PIPELINE

NAME OPARA NDAMAGNUM
MATRIC 15/ENG06/057
DEPT MECHANICAL

1) $Q = 2000\ m^3/h$
$= 33.3\ m^3/$
$P = 1.2\ N/mm^2$
$V = 28\ m/s = 1680\ m/min$
$\sigma_t = 40\ MPa = 40\ N/mm^2$
Inside diameter $D = 1.13\sqrt{\frac{Q}{V}}$

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

$= 0.159 \simeq 160mm$

Wall thickness, From table 8.2
$C = 3mm$

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

$= \frac{1.2 \times 160}{2 \times 40} + 3 = 5.4mm \simeq 6mm$

2 $D = 200mm$; $P = 0.7 N/mm^2$
From table 8.1 ; $\sigma_t = 14 N/mm^2$
From table 8.2 ; $C = 9mm$
Pipe thickness $t = \frac{PD}{2\sigma_t} + C$

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

Other dimensions of a flanged joint for a cast iron pipe include;
- Nominal diameter of bolts; $d = 0.75t + 10$

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

No of bolts ; $n = 0.0275D + 1.6$

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

Thickness of Flanges $t_f = 1.5t + 3$

$t_f = 1.5(14) + 3 = 24mm$

Flange Width $B = 2.3d$

$B = 2.3(21) = 48.3 \simeq 50mm$

Outside Diameter of bolts $D_o = D + 2t + 2B$

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

Pitch Circle Diameter of Bolts $D_P = D + 2t + 2d + 12$

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

Circumferential Pitch of bolts: $P_c = \frac{\pi \times D_P}{n}$

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

To prevent leaks, the value of P_c should be between $20\sqrt{d}$ and $30\sqrt{d}$ where d is diameter of bolt hole.

$d_1 = d + 3$

$d_1 = 21 + 3 = 24mm$

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

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

Circumferential Pitch $> 20\sqrt{d_1}$ and $30\sqrt{d_1}$

$\therefore$ the design is satisfactory

3 $D = 50mm$; $R = 25mm$

$P = 7N/mm^2$

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

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

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

$= 10.35 \simeq 11mm$

If with Width of package $B = 10mm$

Outer diameter $D_1 = D + 2 \times B$

$= 50 \times 2(10) = 70mm$

$\therefore$ Force separating Flanges

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

Since flange is secured with bolts

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

Let d_c = Core diameter of bolts

F_b = Load on each bolt

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

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

$$13471.5 = 21.99 (d_c)^2$$

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

$$d_c = 24.7 \simeq 25mm$$

Norminal diameter of bolts

$$d = \frac{d_c}{0.84} = \frac{25}{0.85} = 29.4 \simeq 30mm$$

Outer diameter of flange:

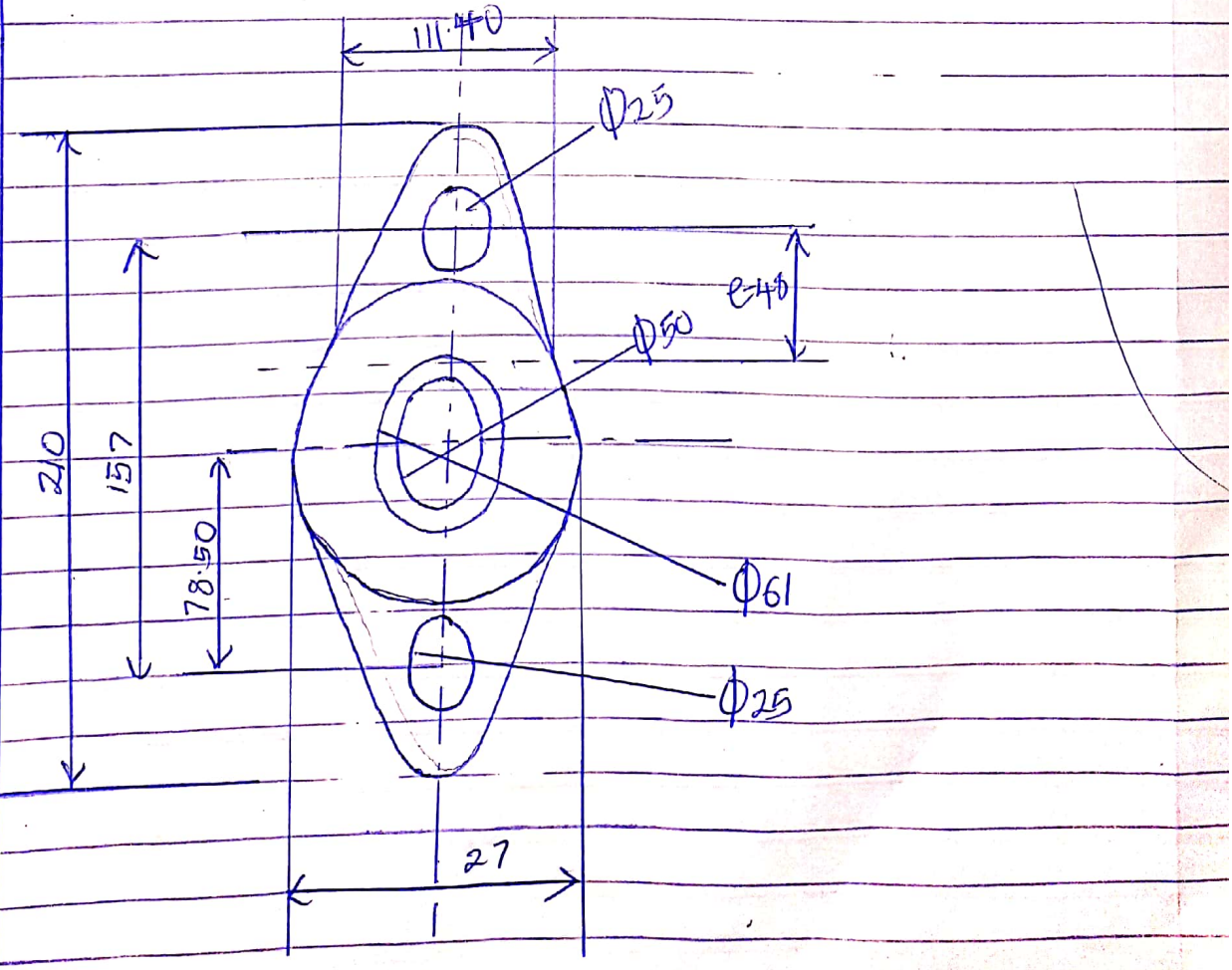
$$D_o = D + 2t + 4.6d$$

$$D_o = 50 + 2(11) + 4.6(30) = 210mm$$

Pitch circle diameter of bolts

$$D_P = D_o - (3t + 20)$$

$$D_P = 210 - (3(11) + 20) = 157mm$$



From the diagram above

$b = 111.40mm$

$e = 48mm$

Bending moment of section x-x

$M_{xx} = F_b \times e = 1347.5 \times 48mm$

$= 6466.32 Nmm$

Section Modulus

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

$$Z = 18.56 (t_f)^2$$

But $M_{xx} = \sigma_b \times Z$

$$\therefore \quad 646632 = 21 \times 18.56 (t_f)^2$$

$$646632 = 389.76 (t_f)^2$$

$$t_f^2 = \frac{646632}{389.76} = 1659.05$$

$$t_f = \sqrt{1659.05}$$

$$t_f = 40.7 \simeq 41mm$$