• Brakes

Brakes are devices that decipate kinetic energy of moving part of machine.

In (ME) brake the decipation is achieve through sliding fric^n b/w a stationary object & a rotating part.

• Brakes

- Mechanical
  - Shoe/block brak
  - Band brack
  - Disc brack

  (Low power abso.)
- Electrical
- Hydrolic
- Pneumatic

(Electrical, Hydrolic, Pneumatic: High power absorbing)

→ Shoe brack: force applied radially

→ Band brack: force applied tangentially

→ Disc brack: force applied axially

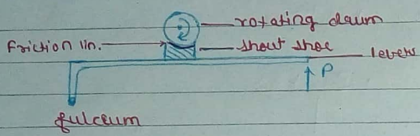
• Band brack

→ Simple band brake

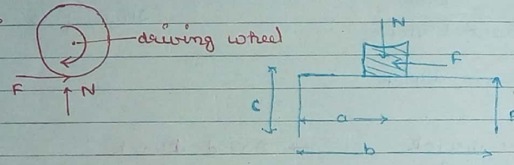
→ Differential band brake.

* Shoe / Block / Drum brake

→ In a shoe brake the rotating drum is brought in contact with the shoe by suitable force.
→ The contacting surface of the shoe is coated with fricⁿ material.



FBD ⇒



⇒ $\Sigma M = 0$

⇒ $Pb + Fc = Na$

⇒ $Pb = Na - Fc$ $\quad [F = \mu N]$

⇒ $P = \dfrac{Na - \mu Nc}{b}$

⇒ $\boxed{P = \dfrac{N(a - \mu c)}{b}}$

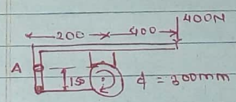
P → actuating force
Applied force
Bracking force

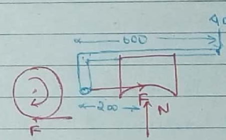
Case I $P = +ve \rightarrow a > \mu c \rightarrow$ desirable condition

** When the moment due to applied force (Pb) & moment due to friction force (Fc), both are acting in same direcⁿ that means friction force help to reduce the value of braking force this types of brake are known as self-energizing brakes

Case II : $P = 0 \rightarrow a = \mu c$ self locking
Case III : $P = -ve \rightarrow a < \mu c$ out of control

Q A block brake shown below has a face width of 300 mm & a mean cofficient of fricⁿ of 0.25 for can actuating force of 400N the braking torque.





taking mom about A,

⇒ $400 \times 600 = N \times 200$

⇒ $\boxed{N = 1200}$

→ $F = \mu N$
→ $F = 1200 \times 0.25$
→ $F = 300N$

→ $\boxed{BT = F \times r}$
→ $BT = 300 \times 150 \times 10^{-3}$
→ $BT = 45$ N-m

• Steps to solving numerical →

a) Observe the sense of rotation of drum.

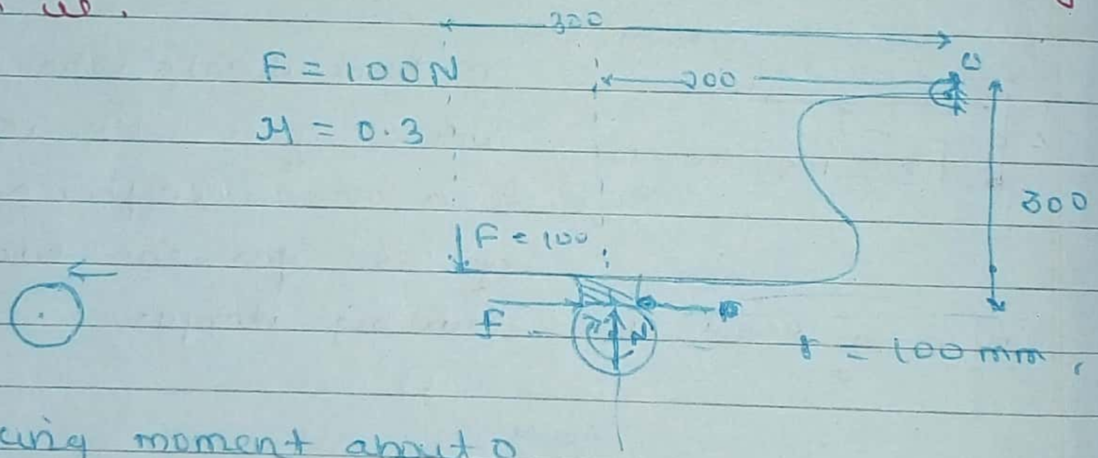
b) acc. to sense draw FBD.

c) calculating moment about the fulcrum.

Q A schematic of an external drum rotating cw engaging with a short shoe as shown fig the shoe is mounted at Y on a rigid lever XYZ hinged at point X. A force F = 100N is applied at the free end of the lever given that $\mu = 0.3$, the BT in Nm applied of drum is.

F = 100N

$\mu = 0.3$



Taking moment about O

$\Rightarrow F \times 300 + f \times 300 = N \times 200$

$\Rightarrow 100 \times 300 + 0.3 \times N \times 300 = N \times 200$

$\Rightarrow 30000 + 90N = 200N$

$\Rightarrow (200 - 90) N = 30000$

$\Rightarrow N = 272.72$

$\Rightarrow f = \mu \times N$

$\Rightarrow f = 0.3 \times 272.72$

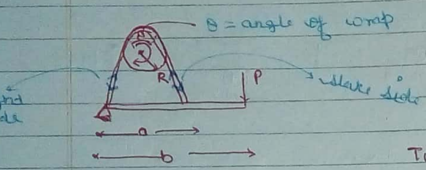
$\Rightarrow f = 81.81$

$\rightarrow BT = 81.81 \times 100 \times 10^{-3}$

$BT = 8.18$ N-m

* Simple band brake

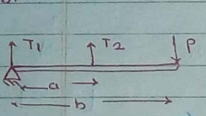
When one end of the band passes through the fulcrum of lever than it's known as simple band brake.



$$\therefore \boxed{\frac{T_1}{T_2} = e^{\mu\theta}}$$

T_1 = tension on tight side
T_2 = tension on slake side
μ = coefficient of fricn
θ = angle of wrap
$e^{\mu\theta} \rightarrow$ radian

FBD

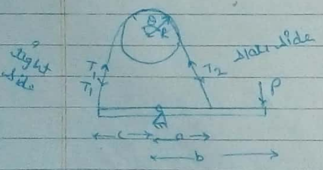


$\Rightarrow Pb + T_1 \times 0 = T_2 a$

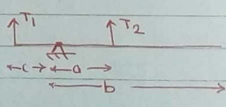
$\Rightarrow \boxed{P = \frac{T_2 a}{b}}$

* Braking torque $\Rightarrow \boxed{T_F = (T_1 - T_2)R}$ — radius of drum

** Differential bank brake



$\Rightarrow$



$\Rightarrow \Sigma M = 0$

$\Rightarrow T_1 c + Pb = T_2 a$

$\Rightarrow P = \frac{T_2 a - T_1 c}{b}$

$\Rightarrow P = \frac{T_2}{b}\left[a - \frac{T_1}{T_2}c\right]$

$\Rightarrow P = \frac{T_2}{b}\left[a - e^{\mu\theta}c\right] \rightarrow \frac{T_1}{T_2} = e^{\mu\theta}$

$\rightarrow T_F = (T_1 - T_2)R$.

* For self locking $[a = e^{\mu\theta}c]$
$P \rightarrow 0$

When neither of the band brake passes to the fulcrum of lever then it is known as differential band brake.

Q. In a band brake the ratio of tight side band tension to the tension on slake side is 3, if the angle of overlap of band on drum is 180°, the coefficient of fricn b/w bank & drum is

$\Rightarrow \frac{T_1}{T_2} = e^{\mu \times \theta}$

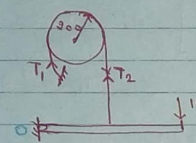
$\Rightarrow 3 = e^{180° \times \mu}$

$\Rightarrow \ln 3 = 180° \times \mu$

$\Rightarrow \ln 3 = 180° \times \frac{\pi}{180} \times \mu$

$\Rightarrow \mu = \frac{\ln 3}{\pi} = 0.349 \approx 0.35$.

Q A band brake consists of a lever attached to one end of the band. The other end of the band is fixed to ground the wheel has a radius of 200 mm & a wrap of angle of band is 270°. The bracking force applied to lever is limitted to 100N, & $\mu = 0.5$.



$$\frac{T_1}{T_2} = e^{0.5 \times 4.71}$$

$$\frac{T_1}{T_2} = 10.550$$

$T_2 = 200$

a) The max tension that can be generated during bracking is?

b) The max wheel torque that can be complely brake is,

$\Sigma M = 0$ about O

$\Rightarrow T_2 \times 1 = 100 \times 2$

$\Rightarrow T_2 = 200$ N

$\Rightarrow T_1 = 200 \times 10.550$

$\Rightarrow T_1 = 2110$ N, $\longrightarrow$ a

$\Rightarrow BT = (2110 - 200)\, 200$

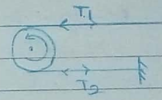
$\Rightarrow BT = 382$ N-m $\longrightarrow$ b

Q Force of 400N is applied to the brake drum of 0.5m diameter in a band brake sys as shown in fig when $\theta = 180°$. if $\mu = 0.25$ the BT applied in N-m is,

$$\Rightarrow \frac{T_1}{T_2} = e^{180 \times \frac{\pi}{180} \times 0.25}$$

$$\Rightarrow \frac{T_1}{T_2} = 2.193$$

$$\longrightarrow \boxed{T_1 = 2.193\, T_2}$$



$\Rightarrow T_1 = 400$

$\Rightarrow T_2 = 182.39$

$BT = (T_1 - T_2)\, r$

$BT = (400 - 182.39) \times \frac{0.25}{2}$

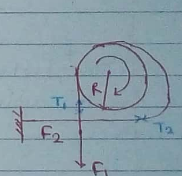
$\boxed{BT = 54.40 \text{ Nm}}$

Q The forces F_1 & F_2 in a brake band & the dir^n of drum are shown in fig the μ is 0.25 & $\theta = \frac{3\pi}{2}$ radian it is given the $r = 1$ m & $F_2 = 1$N the torque in N-m is?

$$\Rightarrow \frac{T_1}{T_2} = e^{\mu\theta}$$

$$\Rightarrow \frac{T_1}{T_2} = e^{\frac{3\pi}{2} \times 0.25}$$

$$\Rightarrow \frac{T_1}{T_2} = 3.24818$$



$\Rightarrow T_1 = F_1 \quad \rightarrow T_2 = 1$ N

$\Rightarrow T_2 = F_2 \quad \rightarrow T_1 = 3.0242818$

$\rightarrow BT = (T_1 - T_2)\, r$

$\rightarrow BT = (3.2428 - 1)\, 1$

$\rightarrow BT =$

• Short - NOTE

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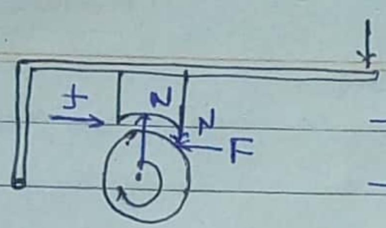

→ $F = \mu N$

→ $P = +ve$ (desirable) $a > \mu c$

→ $P = 0$ (self locking) $a = \mu c$

→ $P = -ve$ (out of control) $a < \mu c$

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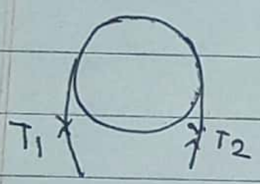

$$\frac{T_1}{T_2} = e^{\mu \theta}$$

$$BT = (T_1 - T_2) R$$

BT → bracking torque