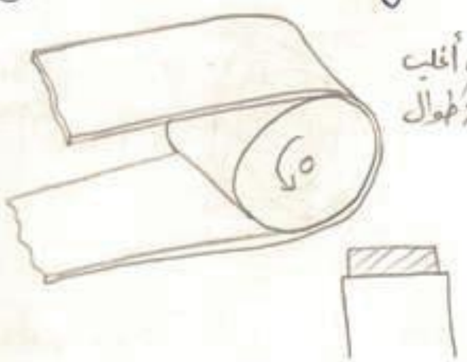
Belt drives

*Types of belt drives

① Flat belt & pulley طارة وسير



يستخدم في أغلب الأحوال مع الأطوال الكبيرة

② V-belt with sheaves

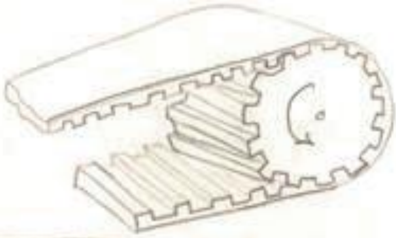
سيور مقطعها لها أرقام تدل على مساحتها وطولها وتنتج بشكل قياسي (standard) هو النوع السائد

③ Toothed belt with sprocket

positive belt drive

كل حركة i/p تقابلها حركة o/p

(لا يوجد انزلاق)



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* Advantages of using belt drives

① light weight
② low Cost
③ No need for lubricating (تزييت) system
④ Available in standard sizes
⑤ Easy to design & select
⑥ low noise (Compared with chains)

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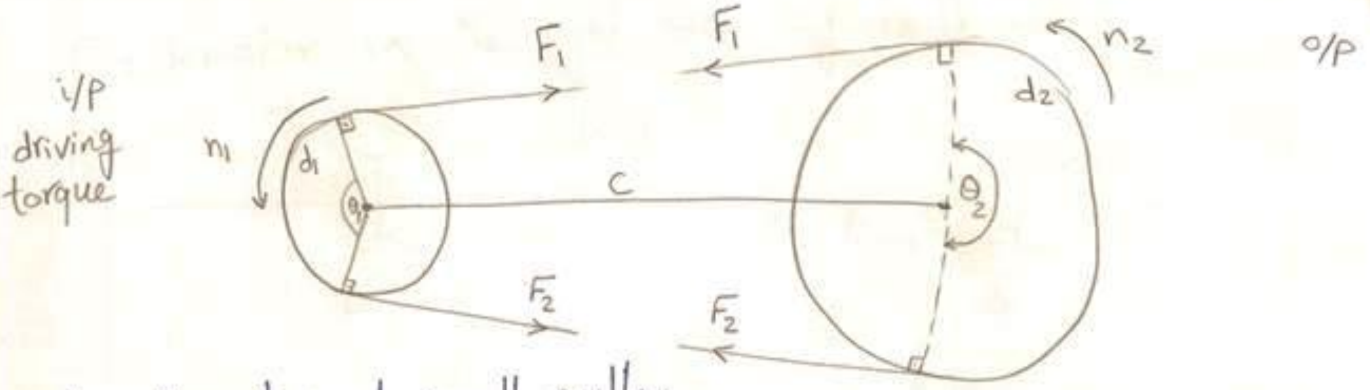
* Disadvantages of using belt drives

① limited power range (Compared with gears).
② short life
③ Can't withstand high temperature.

* ordinary open drive

* Belt dimensions



d_1: diameter of small pulley

d_2: ~ ~ large ~

C: center distance

θ: angle of contact between belt & pulley

L: length of belt.

$$\theta_{1,2} = 180 \mp 2 \sin^{-1} \frac{d_2 - d_1}{2C}$$

$$L = \frac{\theta_1 d_1 + \theta_2 d_2}{2} + 2\sqrt{C^2 - \left(\frac{d_2 - d_1}{2}\right)^2}$$

* Belt speed

n_1: rpm of small pulley

n_2: ~ ~ large ~

$$V = \omega r = \frac{\pi d_1 n_1}{60} = \frac{\pi d_2 n_2}{60}$$ ⟹ to get V in m/s put d in meters

$$d_1 n_1 = d_2 n_2$$

$$\frac{n_1}{n_2} = \frac{d_2}{d_1}$$ reduction ratio

the belt speed $V \leq (25:30)$ m/s according to belt size

* Force analysis

① IF belt weight is neglected.

F_1 : tension in the tight side of belt

F_2 : ~ ~ ~ slack ~ ~ ~

$$\frac{F_1}{F_2} = e^{\mu \theta}$$

as μ : friction bet$_n$ pulley & belt (0.3 to 0.6)

θ : min. of θ_1 & θ_2 (in rad.)

$$F_1 = \sigma_{all} * A$$

σ_{all} of belt material = 2 : 3 MPa

A ← belt cross-section area (mm^2)

الباع = العرض * السمك

② IF the weight is Considered

$$\frac{F_1 - F_c}{F_2 - F_c} = e^{\mu \theta}$$

as $F_c = \frac{W}{g} v^2$

F_c : tension of belt due to centrifugal force

W : weight of belt material per m length (N/m)

v = belt speed in (m/s)

$$T_1 = (F_1 - F_2) * \frac{d_1}{2} \quad (N.m)$$

$$T_2 = (F_1 - F_2) * \frac{d_2}{2} \quad (N.m)$$

$$\text{power} = T_1 \omega_1 = T_2 \omega_2 \quad (\text{watt})$$

$$= (F_1 - F_2) * v$$

$$= K_s (F_1 - F_2) v$$

Design power = K_s * power to be transmitted

$$= K_s * (F_1 - F_2) v * N$$

N → no. of belts (يقرب للرقم الأكبر)

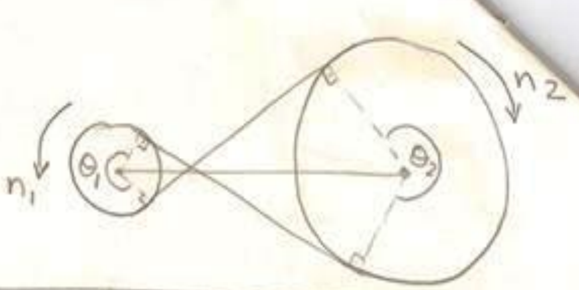
as T : torque

K_s : service factor ≥ 1

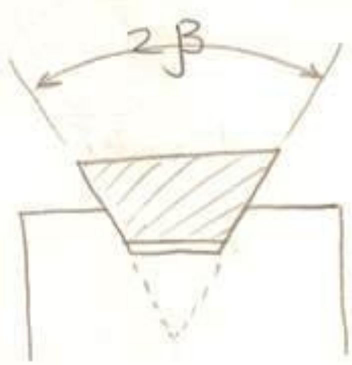
* Crossed (closed) drive

$$\theta_1 = \theta_2 = 180 + 2\sin^{-1}\frac{d_1 + d_2}{2C}$$

$$L = \left(\frac{d_1 + d_2}{2}\right)\theta + 2\sqrt{C^2 - \left(\frac{d_1 + d_2}{2}\right)^2}$$



* for V-belts



replace μ by μ_e

$$\mu_e = \frac{\mu}{\sin\beta}$$

μ_e: effective coefficient of friction

β: half of the groove angle

* Max. power

IF the max. power and the Corresponding velocity are required then

$$\frac{\partial \text{power}}{\partial v} = 0$$

then the value of the $v = \boxed{v^* = \sqrt{\frac{F_1 g}{3W}}}$

then the $\boxed{\text{max. power} = K_s(F_1 - F_2) * v^*}$