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15/ENG06/015 [Pipeline Engineering]
Mechanical Engineering

4) Compute the dimensions of a flagged cast iron pipe 200mm in diameter to carry a pressure of 0.7 N/mm²

Solution.

$D = 200mm$

$P = 0.7 N/mm^2$

$\sigma_t = 14 N/mm^2$ from table 8.1

$C = 9mm$ from table 8.2

thickness $t = \frac{PD}{2\sigma_t} + C$

$t = \frac{0.7 \times 200 + 9}{2 \times 14}$

$t = 14mm$

Other dimensions of a flagged joint for a cast iron pipe are:

* Normal diameter of bolts

$d = 0.75t + 10$

$= 0.75 \times 14 + 10$

$= 20.5mm \simeq 21mm$

* Number of bolts $= 0.0275D + 1.6$

$n = 0.0275 \times 200 + 1.6 = 7.1 \simeq 8mm$

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- Thickness of the flange

$t_f = 1.5t + 3$

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

- ~~Outside diameter of the bolt(s)~~

~~$D_a = D + 2t + 2B$~~

~~$= 200 + 2(14) + 2(50) = 328mm$~~

- ~~Width of the flange =~~

~~B~~

- Width of the flange

$B = 2.3 \times d$

$2.3 \times 21 = 48.3 \approx 50mm$

- Outside diameter of the bolts

$D_a = D + 2t + 2B$

$200 + 2(14) + 2(50) = 328mm$

Pitch circle diameter of the bolts

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

$200 + 2(14) + 2(21) + 12 = 282mm$

Circumferential pitch of the bolts

$P_c = \frac{\pi \times D_p}{n} = \frac{\pi \times 282}{8} = 110.7mm$

For the joint to be leak proof,
the value of P_c should be b/w $20\sqrt{d}$ to $30\sqrt{d}$

d = diameter of bolt hole.

$d_1 = d + 3$

$= 21 + 3 = 24mm$

$20\sqrt{d_1} = 20\sqrt{24} = 97.9$

$30\sqrt{d_1} = 30\sqrt{24} = 146.9$ [C_p above $20\sqrt{d}$ & $30\sqrt{d}$

therefore design is satisfactory

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3) A seamless pipe carries 2000 m³ of Steam per hour at a pressure of 1.2 N/mm². The velocity of flow is 28 m/s. Assuming the tensile Stress as 40 MPa, find the inside diameter of the pipe and its wall thickness.

Solution

$Q = 200 m^3/h = 33.3 m^3/h$

$P = 1.2 N/mm^2$

$V = 28 m/s = 1680 m/min$

$\sigma_t = 40 MPa = 40 N/mm^2$

inside diameter of pipe

$$D = 1.13\sqrt{\frac{Q}{V}}$$

$$D = 1.13\sqrt{\frac{33.3}{1680}}$$

$= 0.159 = 160 mm$

Wall thickness of pipe

from table 8.2 $C = 3 mm$

$$t = \frac{pD}{2} + C$$

$$= \frac{1.2 \times 160}{2 \times 40} + 3$$

$= 5.4 mm \simeq 6 mm$

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

$D = 50mm$ or $R = 25mm$

$p = 7N/mm^2$

$\sigma_t = 21 Mpa = 21 N/mm^2$

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

$$t = R\left[\sqrt{\frac{\sigma_t + p}{\sigma_t - p}} - 1\right] = 25\left[\sqrt{\frac{21+7}{21-7}} - 1\right] = 10.35 \simeq 11mm$$

Assuming the width of packing as 10mm:

Other diameter of packing

$D_1 = D + 2 \times$ width of packing

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

Force trying to seperate the flanges

$$F = \frac{\pi}{4}(D_1)^2 \; p = \frac{\pi}{4}(70)^2 \, 7 = 26943N$$

Since the flange is secured by means of bolts

$$F_b = \frac{F}{2} = \frac{26943}{2} = 13471.5N$$

Let dc = core diameter of bolt

Load on each bolt (F_b)

$$13471.5 = \frac{\pi}{4}(dc^2)28 = 21.99(dc)^2$$

$$(dc)^2 = \frac{13471.5}{21.99} = 612.6$$

$dc = 24.7mm \simeq 25mm$

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Normmal diameter of bolts

$d = \frac{d_c}{0.84} = \frac{25}{0.85}$

$29.4 = 30mm$

Outer diameter of the flange.

$D_e = D + 2t + 4.6(d)$

$D_e = 50 + 2(11) + 4.6(30)$

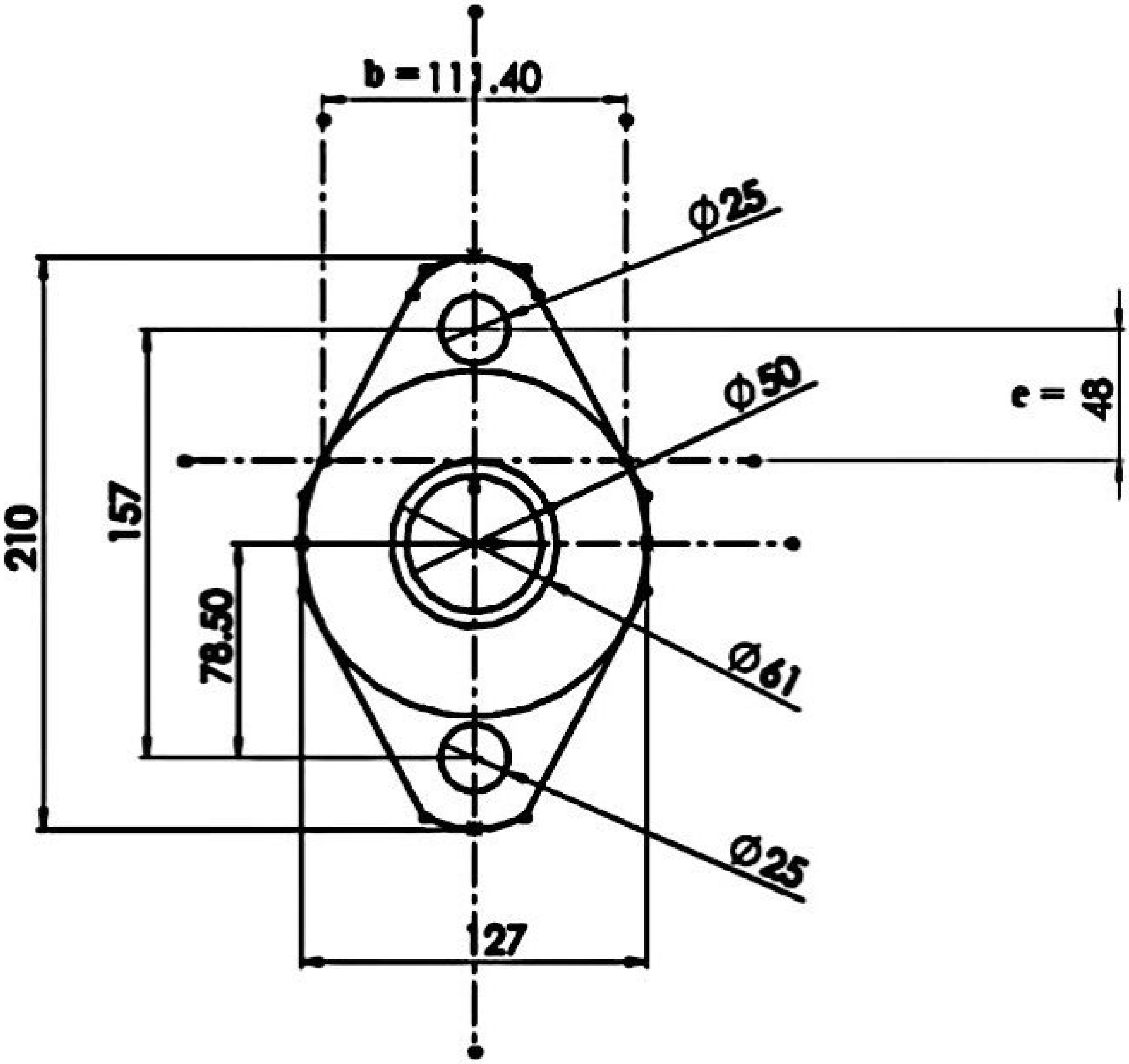
$= 210mm$

Pitch circle diameter of bolts

$D_p = D_o - (3t + 20mm)$

$= 210 - (3(11) + 20)$

$= 157mm$


b = 111.40
Φ25
Φ50
e = 48
210
157
78.50
Φ61
Φ25
127

From the diagram above

$b = 111.40mm$

$l = 48mm$

Bending moment at section x-x

$M_{xx} = F_b \times l =$ ~~13471~~ $13471.5 \times 48mm$

$= 646632 N/mm$

and section modulus

$$Z = \frac{1}{6} b (t_f)^2 = \frac{1}{6} \times 111.40 (t_f)^2$$

$$= 18.56 (t_f)^2$$

$(M_{xx} = \sigma_b \times Z)$

$$646632 = 21 \times 18.55 (t_f)^2$$

$$= 389.76 (t_f)^2$$

$$t_f^2 = \frac{646632}{389.76} = t_f = \sqrt{1659.05} = 40.7 \simeq 41mm$$

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