ROHININ COLLEGE OF ENGINEERING AND TECHNOLOGY
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DEPARTMENT OF MECHANICAL ENGINEERING

NAME OF THE SUBJECT: ENGINEERING MECHANICS

SUBJECT CODE : ME3351

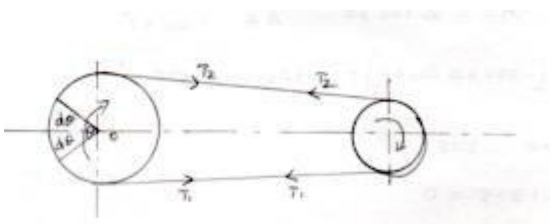
REGULATION 2021

UNIT V: FRICTION

BELT FRICTION

Power is transmitted through a belt that is running round the two plugs.This is used in laths, diesel engine, and rise mills etc for power transmission.

The power is transmission is due to the friction existing b/w the belt and the pulley surface. The friction is called belt friction.



$\frac{T_2}{T_1} = e^{MQ}$ ⟶ Tension Ratio

T_2= tension in fight side

T_1 = tension in slack side

θ = angle of contact

μ = coefficient of friction

$T_2 > T_1$

θ value sub in radian

θ in radian = ${}^{\pi}/_{180} \times \theta\ value\ in\ degree$

Power $P = [T_2 - T_1] \times V$

$V = \frac{\pi dN}{60}\ m/s$

N= speed of drum

D = diameter of drum

V= belt speed (or) velocity of belt

Problem 1

A flat belt develops a tight side tension of 2000 N during power transmission the coefficient of friction b/w pulley and belt is 0.3, the angle of lap on smaller pulley is 165° and the belt speed is 18 m/s. determine the power that can be transmitted, if the belt is assumed to be perfectly elastic and without mass.

Given data:

Tension in tight side $T_1 = 2000N$

Coefficient of friction $\mu = 0.3$

Angle of contact $\theta = 165°$

Velocity of belt $V = 18\frac{m}{s}$

To find:

Power 'P'

Soln:

Power $P = [T_2 - T_1] \times V$

$T_2 = 2000, V = 18\, {}^{m}/_{s}$ *given*

By Tension Ratio

$$\frac{T_2}{T_1} = e^{MQ}, \mu = 0.3$$

$\theta = 165°$

$\theta = 165° \times {}^{\pi}/_{180}$

$\theta = 2.87\ radian$

$$\frac{2000}{T_1} = e^{0.3\times2.87}$$

$$T_1 = \frac{2000}{e^{0.3\times2.87}} = \frac{2000}{e^{0.861}} = \frac{2000}{2.36}$$

$T_1 = 845.47\ N$

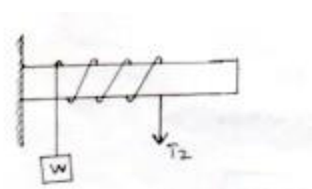
Power $P = [T_2 - T_1] \times V$

$P = [2000 - 845.47] \times 18$

$P = 20 \times 10^3 w$

Problem 2

A rope is wrapped three time around a rod shown in fig



Determine the force T required on the free end of the rope. To support a load of W= 20KN. Take μ *as* 0.3.

Given Data:

Weight w=20 KN $w = T_2$ $w = T_2$

$\mu = 0.3.$ $T_2 = T_1$ $T_1 = T$

To find:

Tension 'T'

Soln:

Tension Ratio

$$\frac{T_2}{T_1} = e^{MQ}$$

$$\theta = 3 \times {}^{\pi}/_{180} \times 360°$$

$$\theta = 18.84\, radian$$

$$\frac{T_2}{T_1} = e^{0.3 \times 18.84}$$

$$\frac{20}{\pi} = e^{0.3 \times 18.84}$$

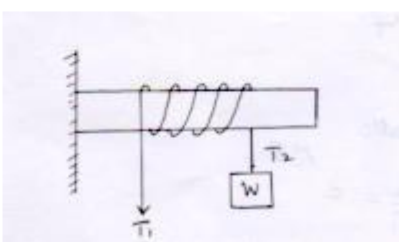
$$T_1 = \frac{20}{e^{0.3 \times 18.84}}$$

$$T_1 = 0.07\, KN$$

$$T = T_1 = 0.07\, KN$$

Problem 3

A wire rope is wrapped three and a half times around a cylinder as shown in below. Determine the force T_1 exerted on the free end of rope that is required to support a 1KN weight the coefficient of friction b/w the rope and the cylinder is 2.5



Given:

Coefficient of friction $\mu = 0.25$

No of turns=3.5

$T_2 = w = 1KN$

To find:

Force exerted T_1

Soln:

Tension ratio

Tension Ratio

$$\frac{T_2}{T_1} = e^{MQ}$$

$$\theta = 360 \times [\pi/_{180}] \times 3.5$$

$$\theta = 21.99\ radian$$

$$\frac{T_2}{T_1} = e^{0.25 \times 21.99}$$

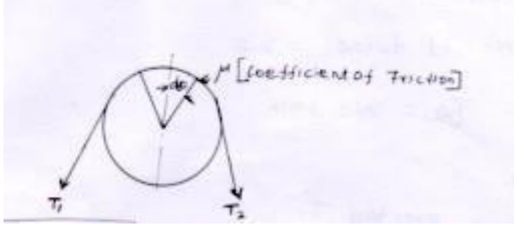
$$\frac{1}{T_1} = e^{0.25 \times 21.99}$$

$$T_1 = \frac{1}{e^{0.25 \times 21.99}}$$

$$T_1 = 4.09 \times 10^3\ KN$$

$$T = T_1 = 4.09\ KN$$

Derive the ratio b/w the two belt tension forces



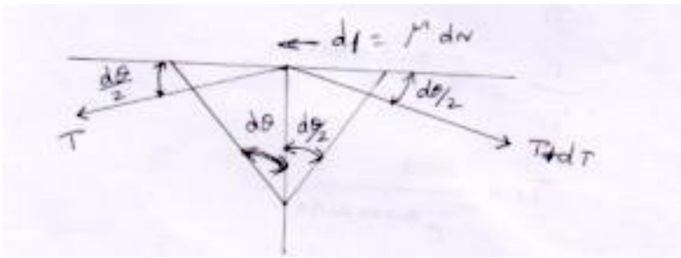
$$\frac{T_2}{T_1} = e^{M\theta}$$

T_1 = Tension in tight side

T_2 = Tension in slack side

θ = Angle of contact

μ = Coefficient of friction



$\Sigma F_X = 0$

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

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

$df = \mu dN$ &$\cos\frac{d\theta}{2} = 1$

$dT = -\mu dN = 0$

$dt = \mu dN$----------- (1)

$\Sigma F_Y = 0$

dN $+([T + dT])sin\frac{d\theta}{2} - Tsin\frac{d\theta}{2} = 0$

$dN - T\sin\frac{d\theta}{2} - dT\sin\frac{d\theta}{2} - Tsin\frac{d\theta}{2} = 0$

$dN = 2T\frac{d\theta}{2} - dT\ do = 0$

$dN - Td\theta = 0$

$dN - Td\theta$-------- (2)

dN value sub in Eqn (1)

$dT = \mu dN$--------- (1)

$dT = \mu \times dN$

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

$\int_{T_1}^{T_2} \frac{dT}{T} = \int_0^{\theta} \mu d\theta$

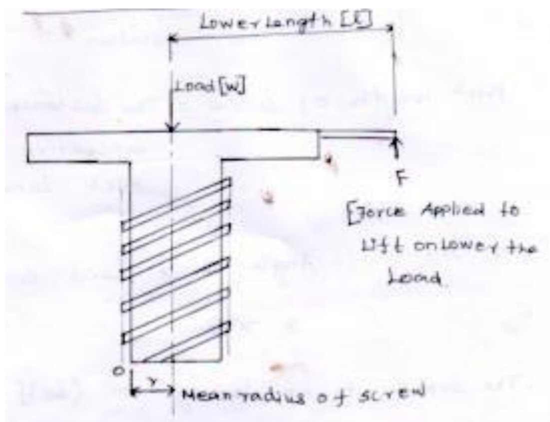
$[\log T]_{T_1}^{T2} = [\mu]_0$

$logT_2 - logT_1 = \mu\theta = log\frac{T_2}{T_1} = \mu\theta$

Flat for belt $\frac{T1}{T_2} = e^{\mu\theta}$

$\frac{T_2}{T_1} = e^{\mu\theta \, cosec\frac{B}{2}}$

Screw friction



w=load active $w\ t[\theta + \emptyset]$

It is used to raise and lower the load

Ex, screw jack

Taking moment about the axis of the screw

$W\tan(\emptyset + \theta) \times r - F \times l = 0$

$W \times r \times \tan(\emptyset + \theta) = Fl$

Force applied to raise (or) Lower the load F

$$F = \frac{wrtan(\emptyset + \theta)}{l}$$

θ =Lead angle

$\emptyset$ =Friction angle

$\tan\emptyset = \mu$

$\theta = tan^{-1}(\mu)$

Lead of screw = the height lifted for one full from rotation

Pitch length of screw = The distance b/w the two connective thread head screw pitch length

If friction angle $\emptyset > lead\ angle\theta$

$$\emptyset > \theta$$

The screw is in locking or (self-locking) of the screw

$$\mu = \frac{tan\theta}{\tan(\emptyset + \theta)} \times 100$$

Mean radius $= r = \frac{pitch\ length}{2}$

$$r = \frac{dia\ meter}{2}$$

Problem: 1

A screw jack has a square thread of mean radius 5cm and pitch length of 1.5 cm. length of lever 50 cm. it is used to raise and lower the load of 25 KN. $\mu = 0.2$ find

(i) Force applied to raise the Load

(ii) Force applied to the lower the load

(iii) Threaded efficiency

Given

Load $w = 25KN = 25 \times 10^3 N$

Mean radius$r = 5\ cm$

Pith length= $1.5cm$

Length of lever (l) =50cm $\mu = 0.2$

Soln

(i) Force applied to raise the road

$$F = \frac{Wrtan[\emptyset + \theta]}{l}$$

$tan\emptyset = \mu$

$\emptyset = tan^{-1}(\mu)$

$\emptyset = tan^{-1}(0.2)$

$\theta = Lead\ angle$

$$tan\theta = \frac{1.5}{2 \times \pi \times 5}$$

$$\theta = tan^{-1} (\frac{1.5}{2 \times \pi \times 5})$$

$$\theta = 2°4'$$

$$F = \frac{25 \times 10^3 \times 5}{50} \tan [11°55' + 2°4']$$

$$F = 653.54\ N$$

(ii) Force applied to lower the load

$$F = \frac{wrtan(\emptyset - \theta)}{l}$$

$$F = \frac{25 \times 10^3 \times 5 \times \tan [11°55' - 2°4']}{50}$$

$$F = 0.104\ KN$$

(iii) Efficiency: η

$$\eta = \frac{tan\theta}{\tan (\theta + \emptyset)} \times 100$$

$$\eta = \frac{\tan 2°4'}{\tan (2°4' + 11°55')}$$

$$\eta = 36$$