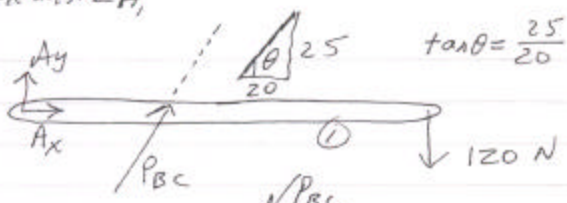
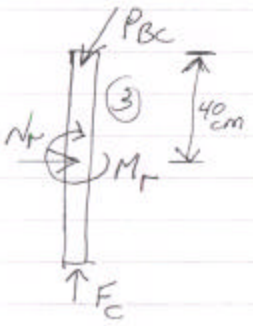
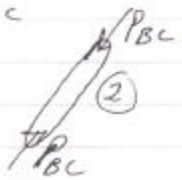
Solutions to Exam #2A,
24-261
Fall 2001



$\tan\theta = \frac{25}{20}$





(1) $\Sigma M|_{A_z} = -120(120\text{ cm}) + P_{BC}\sin\theta(35) = 0$

$P_{BC} = \frac{120(120)}{35\sin\theta} = 527\text{ N}$

(3) $\Sigma F_y = -P_{BC}\sin\theta + F_c = 0 \Rightarrow F_c = 412\text{ N}$

$\Sigma M|_{guide_z} = (P_{BC}\cos\theta)(40\text{ cm}) - M_r = 0$

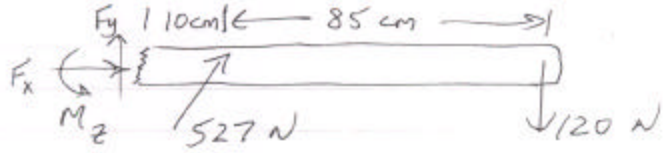
$M_r = 1.32\times10^4\text{ N-cm} = 132\text{ N-m}$

$\Sigma F_x = -P_{BC}\cos\theta + N_r = 0$

$N_r = 329\text{ N}$

Crushing force is 412 N

guide & ram interact with a normal force of 329 N & a moment of 132 N-m

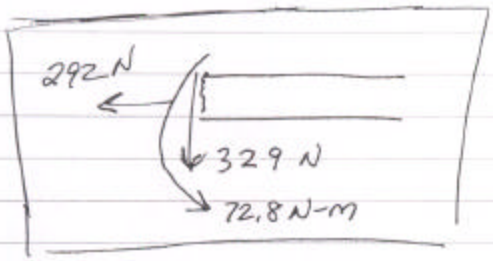


$\Sigma F_x = F_x + 527\cos\theta = 0 \Rightarrow \boxed{F_x = -329\ N}$

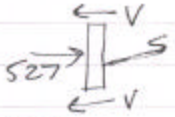
$\Sigma F_y = F_y + 527\sin\theta - 120 = 0 \Rightarrow \boxed{F_y = -292\ N}$

$\Sigma M|_{cut_z} = M_z - 120(95) + 527\sin\theta\,(10) = 0$

$M_z = 7285\ N\text{-}cm = \boxed{72.8\ N\text{-}m = M_z}$



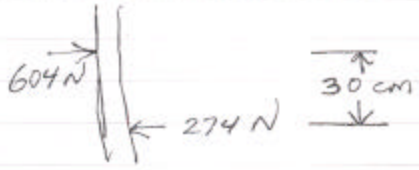
Shear Force V

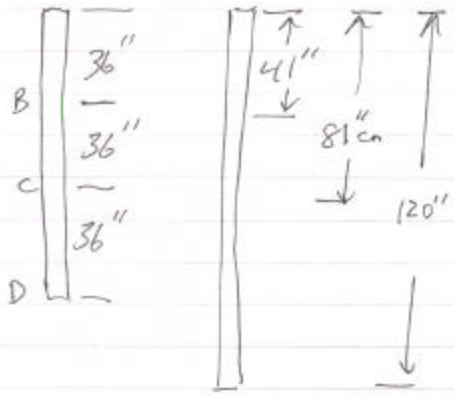


$V = \frac{527}{2}$

$\tau = \frac{V}{A} = \frac{527}{2\left(\frac{\pi}{4}(.006)^2\right)} = 9.3 \times 10^6\ Pa = \boxed{9.3\ MPa = \tau}$

Guide could be viewed as applying two forces to ram





$v_B = 41 - 36 = 5''$

$v_C = 81 - 72 = 9''$

$v_D = 120 - 108 = 12''$

Find stretches:

$\delta_{AB} = v_B - v_A = 5''$; $\delta_{BC} = v_C - v_B = 4''$; $\delta_{CD} = v_D - v_C = 3''$

can find internal forces.

$$\delta = \frac{PL}{EA} \Rightarrow P = \frac{EA\delta}{L}$$

$$P_{AB} = \frac{(200)(0.5)5}{36} = 13.9 \text{ lb}$$

$$P_{BC} = \frac{(200)(0.5)4}{36} = 11.1 \text{ lb}$$

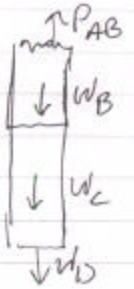
$$P_{CD} = \frac{200(0.5)(3)}{36} = 8.33 \text{ lb}$$

Find weights from equilibrium

$W_D = P_{CD} = 8.33 \text{ lb}$

$P_{BC} = W_C + W_D$

$W_C = P_{BC} - W_D = 11.1 - 8.33 = 2.77\,lb$



$P_{AB} = W_B + W_C + W_D$

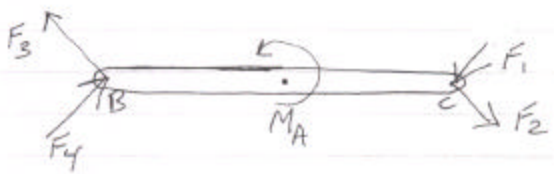
$W_B = P_{AB} - W_C - W_D$

$W_B = 13.9 - 2.77 - 8.33 = 2.80\,lb$

$W_B = 2.80\,lb,\ W_C = 2.77\,lb,\ W_D = 8.33\,lb$

Stress in BC, based on P_{BC}

$$\sigma_{BC} = \frac{P_{BC}}{A} = \frac{11.1}{0.5} = 22.2\ psi$$



$$\Sigma m|_{A_z} = M_A - (F_1 + F_2 + F_3 + F_4)(\cos 30^\circ)(15\text{ cm}) = 0$$

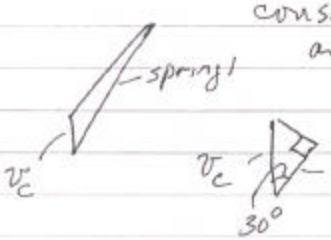
Consider motions, bar rotates by a small angle ⇒ ends move up and down

Say angle is α ⇒ $v_B = (15\text{cm})\alpha$ down

$v_C = (15\text{cm})\alpha$ up

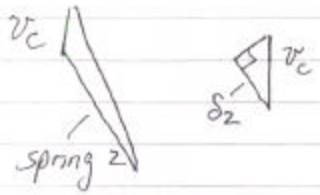
Relate displacements to stretches

consider spring to contract and swivel



$\delta_1 = v_c \cos 30^\circ$

spring 1 contracts



$\delta_2 = v_c \cos 30^\circ$

spring 2 extends

$F_1 = k_1 \delta_1 = 20 \quad v_C \cos 30^\circ = (20)(15)\alpha \cos 30^\circ$

$F_2 = k_2 \delta_2 = 30 \quad v_C \cos 30^\circ = (30)(15)\alpha \cos 30^\circ$

similar for $\delta_3 = v_B \cos 30^\circ$, $\delta_4 = v_B \cos 30^\circ$

$F_3 = k_3 \delta_3 = 30 \quad v_B \cos 30^\circ = (30)(15)\alpha \cos 30^\circ$

$F_4 = k_4 \delta_4 = 20 \quad v_B \cos 30^\circ = (20)(15)\alpha \cos 30^\circ$

$M_A = (F_1 + F_2 + F_3 + F_4)(15)\cos 30^\circ$

$M_A = [20 + 30 + 30 + 20](15)\alpha(15)\cos^2 30^\circ$

$$\alpha = \frac{1000}{(50 + 50)(15 \cos 30)^2} = 0.059 \text{ rad}$$

or $\boxed{\alpha = 3.40^\circ}$