Unit - II

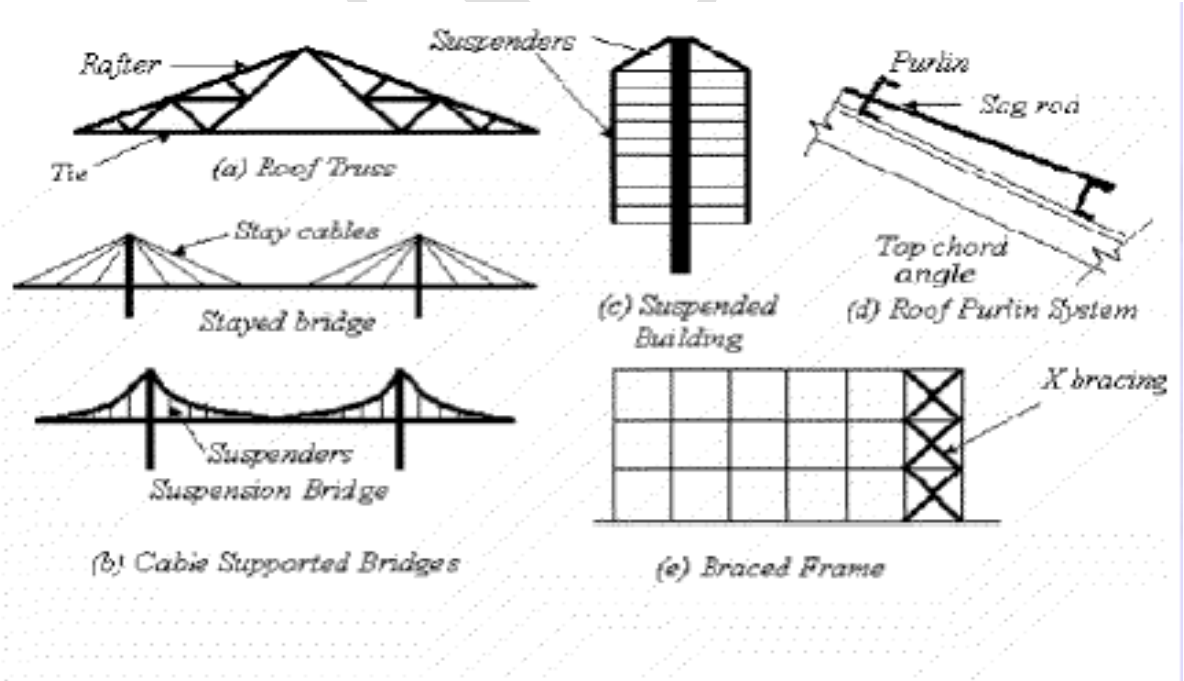
TENSION MEMBERS

ypes of sections – Net area – Net effective sections for angles and Tee in tension – Design of connections in tension members – Use of lug angles – Design of tension splice – Concept of shear lag

PART – A
TWO MARK QUESTION AND ANSWERS

1. Explain the tension member.

Tension members are linear members in which axial forces act so as to elongate (stretch) the member. A rope, for example, is a tension member. Tension members carry loads most efficiently, since the entire cross section is subjected to uniform stress.Unlike compression members, they do not fail by buckling.



2. Explain Behavior of tension members

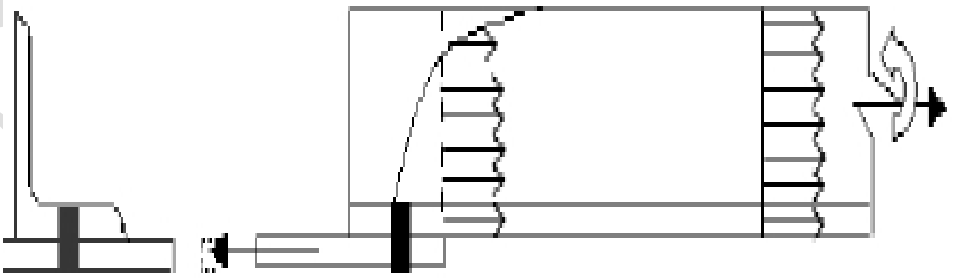
Since axially loaded tension members are subjected to uniform tensile stress, Their load deformation behavior (is similar to the corresponding basic material stress strain behaviour.

In the Yield Plateau the load remains constant as the elongation increases to nearly ten times the yield strain. Under further stretching the material shows a smaller increase in tension with elongation, compared to the elastic range.

3. Write note on Load-elongation of tension member

Angles under tension, Angles are extensively used as tension members in trusses and bracings. Angles, if axially loaded through centroid, could be designed as in the case of plates .However, usually angles are connected to gusset plates by bolting or welding only one of the two legs

This leads to eccentric tension in the member, causing non-uniform Distribution of stress over the cross section. Further, since the load is applied by Connecting only one leg of the member there is a shear lag locally at the end Connections.

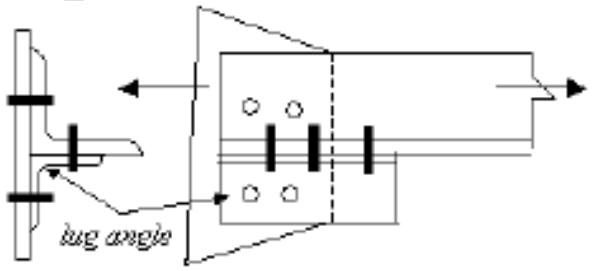


4. How Angle sections eccentrically loaded through gussets plate?

• The effect of the gusset thickness, and hence the out of plane stiffness of the end connection, on the ultimate tensile strength is not significant.
• The thickness of the angle has no significant influence on the member strength.
• The effects of shear lag, and hence the strength reduction, is higher when the ratio of the area of the outstanding leg to the total area of cross-section increases.
• When the length of the connection (the number of bolts in end connections) increases, the tensile strength increases up to 4 bolts and the effect of further increase in the number of bolts, on the tensile strength of the member is not significant.
• Even double angles connected on opposite sides of a gusset plate experience the effect of shear lag

5. What is a Lug angle?

In order to increase the efficiency of the outstanding leg in single angles and to decrease the length of the end connections, some times a short length angle at the ends are connected to the gusset and the outstanding leg of the main angle directly, as shown in Fig.. Such angles are referred to as lug angles.



Tension member with lug angle

6. Why Stiffener required in tension members?

The tension members, in addition to meeting the design strength requirement, Frequently have to be checked for adequate stiffness. The IS: 800 impose the following limitations on the slenderness ratio of members subjected to tension:

(a) In the case of members that are normally under tension but may experience compression due to stress reversal caused by wind / earthquake loading l / r =250 .

(b) In the case of members that are designed for tension but may experience stress reversal for which it is not designed (as in X bracings) l / r =350

(c) In the case of members subjected to tension only. l / r = 400 In the case of rods used as a tension member in X bracings, the slenderness ratio limitation need not be checked for if they are pre-tensioned by using a turnbuckle or other such arrangement.

7.Different types of tension members?

i) Wires and cables
ii) Rods and bars
iii) Single structural shapes and plates
iv) Built-up members

8. Write note on tension member splice

When a joint is to be provided in a tension member, then splice plates are used. Splice plates and rivets are designed for the pull required to be transmitted by the tension member. If the tension members are of unequal thickness, then, packing are used to have surfaces of tension members in one level.

9. What do you understand by Gross area and Net Area?

Gross area (A_g) : Total area of cross section which can be taken as equal weight of the member per unit length divided by density of the material is called Gross area. The sectional area given by the manufacturer is taken as the gross area.

Net area (A_n) : Net area is equal to the gross area less the area due to holes in the cross section.

$A_n = A_g$ – area of rivet holes in line.

10. Write down the formula for finding out the net effective area for angles and Tees in tension.

1. Single angle section connected by one leg angle

$A_{net} = A_1+A_2k$

Where, A_1 = effective cross –sectional area of connected leg.

A_2 = the gross sectional area of unconnected leg.

$k = \frac{3A_1}{3A_1+A_2}$.

2. Pair of angles back to back (or single Tee) connected by one leg angle to the same side of a gusset.

$A_{net} = A_1+A_2k$

Where, A_1 = effective cross –sectional area of connected leg.

A_2 = the gross sectional area of unconnected leg.

$k = \frac{5A_1}{5A_1+A_2}$.

11. A tie of a roof truss consists of double angles ISA 100X75X10 mm with its short legs back to back and long legs connected to the same side of a gusset plate, with 16mm diameter rivets. Determine the strength of tie in axial tension, taking f_t = 150 N/mm^2. take rivets have been provided at suitable pitch.

Dia of rivet hole = 16 + 1.5 = 17.5mm

Each angle is weakened by one rivet hole. Hence this is case 2, where

$A_{net} = A_1+A_2k$ and

$k = \frac{5A_1}{5A_1+A_2}$.

A_1 = Net area of connected legs

= 2 [100 – 10/2 – 17.5] X 10 = 1550mm^2

A_2 = area of connected legs = 2[75 – 10/2]X 10 = 1400mm^2

k = 5X1550 .

5X1550 X1400

= 0.847

$A_{net} = A_1+A_2k$ = 1550 + 1400X0.847 = 2736mm^2

Strength = f_t X A_{net} = 150X2736 = 410369N.

PART - B

16 MARK QUESTIONS

1.Using a lug angle, design a suitable joint for 100 mm * 65mm *10 mm angle, used as a tension member .use 20 mm diameter rivets and thickness of gusset plate 8 mm.

2. The bottom tie of roof truss is 4m long .in addition to an axial tension of 1000 KN,it has to support at its centre a shaft of load of 3600N. The member is composed of two angles 100 mm * 75 mm* 10 mm with the longer legs turned down and placed back to back on either side of 10 mm gusset plate. The angles are tack riveted at 92 cm centres with 20 mm diameter rivets.

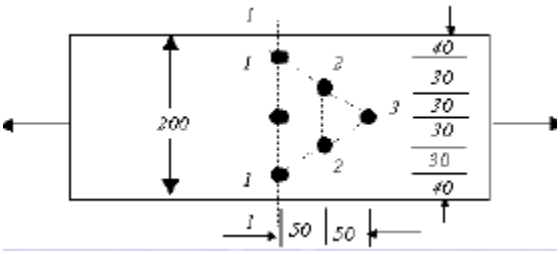
3. Design a horizontal tension member carrying a load 600 KN, The length of the member is 3 mm. The member is connected to 4.5 cm thick gusset plate 20 mm rivets.

4. Design a tension member of heavy truss carrying a force of 4400 KN ,length of the member being 10 metres.

5.A bridge truss diagonal carries an axial pull of 300 KN .two mild steel flats
250 ISF 10 and ISF 18 of the diagonal are to be jointed together. Design a suitable splice

6. Determine the design tensile strength of the plate (200 X 10 mm) with the holes as Shown below, if the yield strength and the ultimate strength of the steel used are 250

MPa and 420 MPa and 20 mm diameter bolts are used.fy = 250 Mpa;fu = 420 MPa



PART – C
ASSIGNMENT QUESTIONS

1. Design a single angle tension member carrying axial load of 300 kN in addition to this, it is also subjected to a uniformly distributed load of 0.4kN/m throughout its length, including self weight. The center to center distance between the end connections is 2.7m.

2. Design a tension splice connect two plates of size 220mmX20mm and 200mmX10mm, for a design load of 220kN. Also sketch the details of the riveted joint.

3. Determine the tensile strength of a roof truss diagonal 100X75X10mm connected to the gusset plate by 20mm diameter power driven rivets in one row along the length of the member. The short leg of the of the angle is kept outstanding.

4. The main tie of a roof truss consists of ISA 150X115X8mm and is connected to a gusset plate by 18mm diameter rivets. Find out the maximum load it can carry.