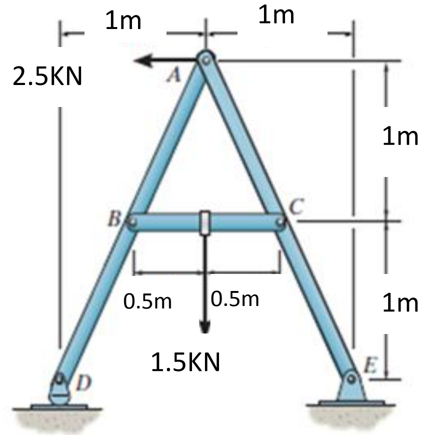
•1–41. Solve Prob. 1–40 assuming that pins *B* and *C* are subjected to *single shear*.

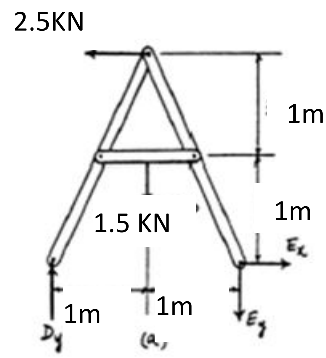


Support Reactions: FBD(a)

$\circlearrowleft + \Sigma M_E = 0;$ 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 – E_y = 0 ; E_y =1.75 KN



From FBD (c),

$\circlearrowleft + \Sigma M_B = 0;$ C_y *1- 1.5*0.5 = 0 ; C_y =0.75 KN

$+\uparrow \Sigma F_y = 0;$ 0.75 – 1.5 + B_y = 0 ; B_y =0.75 KN

From FBD (b)

$\circlearrowleft + \Sigma M_A = 0;$ 0.75*0.5 + B_x *1 – 3.25 *1=0 ;
B_x =2.875 KN

From FBD (c),

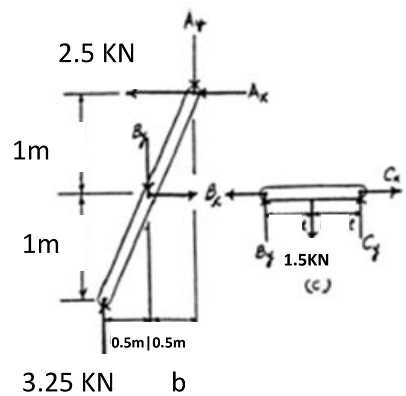
$\overset{+}{\rightarrow} \Sigma F_x = 0;$ C_x *1 – 2.875=0 ; C_x =2.875 KN

Hence, $F_B = F_C =$ $\sqrt{2.875^2 + 0.75^2} = 2.97\ KN.$

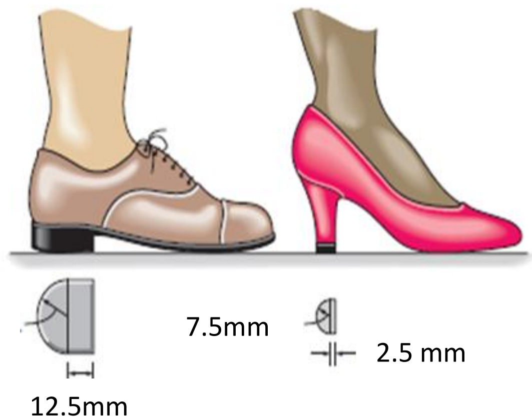
Average shear stress: Pins *B* and *C* are subjected to single shear as shown on FBD (d)

$(\tau_B)_{avg} = (\tau_C)_{avg} = \frac{V}{A} =$ **2.97*1000/(π/4*(6^2))**

105.76 MPa. **Ans.**



***1–44.** A 85-KG woman stands on a vinyl floor wearing stiletto high-heel shoes. If the heel has the dimensions shown, determine the average normal stress she exerts on the floor and compare it with the average normal stress developed when a man having the same weight is wearing flat-heeled shoes. Assume the load is applied slowly, so that dynamic effects can be ignored. Also, assume the entire weight is supported only by the heel of one shoe.



Stiletto shoes:

$A =$ 0.5*π*7.5^2 + 2.5*15 = 125.85 mm^2

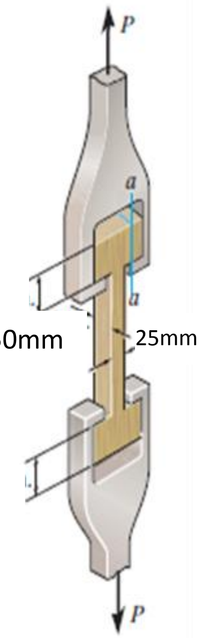
$\sigma = \dfrac{P}{A} =$ 85*9.81/125.86 = 6.625 MPa **Ans.**

Flat-heeled shoes:

$A =$ 0.5*π*30^2 + 12.5*60 = 2163.7 mm^2

$\sigma = \dfrac{P}{A} =$ 85*9.81/2163.7 = 0.385 MPa **Ans.**

1–51. During the tension test, the wooden specimen is subjected to an average normal stress of 15MPa. Determine the axial force **P** applied to the specimen. Also, find the average shear stress developed along section *a–a* of the specimen.



Internal Loading: The normal force developed on the cross section of the middle portion of the specimen can be obtained by considering the free-body diagram shown in Fig. *a*.

$+\uparrow\Sigma F_y = 0;\qquad \frac{P}{2} + \frac{P}{2} - N = 0 \qquad N = P$

Referring to the free-body diagram shown in fig. *b*, the shear force developed in the shear plane *a–a* is

$+\uparrow\Sigma F_y = 0;\qquad \frac{P}{2} - V_{a-a} = 0 \qquad V_{a-a} = \frac{P}{2}$

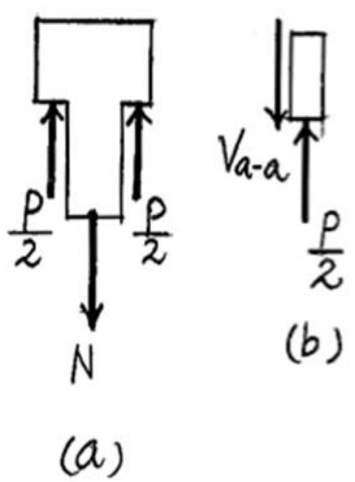
Average Normal Stress and Shear Stress: The cross-sectional area of the specimen is $A =$ 25*50 = 1250 mm^2. We have

$\sigma_{avg} = \frac{N}{A};$ 15 = P/1250 ;

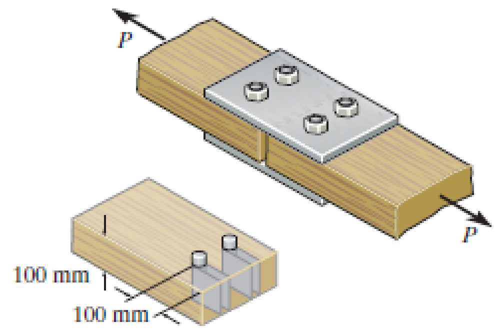
$P =$ 18750 N = 18.75 KN. **Ans.**

Using the result of **P**, $V_{a-a} = \frac{P}{2} =$ 9375 N . The area of the shear plane is $A_{a-a} =$ 50*100 = 5000 mm^2 . we obtain

$(\tau_{a-a})_{avg} = \frac{V_{a-a}}{A_{a-a}} =$ 9375/5000 = 1.875 MPa **Ans.**



•**1–53.** The average shear stress in each of the 6-mm diameter bolts and along each of the four shaded shear planes is not allowed to exceed 80 MPa and 500 kPa, respectively. Determine the maximum axial force **P** that can be applied to the joint.



Internal Loadings: The shear force developed on each shear plane of the bolt and the member can be determined by writing the force equation of equilibrium along the member's axis with reference to the free-body diagrams shown in Figs. *a*. and *b*, respectively.

$\Sigma F_y = 0;\quad 4V_b - P = 0 \qquad V_b = P/4$

$\Sigma F_y = 0;\quad 4V_p - P = 0 \qquad V_p = P/4$

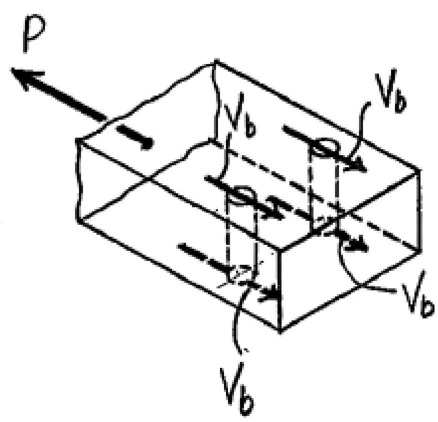
Average Shear Stress: The areas of each shear plane of the bolts and the members are $A_b = \frac{\pi}{4}(0.006^2) = 28.274(10^{-6})\text{m}^2$ and $A_p = 0.1(0.1) = 0.01\text{m}^2$, respectively. We obtain

$(\tau_{\text{allow}})_b = \dfrac{V_b}{A_b};\qquad 80(10^6) = \dfrac{P/4}{28.274(10^{-6})}$

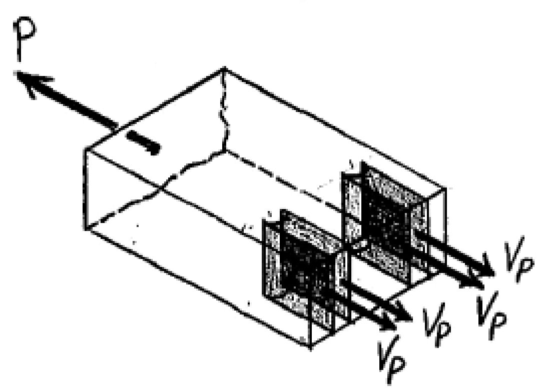
$P = 9047\text{ N} = 9.05\text{ kN (controls)}$ **Ans.**

$(\tau_{\text{allow}})_p = \dfrac{V_p}{A_p};\qquad 500(10^3) = \dfrac{P/4}{0.01}$

$P = 20\,000\text{ N} = 20\text{ kN}$

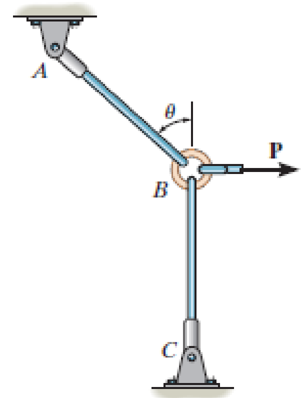


(a)



(b)

1–55. Rods AB and BC each have a diameter of 5 mm. If the load of $P = 2$ kN is applied to the ring, determine the average normal stress in each rod if $\theta = 60^\circ$.



Consider the equilibrium of joint B, Fig. a,

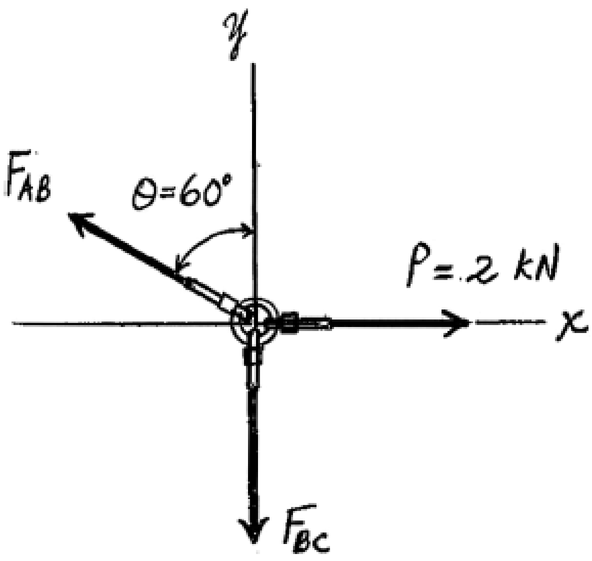
$\xrightarrow{+} \Sigma F_x = 0; \qquad 2 - F_{AB} \sin 60^\circ = 0 \qquad F_{AB} = 2.309 \text{ kN}$

$+\uparrow \Sigma F_y = 0; \qquad 2.309 \cos 60^\circ - F_{BC} = 0 \qquad F_{BC} = 1.155 \text{ kN}$

The cross-sectional area of wires AB and BC are $A_{AB} = A_{BC} = \frac{\pi}{4}(0.005^2) = 6.25(10^{-6})\pi \text{ m}^2$. Thus,

$$\left(\sigma_{\text{avg}}\right)_{AB} = \frac{F_{AB}}{A_{AB}} = \frac{2.309(10^3)}{6.25(10^{-6})\pi} = 117.62(10^6) \text{ Pa} = 118 \text{ MPa} \qquad \textbf{Ans.}$$

$$\left(\sigma_{\text{avg}}\right)_{BC} = \frac{F_{BC}}{A_{BC}} = \frac{1.155(10^3)}{6.25(10^{-6})\pi} = 58.81(10^6) \text{ Pa} = 58.8 \text{ MPa} \qquad \textbf{Ans.}$$



(a)