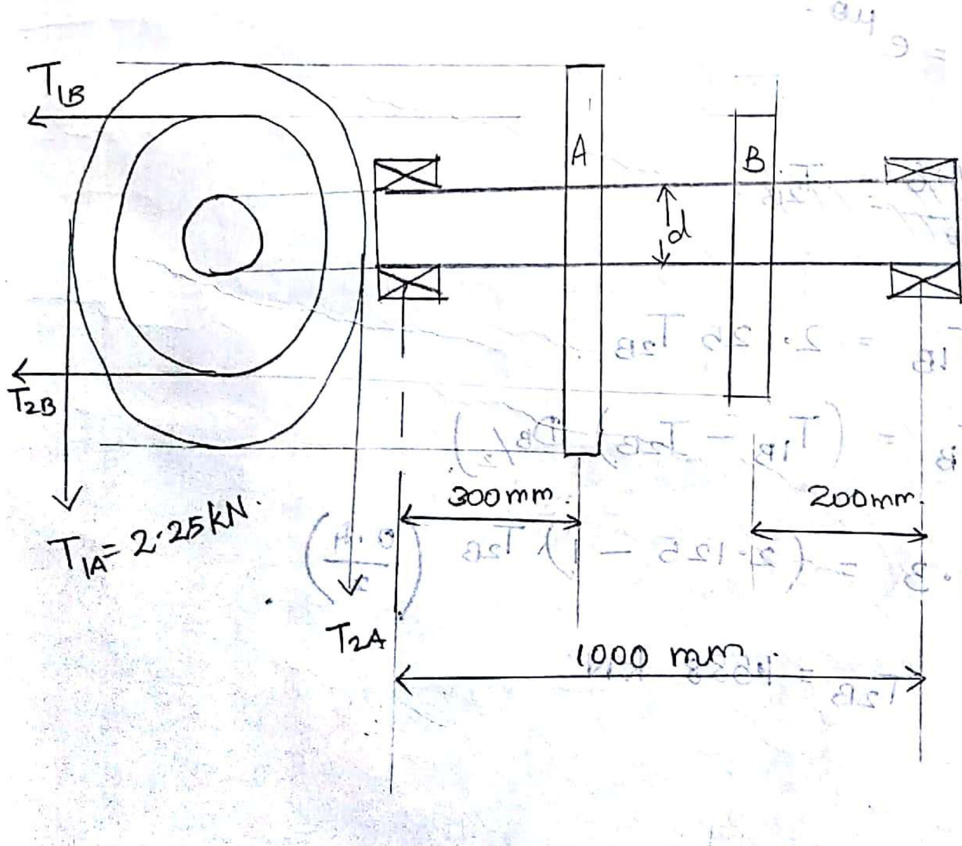
1) - A shaft is supported by 2 bearings placed 1m apart, a 600mm diameter pulley is mounted at a distance of 300 mm to the right of left side bearing and driver pulley below it with the help of belt having the maximum tension of 2.25 kN. Another pulley of 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electrical motor and the belt which is placed horizontally to the right. The angle of contact for both pulley is 180° & coefficient of friction 0.24. Allowable tensile stress is 60MPas. Allowable shear stress is 40 MPa. Assume that torque on the one pulley is equal to the other pulley. Determine the diameter of shaft.



$\mu = 0.24$

$\sigma = 60 \, MPa$

$\tau = 40 \, MPa$

$$\frac{T_{1A}}{T_{2A}} = e^{\mu\theta}$$

$$\frac{T_{1A}}{T_{2A}} = e^{(3.14)(0.24)}$$

$$T_{2A} = 1.059 \, kN.$$

$$T_A = (T_{1A} - T_{2A}) \, D_A/2$$

$$= (2250 - 1059) \, 0.6/2$$

$$= 357.3 \, N\text{-}m$$

$$T_A = T_B.$$

$$\frac{T_{1B}}{T_{2B}} = e^{\mu\theta}.$$

$$T_{1B} = 2.125 \, T_{2B}.$$

$$T_B = (T_{1B} - T_{2B}) \, D_B/2)$$

$$357.3 = (2.125 - 1) \, T_{2B} \left(\frac{0.4}{2}\right).$$

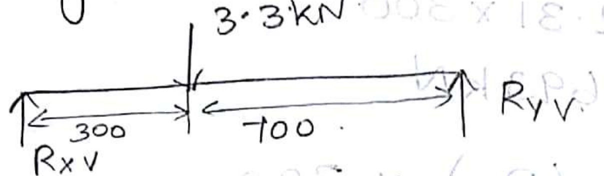
$$T_{2B} = 1.588 \, kN$$

$T_{1B} = 2.125 \times 1.588$

$= 3.3745$ kN.

$T_{1A} + T_{2A} = 33$

Considering Vertical load.



$R_{XV} + R_{YV} = 3.308 \times 10^3$ N

$(R_{XV} \times 0) - ((3.3)(300) + (R_{YV}) \times 1000) = 0.$

$1000 R_{YV} = 990.4$

$R_{YV} = 0.99$ kN.

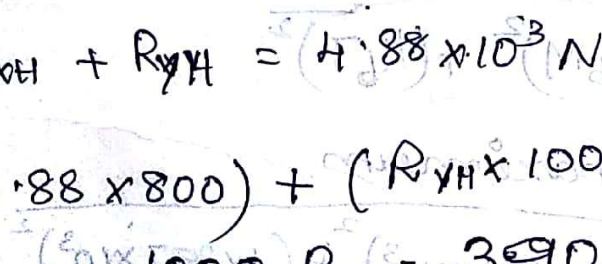
$R_{XV} = 2.318$ kN.

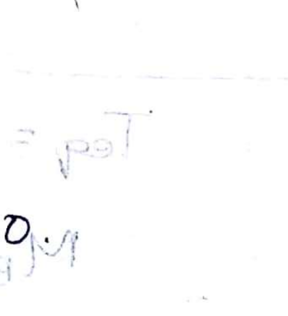
On pulley 'B' the force acting horizontal

Let assume in vertical

$T_{1B} + T_{2B} = 4.88$ kN

Considering Horizontal load.





$R_{XH} + R_{YH} = 4.88 \times 10^3$ N.

$(-4.88 \times 800) + (R_{YH} \times 1000) = 0$

$1000 R_Y = 3904$

$R_{YH} = 3.904$ kN.

$$M_A = \sqrt{(M_A)_V^2 + (M_A)_H^2}$$

$$(M_A)_V = (R_x)_V \times 300.$$

$$= 2.31 \times 300$$

$$= 693 \text{ kN}.$$

$$(M_A)_H = (R_x)_H \times 300$$

$$= 0.976 + 300.$$

$$= 292.8 \text{ kN}.$$

$$M_A = \sqrt{(693)^2 + (292.8)^2}$$

$$= 752.31 \text{ kN.mm}.$$

$$M_B = \sqrt{(M_B)_V^2 + (M_B)_H^2}.$$

$$(M_B)_V = (R_Y)_V \times 200$$

$$= 0.99 \times 200.$$

$$= 198 \text{ kN}.$$

$$(M_B)_H = (R_Y)_H \times 200$$

$$= 3.90 * 200$$

$$= 780 \text{ kN}.$$

$$T_{eq} = \sqrt{(K_b M)^2 + (K_t T)^2}$$

M_B is maximum.

$$T_{eq} = \sqrt{(1 \times 804 \times 10^3)^2 + (1 \times 357 \times 10^3)^2}$$

$$= 879695.95$$

$$= 879.695 \text{ kN.mm}.$$

$M_B = \sqrt{(198)^2 + (-780)^2}$

$M_B = 804$ kN·mm

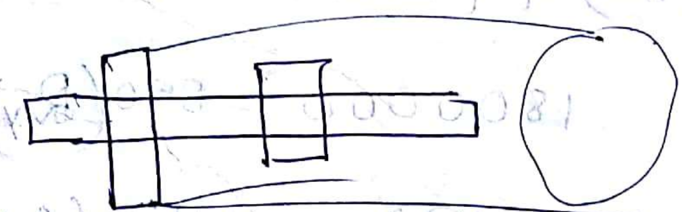
$T_{eq} = \frac{\pi}{16} \tau d^3$

$d^3 = \frac{16 T_{eq}}{\pi \tau}$

$d^3 = \frac{16 \times 879.695 \times 10^3}{\pi \times 40}$

$d = 48.20$ mm

3. A pulley weights 1.2 kN and 500 mm diameter is driven by horizontal belt drive the power transmitted to solid shaft by pinion key to shaft which in turn meshes with gear. The belt tension and component of gear reaction on pinion is shown in figure. Design the shaft if shock & fatigue factor are $K_b = 2$ & $K_t = 1.5$ $\tau = 55$ N/mm².



Torque (T_p) of pulley

$= (T_1 - T_2) \times D/2$

$= (5000 - 1500) \times 250$

$= 875000$.

$T_p = 875 \times 10^3$ N-mm

$F = T_1 + T_2$

$= 6500$ N.

Moment

$(R_x)_V + (R_Y)_V = 8000$ N

$(R_x \times 0) + (8000 \times 225) - ((R_Y)_V \times 850) = 0$

$1800000 = 850 (R_Y)_V$

$(R_Y)_V = 2117.64$ N

$(R_x)_V = 8000 - 2117.64$

$= 5882.35$ N.

$$(R_x)_H + (R_y)_H = 9500.$$

$$[(R_x)_H \times 0] - [3000 \times 225] - [6500 \times 600] + ((R_y)_H \times 850) = 0.$$

$$(R_y)_H \times 850 = 4575000.$$

$$(R_y)_H = 5382.35 \text{ N}.$$

$$(R_x)_H = 9500 - 5382.35$$

$$= 4117.64 \text{ N}.$$

Moment due to "gear"

$$M_G = \sqrt{(M_G)_V^2 + (M_G)_H^2}$$

$$(M_G)_V = (R_x)_V \times 225$$

$$= 1.32 \times 10^6 \text{ N-mm}$$

$$(M_G)_H = (R_x)_H \times 225$$

$$= 926469 \text{ N-m}.$$

$$M_G = \sqrt{(1.32\times10^6)^2 + (926469)^2}$$

$$= 1612682.4$$

$$= 1.612 \times 10^6 \text{ N.mm}$$

Moment due to pulley.

$$M_P = \sqrt{(M_P)_V^2 + (M_P)_H^2}$$

$$(M_P)_V = (R_y)_V \times 250$$

$$= 529410 \text{ N.mm}.$$

$$(M_P)_H = (R_y)_H \times 250$$

$$= 1345587.5 \text{ N.mm}.$$

$$M_P = \sqrt{(529410)^2 + (1345587.5)^2}$$