Chap-7 Design of tubular Steel Structure

Introduction :-

Tubular sections form the most efficient sections for some of the structural elements. However, in the past few decades their use was restricted for following reasons.

1. It was difficult to have a smooth cut surface.
2. It was difficult to cut the tube end to a correct profile, for making joints between steel tubes at angle
3. Connection were a problem.

Classification :-

→ Steel tubes are classified as light, medium & heavy depending upon the wall thickness

→ On the basis of yield stress, these are classified as Yst 210 - tensile strength 330N/mm², yield stress 210 N/mm², Yst 240 - tensile strength 410 N/mm², yield stress 240 N/mm² and Yst 310 - tensile strength 450 N/mm², yield stress 310 N/mm².

ADVANTAGES AND DISADVANTAGES :-

→ These have small self weights. Also because of direct connections, gusset plates are eliminated further reducing dead loads.

→ Tubes have uniform radius of gyration & for the same weight their torsional strength is more than any other rolled section.

→ For dynamic loads tubes have higher frequency of vibration than other rolled sections.

→ Due to smooth finished surface, dirt and moisture donot collected over the surface reducing the possibility of corrosion

→ The only disadvantage of the tubular section is its high manufacturing cost.

Minimum Thickness

For tubes painted with one prime coat of red oxide and then painted periodically, the thickness should not be less than

(i) For construction exposed to weather - 4mm

(ii) For construction not exposed to weather - 3.2mm

(iii) For members not readily accessible for maintenance - 5mm

For tubes painted with one coat of zinc primer followed by two coats of paints, the thickness should not be less than

(i) For construction exposed to weather - 3.2mm

(ii) For construction not exposed to weather - 2.6mm

Q) A Tubular column consists of IS: 1161 grade St. 32 steel. The column is hinged at both the ends. The outside diameter of tube is 219.1 mm. The weight of 1m length of tube is 310 N. The length of column is 4.5 m. Determine the safe load carrying capacity of the column?

Ans :- Given data & section properties

Outside diameter = 219.1mm

weight = 310N/m

So, section is nominal bore 200mm heavy weight (wt = 310N/m)

$A = 39.5 \times 10^2 \ mm^2$ (Table no-1 sizes & properties of steel tubes) Clause 3.1, 6.1, 6.1.1)

$r = 75.4 \ mm$

Step-2

Calculation of $\frac{l}{r}$ (slenderness ratio)

$L = 4.5 m$

$r = 75.4mm$.

$$\frac{l}{r} = \frac{4.5 \times 10^3 mm}{75.4 mm} = 59.82$$

Step-3 :-

Permissible stress in compression from IS 806 : 1968.

(Table-2 Permissible axial stress in compression Clause 5.2)

$\frac{L}{r}$	f_c
50 →	1539
59.82 →	x
60 →	1468

$$\frac{60-50}{60-59.82} = \frac{1468-1539}{1468-x}$$

$$\frac{10}{0.18} = \frac{-71}{1468-x}$$

$\Rightarrow x = 1469.278 \ kgf/cm^2$

$f_c = 0.0981 \times 1469.278$

$= 144.136 \ N/mm^2$

Step-4 :-

Load Carrying Capacity

$P = A \times F_c$

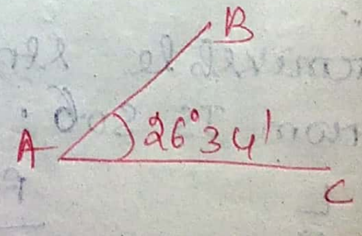
$= 39.5 \times 10^2 \times 144.136$

$P = 569.33 \ kN$

Ans

Q) Design member AB, AC & Joint A of a roof truss as shown in Fig. Ex (5.1) for the following data

member	Length	compressive Force	Tensile Force
AB	2.3m	60KN	55kN
AC	1.8m	55KN	80kN



Soln :-

Given data,

member AB :- Assume Yst 22 grade

Let us try - 65mm nominal bore light section

$A = 733 mm^2$

$r = 25.8mm$

$$\lambda = \frac{l}{r} = \frac{0.7 \times 2.3 \times 10^3}{25.8} = 62.40$$

(Table no-2)
Clause-5.2

$$\lambda = \frac{l_{eff}}{r} = \frac{K \times L}{r_L} = \frac{0.7l}{r}$$

From Code IS 806, table-2

$$f_c = 994.3 \ kgf/cm^2$$

$$f_c = 994.3 \times \frac{9.81}{100}$$

$$= 97.54 \ N/mm^2$$

* load carrying capacity in compression member

$$= 733 \times 97.54$$

$$= 71.49 \ kN > 60 kN$$

(Then ok)

* Check as tension member capacity =

$$733 \times 1250 \times \frac{9.81}{100}$$

$$= 89.86 > 50 kN$$ (Then ok)

member AC :-

$$A_{req} = \frac{Load}{Stress}$$

$$= \frac{80 \times 10^3}{1250 \times \frac{9.81}{100}}$$

$$= 652.40 \ mm^2$$

Let's try - 50 mm nominal bore, heavy section

$$A = 788 \ mm^2$$

hence, Section is safe in tension

→ Check as comp. member

$$\lambda = \frac{0.7 \times 1.8 \times 10^3}{19.8} = 63.63$$

From code 806, table-2

λ	Y_{st} 2.2
60 →	1002
63.63 →	x
70 →	970

$$\frac{70-60}{70-63.63} = \frac{970-1002}{970-x}$$

$\Rightarrow x = 990.384\ kgf/cm^2$

$F_c = 990.384 \times \frac{9.81}{100} = 97.156\ N/mm^2$

Load carrying Capacity $= F_c \times A$

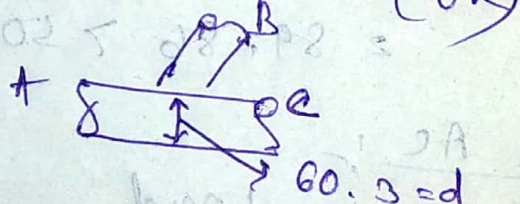
$= 97.156 \times 788$

$= 76.55\ kN > 55\ kN$ (OK)

Joint - A

D = 76.1 mm

d = 60.33 mm



The length of curve of center section

$$L = a + b + 3\sqrt{a^2 + b^2}$$

$a = \frac{d}{2} \operatorname{cosec}\theta = 67.413\ mm$

$b = \frac{d}{3}\left[\frac{3-(d/D)^2}{2-(d/D)^2}\right]$ (IS 806-1968 Page no -19)

$= 34.746\ mm$

L = 329.746 mm

'S' = weld size

Permissible stress in weld = 108 N/mm2

Strength of weld = KS . lw × f

max^n Force = 0.7 × S × 329.68 × 1.8

$\Rightarrow$ $80 \times 10^3 = 0.7 \times S \times 329.68 \times 108$

$\Rightarrow$ S = 3.20 mm ≈ 4 mm

∴ Hence Provide 4mm Fillet weld.