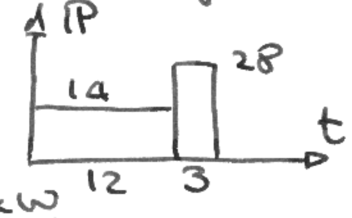
The lives of various components must be assessed here:
- the motor as a whole, from a thermal viewpoint ($n = 5$)
- the motor bearings become critical if the belt pulley diameter is small ($n = 2.5$)
- the belt drive itself ($n = 13$ say)
- the shaft and its bearings, etc.

A target life of 25 yr (25 kh here) is appropriate for everything apart from the belts. Each component has its own fatigue S-N curve (i.e. load-life) and is loaded ultimately by the belt tensions - which ∴ must be found.

CHOICE OF MOTOR

The equivalent continuous demand from the motor's point of view is:



$$P_e^5 \times 15 = 14^5 \times 12 + 28^5 \times 3 \qquad P_e = 20.8\,kW$$

and assuming 95% belt drive efficiency the minimum motor continuous output

$$P_e' = 20.8/0.95 = 21.9\,kW$$

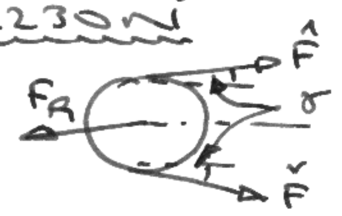
From ABB motor tables, first choice is:

MBT 180L 22kW @ 1470 rpm.

Before considering belt it's advisable to get idea of pulley size D that corresponds to the limiting shaft load F_R. From ABB table this is 1.85 kN (for 40 kh). So

$$F_R = 1850\,(40/25)^{1/2.5} = 2230\,N$$

For a 1:1 drive ($\gamma = 0$) at full load with negligible centrifugal effects (have to particularise as don't yet know further details of drive):



$$\hat{F} - \check{F} = P/v \qquad \text{where } v = \pi D N$$

$$\& \quad \hat{F}/\check{F} = e^{f\pi} = 5 \qquad (\beta = 19^\circ,\ \mu = 1/6)$$

whence $F_R = \hat{F} + \check{F} = \frac{3}{2} P/\pi D N$

so $D = 3P/2\pi F_R N$ which here

$$= 3 \times 28 \times 10^3 / 2\pi \times 2230 \times 1470/60$$

$$= 245\,mm.$$

i.e. belt drive with $D \lesssim 245\,mm$ reduces the life of motor bearings below 25kh.

CHOICE OF BELT DRIVE

The equivalent continuous belt content

$$P_e^{13} \times 15 = 14^{13} \times 12 + 28^{13} \times 3 \qquad P_e = 24.7\,kW$$