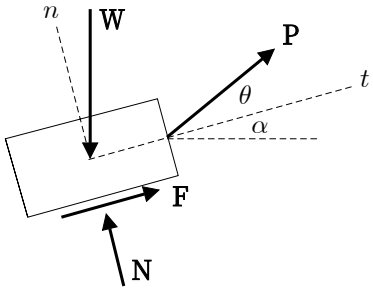
# 정 역 학　　연습문제 풀이　　제8장　　(2009년)

<8.1~8.2절>

8.3　$\theta = 20°$,　$\alpha = 20°$,　$m = 10$ kg,　$P = 40$ N,　$\mu_s = 0.30$,　$\mu_k = 0.25$

$W = m\,g = (10\text{ kg})(9.81\text{ m/s}^2) = 98.1$ N




$\nwarrow \Sigma F_n = 0$ ; $N - W\cos\alpha + P\sin\theta = 0$

$\Rightarrow$　$N = W\cos\alpha - P\sin\theta$

$= (98.1\text{ N})\cos 20° - (40\text{ N})\sin 20° = 78.50$ N

$F_{\max} = \mu_s N = (0.30)(78.50\text{ N}) = 23.55$ N

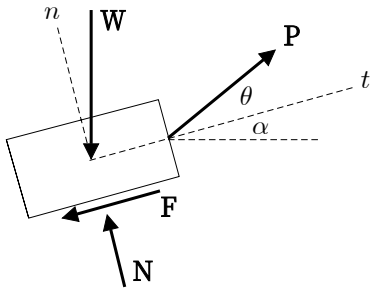
1) 마찰력이 오른쪽 위 방향이라면

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

$\Rightarrow$　$F = W\sin\alpha - P\cos\theta = (98.1\text{ N})\sin 20° - (40\text{ N})\cos 20° = -4.035\text{ N} < 0$

마찰력 $F$가 음수인 것은 마찰력 방향이 맞지 않다는 의미임.

2) 마찰력이 왼쪽 아래 방향




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

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

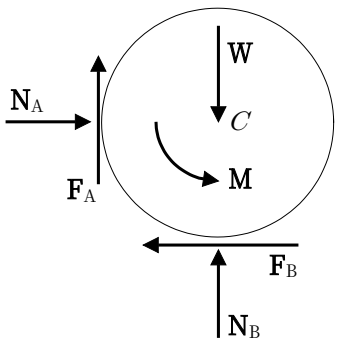
$= -(98.1\text{ N})\sin 20° + (40\text{ N})\cos 20°$

$= 4.035$ N

$F < F_{\max}$ 이므로 평형(equilibrium)상태임.

**F** = 4.04 N $\measuredangle 20°$

8.17 (a) $\mu_A = 0$,　$\mu_B = 0.36$,　$F_A = 0$,　$F_B = \mu_B N_B$




$\rightarrow \Sigma F_x = 0$ ;　$N_A - F_B = 0$　$\Rightarrow$　$N_A = F_B = \mu_B N_B$

$\uparrow \Sigma F_y = 0$ ;　$N_B - W = 0$　$\Rightarrow$　$N_B = W$

$\Rightarrow$　$F_B = \mu_B N_B = \mu_B W$

$\circlearrowleft \Sigma M_C = 0$ ;　$M - r\,F_B = 0$

$\Rightarrow$　$M = r\,F_B = r\,(\mu_B W) = 0.36\,r\,W$

(b) $\mu_A = 0.30$,　$\mu_B = 0.36$,　$F_A = \mu_A N_A$,　$F_B = \mu_B N_B$

$\rightarrow \Sigma F_x = 0$ ;　$N_A - F_B = 0$　$\Rightarrow$　$N_A = F_B = \mu_B N_B$

$\Rightarrow$　$F_A = \mu_A N_A = \mu_A \mu_B N_B$

$\uparrow \Sigma F_y = 0$ ;　$N_B + F_A - W = 0$　$\Rightarrow$　$N_B + \mu_A \mu_B N_B = W$

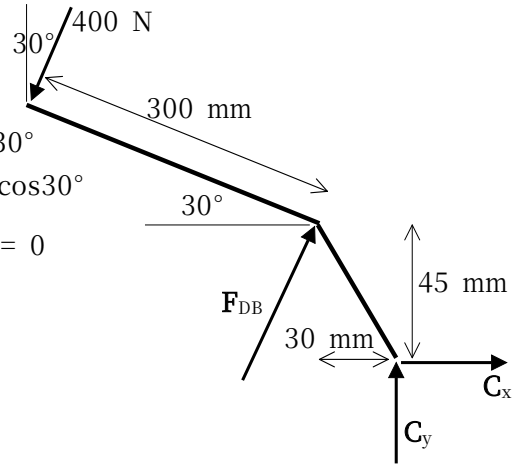
$\Rightarrow$　$N_B = \dfrac{W}{1+\mu_A \mu_B}$　$\Rightarrow$　$F_B = \mu_B N_B = \dfrac{\mu_B W}{1+\mu_A \mu_B}$,　$F_A = \mu_A \mu_B N_B = \dfrac{\mu_A \mu_B W}{1+\mu_A \mu_B}$

$\circlearrowleft \Sigma M_C = 0$ ;　$M - r\,F_A - r\,F_B = 0$

$\Rightarrow$　$M = r\,(F_A + F_B) = r\left(\dfrac{\mu_A \mu_B W}{1+\mu_A \mu_B} + \dfrac{\mu_B W}{1+\mu_A \mu_B}\right) = \dfrac{(1+\mu_A)\,\mu_B}{1+\mu_A \mu_B}\,r\,W$

$= \dfrac{(1+0.30)\,(0.36)}{1+(0.30)\,(0.36)}\,r\,W = 0.422\,r\,W$

8.25 $\mu_k = 0.20$




$\circlearrowleft \Sigma M_C = 0$ ;

$[(45 \text{ mm}) + (300 \text{ mm}) \sin 30°] (400 \text{ N}) \sin 30°$

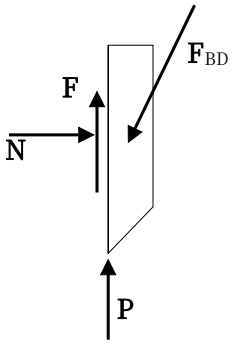
$+ [(30 \text{ mm}) + (300 \text{ mm}) \cos 30°] (400 \text{ N}) \cos 30°$

$- (30 \text{ mm}) \left(\frac{12}{13} F_{BD}\right) - (45 \text{ mm}) \left(\frac{5}{13} F_{BD}\right) = 0$

$\Rightarrow \quad \left[\frac{12}{13}(30 \text{ mm}) + \frac{5}{13}(45 \text{ mm})\right] F_{BD}$

$= 39000 \text{ N·m} + 100392 \text{ N·m}$

$\Rightarrow \quad F_{BD} = 3097.6 \text{ N}$




$\rightarrow \Sigma F_x = 0$ ;

$N - (F_{BD})_x = 0$

$\Rightarrow \quad N = (F_{BD})_x = \frac{25}{65}(3097.6 \text{ N}) = 1191.4 \text{ N}$

$F = \mu_k N = (0.20)\ (1191.4 \text{ N}) = 238.3 \text{ N}$

$\uparrow \Sigma F_y = 0$ ;

$P + F - (F_{BD})_y = 0$

$\Rightarrow \quad P = -F + (F_{BD})_y = -(238.3 \text{ N}) + \frac{60}{65}(3097.6 \text{ N}) = 2621.0 \text{ N}$

Force exerted by the edge of the blade on the laminate

$\mathbf{P}' = -\mathbf{P} = 2620 \text{ N} \downarrow = 2.62 \text{ kN} \downarrow$