TOBB EKONOMİ VE TEKNOLOJİ ÜNİVERSİTESİ

MAK 206 Strength of Materials – 2015 Spring

QUIZ 2

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Ad, Soyad: **SOLUTION**

No:

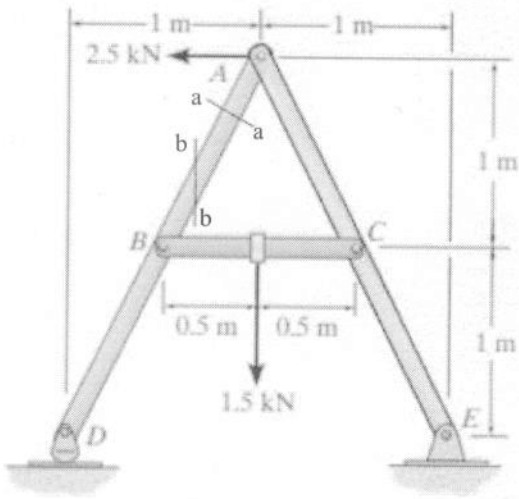
Problem: The truss members are connected between each other. The cross section is square, 12 mm on each side.

Given: τ_{all}=120 MPa F.S=2

a) Determine the normal stress at section a-a in member *AD*.

b) Determine the shear stress at section b-b in member *AD*.

c) What is the required diameter for pins at D and E. Pins are subjected to double shear. (Give your numbers to the nearest integer.)



Support Reactions: FBD(a)

$\zeta + \Sigma M_E = 0$; $2.5(2) + 1.5(1) - D_y(2) = 0$

$D_y = 3.25$ kN

$\overset{+}{\leftarrow} \Sigma F_x = 0$; $2.5 - E_x = 0$ $E_x = 2.5$ kN

$+\uparrow \Sigma F_y = 0$; $3.25 - 1.5 - Ey = 0$ $E_y = 1.75$ kN

From FBD (c),

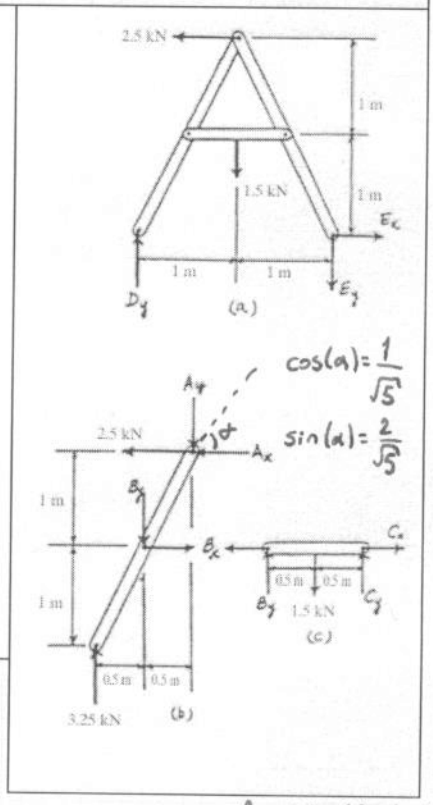
$\zeta + \Sigma M_B = 0$; $C_y(1) - 1.5(0.5) = 0$ $C_y = 0.75$ kN

$+\uparrow \Sigma F_y = 0$; $B_y + 0.75 - 1.5 = 0$ $B_y = 0.75$ kN

From FBD (b)

$\zeta + \Sigma M_A = 0$; $0.75(0.5) + B_x(1) - 3.25(1) = 0$

$B_x = 2.875$ kN



$+\uparrow \Sigma F_y = 0$ $B_y - A_y + 3.25 = 0$

$A_y = 4$ kN

$\overset{+}{\leftarrow} \Sigma F_x = 0$ $A_x - B_x = 0$

$A_x = 2.875$ kN

a) $N_{a-a} = A_x \cos(\alpha) + A_y \sin(\alpha)$

$= 2.875\left(\frac{1}{\sqrt{5}}\right) + 4\left(\frac{2}{\sqrt{5}}\right)$

$N_{a-a} = 4.86$ kN

$A = 12.12 = 144\ mm^2$

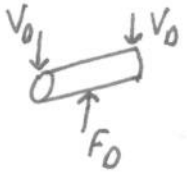
$A_{a-a} = 144\ mm^2$

$\sigma_{a-a} = \frac{N_{a-a}}{A_{a-a}} = \frac{4860\ N}{144\ mm^2} = 33.77\ MPa$

b) $V_{b-b} = A_x \sin(\alpha) - A_y \cos(\alpha)$ $\quad V_{b-b} = 0,78\ kN$ $\quad A_{b-b} = \frac{A_{a-a}}{\cos(\alpha)}$

$= 2.875\left(\frac{2}{\sqrt{5}}\right) - 4\left(\frac{1}{\sqrt{5}}\right)$ $\quad \tau_{b-b} = \frac{V_{b-b}}{A_{b-b}} = 2,43\ MPa$

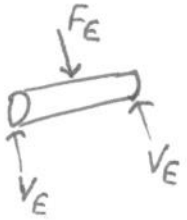
c) $F_D = O_y = 3.25\ kN$



(For pin D)

$V_D = \frac{F_D}{2} = 1.625\ kN$

$F_E = \sqrt{2.5^2 + 1.75^2} = 3.05\ kN$



$V_E = \frac{F_E}{2} = 1.525\ kN$

$\Rightarrow$ Pin design:

F.S = 2 $\quad \tau_{all} = 120\ MPa$ $\quad F.S = \frac{\tau_{all}}{\tau}$ $\quad \tau = 60\ MPa$

$V_D > V_E$

$60 = \frac{V_D}{A}$ $\quad A = \frac{1625}{60} = 27.08\ mm^2$

Required diameter $\rightsquigarrow$ $\frac{\pi D^2}{4} \geq 27.08$

$D \geq 6\ mm$