_y = 19.1 mm, Z_{ez} = 68.1 x 10^3 mm^3, Z_{pz} = 77.15 x 10^3 mm^3, Z_{ey} = 13.0 x 10^3 mm^3, Z_{py} = 15.0 x 10^3 mm^3.