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Assignment.

3) A seamless pipe carries 2000m^3 of steam per hour at a pressu of 1.2 N/mm^2. The velocity of flow is 28m/s. Assuming the tensile stress as 40 MPa, find the inside diameter of the pipe and its wall thickness.

Solution

Given:

$Q = 2000 m^3/hr = 2000/60 = 33.33 m^3/min$

$P = 1.2 N/mm^2$

$v = 28 m/s = 28/60 = 1680 m/min$

$\sigma_t = 40 MPa = 40 N/mm^2$ $(1MPa = 1N/mm^2)$

i) Inside diameter of the pipe, D

$$D = 1.13\sqrt{\frac{Q}{v}} = 1.13\sqrt{\frac{33.33}{1680}} = 0.1592m$$

$= 159.2mm \simeq 160mm$

ii) Wall thickness of the pipe, t

From Table 8.2, for steel pipe, C = 3mm

$$\therefore t = \frac{P.D}{2\sigma_t} + C = \frac{1.2 \times 160}{2 \times 40} + 3$$

$= 5.4mm$

4) Compute the dimensions of a flanged cast iron pipe 200mm in diameter to carry a pressure of 0.7 N/mm^2

Solution

Given:

$D = 200mm$

$P = 0.7 N/mm^2$

∴ From table 8.1, allowable tensile stress for cast iron $\sigma_t = 14 N/mm^2$

Also, from table 8.2, For cast iron, C = 9mm

∴ Thickness of pipe:

$$t = \frac{P.D}{2\sigma_t} + C = \frac{0.7 \times 200}{2 \times 14} + 9 = 14mm$$

Other dimensions of the flanged joint for a cast iron pipe may be fixed as follows:

i) Nominal diameter of the bolts, d:

$d = 0.75t + 10mm = 0.75 \times 14 + 10 = 10.5 + 10$

$= 20.5 mm \simeq 20mm.$

ii) Number of bolts; n:

$n = 0.0275 D + 1.6 = 0.0275 \times 200 + 1.6$

$= 5.5 + 1.6 = 7.1$ say 8mm

iii) Thickness of the flanges, t_f:

$t_f = 1.5t + 3mm = 1.5 \times 14 + 3 = 24mm$

iv) Width of the flange, B:

$B = 2.3d = 2.3 \times 20 = 46mm$

v) Outside diameter of the flange,

$D_o = D + 2t + 2B$

$= 200 + 2 \times 14 + 2 \times 46 =$

$= 200 + 28 + 92$

$= 320mm$

vi) Pitch circle diameter of the bolts,

$D_p = D + 2t + 2d + 12mm$

$= 200 + 2 \times 14 + 2 \times 20 + 12$

$= 200 + 28 + 40 + 12$

$= 280mm$

vii) Circumferential pitch of bolts; P_c:

$P_c = \frac{\pi \times D_p}{n} = \frac{\pi \times 280}{8}$

$= 109.96 \simeq 110mm$

diameter of bolt hole; d_1

$d_1 = d + 3 = 20 + 3 = 23mm$

$20\sqrt{d_1} = 20\sqrt{23} = 96mm$

$30\sqrt{d_1} = 30\sqrt{23} = 144mm$

Since P_c is between 96 and 144, design is satisfactory.

5) Design an oval flanged pipe joint for pipes of internal diameter 50mm subjected to a fluid pressure of 7N/mm². The maximum tensile stress in the pipe material is not to exceed 21MPa and in the bolts 28MPa.

Soln.

Given:

$D = 50mm$, $R = 50/2 = 25mm$

$P = 7 N/mm^2$

$\sigma_t = 21 MPa = 21 N/mm^2$ $(1N/mm^2 = 1MPa)$

$\sigma_{tb} = 28 MPa = 28 N/mm^2$

According to lame equations:

$$t = R\left[\sqrt{\frac{\sigma_t + P}{\sigma_t - P}} - 1\right] = 25\left[\sqrt{\frac{21 + 7}{21 - 7}} - 1\right]$$

$t = 10.86$ say $12mm$

Assuming the width of packing as 10mm, Outside diameter of the packing,

$D_1 = D + 2 \times \text{Width of packing}$

$= 50 + 2 \times 10 = 70mm$

∴ Force trying to seperate flanges,

$F = \frac{\pi}{4}(D_1)^2 p = \frac{\pi}{4}(70)^2 7 = 26,943\ N$

Since the flange is secured by means of two bolts, there fore load on each bolt,

$F_b = F/2 = 26943/2 = 13471.5N$

let d_c = Core diameter of bolts

We know that loads on each bolt (F_b):

$F_b = 13471.5 = \frac{\pi}{4} d_c^2 \sigma_{tb} = \frac{\pi}{4} d_c^2 \times 28\ 7$

$13471.5 = 7\pi d_c^2$

$d_c = \sqrt{\frac{13471.5}{7\pi}} = 24.75mm$ say 25mm

(ii) and nominal diameter of bolts, d:

$d = \frac{d_c}{0.84} = \frac{25}{0.84} = 29.76$ say 30mm

Outer diameter of the flange,

$D_o = D + 2t + 4.6d$

$= 50 + 2 \times 12 + 4.6 \times 30$

$= 212mm$

and pitch circle diameter of the bolts

$D_p = D_o - (3t + 20mm = 212 - (3 \times 12 + 20) = 156mm$

$D_p = 156mm$

The elevation of the flange is shown in figure 1 to determine the width of flange at section x-x, b and the distance of section x-x from the centre of the bolt, e: Assuming major axis, $D_o = 212mm$, and minor axis $D_p - d = 156 - 30 = 126mm$

From the figure:

$b = 111mm$ $e = 41mm$

Check: $e = \frac{D_p}{2} - \left[\frac{D}{2} + t\right] = \frac{156}{2} - \left(\frac{50}{2} + 12\right) = 41mm$

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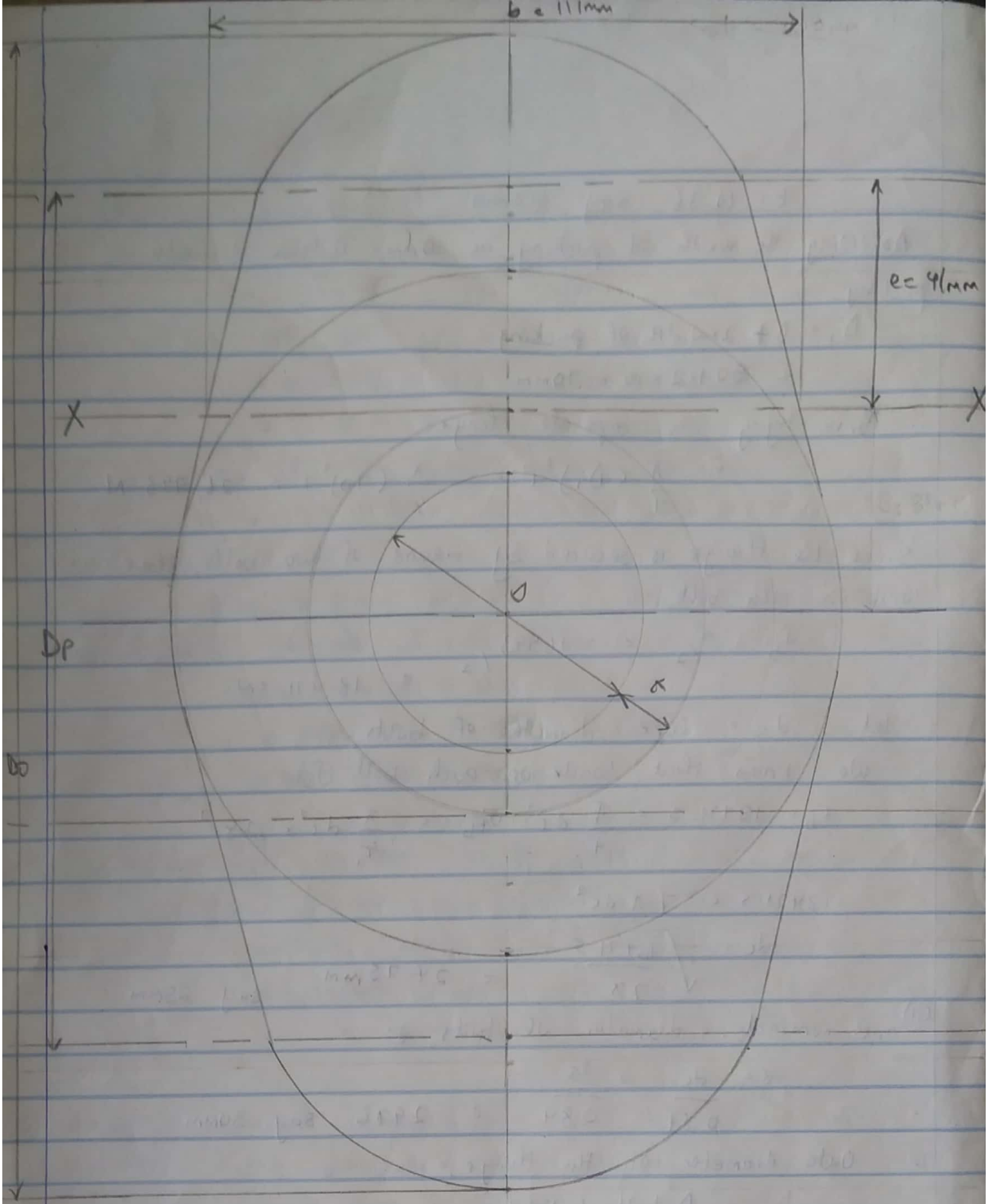

Fig 1: Elevation of Flange.

1. Bending moment of section x - x

$M_{xx} = f_b \times e = 13471.5 \times 41\,mm = 552331.5\ Nmm$

section modulus:

$Z = \frac{1}{6} b t_f^2 = \frac{1}{6} \times 111 \times t_f^2$

$= 18.5 t_f^2$

Recall: $M_{xx} = \sigma_b \times Z$

$\therefore 552331.5 = 21 \times 18.5 t_f^2$

$t_f = \sqrt{\frac{552331.5}{388.5}} = 37.7$ say $38mm$