Ashwani kr. Chaudhary
ACE077 BCT 020

PAGE NO.:
DATE: / /

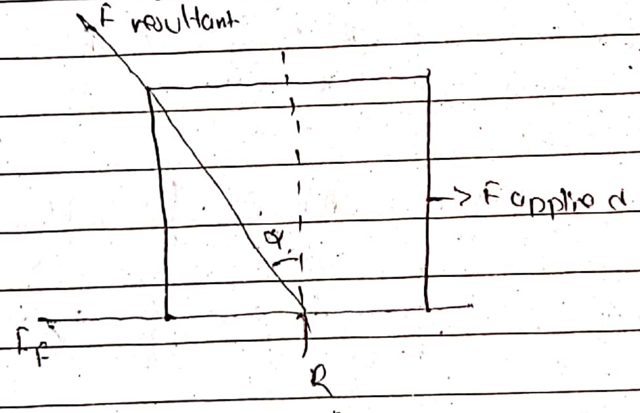
Q.1.

Limiting Friction

The maximum value of frictional force which acts on the body when its just starts to slide over another body is termed as limiting friction

Angle of Friction

An Angle made by resultant of normal reaction & friction force with normal reaction



Co-efficient of static friction.

The ratio of limiting friction to normal reaction

$$\mu_s = \frac{F_s}{R}$$

Dynamic friction

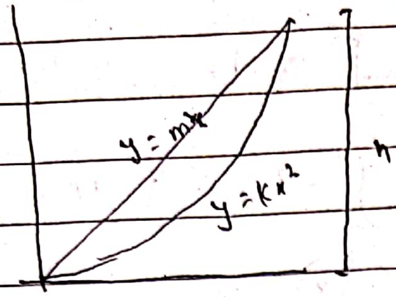
The ratio of force of kinetic friction to normal reaction is called dynamic friction

$$\mu_d = \frac{F_d}{R}$$

Ashwani kr. Choudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

Q.2.



$y_1 = mx$ ——— (1)
$y_2 = kx^2$ ——— (2)

At point (a, h)

$h = ma$

$m = \frac{h}{a}$

$\therefore y_1 = \frac{h}{a} x$

$h = ka^2$

$\therefore k = \frac{h}{a^2}$

$\therefore y_2 = \frac{h}{a^2} x^2$

Now,

Area bounded by the curve is

$$A = \int_0^a dA = \int_0^a (y_1 - y_2)\, dx = \int_0^a \left(\frac{h}{a} x - \frac{h}{a^2} x^2 \right) dx$$

$$= \left| \frac{h}{a} \cdot \frac{x^2}{2} - \frac{h}{a^2} \cdot \frac{x^3}{3} \right|_0^a$$

$$= \frac{ah}{2} - \frac{ah}{3}$$

$$= \frac{3ah - 2ah}{6}$$

$$= \frac{ah}{6} \text{ sq. unit}$$

Ashwani kr. Chaudhary
ACE 077 BCE 020

PAGE NO.:
DATE: / /

Now

First MOI about Y-axis $= \int_0^a x \cdot dA$

$= \int_0^a x(y_1 - y_2)\, dA$

$= \int_0^a x\left[\frac{hx}{a} - \frac{hx^2}{a^2}\right] dx$

$= \int_0^a \left(\frac{hx^2}{a} - \frac{hx^3}{a^2}\right) dx$

$= \left[\frac{h}{a}\cdot\frac{x^3}{3} - \frac{h}{a^2}\cdot\frac{x^4}{4}\right]_0^a$

$= \frac{a^2h}{3} - \frac{a^2h}{4}$

$= \frac{a^2h}{12}$

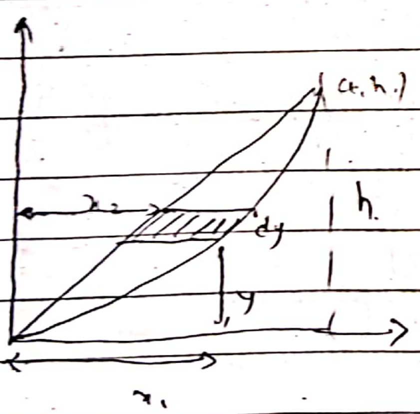
Radius of gyration $(k_y) = \sqrt{\frac{I_y}{A}}$

$= \sqrt{\frac{\frac{1}{20}ha^3}{1/6\, ha}}$

$= a\sqrt{\frac{3}{10}}\, m$.

Centroid

Now $(\bar{x}) = \frac{1}{A}\int_0^a x_c\, dA = \frac{6}{ah} \times \frac{a^2h}{12} = \frac{a}{2}$.



$y_c = y$

$dA = (x_1 - x_2)\, dy$

Now First MOI about X-axis $= \int_0^h y_c\, dA$

$= \int_0^h y(x_1 - x_2)\, dy$

Ashwani Kr. Chaudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

$$= \int_0^h y\left(\frac{y^{1/2}}{k^{1/2}} - \frac{y}{m}\right)dy$$

$$= \int_0^h y\left(\frac{y^{1/2}}{\frac{h^{3/2}}{a^1 \, x^{1/2}}} - \frac{y}{\frac{x}{a}}\right)dy$$

$$= \int_0^h y\left(\frac{a}{h} y^{1/2} - \frac{a \times y}{h}\right)dy$$

$$= \int_0^h \left(\frac{a^{3/2}}{h^{1/2}} - \frac{a y^2}{h}\right) dy$$

$$= \frac{2}{5}\frac{a}{h^{1/2}} h^{5/2} - \frac{a}{h}\frac{h^3}{3}$$

$$= \cancel{y}\frac{1}{15} a h^2$$

Centroid's $(\bar{y}) = \frac{1}{A}\int_0^h y_c \, dA$

$$= \frac{6}{\cancel{ah}} \times \frac{1}{15} a h^2$$

$$= \frac{2h}{5}$$

So, $(\bar{x}, \bar{y}) = \left(\frac{a}{2}, \frac{2h}{5}\right)$.

radius of gyration (k_x)

$$= \sqrt{\frac{I_x}{A}}$$

$$= \sqrt{\frac{ab^3}{28} \times \frac{6}{ha}}$$

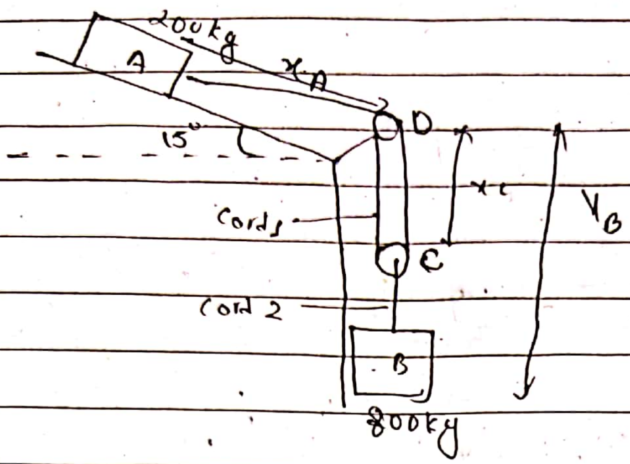
$$= \sqrt{\frac{3}{14}} \, h \text{ m}$$

Scanned with CamScanner

Ashwani kr. Chaudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

Q.N.3)



~~Let the tension in the~~

$x_A \rightarrow$ position of block A
$x_B \rightarrow$ position of block B
$x_c \rightarrow$ position of block C

$$x_c + k = x_B$$
$$x_B = x_c$$

A D C O is a continous cord

$$AD + DC + CO = K$$
$$x_A + 2x_c = k$$
$$x_A + 2x_B = k$$
$$V_A = -2V_B \quad \& \quad a_A = -2a_B$$

Block A:

$$\Sigma F_x = ma$$
$$T_1 + m_A g \cdot \sin 15 - f_A = m_A a_A$$
$$T_1 + 507.8 - \mu_k R_A = 200 a_A$$

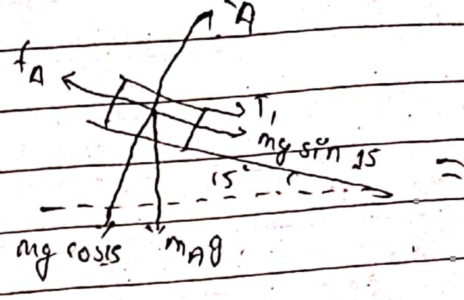
Ashwani kr. Chaudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

$T_1 + 507.8 - 0.2 m_A g \cos 15 = 200 a_A$

$T_1 + 507.8 - 387.37 = 200 a_A$

$T_1 - 200 a_A - \cancel{} 121.42 = 0$ — (i)

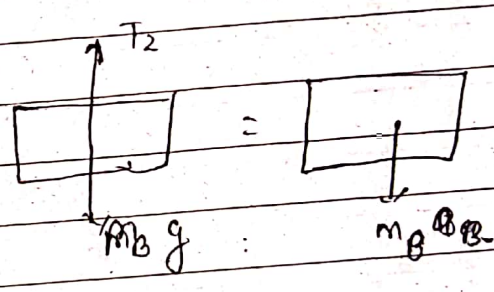


Block B.

$\Sigma F_y = ma$

$m_B g - T_2 = m_B \cdot a_B$

$7848 - T_2 = 800 a_B$ — (ii)



Pully C

$T_2 = 2T_1$ — (iii)

we $a_A = 2a_B$ & $T_2 = 2T_1$ in eq i)

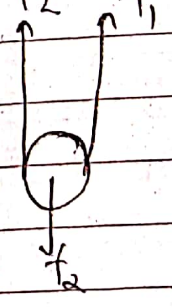
$\frac{T_2}{2} - 200(2a_B) - 121.42 = 0$

$T_2 - 800 a_B - 243.01 = 0$ — iv)

from Eq (ii) & eq (iv)

$T_2 - 800 a_B - 243.01 = 0$

$-T_2 - 800 a_B + 7848 = 0$



$-1600 a_B = -7604.98$

$a_B = .475 \ m/s^2 (\downarrow)$

$a_A = 9.58 \ m/s^2$

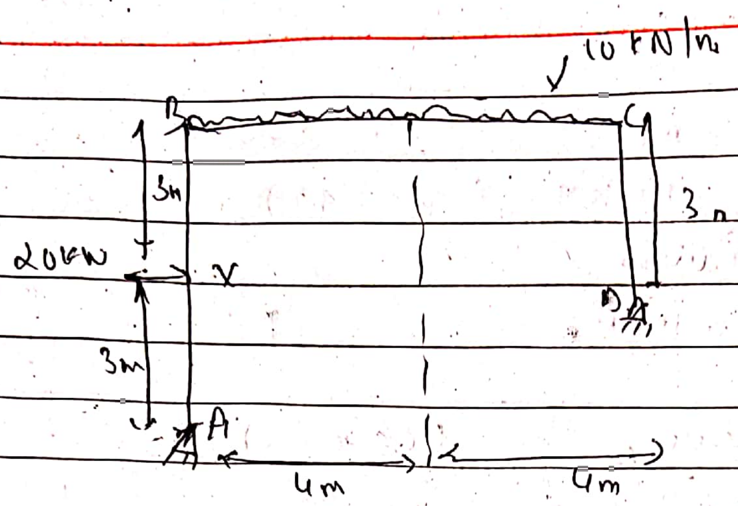
$T_1 = 1794.58 \ N$

$T_2 = 3589.16 \ N$ #

Ashwani kr. Chaudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

Q.5)



$\Sigma F_x = 0$

$A_x + D_x + 20 = 0$

$A_x + D_x = -20$ — (ii)

$\Sigma F_y = 0$

$A_y + D_y - 80 = 0$

$A_y + D_y = 80$ — (i)

$\Sigma M_x = (\curvearrowleft +ve)$

$20 \times 3 + 80 \times 4 - 8D_y + D_y * 3 = 0$

$380 - 8D_y + 3D_x = 0$

$3D_x + D_y = -380$ — (iii)

again

$A_x = -20 + 24.44$

$= 4.44$ kN

$\Sigma M_y = 0$ (Due to internal hinge)

$10 \times 4 \times 4/2 - D_x \times 3 - D_y \times 4 = 0$

$3D_x + 4D_y = 8$ — (iv)

$A_y = 80 - 38.33$

$= 41.67$ kN

~~Solving eqn (3) & (4) we get~~

$D_x = -24.44$ kN

$D_y = 38.33$ kN

Ashwani kr. Chaudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

taking setion AX

$V_x = -4.44$ kN $(0 \le x \le 3)$

$V_A = -4.44$ kN

$V_{xL} = -4.44$ kN

$M_x = -4.44x$ $(0 \le x < 3)$

$M_a = 0$

$M_{xL} = -4.43 \times 3 = -13.32$

section XB

$V_x = -4.44 - 20$

$= -24.44$

$V_{xR} = -24.44$ kN

$V_{BL} = -24.44$ kN

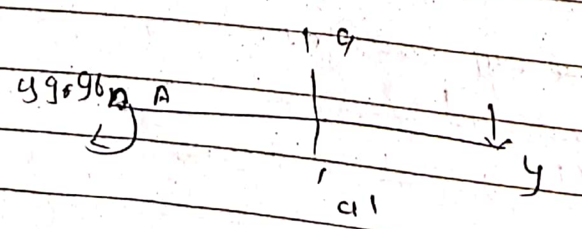
$M_x = -4.44x - 13.32 - 24.44x$

$= 13.32 - 28.88x$

$M_{x,R} = -13.32$ KNm

$M_{B,L} = -99.96$ KNm

BC Section By due to hing



Ashwani kr. choudhary
ACE077 BCT 020.

PAGE NO.:
DATE: / /

$V_x = 41.67 - 10x \quad (0 \leq x < 4)$

$V_{BR} = 41.67$ kN

$V_{YL} = 41.67 - 10 \times 4 = 1.67$ kN $(x = 4)$

$M_x = 41.67x - 10x \times x/2$

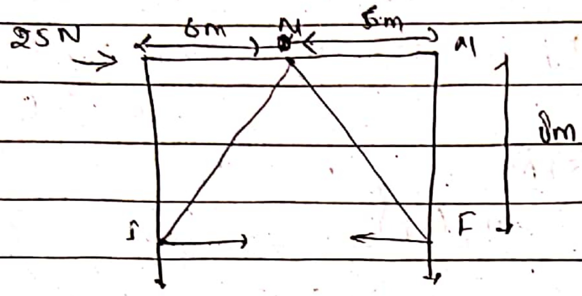
$M_{BR} = 0$

$M_{YL} = 41.67 \times 4 - 10 \times 4 \times 4/2$
$= 86.68$ kNm.

Ashwani kr. Chaudhary
ACE 077 BCT 020

PAGE NO.:
DATE: / /

Q. 4) Here
cutting the tower through FI, IK Q, KH in such a way that.



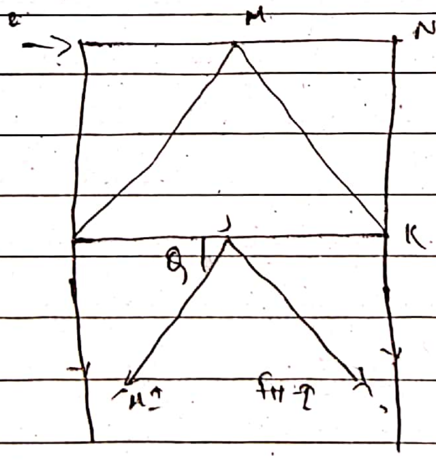
$\Sigma M_I = 0$ (+ve in ↺ direction)

$-25 \times 8 - F_{HK} \times 12 = 0$

$F_{HK} = -16.67$

$F_{HK} = 16.67\ KN\ (\downarrow)$

again,
cutting the tower horizontally through FI, Q, HI,



we

$\tan\theta = \frac{8}{6}$

$\theta = \tan^{-1}(4/3)$

$= 53.13^{\circ}$

Ashwani kr. Chaudhary
ACE 077 BCT 020

so, Resolved component of F_{HI} will be $F_{HI} \cos 53.13°$
& $F_{HI} \sin 53.13$

Now,
$\Sigma M_I = 0$ (+ve in ↺ direction)
$\Rightarrow -25\times16 + 80\times8 + 10.67\times12 - F_{HJ}\cos 53.13\times8 - F_{HJ}\sin 53.13\times6 = 0$

$\Rightarrow F_{HJ} = -62.5 kN$
$\therefore F_{HJ} = 62.5 kN$ (C)

Again,
$\Sigma F_x = 0$ (+ve in → direction)
$\Rightarrow 25 + 50 - F_{HJ}\cos 53.13° - F_{EJ}\cos 53.13 = 0$
$\Rightarrow 25 + 50 - 62.5\times\cos 53.13 - F_{HJ}\cos 53.13 = 0$
$\therefore F_{HJ} = 62.5 kN.$