Approach: find belt tensions & hence radial load on shaft. Can then correlate with tabulated loads to find life of bearing.

For the belt drive:

$$v = \pi DN = \pi \times 0.212 \times \frac{1485}{60} = 16.5 \text{ m/s}$$

Set $\hat{F}, \check{F}$ strand tensions for all 5 belts they must satisfy power transfer $P = (\hat{F} - \check{F})v$

(i) $\therefore \hat{F} - \check{F} = 75 \times 10^3 / 16.5 = 4.550$ kN

gross slip, since at full capacity

$$\therefore (\hat{F} - \rho v^2)/(\check{F} - \rho v^2) = e^{(f\theta)_{min}}$$

$\gamma = \arcsin(630-212)/2\times889 = 13.6°$

$\rho v^2 = 5 \times 0.2037 \times 16.5^2 = 0.277$ kN

$e^{(f\theta)_{min}} = e^{0.3 \operatorname{cosec} 19° \times (\pi - 13.6\pi/90)}$

$= 3.917$

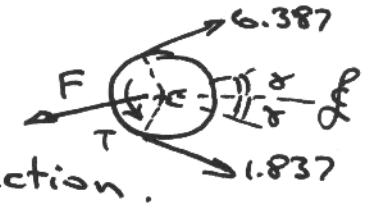
(ii) $\therefore (\hat{F} - 0.277)/(\check{F} - 0.277) = 3.917$

Solving (i) & (ii): $\hat{F} = 6.387$, $\check{F} = 1.837$ kN

Resolving $\hat{F}, \check{F} \parallel$ & $\perp$ to ℓ:

$$F = \sqrt{[(6.387+1.837)^2 \cos^2\gamma + (6.387-1.837)^2 \sin^2\gamma]}$$

$= \underline{8.06}$ kN is the shaft reaction.



For the motor, assuming F acts thro' middle of pulley, F = 8.06 kN at x = 51 mm.

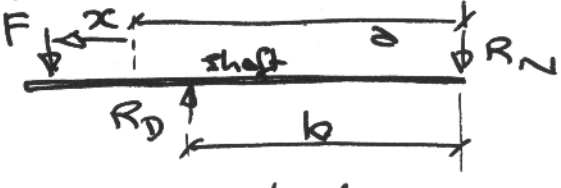
To find out how to interpolate given tabulated loads, examine load on D-end bearing for different F-positions.

'a' & 'b' are unknown fixed dimensions

$$F(a+x) = R_D b$$

so for a fixed R_D & fixed bearing life, we must have

$$F(a+x) = \text{constant}$$



i.e. $F_0(a+0) = \ldots$

& $F_E(a+E) = \ldots$ } F_0 & F_E are tabulated

Eliminating unknown constants 'a' & RHS

(iii) $1/F = 1/F_0 + \frac{x}{E}(1/F_E - 1/F_0)$

at 40 kh: $F = 1/[1/7.32 + \frac{51}{140}(1/6.18 - 1/7.32)] = 6.86$ kN

at 63 kh: $= 1/[1/6.29 + \ldots (1/5.31 - 1/6.29)] = 5.89$ kN

So if actual load gives life L kh, then assuming life law: $F^n \times L = \text{constant}$

$6.86^n \times 40 = 5.89^n \times 63 = 8.06^n \times L \Rightarrow L = \underline{24.6 \text{ kh}}$

Given variability of fatigue, replacement by roller very much depends on reliability sought.

Note: F not ⊥ x