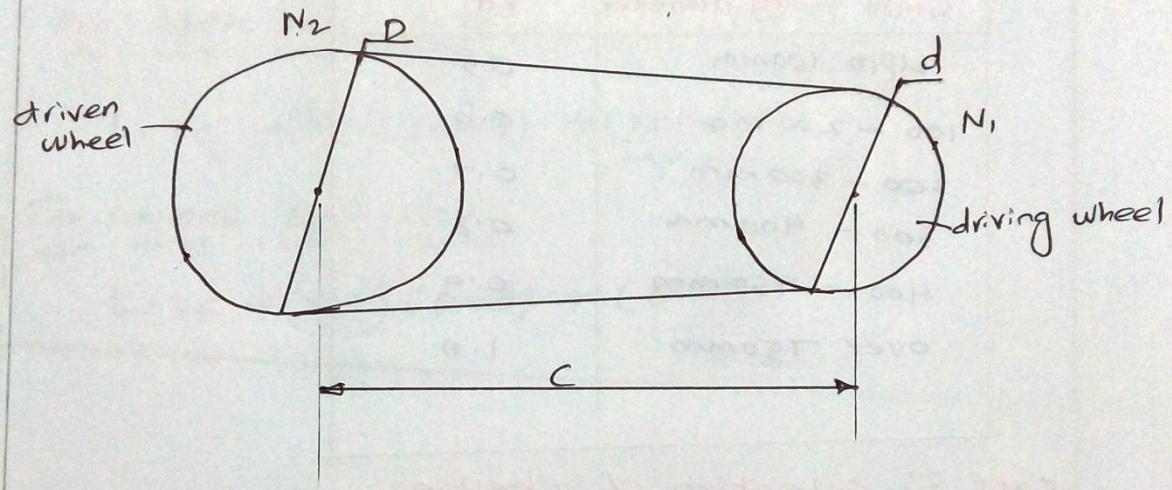
DESIGN OF FLAT BELT DRIVE

The two different design procedures used are

1) using the manufacturer's data
2) using the basic equations.

Design of flat belt drive based on manufacturer's data:-

STEP 1: selection of pulley diameters



speed ratio $i = \frac{D}{d} = \frac{N_1}{N_2}$

The N_1, N_2, D, d may be given (or) some of the data missing.

To find out std. Diameter of smaller and larger pulley refer PSG DB: 7.54

STEP 2: Calculation of design power in kW

$$\text{Design kW} = \frac{\text{Rated kW (given)} \times \text{Load correction factor } (K_s)}{\text{Arc of contact factor } (K_\alpha) \times \text{Small Pulley factor } (K_d)}$$

(i) Load correction factor (k_s):-

Refer. PSGDB Page No: 7.53

(ii) Arc of contact factor (k_α):-

Refer PSGDB Page No: 7.54

Arc of contact = $180° - \left(\frac{D-d}{C}\right) \times 60°$

(iii) Small pulley factor (k_d):-

Small pulley diameter	k_d
Upto 100mm	0.5
100 – 200 mm	0.6
200 – 300 mm	0.7
300 – 400 mm	0.8
400 – 750 mm	0.9
over 750mm	1.0

STEP 3: Selection of a belting

Refer PSGDB. Page no: 7.54 [Load rating per mm ply at 180° arc of contact at 10m/s

STEP 4:- Load rating correction

Refer PSGDB. Page no: 7.54

$\therefore V = \frac{\pi d N_1}{60}$

Load rating at V m/s = Load rating at 10m/s $\times \frac{V}{10}$

STEP 5:- Determination of belt width

$$\text{width of belt} = \frac{\text{Design power (driven)}}{\text{Load rating} \times \text{No. of plies}}$$

Std. width of transmission belt [From PSGDB Pg. No: 7.52]

STEP 6:- Determination of pulley width

⇒ Pulley width [from PSGDB. Pg.no: 7.54]

⇒ Recommended series of width of flat pulleys, m

[from PSGDB Pg.no: 7.55]

STEP 7:- calculation of belt length (L)

From PSGDB Pg.no: 7.53

For open belt drive:-

$$L = 2C + (\pi/2)(D+d) + \frac{(D-d)^2}{4C}$$

For crossed belt drive:-

$$L = 2C + (\pi/2)(D+d) + \frac{(D+d)^2}{4C}$$

Problem

It is required to select a flat-belt drive for a fan running at 360rpm. which is driven by a 10kw, 1440rpm motor. The belt drive is open-type and space available for a centre distance of 2m approximately. The

diameter of a driven pulley is 1000mm.

Given data:-

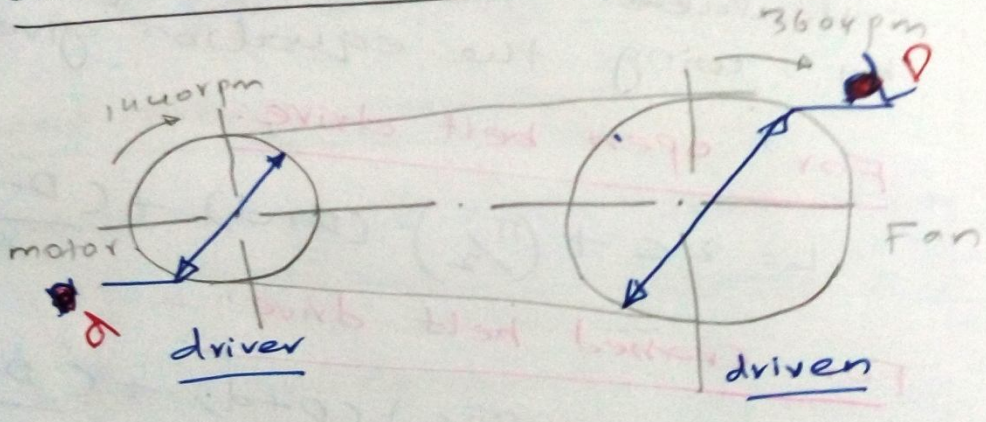
$N_1 = 1440$ rpm, $N_2 = 360$ rpm

$P = 10kw = 10 \times 10^3 W$, $C = 2m$, $D = 1000mm$

To find:-

select (or design) a open belt drive.

1) calculation of pulley diameters:



Driven pulley diameter $D = 1000$ mm

Velocity ratio $= D/d$ = Driver pulley speed / Driven pulley speed

$= \frac{N_1}{N_2} = \frac{1440}{360}$

$\frac{D}{d} = 4$

$d = D/4 = \frac{1000}{4}$

$d = 250mm$

$\frac{N_2}{N_1} = \frac{D}{d} = \frac{360}{1440} = \frac{1000}{d}$

$d = \frac{1000 \times 1440}{360}$

$d =$

see - Recommended Pulley diameters in mm [from DB - Pg.no - 7.54)

recommended Driven pulley diameter

= 250mm

2) calculation of design power in kW

Design kW = Rated kW x Load correction factor (Ks)

Arc of contact factor (K_α) x Small Pulley factor (kd)

(i) Rated kW = 10kW

(ii) Refering, Load correction factor Ks - [from DB - Pg.no 7.53]

$K_s = 1.2$ for steady load.

(iii) To find arc of contact factor (K_α)

$$\text{Arc of contact} = 180^\circ - \left(\frac{D-d}{C}\right) \times 60^\circ$$

$$= 180^\circ - \left(\frac{1000 - 250}{2000}\right) \times 60^\circ$$

$$= 157.5^\circ$$

ref. Arc of contact factor K_α [from DB - Pg.no. 7.54]

$K_d \approx 1.08$

(v) consulting small pulley factor kd [from DB - Pg.no - 7.62)

$K_d = 0.7$

Design kW $= \frac{10 \times 1.2}{1.08 \times 0.7} = 15.873$ kW

3) Selection of belt:-

Load rating of fabric belts per mm width per ply at 180° arc of contact at 10 m/s belt speed [from DB-Pg.no 7.54]

HI-SPEED duck belting is selected.

Its capacity is given as 0.023 kW/mm/ply

4) Load rating correction:-

Velocity of the belt $V = \frac{\pi d N_1}{60}$

$= \frac{\pi \times 0.25 \times 1440}{60}$

$V = 18.85$ m/s

Load rating at V m/s

= Load rating at 10 m/s $\times \frac{V}{10}$

Load rating at 18.85 m/s

= Load rating at 10 m/s $\times (18.85/10)$

$= 0.023 \times (18.85/10)$

$= 0.04335$ kw/mm/ply.

5) Determination of belt width

For 250mm smaller pulley diameter and velocity of 18.85 m/s, ref CPB-pg.no:T.5

– minimum pulley diameter in mm for given speed and belting plies.

can be selected as 5

width of belt = $\frac{\text{Design power}}{\text{Loading rating} \times \text{no. of plies}}$

$= \frac{15.873}{0.04335 \times 5}$

$= 73.23$ mm

From DB – Pg.no – T.52 – Std width (belt)

For 5 ply belt, Standard belt width = 76mm

6) Determination of Pulley width:–

From DB – Pg.no – T.52 – pulley width

Pulley width = Belt width + 13

$= 76 + 13 = 89$mm.

ref- DB - Page no - 7.55 ✓

Standard Pulley width = 90mm

1) Calculation of length of the belt (L)

ref. DB pg.no - 7.53

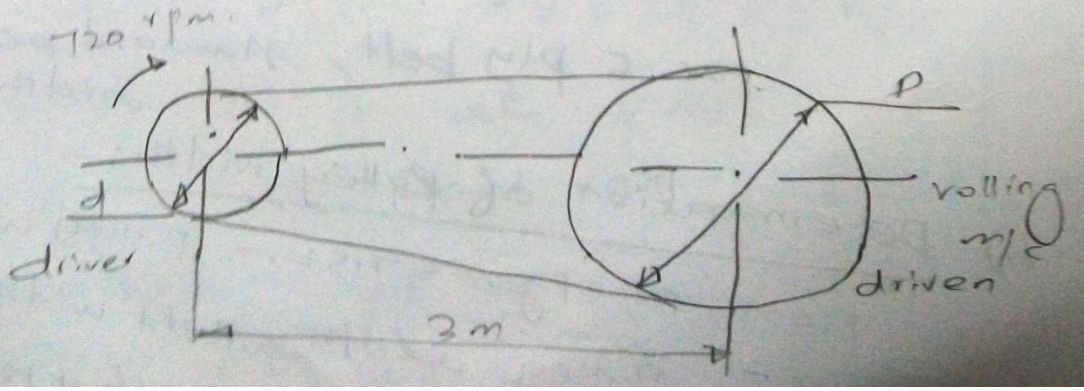
For open belt drive

$$L = 2C + \pi/2 (D+d) + \frac{(D-d)^2}{4C}$$

$$= 2 \times 2000 + \pi/2 (1000+250) + \frac{(1000-250)^2}{4 \times 2000}$$

$$L = 6033.8 \text{ mm}$$

Design a belt drive to transmit 20kw at 720rpm to an aluminium rolling machine, the speed ratio being 3. The distance between the pulleys is 3m. Diameter of rolling machine pulley is 1.2m



Given data:-

$P = 20 kW$

$N_1 = 720 rpm$

Speed ratio = 3

$C = 3m \quad D = 1.2m = 1.2 \times 1000 = 1200mm$

To find:- Design a belt drive

Solution:-

1) Calculation of pulley diameters:

$$\text{Speed ratio} = \frac{D}{d} = \frac{\text{Driver Pulley speed}}{\text{Driven Pulley speed}}$$

$$\frac{D}{d} = 3 \Rightarrow d = D/3 = \frac{1200}{3}$$

$$\boxed{d = 400mm}$$

2) Calculation of design power in kW

$$\text{Design kW} = \frac{\text{Rated kW} \times \text{Load correction factor (ks)}}{\text{Arc of contact factor (kd)} \times \text{small Pulley factor (kd)}}$$

(i) Rate kW = 20 kW

(ii) Load correction factor (ks) - DB Pg. no: 7.51

$K_s = 1.5$

(iii) Arc of contact (K_d) From DB - Pg. no - 7.54

Arc of contact $= 180° - \left(\frac{D-d}{C}\right) \times 60°$

$= 180° - \left(\frac{1200-400}{3000}\right) \times 60°$

$= 164°$

From DB - Pg. no. 7.54

$K_d = 1.06$

∴	160°	170°
	1.08	1.04

1.06

(iv) Small pulley factor (K_d)

$K_d = 0.8$

Design kw $= \frac{20 \times 1.5}{1.06 \times 0.8} = 35.377$ kw

3) Selection of belt:-

From DB - Pg. no. 7.54

Fort duck belting is selected. Its capacity is given as 0.0289 kw/mm/ply

4) Load rating correction:-

velocity of the belt $v = \frac{\pi d N_1}{60}$

$= \frac{\pi \times 0.4 \times 720}{60}$

$= 15.08$ m/s

Load rating at v m/s = Load rating at 10m/s $\times \frac{V}{10}$

∴ Load rating at 15.08 m/s

= Load rating at 10m/s $\times \left(\frac{15.08}{10}\right)$

$= 0.0289 \times \left(\frac{15.08}{10}\right)$

$= 0.04358$ KW/mm/ply

5) Determination of belt width :

For 400mm smaller pulley diameter and velocity of 15.08 m/s,

From DB - Pg. no. T.52.

no. of plies = 6

width of belt = $\frac{\text{Design power}}{\text{Load rating} \times \text{no. of plies}}$

$= \frac{35.377}{0.04358 \times 6}$

$= 135.29$mm

From DB - Pg. no. Std. width = 152mm

6) Determination of pulley width

From DB - Pg.no. 7.55

Pulley width = belt width + 25

= 152 + 25 = 177 mm

From DB - Pg.no. 7.52

Std. pulley width = 180 mm.

7) Calculation of length of the belt (L)

For open belt,

$$L = 2C + (\pi/2)(D+d) + \frac{(D-d)^2}{4C}$$

$$= 2 \times 3000 + \pi/2\,(1200+400) + \frac{(1200-400)^2}{4 \times 3000}$$

$$L = 8566.6 \text{ mm}$$