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Problem:Two parallel shafts whose centre line are 4.8 m apart, are connected by open belt drive.

Question:
Two parallel shafts whose centre line are 4.8 m apart, are connected by open belt drive. The diameter of larger pulley is 1.5 m and that of smaller pulley 1 m. The initial tension in the belt when stationary is 3 kN. The mass of the belt is 1.5 kg/m length. The coefficient of friction between the belt and pulley is 0.3 Taking centrifugal tension into account, calculate the power transmitted when the smaller pulley rotates at 400 rpm.

Answer:

We know that velocity of the belt,

$$v = \frac{\pi d_2 . N_2}{60} = \frac{\pi \times 1 \times 400}{60} = 21 \text{ m/s}$$

and centrifugal tension, $T_C = m.v^2 = 1.5\,(21)^2 = 661.5$ N

Let T_1 = Tension in the tight side, and

T_2 = Tension in the slack side.

We know that initial tension (T_0),

$$3000 = \frac{T_1 + T_2 + 2T_C}{2} = \frac{T_1 + T_2 + 2 \times 661.5}{2}$$

$$\therefore \quad T_1 + T_2 = 3000 \times 2 - 2 \times 661.5 = 4677 \text{ N} \qquad \text{...(i)}$$

For an open belt drive,

$$\sin\alpha = \frac{r_1 - r_2}{x} = \frac{d_1 - d_2}{2x} = \frac{1.5 - 1}{2 \times 4.8} = 0.0521 \quad \text{or} \quad \alpha = 3°$$

$\therefore$ Angle of lap on the smaller pulley,

$$\theta = 180° - 2\alpha = 180° - 2 \times 3° = 174°$$
$$= 174° \times \pi / 180 = 3.04 \text{ rad}$$

We know that

$$2.3 \log\left(\frac{T_1}{T_2}\right) = \mu.\theta = 0.3 \times 3.04 = 0.912$$

$$\log\left(\frac{T_1}{T_2}\right) = \frac{0.912}{2.3} = 0.3965 \quad \text{or} \quad \frac{T_1}{T_2} = 2.5 \qquad \text{...(ii)}$$

...(Taking antilog of 0.3965)

From equations (i) and (ii),

$$T_1 = 3341 \text{ N}; \text{ and } T_2 = 1336 \text{ N}$$

$\therefore$ Power transmitted,

$$P = (T_1 - T_2)\, v = (3341 - 1336)\, 21 = 42\,100 \text{ W} = 42.1 \text{ kW}$$ **Ans.**