{8.1~8.2절}

8.2 $\theta = 30°$, $P = 150$ N, $W = 1,200$ N

      $\mu_s = 0.35$, $\mu_k = 0.25$

<방법1>

$\nearrow \Sigma F_n = 0$; $N - W \cos\theta - P \sin\theta = 0$

    $\Rightarrow$ $N = W \cos\theta + P \sin\theta$

        $= (1,200 \text{ N}) \cos30° + (150 \text{ N}) \sin30°$

        $= 1114.2$ N

   $F_{\max} = \mu_s N = (0.35)(1114.2 \text{ N}) = 390.0$ N
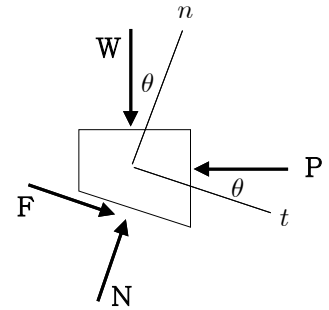
$\searrow \Sigma F_t = 0$; $F + W \sin\theta - P \cos\theta = 0$

    $\Rightarrow$ $F = - W \sin\theta + P \cos\theta$

      $= -(1,200 \text{ N}) \sin30° + (150 \text{ N}) \cos30° = -470.1$ N

$|F| > F_{\max}$ $\Rightarrow$ 불가능 $\Rightarrow$ 평형상태 아님.

$F < 0$ $\Rightarrow$ 마찰력 반대 방향 $\Rightarrow$ 미끄러져 내려감.

$F = \mu_k N = (0.25)(1114.2 \text{ N}) = 278.5$ N $\Rightarrow$ **F** $= 279$ N $\searrow 30.0°$

<방법2>

$\nearrow \Sigma F_n = 0$; $N - W \cos\theta - P \sin\theta = 0$

    $\Rightarrow$ $N = W \cos\theta + P \sin\theta$

        $= (1,200 \text{ N}) \cos30° + (150 \text{ N}) \sin30°$

        $= 1114.2$ N

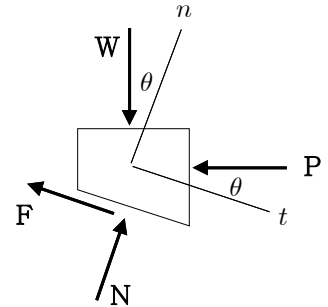 $F_{\max} = \mu_s N = (0.35)(1114.2 \text{ N}) = 390.0$ N

$\searrow \Sigma F_t = 0$; $-F + W \sin\theta - P \cos\theta = 0$

    $\Rightarrow$ $F = W \sin\theta - P \cos\theta$

      $= (1,200 \text{ N}) \sin30° - (150 \text{ N}) \cos30° = 470.1$ N

$|F| > F_{\max}$ $\Rightarrow$ 불가능 $\Rightarrow$ 평형상태 아님.

$F > 0$ $\Rightarrow$ 마찰력 반대 맞음 $\Rightarrow$ 미끄러져 내려감.

$F = \mu_k N = (0.25)(1114.2 \text{ N}) = 278.5$ N $\Rightarrow$ **F** $= 279$ N $\searrow 30.0°$

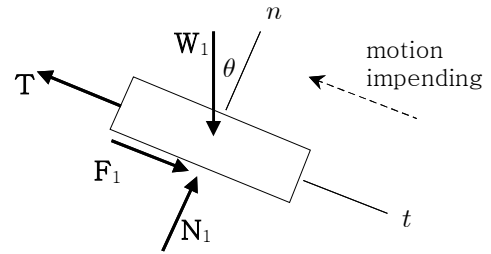8.12　　$W_1 = 20$ N,　$W_2 = 30$ N,　$\mu_s = 0.15$

블럭 A

　$\nearrow \Sigma F_n = 0$;　$N_1 - W_1 \cos\theta = 0$

　　　$\Rightarrow$　$N_1 = W_1 \cos\theta$

　　　$F_1 = \mu_s N_1 = \mu_s W_1 \cos\theta$

　$\searrow \Sigma F_t = 0$;　$T - W_1 \sin\theta - F_1 = 0$

　　　$\Rightarrow$　$T = W_1 \sin\theta + \mu_s W_1 \cos\theta$

블록 B

　$\nearrow \Sigma F_n = 0$;　$N_2 - N_1 - W_2 \cos\theta = 0$

　　　$\Rightarrow$　$N_2 = N_1 + W_2 \cos\theta$
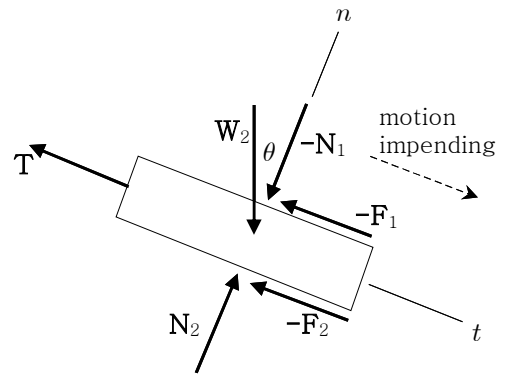
　　　　　$= W_1 \cos\theta + W_2 \cos\theta$

　$\searrow \Sigma F_t = 0$;　$T + F_1 + F_2 - W_2 \sin\theta = 0$

　　　$\Rightarrow$　$T = W_2 \sin\theta - F_1 - F_2$

　　　　　$= W_2 \sin\theta - \mu_s W_1 \cos\theta$

　　　　　$- \mu_s(W_1 + W_2) \cos\theta$

$W_1 \sin\theta + \mu_s W_1 \cos\theta = W_2 \sin\theta - \mu_s (2W_1 + W_2) \cos\theta$

$\Rightarrow (W_2 - W_1) \sin\theta = \mu_s (3W_1 + W_2) \cos\theta$

　　　$\Rightarrow$　$\tan\theta = \dfrac{\mu_s (3W_1 + W_2)}{W_2 - W_1} = \dfrac{(0.15)\left[3(20\text{ N}) + (30\text{ N})\right]}{(30\text{ N}) - (20\text{ N})} = 1.35$

　　　　$\Rightarrow$　$\theta = \tan^{-1}(1.35) = 53.47°$　$\Rightarrow$　　$\theta = 53.5°$

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

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

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

$\Rightarrow$　$N_A + N_B = W$

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

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

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

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

넘어지지 않는지 검토

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

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

$\therefore$ 넘어지지 않음

(b)　$F_A = 0$,　　$F_B = \mu_s N_B$

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

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

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

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

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

넘어지지 않는지 검토

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

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

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

(c) $F_A = \mu_s N_A$,　　$F_B = 0$

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

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

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

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

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

넘어지지 않는지 검토

$N_A = -\dfrac{h}{d} P + \dfrac{1}{2} W = -\dfrac{0.8}{0.6} (51.4 \text{ N}) + \dfrac{1}{2} (480 \text{ N}) = 171 \text{ N} > 0$

$\therefore$ 넘어지지 않음