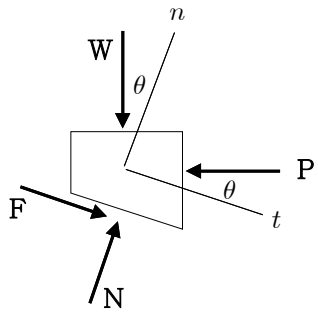
[8.1~8.2절]

8.1 θ = 25°, P = 150 N, W = 240 N

μ_s = 0.35, μ_k = 0.25

<방법1>



↗ΣF_n = 0 ; N − W cosθ − P sinθ = 0

⇒ N = W cosθ + P sinθ

= (240 N) cos25° + (150 N) sin25° = 280.9 N

$F_{\max}$ = $\mu_s N$ = (0.35) (280.9 N) = 98.32 N

↘ΣF_t = 0 ; F + W sinθ − P cosθ = 0

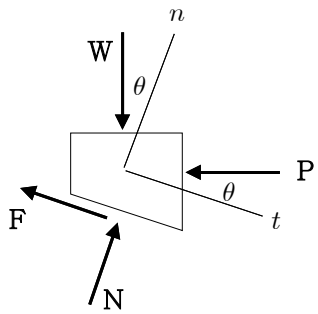
⇒ F = − W sinθ + P cosθ

= −(240 N) sin25° + (150 N) cos25° = 34.52 N

$|F|$ < $F_{\max}$ ⇒ 가능 ⇒ 평형상태.

F > 0 ⇒ 마찰력 방향 맞음 ⇒ F = 34.5 N ↘25.0°

<방법2>



↗ΣF_n = 0 ; N − W cosθ − P sinθ = 0

⇒ N = W cosθ + P sinθ

= (240 N) cos25° + (150 N) sin25° = 280.9 N

$F_{\max}$ = $\mu_s N$ = (0.35) (280.9 N) = 98.32 N

↘ΣF_t = 0 ; −F + W sinθ − P cosθ = 0

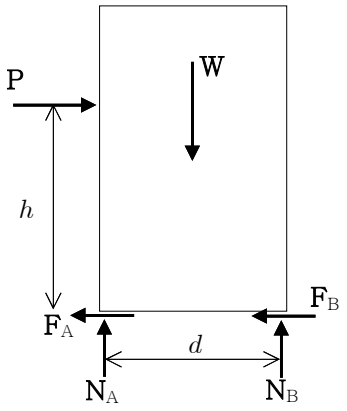
⇒ F = W sinθ − P cosθ

= (240 N) sin25° − (150 N) cos25° = −34.52 N

$|F|$ < $F_{\max}$ ⇒ 가능 ⇒ 평형상태.

F < 0 ⇒ 마찰력 방향 반대 ⇒ F = 34.5 N ↘25.0°

8.15 $W = 480$ N, $\mu_s = 0.30$, $d = 0.6$ m, $h = 0.8$ m



(a) $F_A = \mu_s N_A$, $F_B = \mu_s N_B$

$\uparrow \Sigma F_y = 0$; $N_A + N_B - W = 0$

$\Rightarrow N_A + N_B = W$

$\rightarrow \Sigma F_x = 0$; $P - F_A - F_B = 0$

$\Rightarrow P = F_A + F_B = \mu_s N_A + \mu_s N_B$

$= \mu_s (N_A + N_B) = \mu_s W$

$= (0.30)(480 \text{ N}) = 144.0 \text{ N}$

넘어지지 않는지 검토

$\circlearrowleft \Sigma M_B = 0$; $h P - \frac{d}{2} W + d N_A = 0$

$\Rightarrow N_A = -\frac{h}{d} P + \frac{1}{2} W = -\frac{0.8}{0.6}(144.0 \text{ N}) + \frac{1}{2}(480 \text{ N}) = 48.0 \text{ N} > 0$

∴ 넘어지지 않음

(b) $F_A = 0$, $F_B = \mu_s N_B$

$\circlearrowleft \Sigma M_A = 0$; $h P + \frac{d}{2} W - d N_B = 0$ $\Rightarrow N_B = \frac{h}{d} P + \frac{1}{2} W$

$\rightarrow \Sigma F_x = 0$; $P - F_B = 0$

$\Rightarrow P - \mu_s N_B = P - \mu_s (\frac{h}{d} P + \frac{1}{2} W) = 0$

$\Rightarrow (1 - \mu_s \frac{h}{d}) P = \frac{1}{2} \mu_s W$

$\Rightarrow P = \frac{\mu_s}{2(1 - \mu_s \frac{h}{d})} W = \frac{0.3}{2[1 - (0.3)\frac{0.8}{0.6}]}(480 \text{ N}) = 120.0 \text{ N}$

넘어지지 않는지 검토

$\uparrow \Sigma F_y = 0$; $N_A + N_B - W = 0$

$\Rightarrow N_A = W - N_B = W - (\frac{h}{d} P + \frac{1}{2} W) = \frac{1}{2} W - \frac{h}{d} P$

$= \frac{1}{2}(480 \text{ N}) - \frac{0.8}{0.6}(120 \text{ N}) = 80 \text{ N} > 0$ ∴ 넘어지지 않음

(c) $F_A = \mu_s N_A$, $F_B = 0$

$\circlearrowleft \Sigma M_B = 0$; $h P - \frac{d}{2} W + d N_A = 0$ $\Rightarrow N_A = -\frac{h}{d} P + \frac{1}{2} W$

$\rightarrow \Sigma F_x = 0$; $P - F_A = 0$

$\Rightarrow P - \mu_s N_A = P - \mu_s (-\frac{h}{d} P + \frac{1}{2} W) = 0$

$\Rightarrow (1 + \mu_s \frac{h}{d}) P = \frac{1}{2} \mu_s W$

$\Rightarrow P = \frac{\mu_s}{2(1 + \mu_s \frac{h}{d})} W = \frac{0.3}{2[1 + (0.3)\frac{0.8}{0.6}]}(480 \text{ N}) = 51.4 \text{ N}$

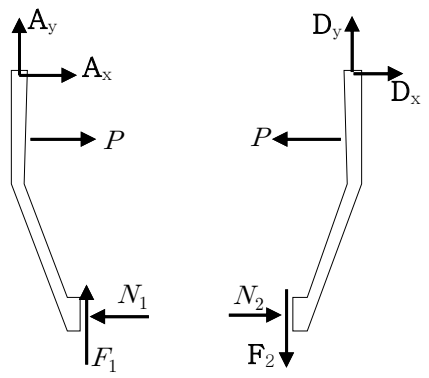
넘어지지 않는지 검토

$N_A = -\frac{h}{d} P + \frac{1}{2} W = -\frac{0.8}{0.6}(120 \text{ N}) + \frac{1}{2}(480 \text{ N}) = 80 \text{ N} > 0$ ∴ 넘어지지 않음

8.20 $\mu_s = 0.40$, $\mu_k = 0.30$, $M = 100$ N·m

최소 P ⇒ 최대 마찰력

$F_1 = \mu_s N_1$, $F_2 = \mu_s N_2$



AB에서 $\circlearrowleft \Sigma M_A = 0$;

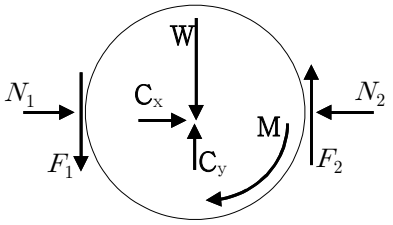
$$(0.150\ \text{m})\ P + (0.150\ \text{m})\ \mu_s N_1 - (0.450\ \text{m})\ N_1 = 0$$

$$\Rightarrow \quad N_1 = \frac{0.150\ \text{m}}{(0.450\ \text{m}) - (0.150\ \text{m})(0.40)} P = 0.3846\ P$$

DE에서 $\circlearrowleft \Sigma M_D = 0$;

$$-(0.150\ \text{m})\ P + (0.150\ \text{m})\ \mu_s N_2 + (0.450\ \text{m})\ N_2 = 0$$

$$\Rightarrow \quad N_2 = \frac{0.150\ \text{m}}{(0.450\ \text{m}) + (0.150\ \text{m})(0.40)} P = 0.2941\ P$$



드럼에서 $\circlearrowleft \Sigma M_C = 0$;

$$(0.250\ \text{m})\ (F_1 + F_2) - M = 0$$

$$\Rightarrow \quad (0.250\ \text{m})\ (\mu_s N_1 + \mu_s N_2) - M = 0$$

$$\Rightarrow \quad (0.250\ \text{m})\ \mu_s\ (0.3846 + 0.2941)\ P = M$$

$$\Rightarrow \quad P = \frac{100\ \text{N}\cdot\text{m}}{(0.250\ \text{m})(0.40)(0.3846+0.2941)} = 1473\ \text{N} = 1.473\ \text{kN}$$