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B22ME055

Design of Machine Elements:

Lab-10

Calculations:

$P_{max} = 5\ MPa$. F.O.S. against buckling failure = 5

cylinder box = 100mm = D.

L = 400mm stroke = 100mm

$P_c = \left(\frac{\pi}{4} D^2\right) P_{max} = \frac{3.14 \times (100)^2}{4} \times 5 = 39250\ N$

critical buckling-load $P_{cr} = P_c(FOS) = 196250\ N$

Thickness of the I-section

$\frac{P}{cr} = \frac{\sigma_c A}{1 + a(L/K_{CL})^2}$

steel 40

$\{ \sigma_c = 380\ N/mm^2 \}$

$A = 11t^2$

$K_{min} = 1.78t$

$a = 1/7500$

$$19250 = \frac{380 \times 11t^2}{1 + \frac{1}{7500}\left(\frac{400}{1.78}\right)^2}$$

$$196250 = \frac{380 \times 11t^2 \times t^2}{7500t^2 + 50499}$$

$\Rightarrow$ $\boxed{t = 7.27mm}$

$H = 5t = 36.35mm$

$B = 4t = 29.08mm$

$H_{middle\ SOC} = 5t = 36.35mm$

$= 0.8H = 29.08mm$

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$H_{big} = 1.2d = 43.62\ mm$

Force acting on the piston pin bearing

let $P_a = d_p L_p (P_b)_p$.

$(P_b)_p = 12.5\ MPa$ and $L_p/d_p = 1.5$

$39250 = d_p (1.5 d_p) 12.5$ $\therefore d_p = 45.75\ mm$

$L_p = 68.63\ mm$

$(P_a)_c = 10\ MPa$, $L_c/d_c = 1.5$

$39250 = d_c (1.5 d_c) 10$

$d_c = 51.15\ mm$, $L_c = 76.73\ mm$

$m_r = 1.5\ kg$, $\omega = 2000\ rpm$, $= 209.4\ rad/s$

$r = L/2 = \frac{100}{2} = 50\ mm$ $n = L/r = \frac{400}{50} = 8$

$\sigma_t = \frac{450}{5}\ N/mm^2$ $(P_i)_{max} = m_r \omega^2 r \left(1 + \frac{1}{n}\right)$

$\frac{2 \times \pi d_c^2}{4} \sigma_t = 1.5 (209.4)^2 \frac{50}{1000} \left(1 + \frac{1}{8}\right)$

$d_c = 5.09$

$d = d_c / 0.8 = 6.36 \simeq 7\ mm$

Thickness of big end cap t_c.

$\sigma_b = \frac{M_b y}{I}$ for cap $\sigma_y \geq 380\ N/mm^2$

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$$M_b = \frac{(P_i)_{max} L}{6} = \frac{3600.81 \times 100}{6}$$

$$y = t_c/2 \quad , \quad I = \frac{b_c t_c^3}{12}$$

$$\sigma_b = \frac{380}{5} = \frac{\frac{3660.81 \times 100 \times t_c/2}{6}}{(b_c t_c^3)/12}$$

$$t_c = 7.92 \text{ mm}$$