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15/ENG06/012

MECHANICAL ENGINEERING

PIPELINE ENG.

Question 1

i $Q = 2000\ m^3/hr = 33.3\ m^3/hr$

$P = 1.2\ N/mm^2$

$V = 28\ m/s$

$D_t = 40MPa$

$D = ? = 1.13\sqrt{Q/R} = 1.13\sqrt{\frac{33.3}{1680}}$

$= 0.159 = 160mm$

Wall thickness

ii from table 8.2 $C = 3mm$

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

$t = (1.2 \times 160) + 3 = 5.4mm \approx 6mm$

Question 2

$D = 200mm$ $P = 12.7\ N/mm^2$

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

8.2 $C = 9mm$

$t = \frac{PD}{2D_t} + C = \frac{(0.7 \times 200)}{(2 \times 14)} + 19 = 14mm$

Using the thickness

i) Nominal diameter of bolts

Nominal diameter of bolts

$d = 0.75t + 10$

$= (0.75 \times 14) + 10 = 20.5\,mm$

Number of bolts

$n = 0.0275D + 1.6$

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

Thickness of the flanges

$t_f = 1.5t + 3 = (1.5 \times 14) + 3$

$= 24\,mm$

Width of the flanges

$W = 2.3d = 2.3 \times 21 = 48.3\,mm$

Outside diameter of the bolts

$D_o = D + 3t + 2B = 200 + 2(14) + 2(50) = 328\,mm$

Pitch circle diameter of the holes

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

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

Pitch circle diameter

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

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

Cir. Pitch

$= P_c = \frac{\pi \times D_p}{n} = 110.9\,mm$

∴ Since $d_1 = d + 3 = 24\,mm$

$21 + 3 = 24\,mm$

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

$30\sqrt{d_1} = 30\sqrt{24} = 140.9$

$P_c > 20\sqrt{d}$ ∴ design is satisfactory

3) Given $D = 50mm$ or $r = 25mm$

$p = 7N/mm^2$ $\sigma_t = 21MPa$ $\sigma_{cu} = 28MPa$

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

Outside dia

$D_i = D + 2 \times width$

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

∴ Force trying to separate the flanges

$$F = \frac{\pi}{4}(D_i)^2 \quad p = \pi/4\,(70^2) \times 7 = 26943N$$

∴ Since the flange is screwed at one end

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

let d_c = core diameter

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

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

$d_c = 24.7 \approx 25mm$

Nominal diameter of bolts

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

Outer diameter of the flange

$D_o = D + 2t + 4.6d$

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

Pitch Circle diameter

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

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

$= 157mm$

From the diagram

$b = 111.40mm$

$a = 48mm$

∴ Bending moment of section x-x

$F_b \times e = 13471.5 \times 48mm$

$= 646632 N.mm$

and section modulus

$= \frac{1}{6} b (tf)^2 = \frac{1}{6} \times 111.40 (6F)^2$

$= 18.57 (tf^2)$

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

$646632 = 21 \times 18.56\ tf^2$

$tf^2 = \frac{646632}{389.76}$

$tf = \sqrt{1659.05}$

$tf = 40.7 \approx 41mm$