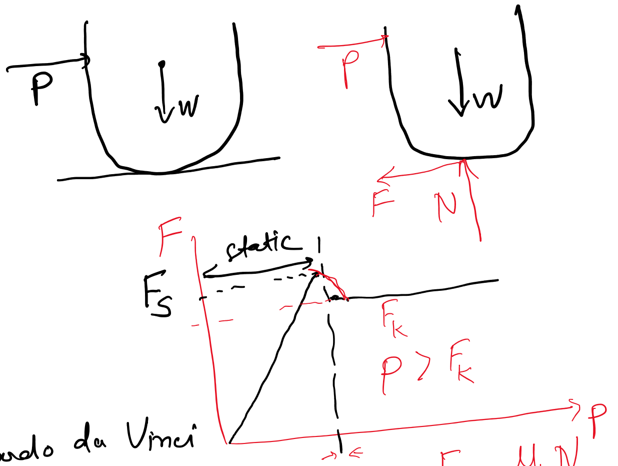
Friction

Thursday, February 13, 2025 6:34 PM



$\Sigma F_x = 0$

$P = F$

$\Sigma F_x \neq 0$

$\Sigma F_x = ma$

Leonardo da Vinci

$F \propto N$

Guilaume Amontons

$F \approx \frac{N}{3}$

Coulomb

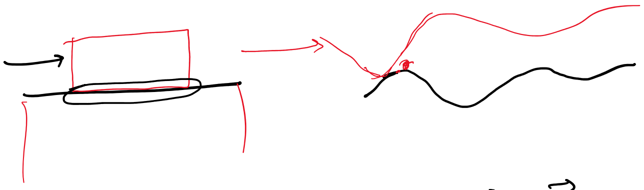
$F_s = \mu_s N$

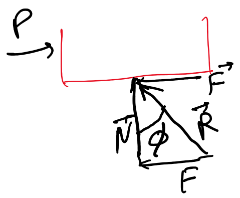
$F_k = \mu_k N$

$\boxed{F = \mu N}$

$F_{max} = \mu_s N$

$\boxed{F \leq \mu_s N}$





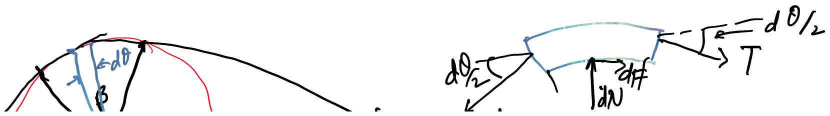
$\vec{R} = \vec{F} + \vec{N}$

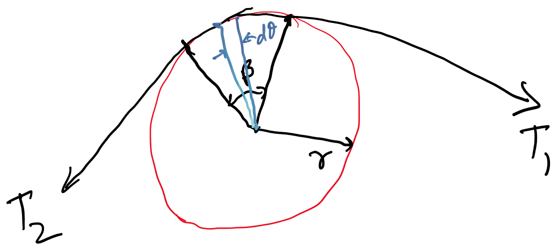
$\tan\phi = \frac{|\vec{F}|}{|\vec{N}|} = \mu$

Cone of Friction

$F = \sqrt{F_x^2 + F_y^2} \leq \mu_s N$

Belt/Cable in contact with Cylindrical Body





$$\Sigma F_x = 0 \qquad \Sigma F_y = 0$$

$T_2 > T_1$

β = Angle of wrap

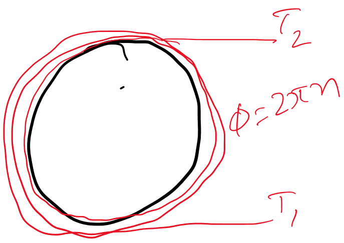
$$-(T+dT)\cos\frac{d\theta}{2} + T\cos\frac{d\theta}{2} + dF = 0$$

$$-(T+dT)\sin\frac{d\theta}{2} - T\sin\left(\frac{d\theta}{2}\right) + dN = 0$$

$$dF = \mu\, dN$$

$$d\theta \to 0 \qquad \cos\left(\frac{d\theta}{2}\right) \to 1$$

$$\sin\left(\frac{d\theta}{2}\right) \to \frac{d\theta}{2}$$



$$\boxed{\frac{dT}{d\theta} = \mu T}$$

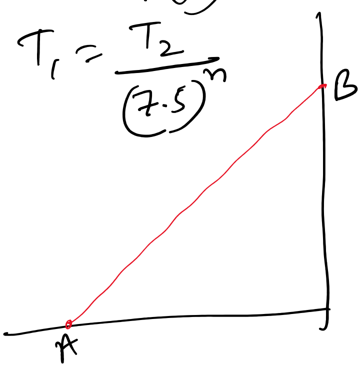
$$\boxed{T_2 = T_1 e^{\mu\beta}} \rightarrow \mu = \mu_s$$

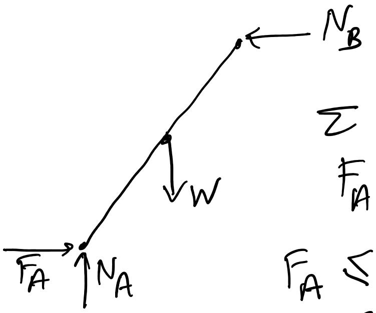
$$T_{2max} = T_1 e^{\mu_s \beta} > T_2 \geq T_1$$

$\mu = \frac{1}{\pi}$ $\quad \mu(2\pi n)$

$$T_2 = T_1 e^{2n}$$
$$= T_1 (e^2)^n$$

$$T_1 = \frac{T_2}{(7.5)^n}$$

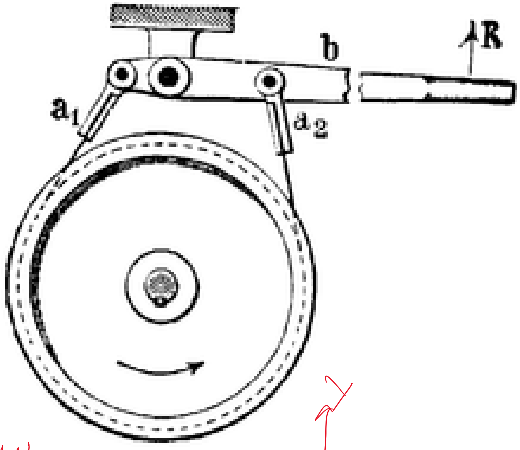


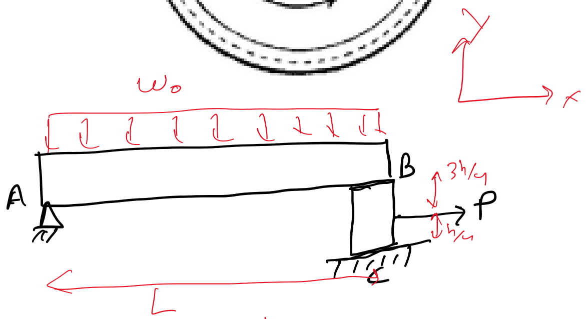


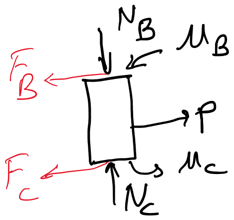
$$\Sigma F_y = 0$$
$$N_A = W$$

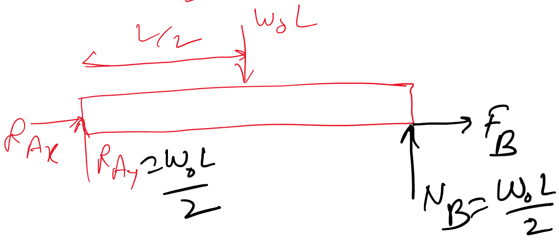
$$\Sigma F_x = 0$$
$$F_A = N_B$$

$$F_A \leq \mu_{A_s} N_A$$
$$\leq \mu_{A_s} W$$









$\sum F_y = 0$

$N_B = N_C$

$\sum F_x = 0$

$P - F_B - F_C = 0$

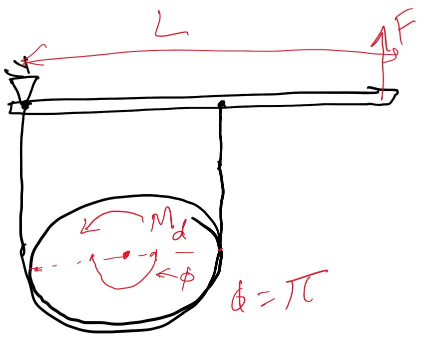
$F_B \leq \mu_B N_B = \mu_B \frac{w_0 L}{2}$

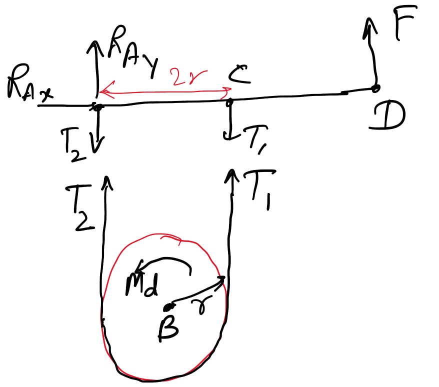
$F_C \leq \mu_C N_C = \mu_C \frac{w_0 L}{2}$

$\sum M_C = 0$

$\Rightarrow P = 4 F_B$

$= 4 \mu_B N_B$





$T_2 = T_1 e^{\mu\pi}$

$\sum M_B = 0$

$M_d + (T_1 - T_2) r = 0$

$T_1 = T_2 - \frac{M_d}{r} = T_1 e^{\mu\pi} - \frac{M_d}{r}$

$T_2 > T_1 \Rightarrow T_1 = \frac{M_d}{r(e^{\mu\pi} - 1)}$

For lever $\underline{ACD}$

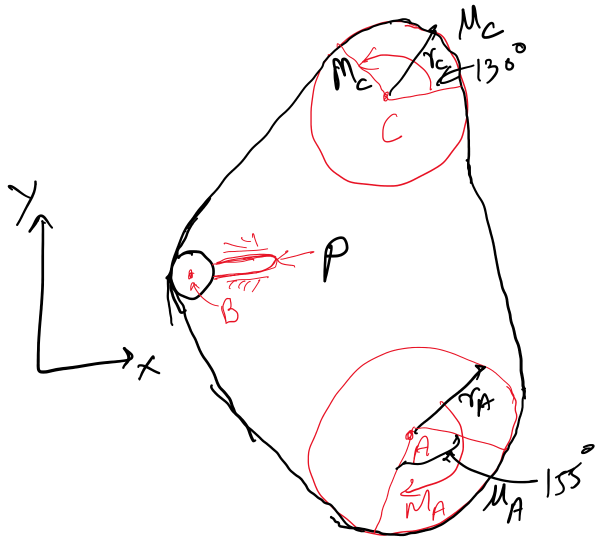
$\sum M_A = 0$

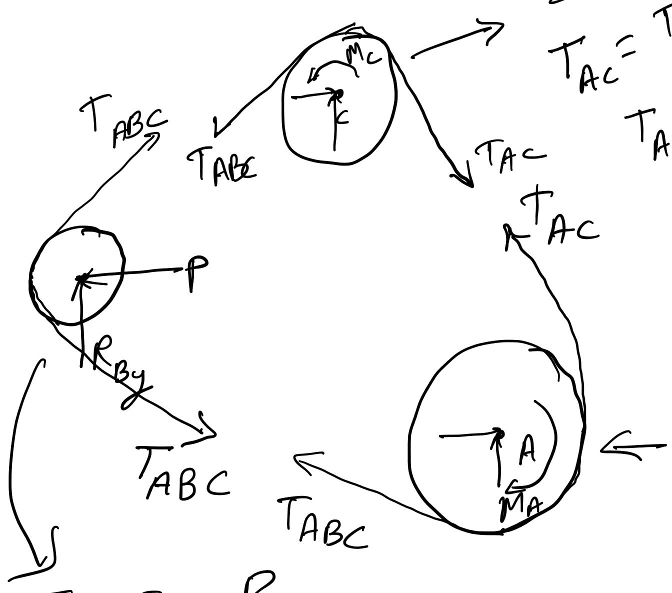
$T_1 \times 2r - F \times L = 0$

$$T_1 \times 2r - F \times L = 0$$

$$F = \frac{2rT_1}{L}$$

$$= \frac{2M_d}{L(e^{\mu\pi}-1)}$$





$$\Sigma M_C = 0$$

$$T_{AC} = T_{ABC} + \frac{M_c}{r_C}$$

$$T_{AC} > T_{ABC}$$

$$T_{ABC} = \frac{P}{\cos 45° + \cos 60°}$$