

**Design of Steel Structure****Time Allowed - 3 Hours****Full Marks - 70**

**Use of IS 800(2007) & SP 6 (I) is allowed.  
Any data which is not clearly mentioned may be suitably assumed**

**GROUP A**

1. **MCQ types : Choose correct option: Answer any ten from the following: 10 x 1 = 10**
- i) A member effectively held in position at both ends but not restrained in position will have effective length (a) L (b) 0.85 L (c) 0.65 L (d) None of these
  - ii) Maximum pitch of any two adjacent bolt should be less than (a) 36t (b) 32t (c) 28t (d) 24t, where t= thickness of plate.
  - iii) Details of structural steel sections with their properties are given in (a) SP:16 (b) IS:800 (c) SP: 6(1) (d) IS:875.
  - iv) The shear strength of bolt can be written as  $f_s A_n$ , where  $f_s$  is given by: a)  $f_y / (\sqrt{3} \times 1.25)$ ; b)  $f_y / (\sqrt{3} \times 1.10)$ ; c)  $f_u / (\sqrt{3} \times 1.25)$ ; d)  $f_u / (\sqrt{3} \times 1.10)$ .
  - v) The partial safety factor for the material of bolt is: a) 1.0; b) 1.10; c) 1.15; d) 1.25
  - vi) Unit of mass of steel is : a) 2400 kg/m<sup>3</sup> ; b) 6850 kg/m<sup>3</sup> ; c) 7850 kg/m<sup>3</sup> ; d) 7500 kg/m<sup>3</sup>
  - vii) Permissible wind loads for designing buildings and structures are given in (a) IS:456 (b) IS:800 (c) IS:875,P-III (d) IS:1893
  - viii) Deflection is a problem related to: a) safety; b) serviceability; c) both safety and serviceability; d) none of these.
  - ix) A mode of failure of fillet weld is a) tension; b) shear; c) bearing; d) crushing
  - x) Beam should be designed for a) flexural strength; b) stiffness; c) local buckling; d) all of the above
  - xi) Partial safety factor for materials governed by ultimate stress  $\gamma_{m1}$  - a) 1.5 b) 1.1 c) 1.25 d) 1.0
  - xii) Web crippling generally occurs at the point where: a) bending moment is maximum; b) shearing force is minimum; c) concentrated loads act; d) deflection is maximum
  - xiii) The maximum deflection in beam should not exceed: a) L/180; b) L/250; c) L/325; d) L/360.
  - xiv) The efficiency of a welding joint is \_\_\_\_\_ than that of bolted joint. a) less; b) more; c) equal d) none of these

xv) The yield stress of a bolt of grade 9.8 is: a) 250 MPa. b) 410 MPa. c) 720 MPa. d) 980 MPa.

2. **Fill the Blanks: Answer any ten from the followings :** (10 X 1 = 10)

- i) Minimum size of weld for thickness of thicker part upto and including 10mm is \_\_\_\_.
- ii) Minimum size of weld for welded connection is \_\_\_\_\_ mm.
- iii) If the nominal bolt diameter is 20 mm the minimum pitch of the bolt will be \_\_\_\_\_.
- iv) Rivets are made of \_\_\_\_\_.
- v) Generally the maximum deflection of beam should not exceed \_\_\_\_ of span.
- vi) The effective length of weld should not be less than \_\_\_\_\_.
- vii) A laterally unsupported beam buckles in \_\_\_\_\_ direction.
- viii) Bending stress is maximum in \_\_\_\_\_ of the beam.
- ix) The load factor under ( DL+LL ) combination is \_\_\_\_\_.
- x) Deflections, vibrations, deterioration, corrosion, and cracks etc. are limit states of \_\_\_\_\_.
- xi) The bearing strength of concrete is taken in IS 800-2007 as \_\_\_\_\_.
- xii) Anchor bolts are provided in column base to \_\_\_\_\_.
- xiii) For nominal diameter of bolt 20 mm, the gross diameter of bolt is \_\_\_\_\_.
- xiv) The minimum number of bolts required for a rigid end connection is \_\_\_\_\_.
- xv) The throat thickness of fillet weld is \_\_\_\_\_.

3. **Very short answer type question: Answer any ten.** 10 X 1 = 10

- i) What is lap joint ?
- ii) What is throat thickness ?
- iii) What is the maximum slenderness ratio for compression member loaded by axial compression (dead) load?
- iv) What is the yield stress for grade of 4.6 bolt ?
- v) If both ends of a column are held in position but not restrained against rotation and length of column is 'L' then what is its effective length?
- vi) How much axial load is assumed to be transferred to base plate when the end of the column is machined for complete bearing on the base plate?
- vii) If the thickness of a plate is 10 mm and nominal diameter of bolt used in lap joint is 20 mm then what will be the minimum edge distance for the connection ?
- viii) Which kind of failures of bolted joint can be avoided by providing sufficient edge distance?
- ix) What is the minimum dimension of a cross section of a weld?

- x) What is the maximum pitch of bolt in compression zone as per IS 800-2007?
- xi) What will be the slenderness ratio of a column if it is supported through its length by a masonry wall?
- xii) What is the value of imperfection index ( $n$ ) in the Merchant Rankine formula as per IS 800-2007 ?
- xiii) What is tack welding ?
- xiv) What is the range of angle between fusion faces during a weld connection?
- xv) What is the difference between rolled steel section and built-up steel section?

### GROUP - B

4. **Large answer type questions: Answer any five.**

**(5 x 2 = 10)**

- i) Mention the different types of bolted connection failure.
- ii) Write down the different types of loads on steel structure and its IS code specifications.
- iii) How the approximate size of the weld is selected?
- iv) What are the advantages and disadvantages of using steel as a structural material?
- v) ISA 100 x 100 x 6 is used as a strut. For  $f_y$  (yield stress) = 250 MPa, if the design compressive stress in limit state ( $f_{cd}$ ) is equal to 150 Mpa. Determine the load carrying capacity.
- vi) Define size of weld and effective length of weld.
- vii) State the advantages and disadvantages of weld joints.
- viii) State the assumptions used in the analysis of welded joints.

### GROUP - C

**Large answer type questions: Answer any five.**

**(5 x 6 = 30)**

5. Determine the strength of 20 mm diameter bolt of grade 4.6 for the following condition:

Double cover butt joint with 8 mm thick cover plates.

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

(6)

6. Design a slab base plate for a column made of ISHB 350 to carry a normal load of 800 kN. Assume Fe - 410 steel and M25 grade concrete. Only size and thickness of the base plate are to be found out.

[  $w = 67.4 \text{ kg/m}$ ;  $A = 85.91 \text{ cm}^2$ ;  $b = 250 \text{ mm}$ ;  $t_f = 11.6 \text{ mm}$ ;  $t_w = 8.3 \text{ mm}$ ;  $r_x = 14.93 \text{ cm}$ ;  
 $r_y = 5.34 \text{ cm}$ ;  $Z_{xx} = 1094.8 \text{ cm}^3$ ;  $Z_{yy} = 1213.53 \text{ cm}^3$  ] (6)

7. Draw a neat sketch to show (i) double bolted lap joint. (ii) single bolted butt joint with double cover. (6)

8. A simply supported beam ISMB - 400 @ 61.6 kg/m has an effective span of 5 m. Find the design bending strength of the beam. Assume the beam is laterally supported. The grade of the steel is Fe - 250. Also assume the section to be plastic.

[  $I_{xx} = 20458.4 \text{ cm}^4$ ;  $Z_{ez} = 1022.9 \text{ cm}^3$ ;  $Z_{pz} = 1176.18 \text{ cm}^3$ ;  $b = 140 \text{ mm}$ ;  $t_w = 8.9 \text{ mm}$ ;  $t_f = 16 \text{ mm}$ ;  $A = 78.46 \text{ cm}^2$ ; ] (6)

9. A simply supported steel joist of 5.0 m span has to support a load of 60 kN/m (inclusive of self weight). The beam compression flange is restrained against buckling. Design an approximate section for shear only ( no check for bending required) using steel of grade Fe - 410. (6)

10. Design a lap joint for two plates of size (150 mm X 8 mm) and (150 mm X 12 mm) to transfer a load of 150 kN. The permissible stress of plate is 150 MPa and The permissible stress of weld is 108 MPa. <https://www.wbscteonline.com> (6)

11. An ISHB 400 @ 806.4 N/m is to be used as a column 3.5 m long with both ends restrained against rotation and translation. Determine the design axial load on the column section. Also assume the following data.

[  $A = 10466 \text{ mm}^2$ ;  $b = 250 \text{ mm}$ ;  $t_w = 10.6 \text{ mm}$ ;  $h = 400 \text{ mm}$ ;  $t_f = 12.7 \text{ mm}$ ;  $r_x = 166.1 \text{ mm}$ ;  
 $r_y = 51.6 \text{ mm}$ ;  $I_{xx} = 28823.5 \text{ cm}^4$ ;  $I_{yy} = 2783 \text{ cm}^4$ ;  $Z_{xx} = 1444.2 \text{ cm}^3$ ;  $Z_{yy} = 221.3 \text{ cm}^3$  ] 6

12. Determine the bolt value of 18mm diameter bolts connecting 10 mm thick plate and is in : (i) Single share & (ii) double shear. The permissible stresses for bolts in shear & bearing are 80MPa & 250 MPa respectively and for plate for in bearing is 250 MPa. (3+3)