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15/ENG06/033
Mechanical Engineering

1 $Q = 2000\,m^3/h \rightarrow 33.3\,m^3/h$

$P = 1.2\,N/mm^2$

$v = 28\,m/s = 1680\,m/min$

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

Ans

Inside diameter of Pipe

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

$$= 1.13\sqrt{\frac{33.3}{1680}} = 0.159 = 160\,mm$$

Wall thickness of Pipe

From table 8.2 - $C = 3\,mm$

$$\therefore t = \frac{PD}{2} + C = \frac{1.2 \times 160}{2 \times 40} + 3$$

$$= 5.4\,mm \simeq 6\,mm$$

(2) $D = 200\,mm$

$P = 0.7\,N/mm^2$

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

From table 8.2 $C = 9\,mm$

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

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

$$t = 14\,mm$$

$= 187 mm$

from the diagram

$b = 111.43 mm$

$e = 48 mm$

Bending Moment of Section x-x

$M_{xx} = F_b \times e = 13471.5 \times 48 mm$

$= 646632 \text{ N-mm}$

and Section Modulus

$Z = \frac{1}{6} b (t_f)^2 = \frac{1}{6} \times 111.43 (t_f)^2$

$= 18.56 (t_f)^2$

Scanned with CamScanner

$d_1 = d + 3$

$= 21 + 3 = 24mm$

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

$30\sqrt{d_1} = 30\sqrt{24} = 146.9$

Since the circumferential pitch is above $20\sqrt{d_1}$ and $30\sqrt{d_1}$, the design is satisfying

③ Given $D = 50mm$ or $R = 25mm$

$P = 7 N/mm^2$

$\sigma_t = 21 MPa \therefore = 21 N/mm^2$

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

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

$= 10.35$ say $11mm$

Assume the width of packing as 10mm.

Outer diameter of the packing:

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

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

Force trying to separate the flanges

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

Since the flange is ~~separated~~ secured by the means of bolt

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

Let d_c = core diameter of bolt

Load on each bolt (F_b)

$13471.5 = \frac{\pi}{4}(d_c)^2 \sigma_{tb}$

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

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

$d_c = 24.7mm$ or $25mm$

Nominal diameter of bolts

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

$= 29.4 = 30mm$

Outer diameter of the flange

$D_o = D + 2t + 4.6d$

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

$= 210mm$

Pitch circle diameter of bolts

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

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

$= 157mm$

10 : $M_{xx} = 5632$

$64113 = 21 \times 18.51 (t_f)^2$

$= 387.76 (t_f)^2$

$t_f^2 = \frac{646632}{387.76}$

$t_f = \sqrt{1659.05}$

$t_f = 40.7 \approx 41 mm$

Other dimensions of a flanged joint for a cast iron pipe are Nominal diameter of bolts:

$d = 0.75t + 10$

$= 0.75 \times 14 + 10 = 20.5mm = 21mm$

Number of bolts

$n = 0.0275D + 1.6$

$= 0.0275 \times 200 + 1.6 = 7.1 = 8$

Thickness of the flanges

$t_f = 1.5t + 3$

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

Width of the flange

$B = 2.3d$

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

Outside diameter of the bolts

$D_o = D + 2t + 2B$

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

Pitch circle diameter of the bolts

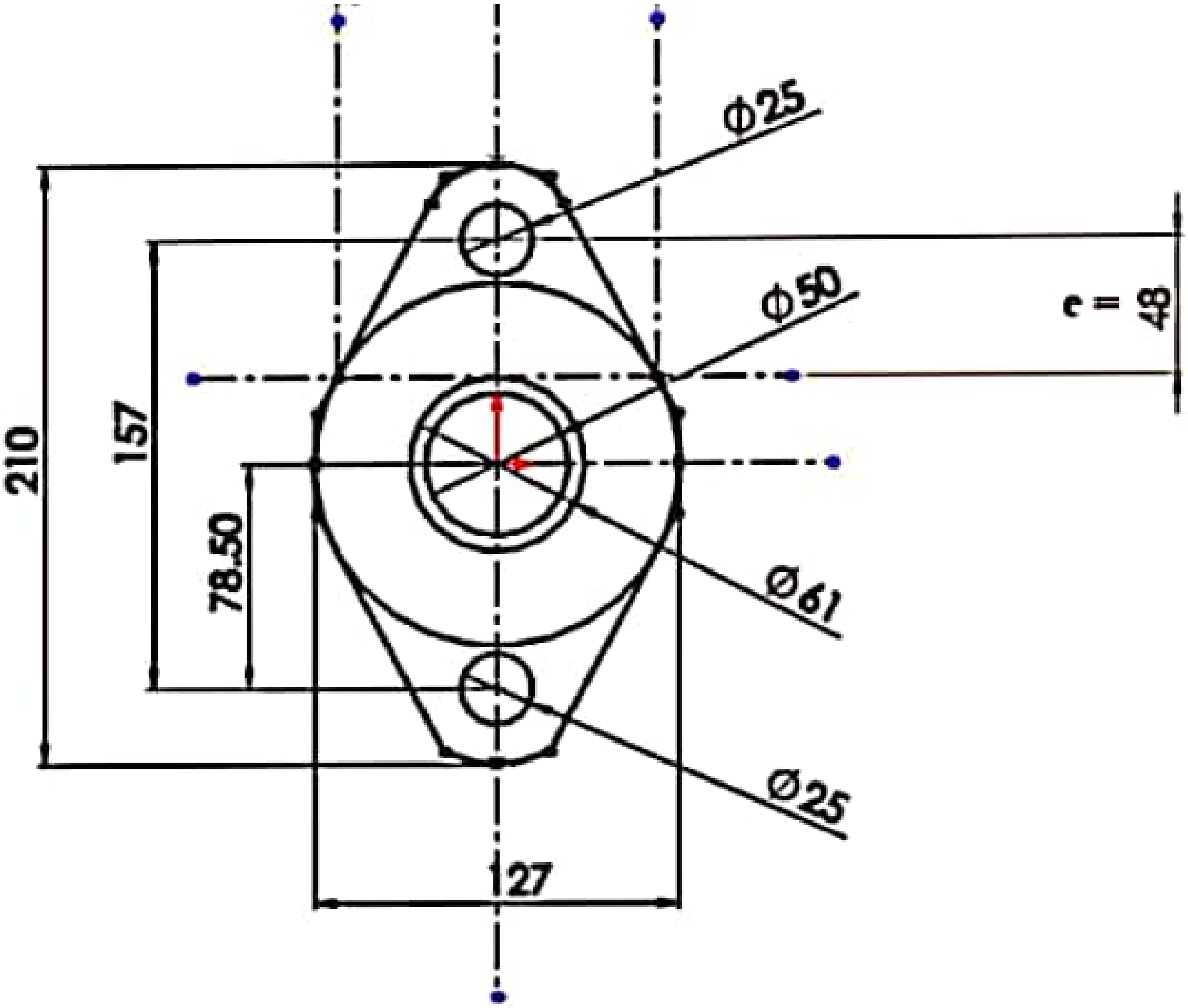
$D_p = D + 2t + 2d + 12$

$= 200 + 2 \times 14 + 2 \times 21 + 12 = 282 mm$

Circumferential pitch of the bolts

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

To make the joint leak proof the value of P_c should be between $20\sqrt{d}$ to $30\sqrt{d}$, where d is diameter of bolt hole



Φ25
Φ50
Ø61
Ø25
e = 48
210
157
78.50
127