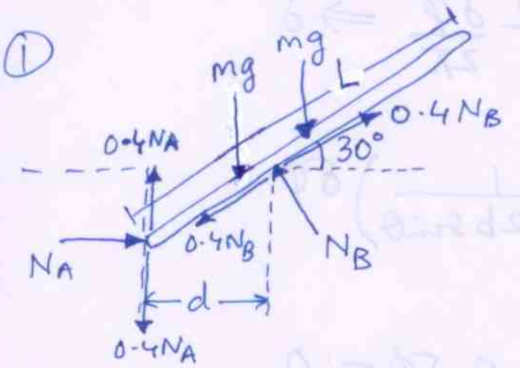
CE102 – Quiz II – 2006

P.1



Case (A): Impending slip downward. So use upward pointing friction forces, and mg acting at $L/2$ which is left of pt. B.

Case (B): Impending slip upward. Use downward pointing friction forces, and mg acting at $L/2$ which is right of B.

3 eqns, 3 unknowns! (N_A, N_B, L/d)!

$$\pm 0.4 N_A - mg + N_B \cos 30^\circ \pm 0.4 N_B \sin 30^\circ = 0 \longrightarrow (1)$$

$$N_A \pm 0.4 N_B \cos 30^\circ - N_B \sin 30^\circ = 0 \longrightarrow (2)$$

$$N_A (d \tan 30) \mp 0.4 N_A (d) \pm mg \left(\pm d \mp \frac{L}{2}\cos 30\right) = 0 \longrightarrow (3)$$

Top sign for Case (A), bottom sign for Case (B)

(2) in (1) $\rightarrow \left[\pm 0.4(\sin 30 \mp 0.4\cos 30) + \cos 30 \pm 0.4 \sin 30\right] N_B = mg$

$$N_B = \left(\frac{1}{0.84\cos 30 \pm 0.8 \sin 30}\right) mg$$

$$N_A = \left(\frac{\sin 30 \mp 0.4 \cos 30}{0.84 \cos 30 \pm 0.8 \sin 30}\right) mg$$

(3) $\rightarrow$ $$\frac{L}{2}\cos 30 - d = \frac{N_A\, d\,(\tan 30 \mp 0.4)}{mg}$$

$$\Rightarrow \quad \frac{L}{d} = \frac{2}{\cos 30}\left[1 + \left(\frac{\sin 30 \mp 0.4\cos 30}{0.84\cos 30 \pm 0.8 \sin 30}\right)(\tan 30 \mp 0.4)\right]$$

= 2.3652 for impending downward slip & 8.1435 for impending upward slip.

$\Rightarrow$ Bar in equilibrium for $2.3652 < L/d < 8.1435$

P.2 Let ϕ be rotation of screw and y be measured from bottom to mass m. The AFD is the figure itself. Let x be dist AB.

$$\delta U = M\,\delta\phi + (-mg)\,\delta y = 0$$

$y = 4b\sin\theta$, $x = 2b\cos\theta$, from geometry.

Also $\delta x = -L\,\delta\phi/2\pi$ from given information on lead of screw.

P. 2 (contd).

$$\Rightarrow \delta y = 4b\cos\theta\,\delta\theta$$

$$\delta x = -2b\sin\theta\,\delta\theta = -L\frac{\delta\phi}{2\pi}$$

$$\Rightarrow \delta\phi = \left(\frac{2\pi}{L}\,2b\sin\theta\right)\delta\theta$$

$$\delta y = 4b\cos\theta\left(\frac{L}{2\pi}\,\frac{1}{2b\sin\theta}\right)\delta\phi$$

$$= \frac{L}{\pi}\cot\theta\,\delta\phi.$$

$$\delta U = 0 \Rightarrow M\,\delta\phi + (-mg)\frac{L}{\pi}\cot\theta\,\delta\phi = 0$$

$$\Rightarrow M = mg\,\frac{L}{\pi}\cot\theta$$