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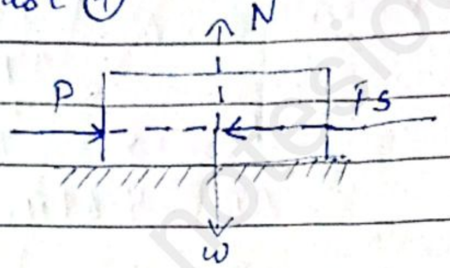
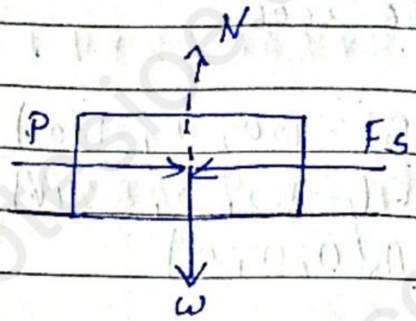
Friction

case ①



$P < F_s$

case ②



$P = F_s$

~~Or~~ impending motion

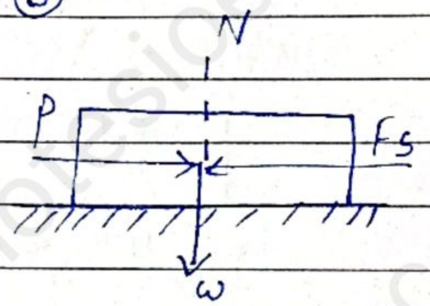
During impending motion,

$P - F_s = 0$

or, $P - \mu_s N = 0$

$\therefore \mu_s = \frac{P}{N}$ — ①

case ③



$P > F_s$ [when body starts to move]

F_K, μ_K

$P - F_K = Ma$

$P - \mu_K N = Ma$

$\frac{P - Ma}{N} = \mu_K$

$\therefore \mu_K = \frac{P - Ma}{N}$

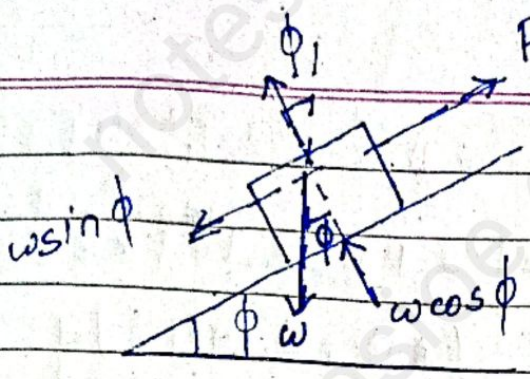
Thus, $\mu_s > \mu_K$

$F_s \propto N$

$F_s = \mu_s N$

$\therefore \mu_s = \frac{F_s}{N}$

[यो गाह्रो case ② र cas ③ लाई लयेर गर्नौ

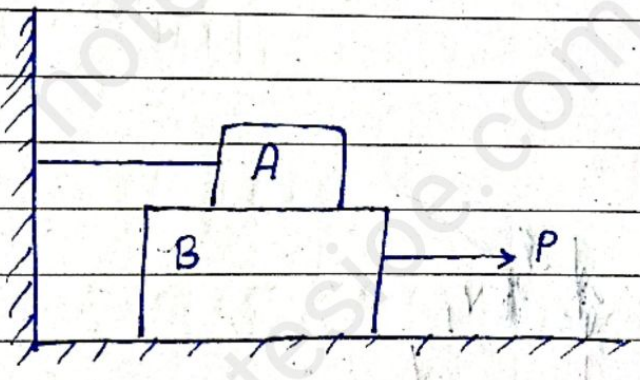


$F_s = w\sin\phi$

$\mu_s N = w\cos\phi\sin\phi$

$\mu_s \cdot w\cos\phi = w\sin\phi$

$\boxed{\mu_s = \tan\phi}$ angle of repose.



wt. of block A = 1000N

wt. of block B = 2000N

$\mu_{A/B} = 0.25$

$\mu_{B/f} = 1/3$

A block 'A' weighing 1000N rests over block 'B' which weighs 2000N as shown. Block 'A' is tied to wall with horizontal string. If coeff of friction bet^n A & B is 0.25 & coeff of friction bet^n B & floor is 1/3. what should be value of P to move block B if

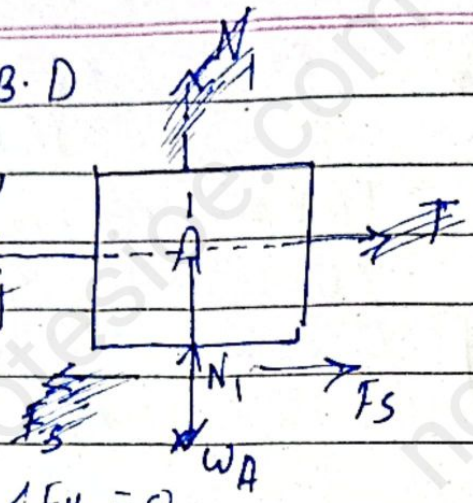
a) if P is horizontal.

b) P acts at 30° upward to horizontal.

a) when P acts as horizontal.

Sol?

F.B.D of A,



$\Sigma F_y = 0$

$N_1 = 1000N$

$\Sigma F_x = 0$

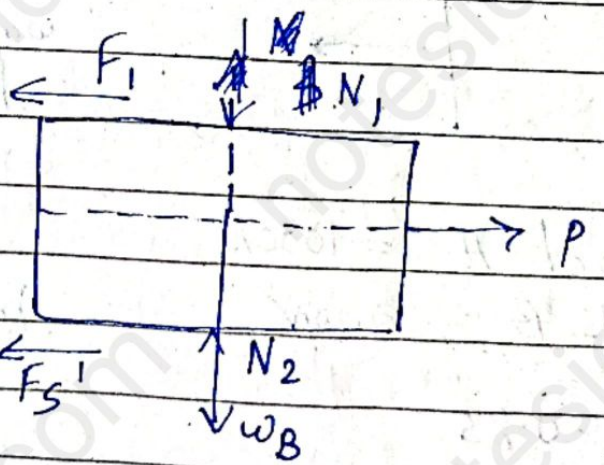
$T = F_s$

$= \mu_{A/B} \cdot N_1$

$= 0.25 \times 1000$

$= 250N.$

F.B.D of B,



$\Sigma F_y = 0$

or, $N_1 + \omega_B - N_2 = 0$

or, $1000 + 2000 - N_2 = 0$

$\therefore N_2 = 3000N$

$\Sigma F_x = 0$

or, $P = F_1 + F_s'$

or, $P = \cancel{1000 +} 250 + 3000 \times \frac{1}{3}$

$P = 1250N$

b) F.B.D

$\Sigma F_y = 0$

$\therefore N_1 = 1000N$

$\Sigma F_x = 0$

or, $T = F_s$

$= 250N$.

$\Sigma F_y = 0$

or, $N_1 + \omega_B - N_2 - P\sin 30 = 0$

or, $1000 + 2000 - N_2 - \frac{1}{2}P = 0$.

$\Sigma F_x = 0$

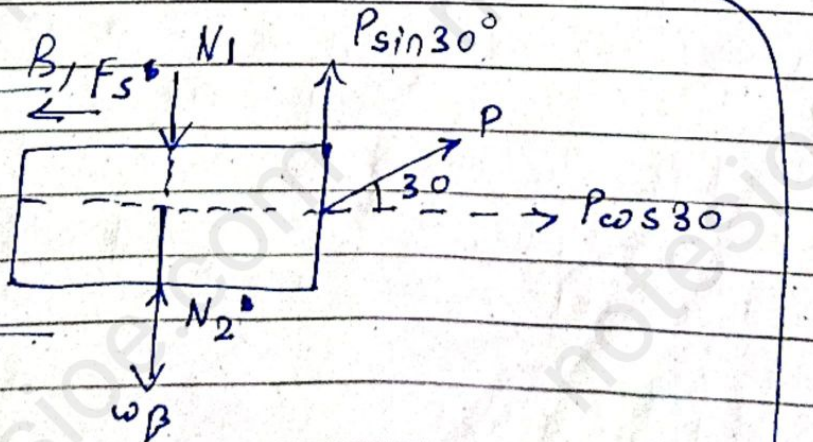
or, $P\cos 30 - 250 - \frac{1}{3} \times N_2 = 0$

$\therefore \cancel{N_2 = 1210.4N}$

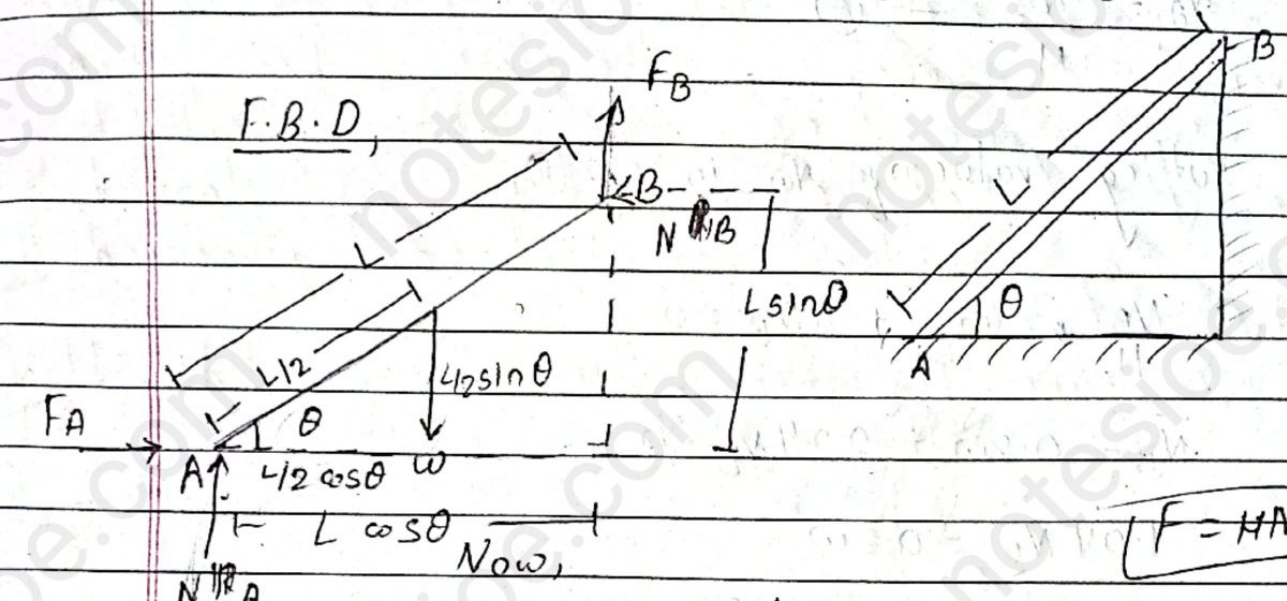
$\cancel{P = P = 1210.4N}$

$N_2 = 2394.78N$

FBD of B, F_s



Determine min. angle 'θ' at which a uniform ladder can be placed against a wall without slippage under its own weight coeff of friction of all surface = 0.2.



F.B.D,

$F = \mu N$

Now,

$\Sigma F_x = 0 \; (\rightarrow +ve)$

$F_A - R_B = 0$

$\mu N_A - N_B = 0 \quad -(I)$

$\Sigma F_y = 0 \; (\uparrow +)$

$N_A - W + F_B = 0$

or, $N_A - W + \mu N_B = 0 \quad -(II)$

$(\curvearrowright +) \; \Sigma M_A = 0$

or, $W \times \frac{L}{2} \cos\theta - N_B \times L \sin\theta - F_B \times L \cos\theta = 0 \quad -(III)$

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Now,

From eqn (I),

$$N_A = \frac{N_B}{M} \quad - (A)$$

Putting value of N_A in eqn (II),

$$\frac{N_B}{M} + -\omega + HN_B = 0$$

$$N_B - 0.2\omega + 0.04N_B = 0$$

$$1.04N_B = 0.2\omega$$

$$\therefore \omega = 5.2N_B \quad - (B)$$

Putting value of B. in eqn (III),

$$\text{or, } 5.2N_B \times \frac{L}{2}\cos\theta - N_B \times L\sin\theta - 0.2N_B \times L\cos\theta = 0$$

$$\text{or, } N_B \left| 2.6L\cos\theta - L\sin\theta - 0.2L\cos\theta \right| = 0$$

$$\text{or, } 2.4L\cos\theta - L\sin\theta = 0$$

$$\text{or, } 2.4\cos\theta - \sin\theta = 0$$

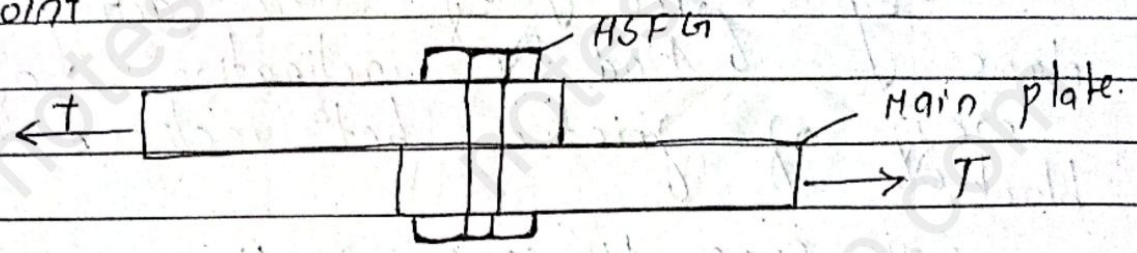
$$\text{or, } 2.4 = \tan\theta$$

$$\therefore \theta = 67.38^\circ \text{ //}$$

High strength frictional grip/bolt: (HSFG)

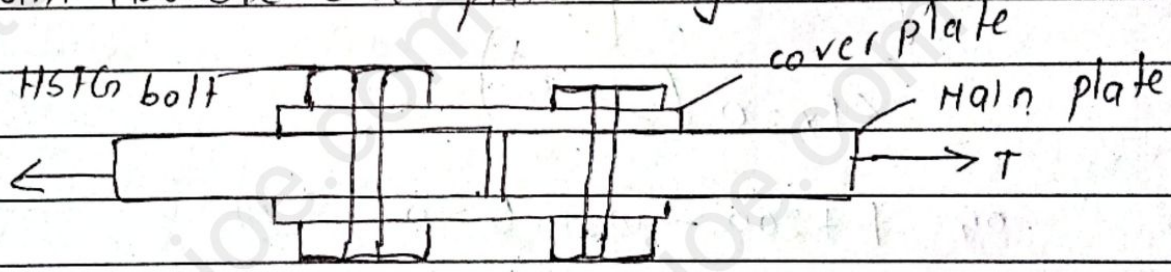
using of HSFG bolt in member connection:

(i) Lap joint



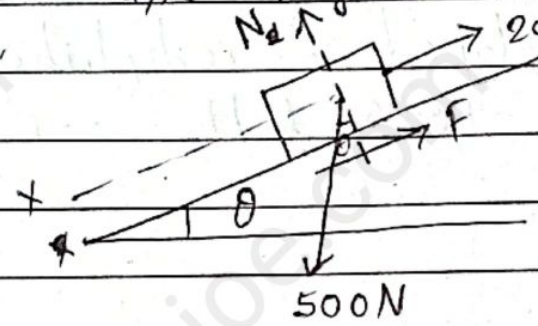
→ Friction force is developed in rediptributed in the member through HSFG bolt

(ii) Butt joint. (Double cover plate butt joint):



A block of weight 500N just starts moving down on rough inclined plane when supported by a force of 200N acting parallel to plane in upward direction. The same block is on the verge of moving up the plane when pulled by force of 300N acting parallel to plane. Find the inclination of plane & coeff of friction betn inclined plane and the block.

Sol: Case 1: when 200N force is acted on block



Using ~~static~~ equilibrium,

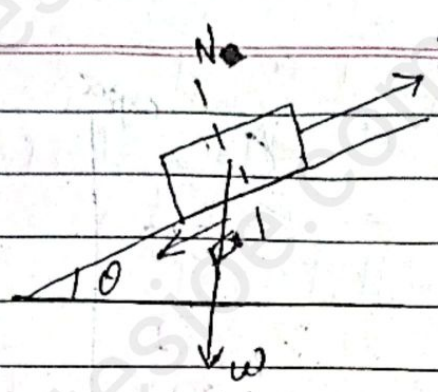
$$\Sigma F_x = 0 \quad (\nearrow +)$$

or, $F + 200 - w \sin\theta = 0 \quad -(1)$

$$\Sigma F_y = 0 \quad (\uparrow +)$$

or, $-w\cos\theta + N_1 = 0$

Case 2: when 300N force is applied,



$\Sigma F_x = 0 \quad (\rightarrow +)$

or, $300 - w\sin\theta - F' = 0 \quad -(iii)$

$\Sigma F_y = 0 \quad (\uparrow +)$

or, $-w\cos\theta + N = 0$

$\therefore N = w\cos\theta \quad -(iv)$

~~From eq° (i) & (iii),~~

~~$F + 200 + 300 = F$~~

Thus, $N = w\cos\theta$,

Now,

$300 - w\sin\theta - \mu w\cos\theta = 0 \quad -(v)$

Then, $300 - 500\sin 30 - \mu \times 500\cos 30 = 0$

or, $300 - 250 - \mu \times 433.01 = 0$

or, $\mu = \frac{50}{433.01}$

$= 0.11$