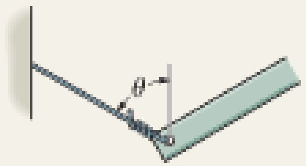
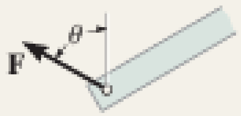
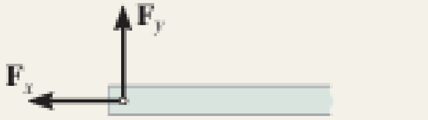
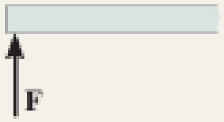
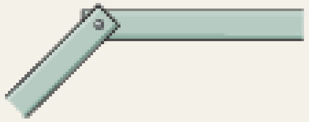
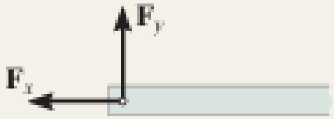
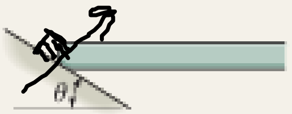
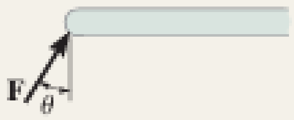
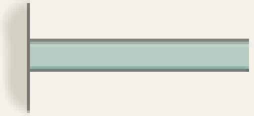
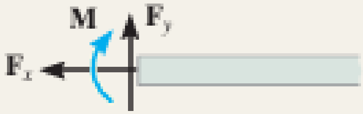
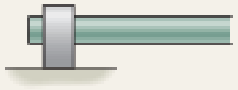
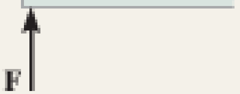
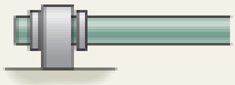
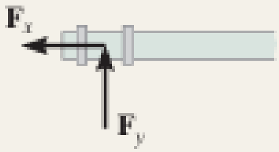
Chapter 1
Stress

* Reactions

TABLE 1–1

Type of connection	Reaction	Type of connection	Reaction
 Cable	 One unknown: F	 External pin	 Two unknowns: F_x, F_y
 Roller	 One unknown: F	 Internal pin	 Two unknowns: F_x, F_y
 Smooth support	 One unknown: F	 Fixed support	 Three unknowns: F_x, F_y, M
 Journal bearing	 One unknown: F	 Thrust bearing	 Two unknowns: F_x, F_y

* Equilibrium

2-D

$$\sum F_x = \text{zero}$$

$$\sum F_y = \text{zero}$$

$$\sum M_z = \text{zero}$$

3-D

$$\sum F_x = \text{zero}$$

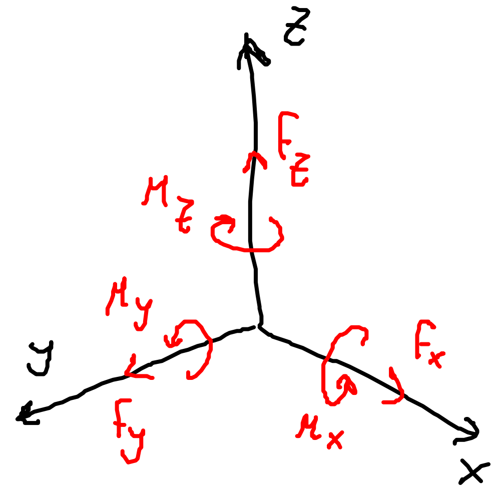
$$\sum F_y = \text{zero}$$

$$\sum F_z = \text{zero}$$

$$\sum M_x = \text{zero}$$

$$\sum M_y = \text{zero}$$

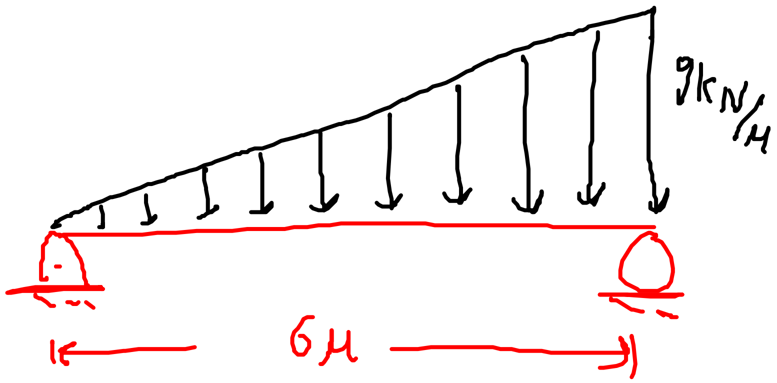
$$\sum M_z = \text{zero}$$

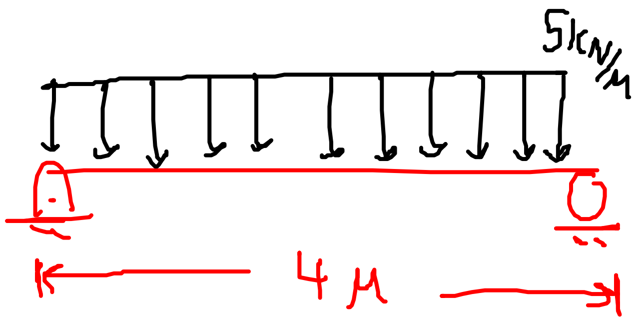


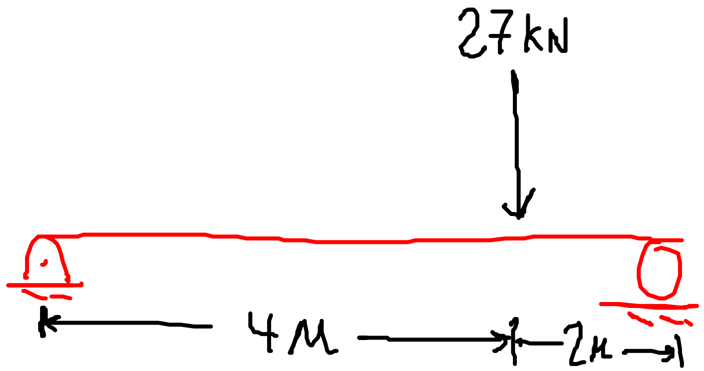
* Distributed Load (القوى الموزعة)

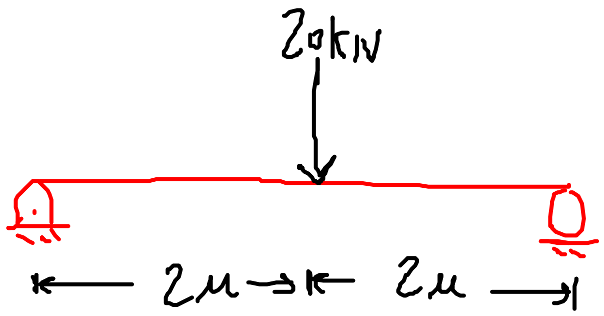
← لتحويل القوى الموزعة لقوى مركزة ← القيمة = مساحة القوى الموزعة

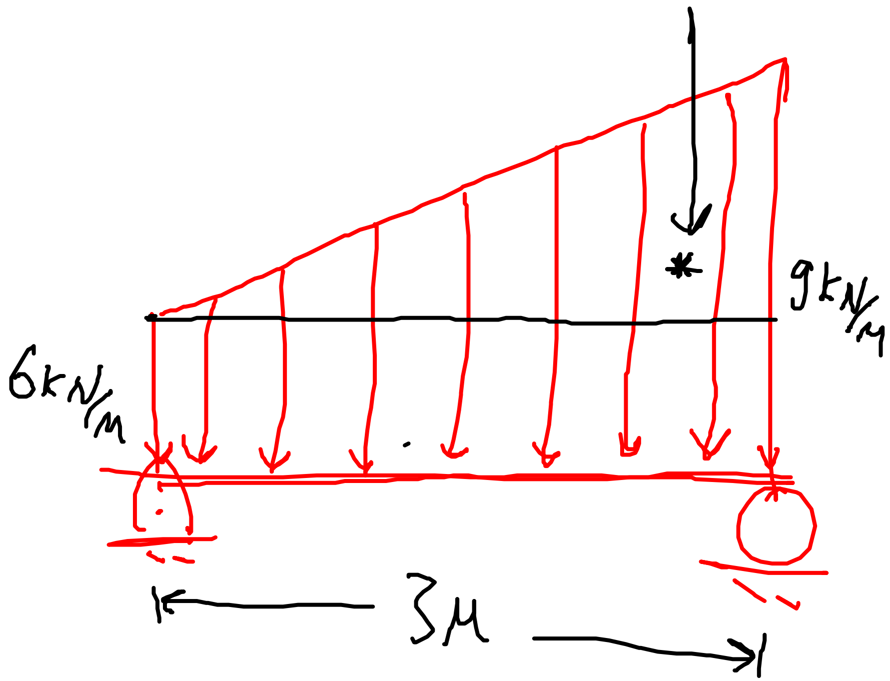
نقطة التأثير ← في مركز المساحة للقوى الموزعة

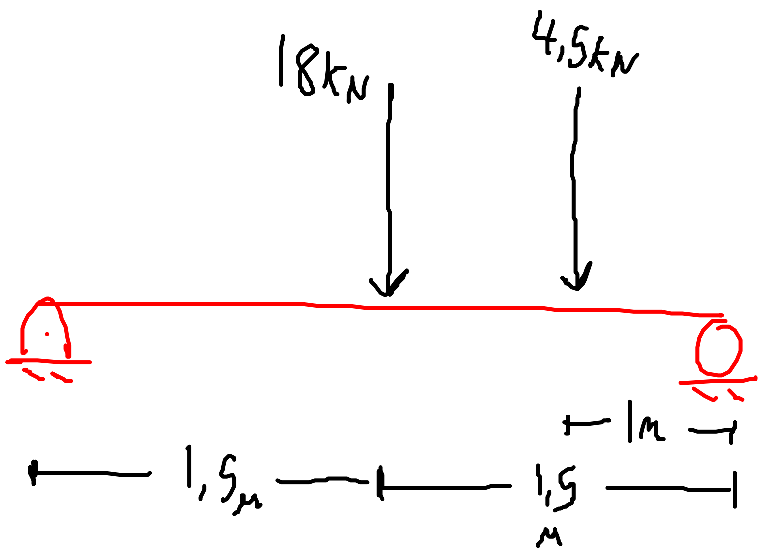









6kN/m
9kN/m
3m

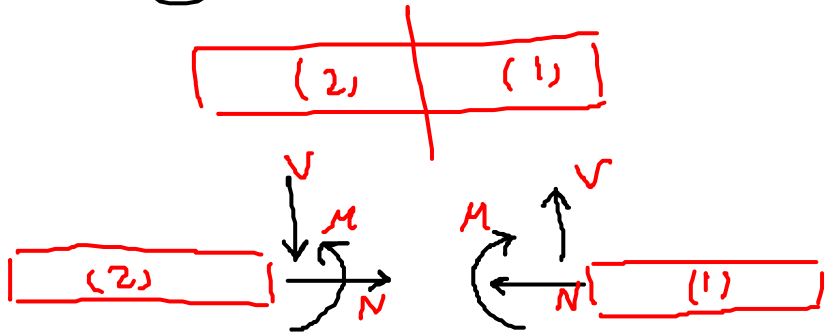

18kN
4,5kN
1m
1,5m
1,5
m

* عند طلب ال internal reactions عند نقطه معينه لازم نقطع العمود عند هذه النقطه ونفرض عندها ردود أفعال

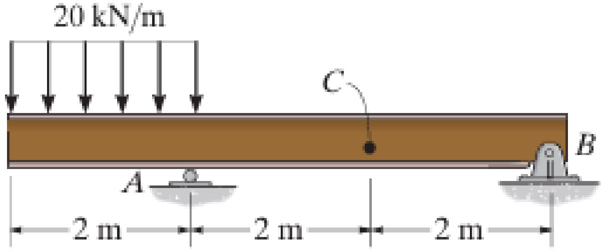
2-D → F_x , F_y , M_z

3-D → $F_x , F_y , F_z , M_x , M_y , M_z$

ثم نطبق معادلات الاتزان للجزء المقطوع لنحصل على ال internal reaction

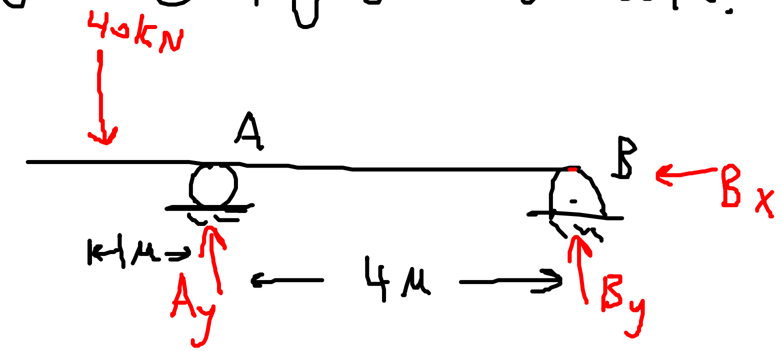


F1–3. Determine the resultant internal normal force, shear force, and bending moment at point C in the beam.



Prob. F1–3

① نطبق معادلات الاتزان على كامل الشكل



$$\Sigma F_x = \text{zero} \longrightarrow \boxed{B_x = \text{zero}}$$

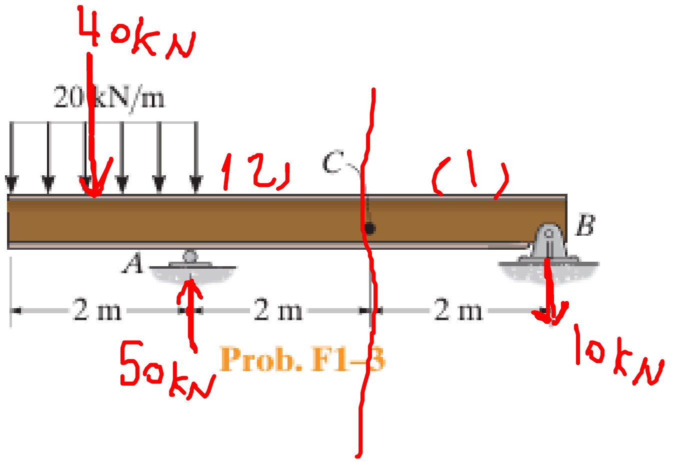
$$\Sigma M_A = \text{zero} \rightarrow 40 * 1 + B_y * 4 = \text{zero}$$

$$\boxed{B_y = -10\,kN}$$

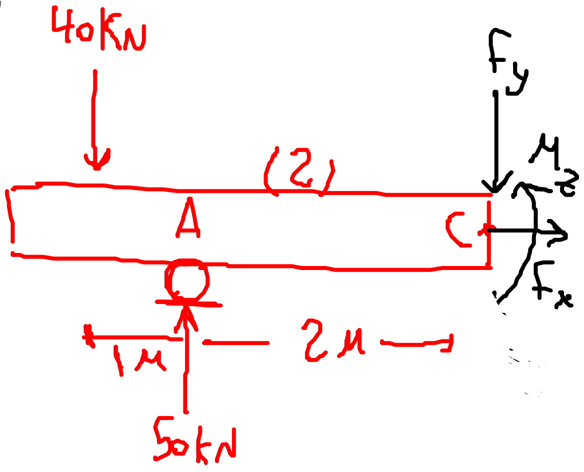
$$\Sigma F_y = \text{zero} \qquad A_y - 10 - 40 = \text{zero}$$

$$\boxed{A_y = 50\,kN}$$

F1–3. Determine the resultant internal normal force, shear force, and bending moment at point C in the beam.



Prob. F1–3



$\Sigma F_x = \text{Zero}$

$\boxed{F_x = \text{Zero}}$

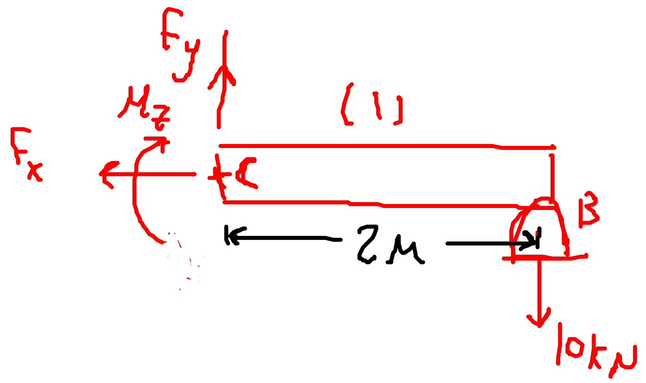
$\Sigma F_y = \text{Zero}$

$\boxed{F_y = 10\ \text{kN}}$

$\Sigma M_c = \text{Zero}$

$40 \times 3 - 50 \times 2 + M_z = \text{Zero}$

$\boxed{M_z = -20\ \text{kN}\cdot\text{m}}$



N

$\Sigma F_x = \text{Zero} \rightarrow \boxed{F_x = \text{Zero}}$

V

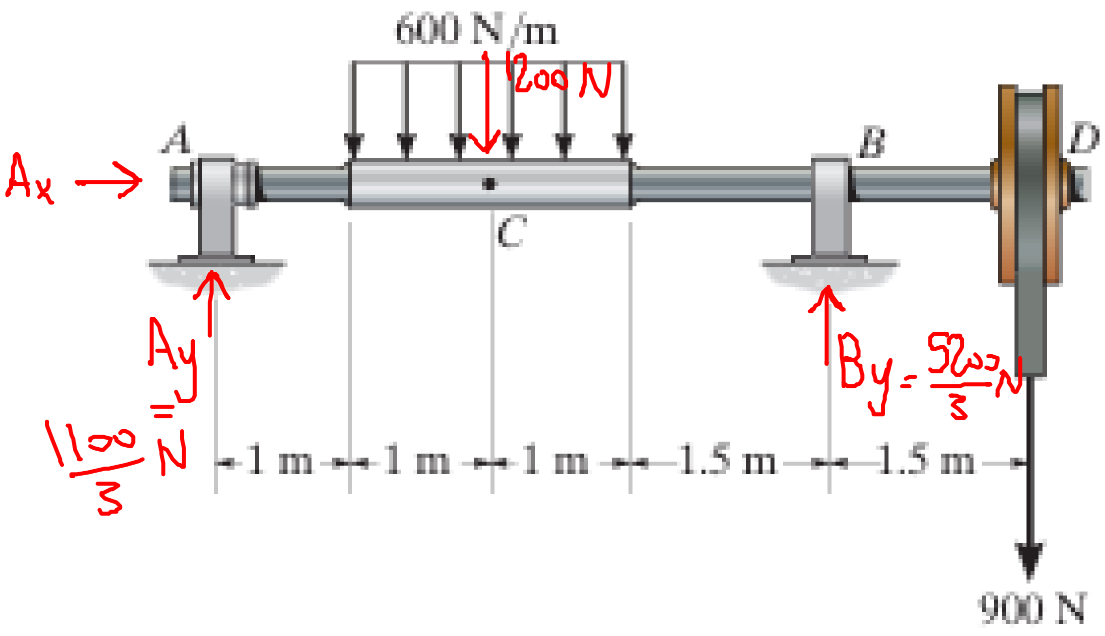
$\Sigma F_y = \text{Zero} \rightarrow \boxed{F_y = 10\ \text{kN}}$

$\Sigma M_c = \text{Zero} \rightarrow 10 \times 2 + M_z = \text{Zero}$

M

$\boxed{M_z = -20\ \text{kN}\cdot\text{m}}$

***1–4.** The shaft is supported by a smooth thrust bearing at A and a smooth journal bearing at B. Determine the resultant internal loadings acting on the cross section at C.



$\sum F_x = \text{Zero} \rightarrow \boxed{A_x = \text{Zero}}$

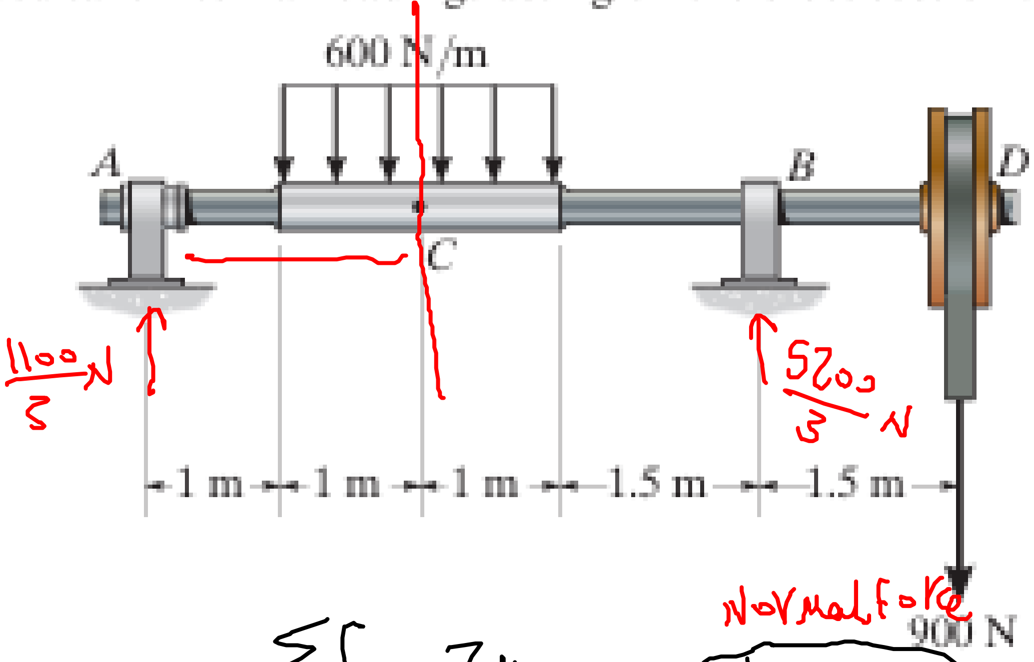
$\sum M_A = \text{Zero} \rightarrow 1200 * 2 - B_y * 4{,}5 + 900 * 6 = \text{Zero}$

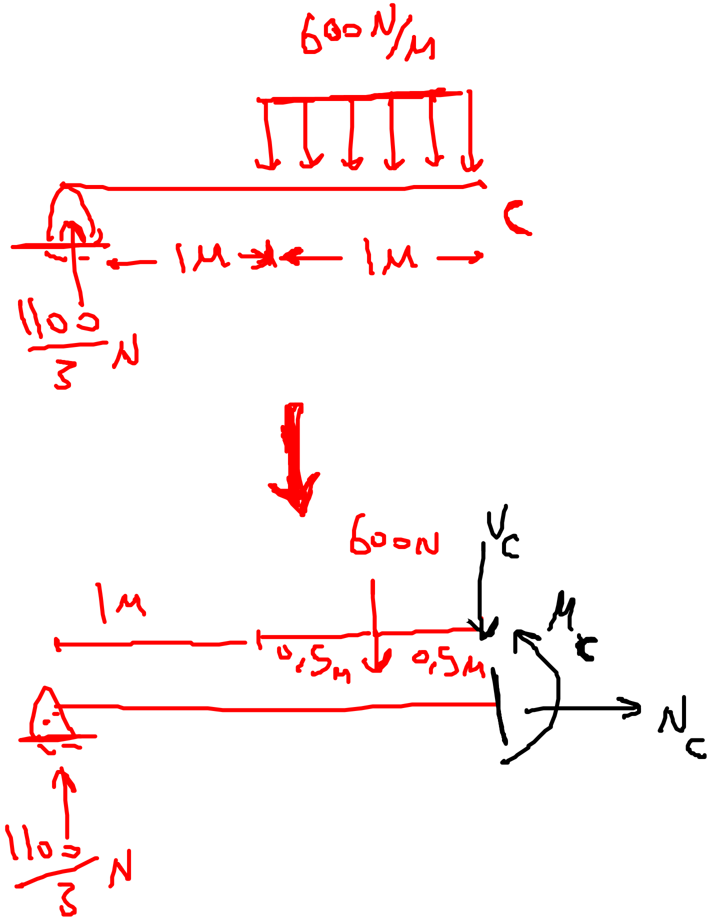
$\boxed{B_y = \frac{5200}{3}\ N}$

$\sum F_y = \text{Zero} \rightarrow A_y - 1200 + \frac{5200}{3} - 900 = \text{Zero}$

$\boxed{A_y = \frac{1100}{3}\ N}$

*1–4. The shaft is supported by a smooth thrust bearing at A and a smooth journal bearing at B. Determine the resultant internal loadings acting on the cross section at C.





$\Sigma F_x = \text{Zero}$

Normal force

$\boxed{N_c = \text{Zero}}$

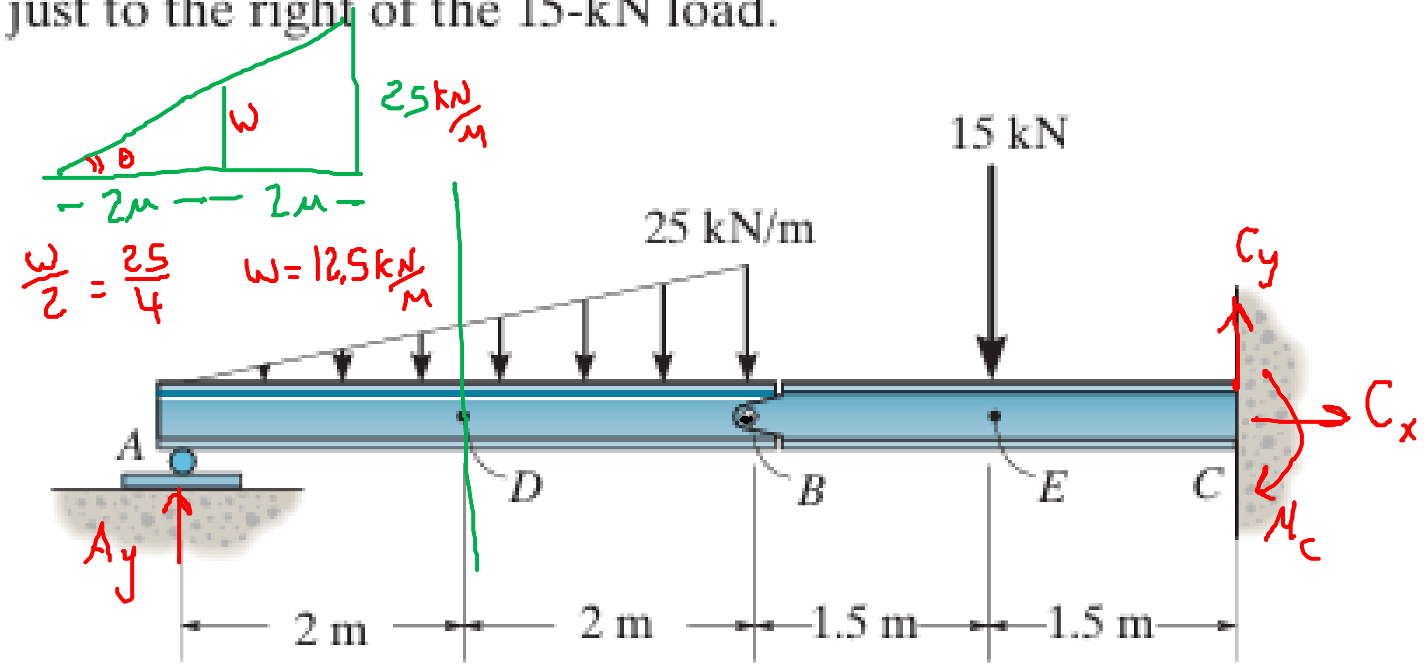
$\Sigma M_c = \text{Zero} \qquad \frac{1100}{3} * 2 - 600 * 0.5 - M_c = \text{Zero}$

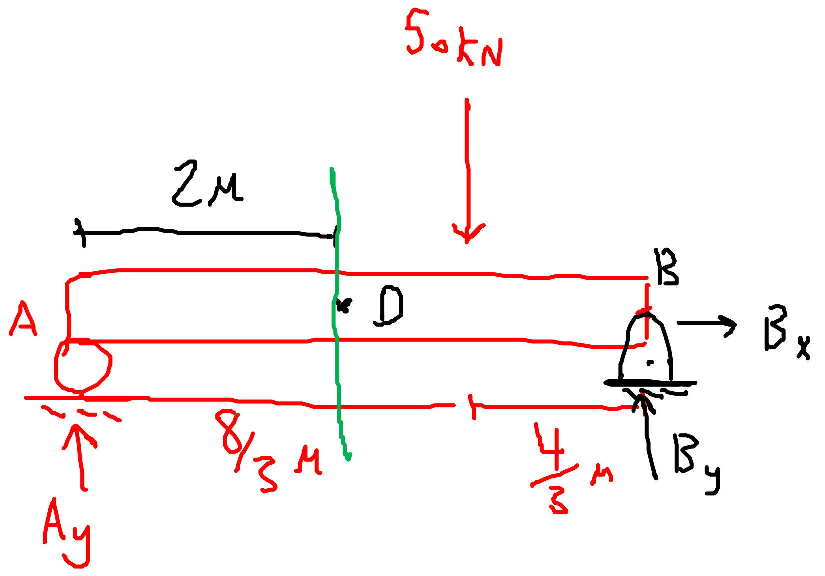
$\boxed{M_c = \frac{1300}{3}\ \text{N}\cdot\text{m}}$ Moment

$\Sigma F_y = \text{Zero} \qquad \frac{1100}{3} - 600 - V_c = \text{Zero}$

$\boxed{V_c = -\frac{700}{3}\ \text{N}}$ Shear force

1–5. Determine the resultant internal loadings in the beam at cross sections through points D and E. Point E is just to the right of the 15-kN load.



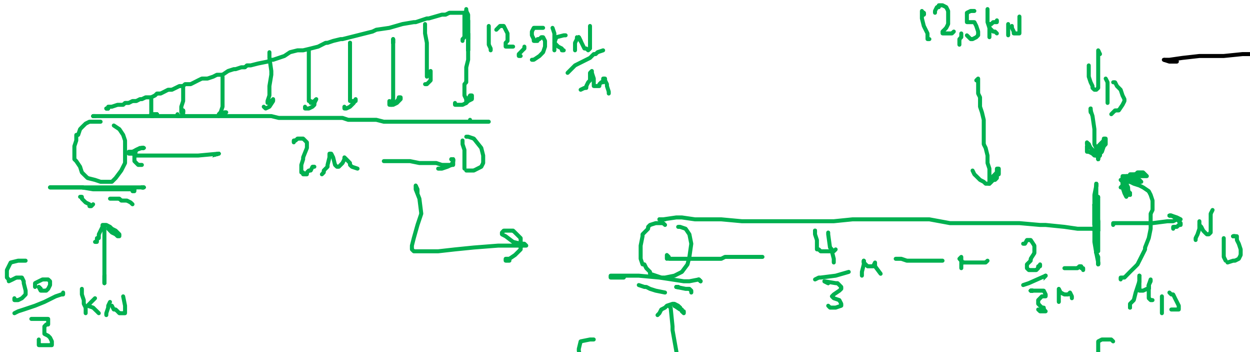


$$\Sigma M_B = \text{Zero}$$

$$A_y * 4 - 50 * \frac{4}{3} = \text{Zero}$$

$$\boxed{A_y = \frac{50}{3}\ \text{kN}}$$

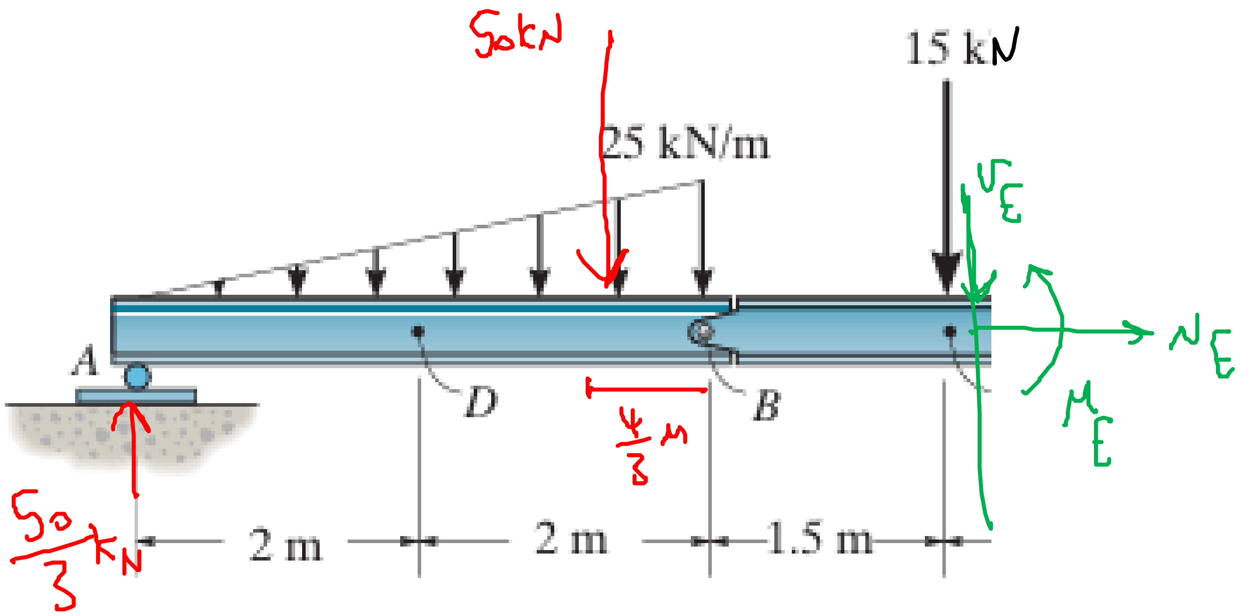
@ Point D



$$N_D = \text{Zero}$$

$$V_D = \frac{25}{6}\ \text{kN}$$

$$\frac{50}{3} * 2 - 12.5 * \frac{2}{3} - M_D = \text{Zero} \qquad M_D = 25\ \text{kN·m}$$



@ Point E

$\sum F_x = \text{Zero}$

$\boxed{N_E = \text{Zero}}$

$\sum M_E = \text{Zero}$

$\frac{50}{3} * 5.5 - 50\left(\frac{4}{3} + 1.5\right) - M_E = \text{Zero}$

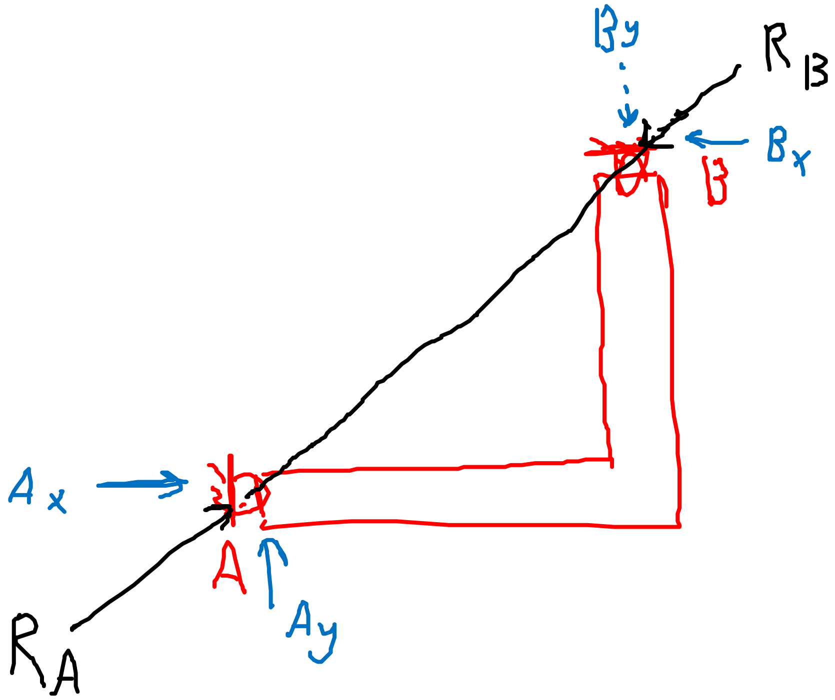
$\boxed{M_E = -50 \text{ kN.m}}$

$\sum F_y = \text{Zero}$

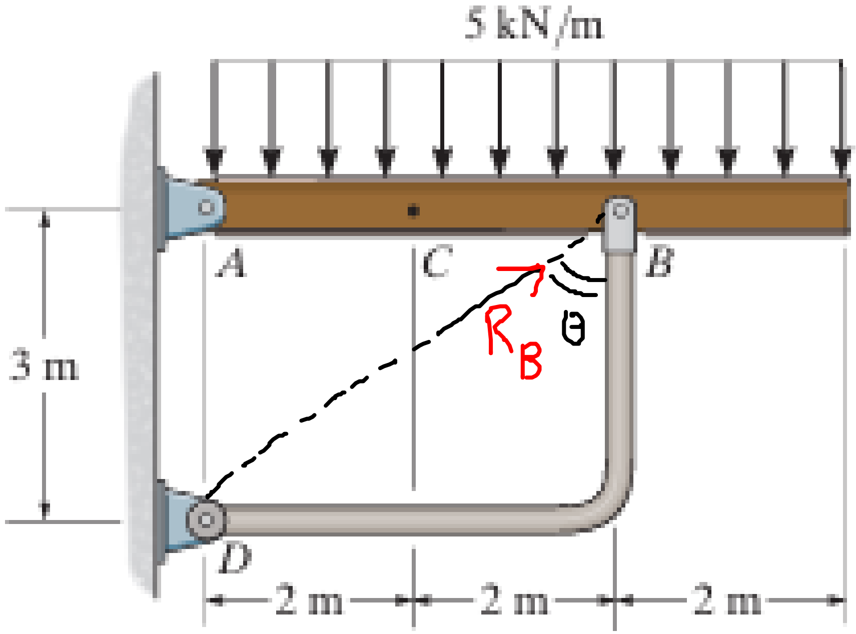
$\frac{50}{3} - 50 - 15 - V_E = \text{Zero}$

$\boxed{V_E = \frac{-145}{3} \text{ kN}}$

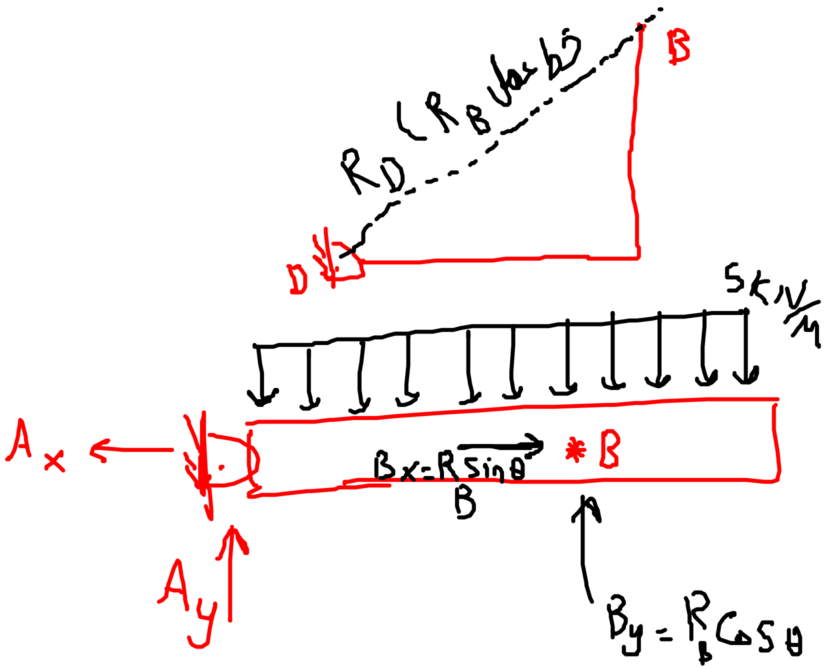
* في حالة وجود Member عليه قوتين فقط فإنه خط عمل القوتين يمر بالخط الواصل بين نقطتين تأثير القوتين.

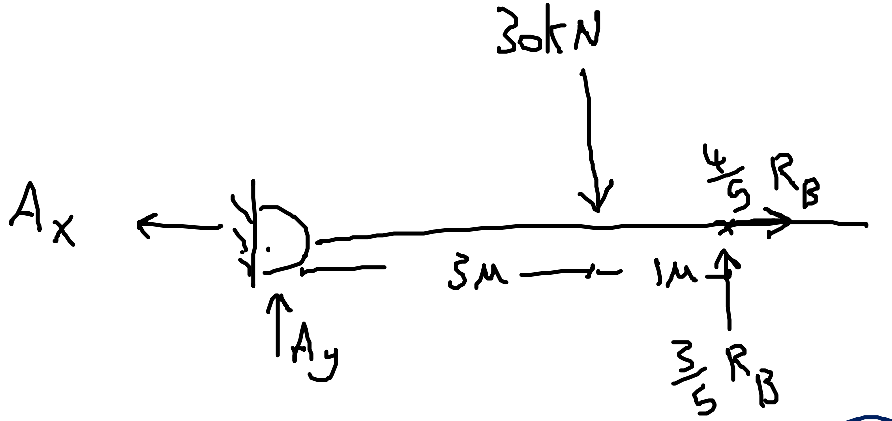


F1–6. Determine the resultant internal normal force, shear force, and bending moment at point C in the beam.



Prob. F1–6





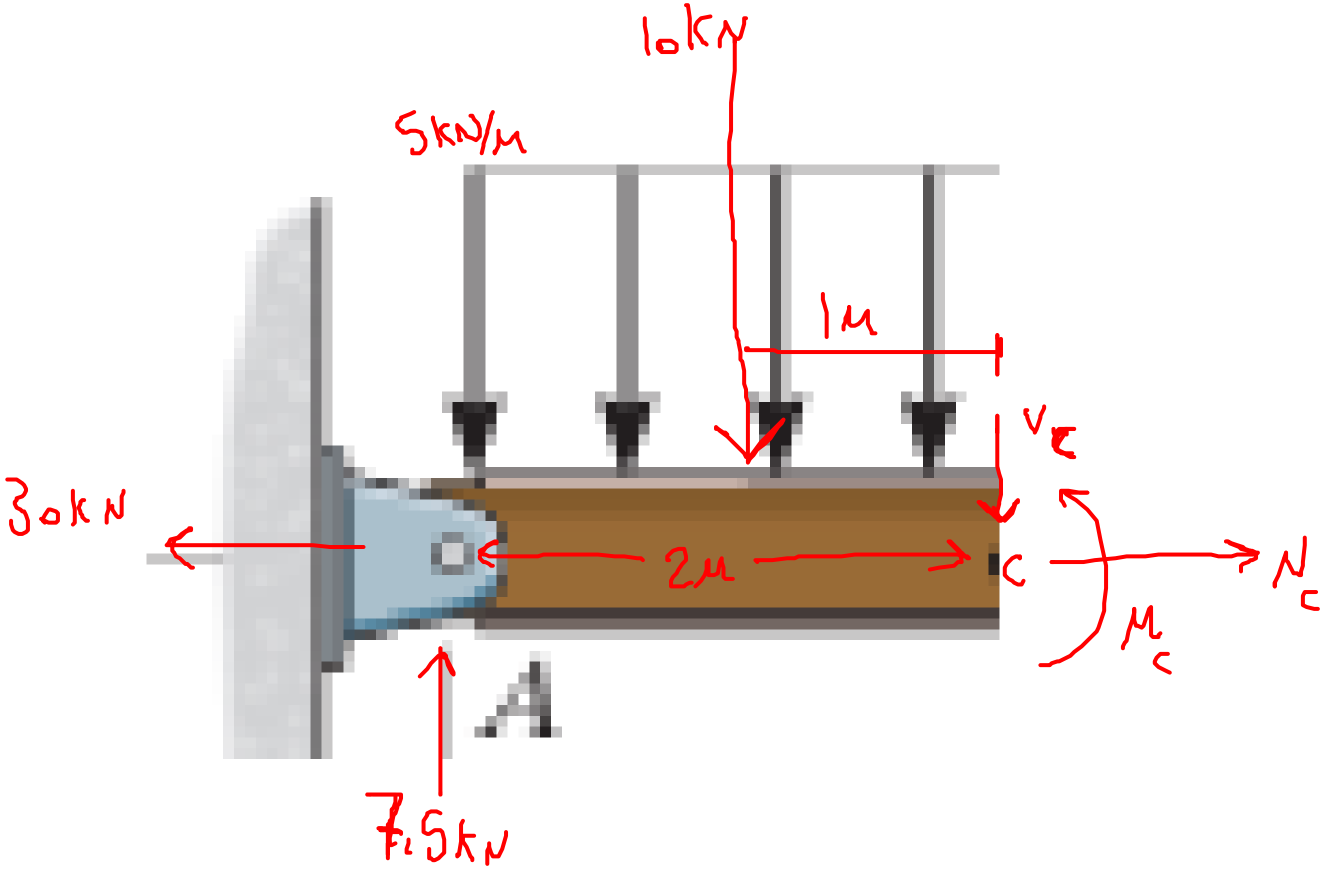
$\cos\theta = \frac{3}{5}$

$\sin\theta = \frac{4}{5}$

$\sum M_A = \text{zero}$ $\quad 30 * 3 - \frac{3}{5} R_B * 4 = \text{zero}$ $\quad \boxed{R_B = 37{,}5\ \text{kN}}$

$\sum F_x = \text{zero}$ $\quad A_x = \frac{4}{5} * 37{,}5 = \boxed{30\ \text{kN}}$

$\sum F_y = \text{zero}$ $\quad A_y - 30 + \frac{3}{5} * 37{,}5 = \text{zero}$ $\quad \boxed{A_y = 7{,}5\ \text{kN}}$



$$\Sigma F_x = \text{zero}$$

$$-30 + N_C = \text{zero}$$

$$\boxed{N_C = 30\ \text{kN}}$$

← Normal force

$$\Sigma F_y = \text{zero}$$

$$7.5 - 10 - V_C = \text{zero}$$

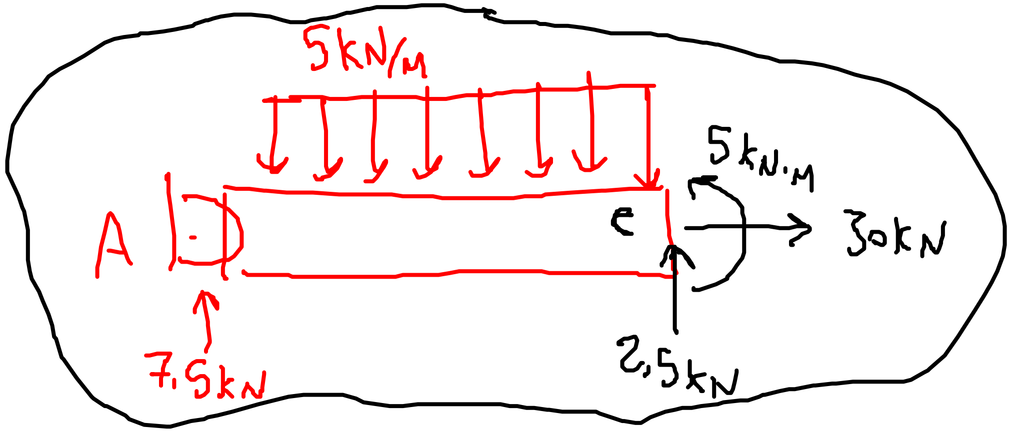
$$\boxed{V_C = -2.5\ \text{kN}}$$

← Shear force

$$\Sigma M_C = \text{zero}$$

$$7.5 * 2 - 10 * 1 - M_C = \text{zero}$$

$$\boxed{M_C = 5\ \text{kN.m}}$$



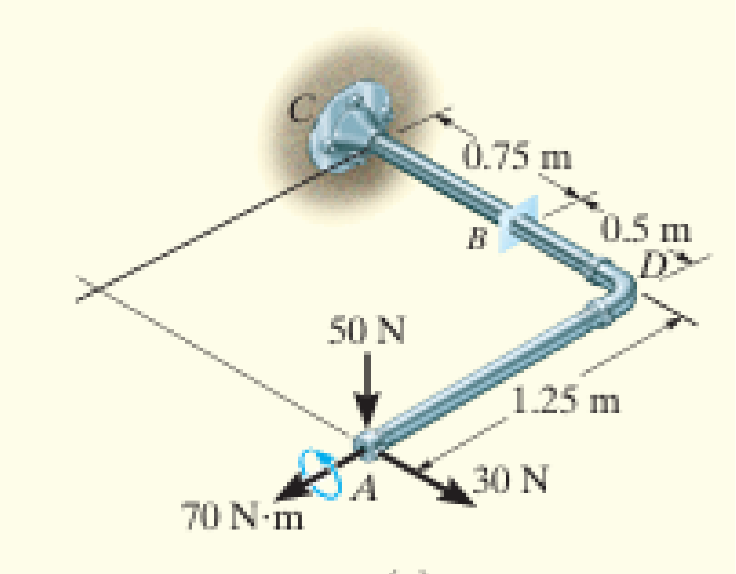
* 3-D Equilibrium

← لمعرفة المحور الذي يدور حوله العزم نتيجة التأثير بقوة.

محور دوران العزم		اتجاه ذراع العزم		اتجاه القوة
z	←	y	←	x
y	←	z	←	
z	←	x	←	y
x	←	z	←	
y	←	x	←	z
x	←	y	←	

EXAMPLE 1.4

Determine the resultant internal loadings acting on the cross section at B of the pipe shown in Fig. 1–7*a*. End A is subjected to a vertical force of 50 N, a horizontal force of 30 N, and a couple moment of 70 N · m. Neglect the pipe's mass.

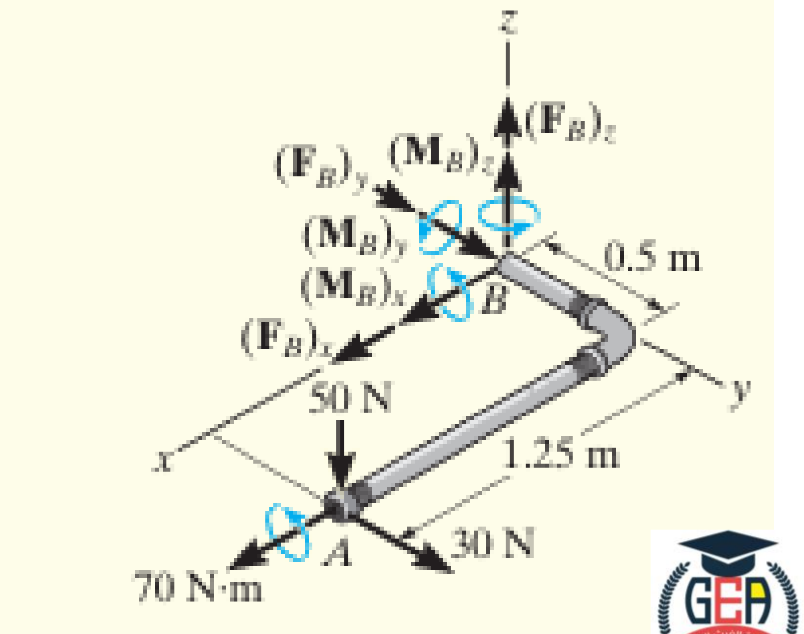


(a)

SOLUTION

The problem can be solved by considering segment AB, so we do not need to calculate the support reactions at C.

Free-Body Diagram. The free-body diagram of segment AB is shown in Fig. 1–7*b*, where the x, y, z axes are established at B. The resultant force and moment components at the section are assumed to act in the *positive coordinate directions* and to pass through the *centroid* of the cross-sectional area at B.



(b)

Equations of Equilibrium. Applying the six scalar equations of equilibrium, we have*

$\Sigma F_x = 0;$		$(F_B)_x = 0$	*Ans.*
$\Sigma F_y = 0;$	$(F_B)_y + 30\text{ N} = 0$	$(F_B)_y = -30\text{ N}$	*Ans.*
$\Sigma F_z = 0;$	$(F_B)_z - 50\text{ N} = 0$	$(F_B)_z = 50\text{ N}$	*Ans.*

$\Sigma(M_B)_x = 0;\quad (M_B)_x + 70\text{ N}\cdot\text{m} - (50\text{ N})(0.5\text{ m}) = 0$

$$(M_B)_x = -45\text{ N}\cdot\text{m} \qquad \textit{Ans.}$$

$\Sigma(M_B)_y = 0;\quad (M_B)_y + (50\text{ N})(1.25\text{ m}) = 0$

$$(M_B)_y = -62.5\text{ N}\cdot\text{m} \qquad \textit{Ans.}$$

$\Sigma(M_B)_z = 0;\quad (M_B)_z + (30\text{ N})(1.25) = 0 \qquad \textit{Ans.}$

$$(M_B)_z = -37.5\text{ N}\cdot\text{m}$$

EXAMPLE 1.4

$\sum F_x = \text{Zero}$ $\quad \boxed{F_{x_B} = \text{Zero}}$

$\sum F_y = \text{Zero} \quad 30 + F_{y_B} = \text{Zero} \quad \boxed{F_{y_B} = -30\ N}$

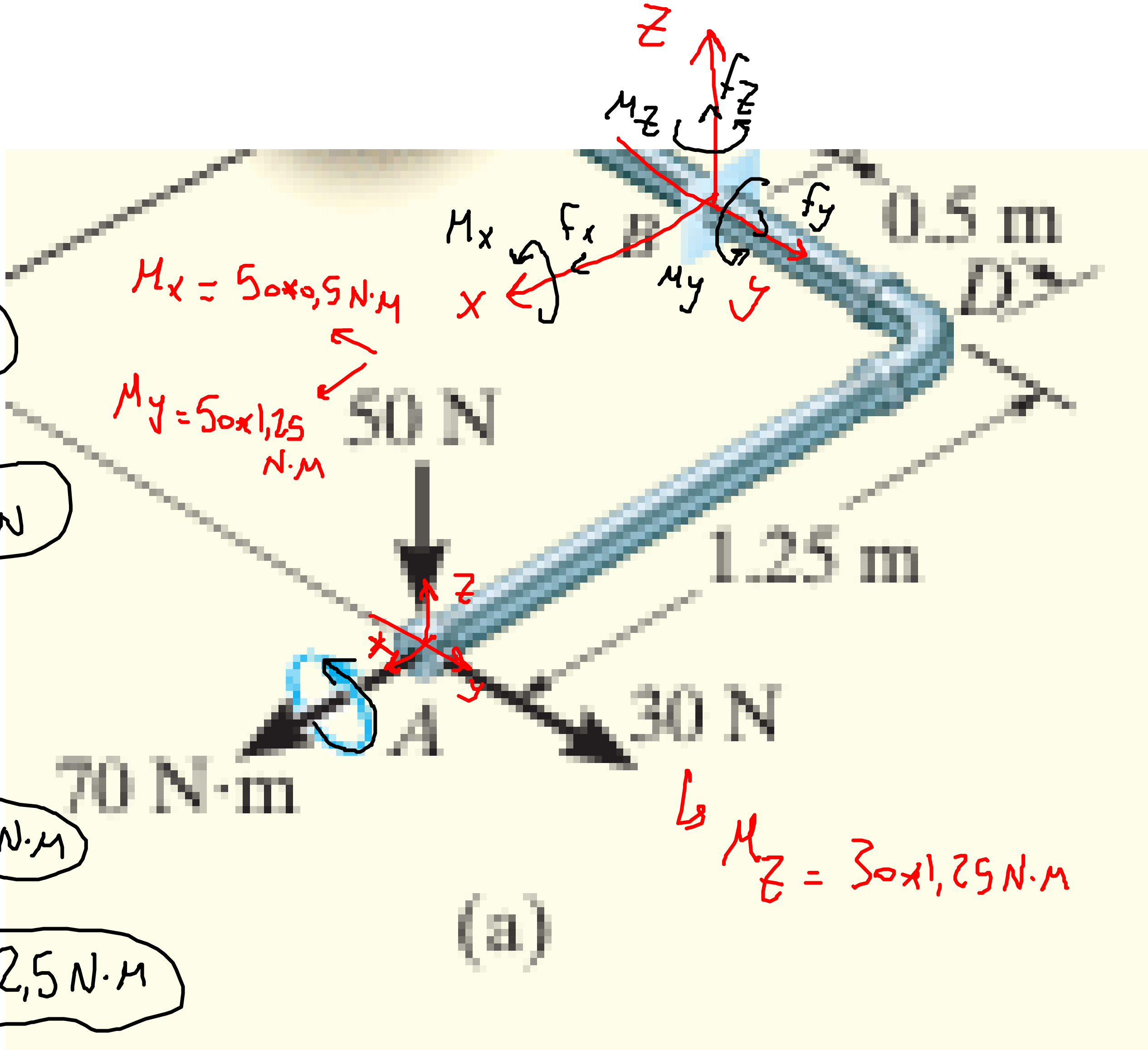
$\sum F_z = \text{Zero} \quad -50 + F_{z_B} = \text{Zero} \quad \boxed{F_{z_B} = 50\ N}$

$\sum M_x = \text{Zero} \quad 70 - 50 * 0.5 + M_{x_B} = \text{Zero}$

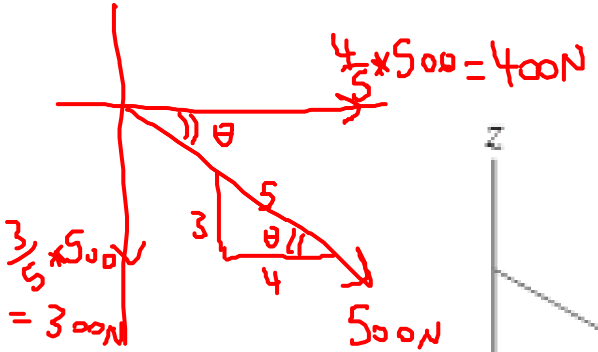
$\boxed{M_{x_B} = -45\ N \cdot M}$

$\sum M_y = \text{Zero} \quad 50 * 1.25 + M_{y_B} = \text{Zero} \quad \boxed{M_{y_B} = -62.5\ N \cdot M}$

$\sum M_z = \text{Zero} \quad 30 * 1.25 + M_{z_B} = \text{Zero} \quad \boxed{M_{z_B} = -37.5\ N \cdot M}$

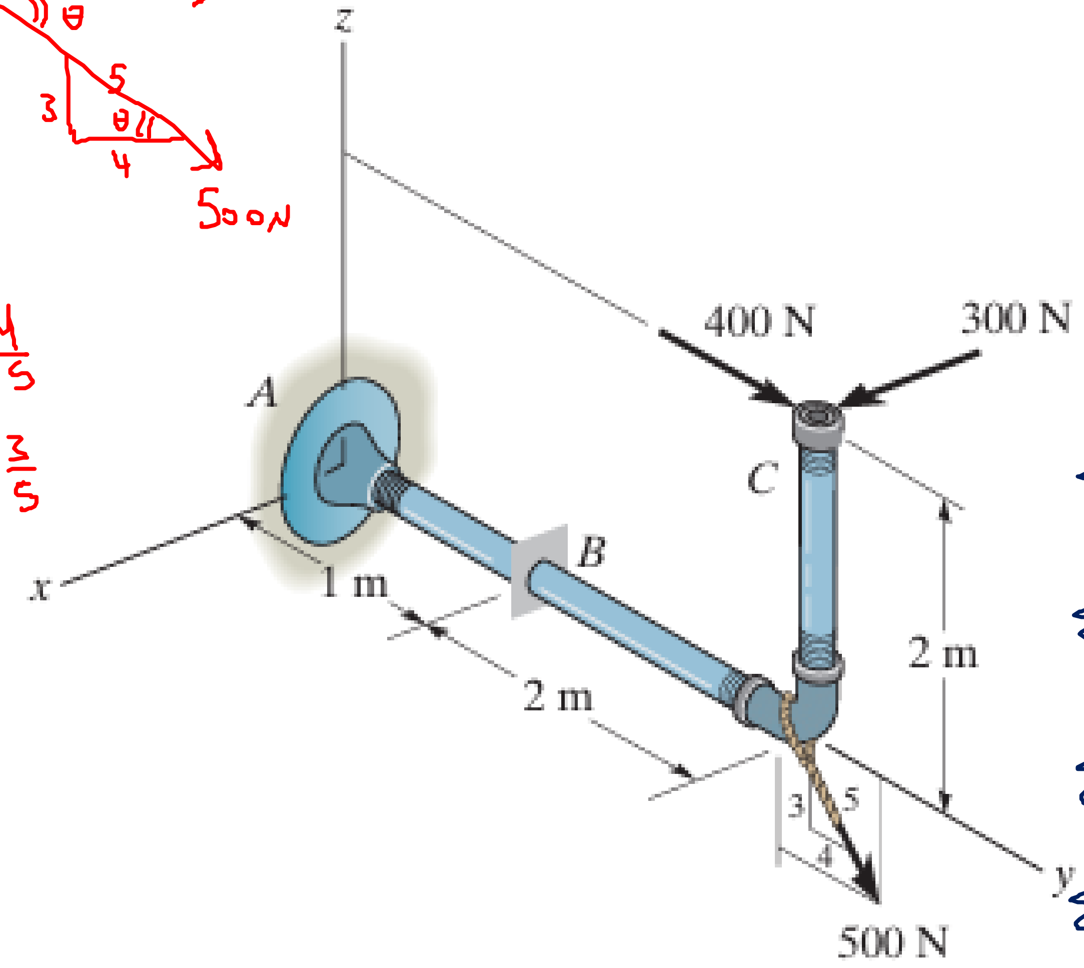


1–27. The pipe has a mass of 12 kg/m. If it is fixed to the wall at A, determine the resultant internal loadings acting on the cross section at B.

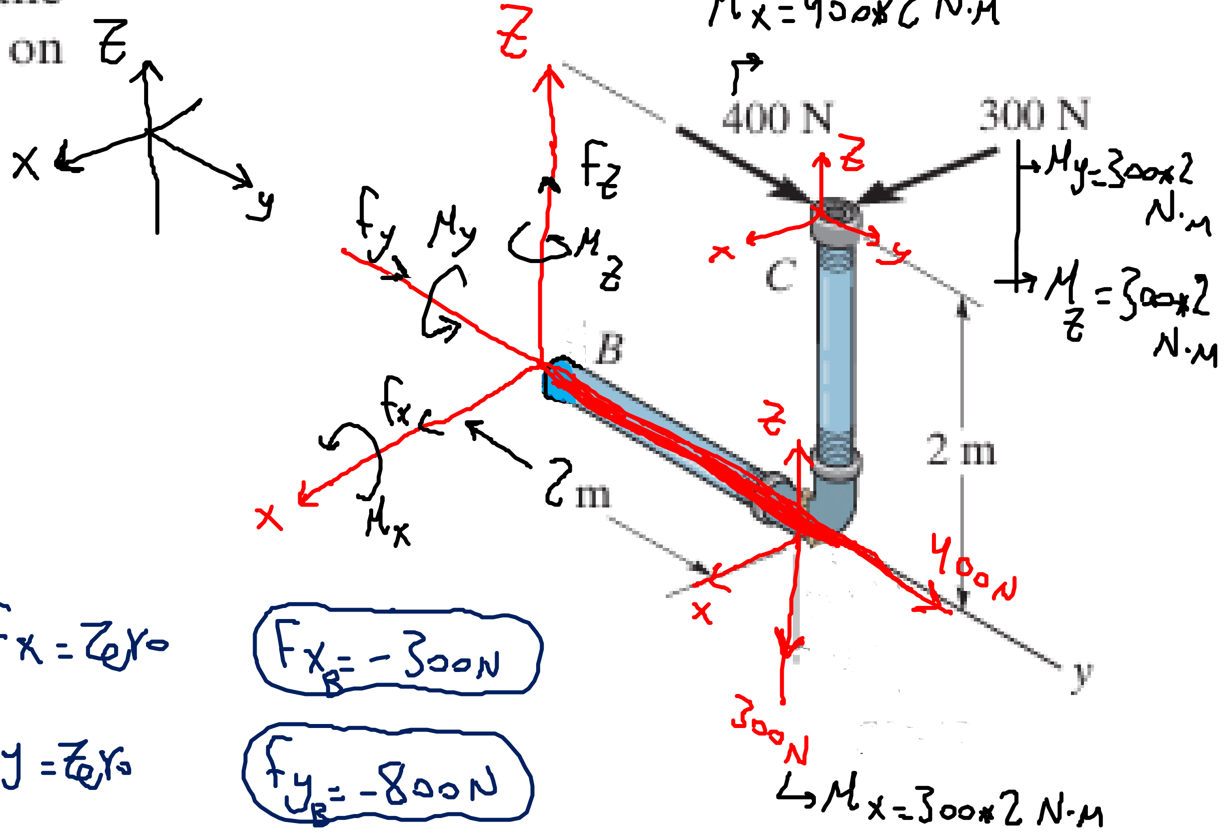


$\cos\theta = \frac{4}{5}$

$\sin\theta = \frac{3}{5}$



Prob. 1–27



$\Sigma F_x = \text{Zero}$ $\quad \boxed{F_{x_B} = -300\,N}$

$\Sigma F_y = \text{Zero}$ $\quad \boxed{F_{y_B} = -800\,N}$

$\Sigma F_z = \text{Zero}$ $\quad \boxed{F_{z_B} = 300\,N}$

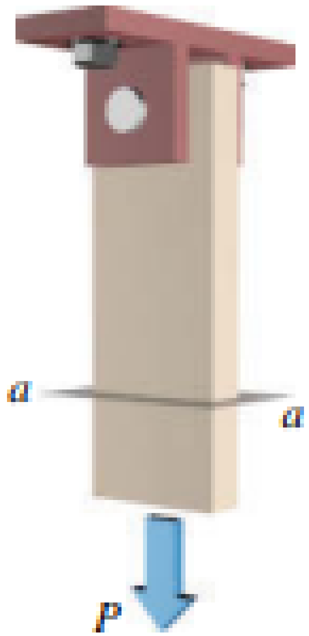
$\Sigma M_x = \text{Zero}$ $\quad 300*2 + 400*2 - M_{x_B} = \text{Zero}$ $\quad \boxed{M_{x_B} = 1400\,N.M}$

$\Sigma M_y = \text{Zero}$ $\quad 300*2 + M_{y_B} = \text{Zero}$ $\quad \boxed{M_{y_B} = -600\,N.M}$

$\Sigma M_z = \text{Zero}$ $\quad 300*2 - M_{z_B} = \text{Zero}$ $\quad \boxed{M_{z_B} = 600\,N.M}$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

$$\sigma = \frac{F}{A}$$



شد أو ضغط

$$\frac{N}{m^2} \longrightarrow \text{Pascal}$$

$$\frac{N}{mm^2} \longrightarrow \text{MPa}$$

$\text{KPa} \rightarrow 10^3\ \text{Pa}$

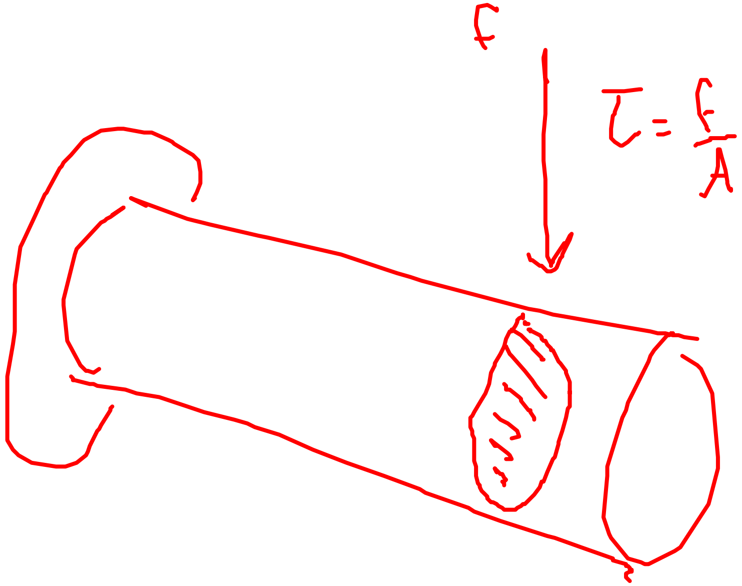
$\text{MPa} \rightarrow 10^6\ \text{Pa}$

$\text{GPa} \rightarrow 10^9\ \text{Pa}$

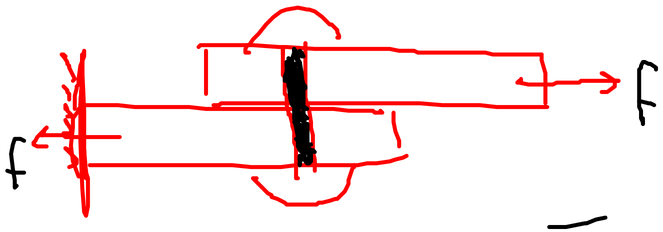
$$\text{Area of circle} = \pi r^2 = \frac{\pi d^2}{4}$$

إجهاد القص

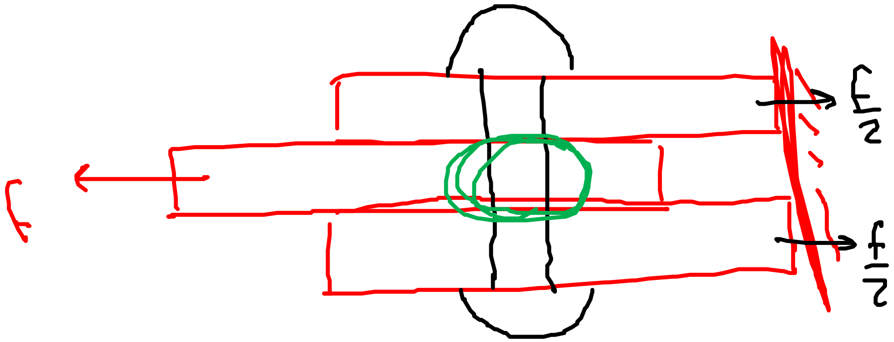
* Shear Stress (τ)



$$\tau = \frac{F}{A}$$



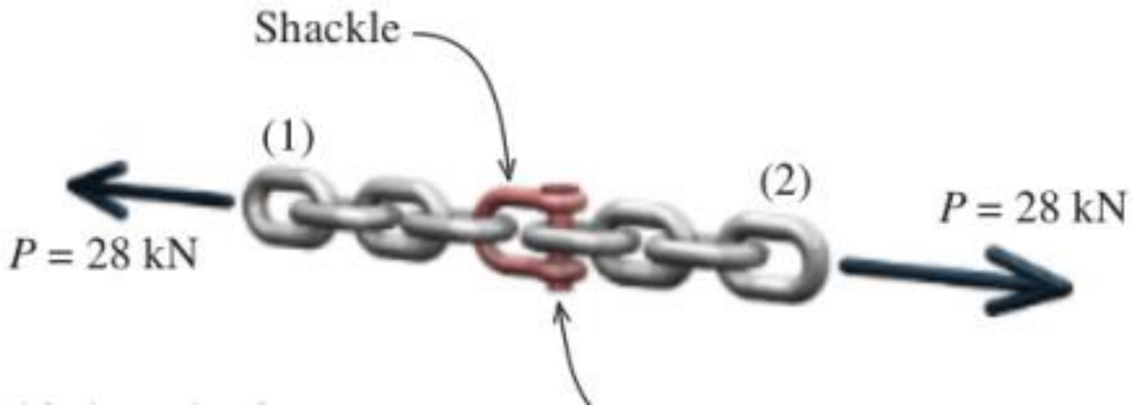
$$\tau = \frac{F}{A} \quad \text{(Single shear)}$$



$$\tau = \frac{F}{2A} \quad \text{(double shear)}$$

EXAMPLE 1.4

Chain members (1) and (2) are connected by a shackle and pin. If the axial force in the chains is $P = 28$ kN and the allowable shear stress in the pin is $\tau_{\text{allow}} = 90$ MPa, determine the minimum acceptable diameter d for the pin.

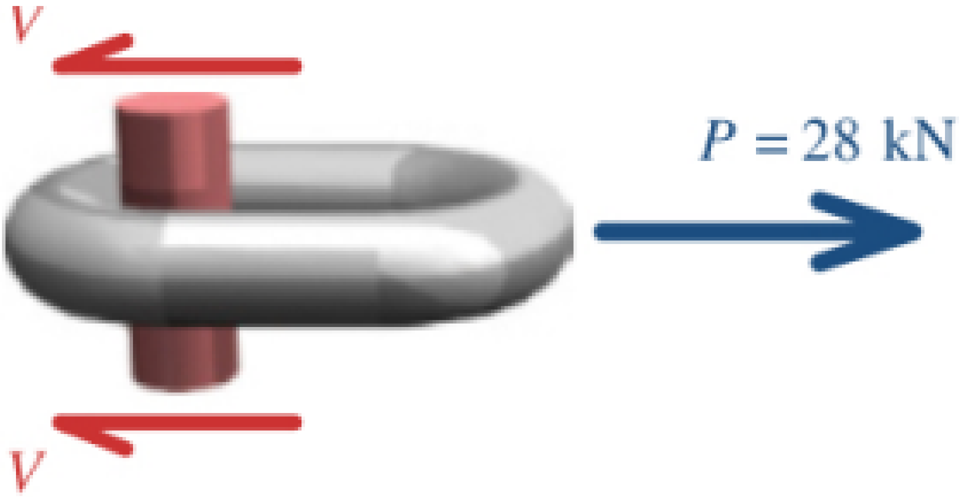


$$\tau = \frac{F}{2A}$$

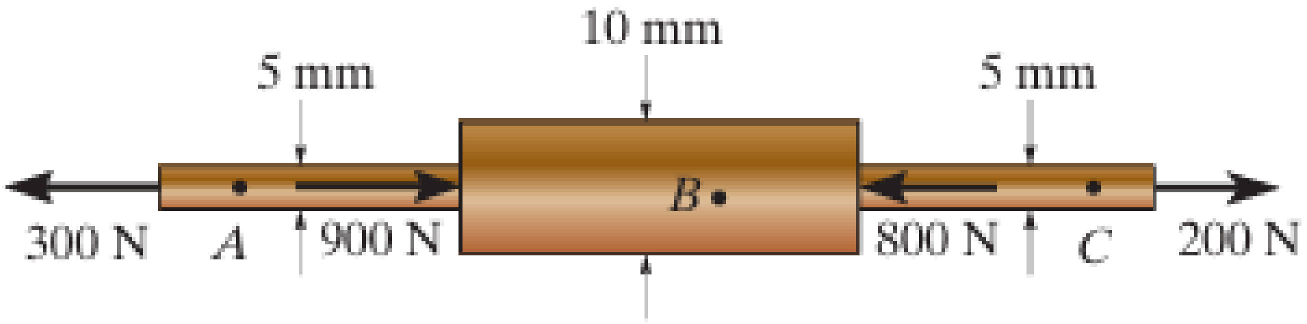
$$90 = \frac{28 * 10^3}{2 * \frac{\pi}{4}(d)^2}$$

$$d = \sqrt{\frac{28 * 10^3}{2 * 90 * \frac{\pi}{4}}} = 14{,}07 \text{ mm}$$

$\hookrightarrow \simeq \underline{\underline{15 \text{ mm}}}$

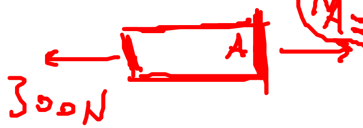


F1–11. Determine the average normal stress developed at points A, B, and C. The diameter of each segment is indicated in the figure.



Prob. F1–11

Point A

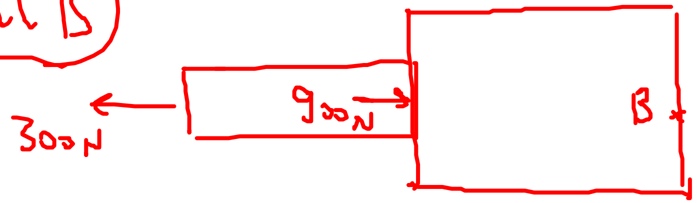


$N_A = 300N$

$$\sigma_A = \frac{300}{\frac{\pi}{4}(5)^2} = 15{,}27\,MPa$$

Tension

Point B

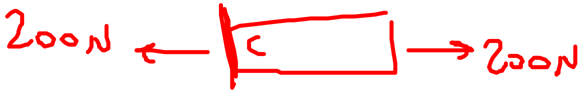


$N_B = 600N$

$$\sigma_B = \frac{600}{\frac{\pi}{4}(10)^2} = 7{,}64\,MPa$$

Compression

Point C

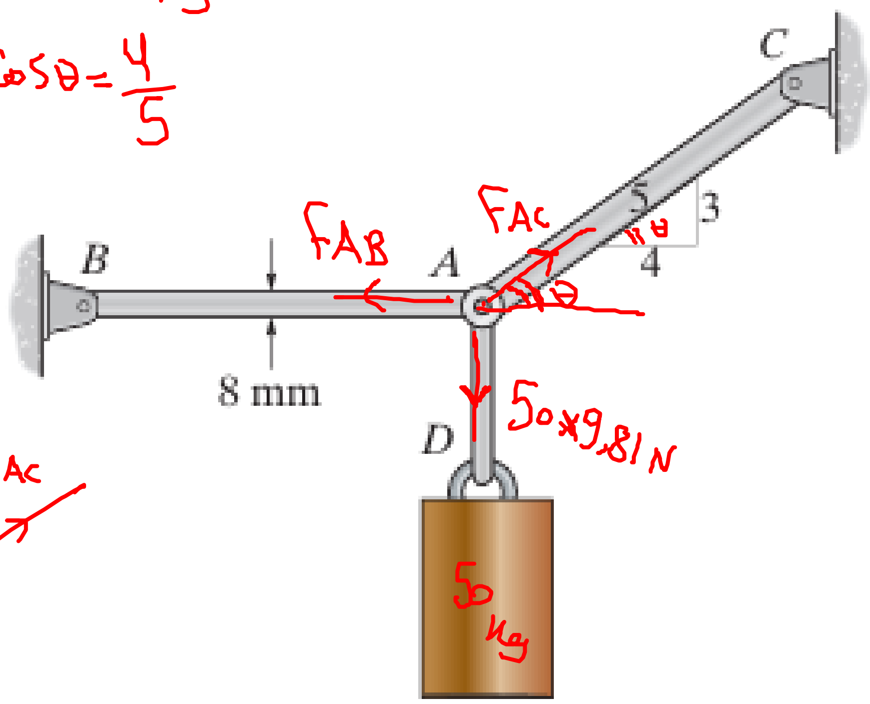


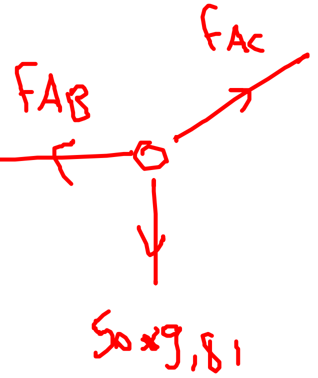
$$\sigma_C = \frac{200}{\frac{\pi}{4}(5)^2} = 10{,}18\,MPa$$

F1–12. Determine the average normal stress in rod AB if the load has a mass of 50 kg. The diameter of rod AB is 8 mm.

$\sin\theta = 3/5$

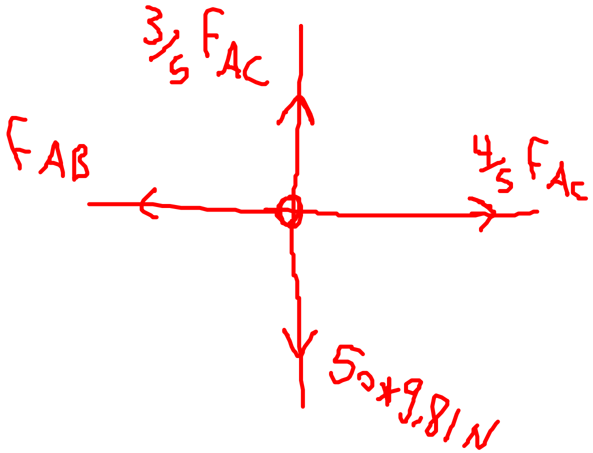
$\cos\theta = \frac{4}{5}$





Prob. F1–12

Joint A



$\Sigma F_y = \text{Zero}$

$\frac{3}{5}F_{AC} = 50*9{,}81$

$F_{AC} = 817{,}5N$

$\Sigma F_x = \text{Zero}$

$\frac{4}{5}*817{,}5 = F_{AB}$

$F_{AB} = 654N$

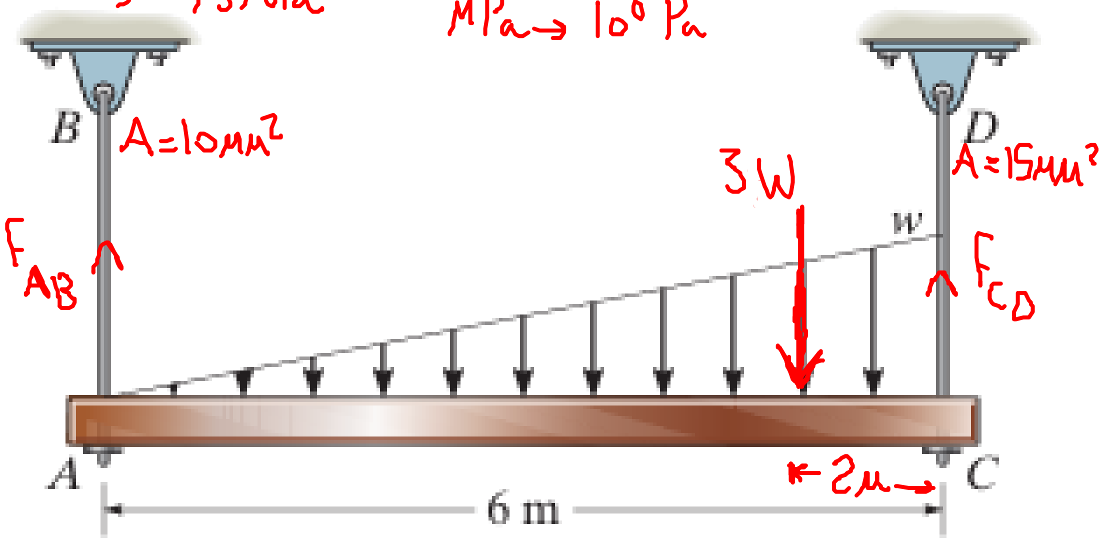
$$\sigma_{AB} = \frac{654}{\frac{\pi}{4}(8)^2} = 13{,}01\,MPa$$

F1–7. The uniform beam is supported by two rods AB and CD that have cross-sectional areas of 10 mm^2 and 15 mm^2, respectively. Determine the intensity w of the distributed load so that the average normal stress in each rod does not exceed 300 kPa.

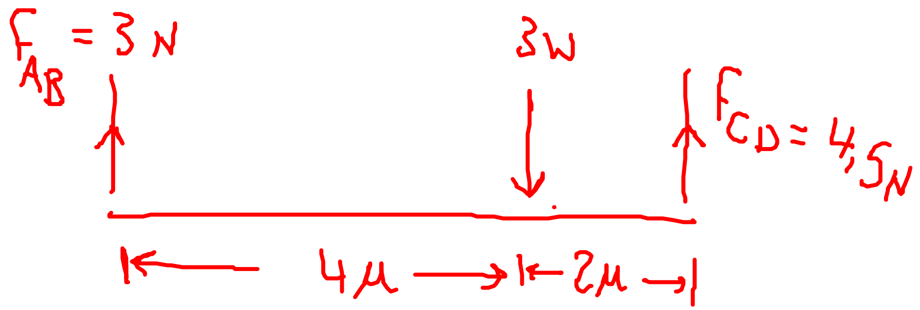
↳ 0,3 MPa

KPa → 10^3 Pa

MPa → 10^6 Pa



Prob. F1–7



$CD \rightarrow \quad 0{,}3 = \dfrac{F_{CD}}{15} \qquad F_{CD} = 4{,}5\ N$

$AB \rightarrow \quad 0{,}3 = \dfrac{F_{AB}}{10} \qquad F_{AB} = 3\ N$

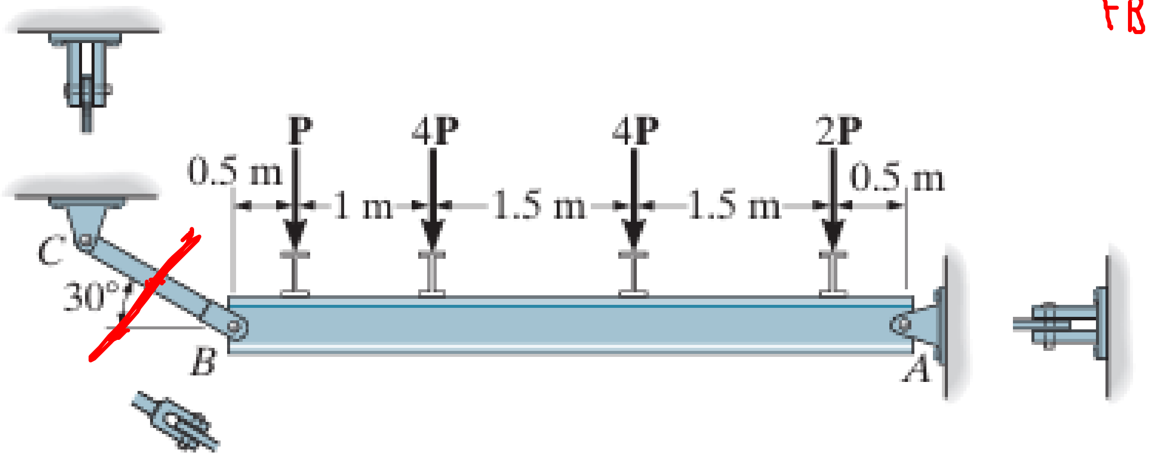
$\sum F_y = \text{Zero}$

$3W = 7{,}5$

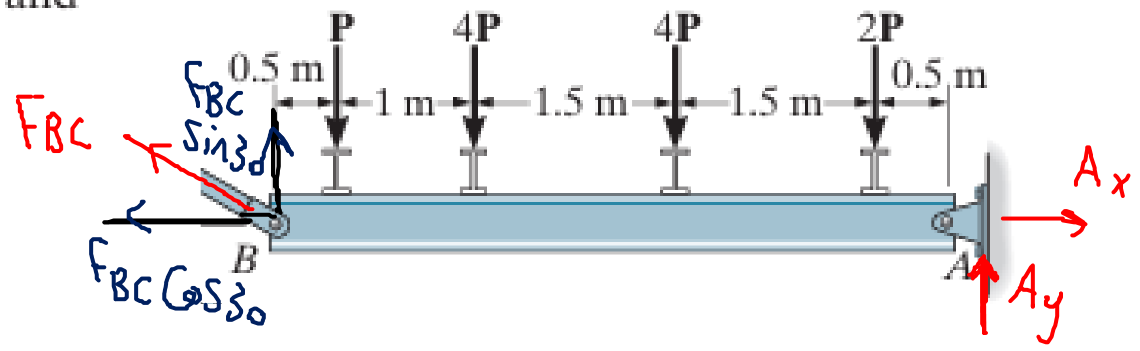
$W = \dfrac{7{,}5}{3}$

$\boxed{W = 2{,}5\ \frac{N}{m}}$

1–47. If $P = 15$ kN, determine the average shear stress in the pins at A, B, and C. All pins are in double shear, and each has a diameter of 18 mm.



Prob. 1–47



$$\Sigma M_A = \text{Zero}$$

$$2P(0.5) + 4P(2) + 4P(3.5) + P(4.5) - F_{BC} * \tfrac{1}{2} * 5 = \text{Zero}$$

$$\boxed{F_{BC} = 11\,P}$$

$$\Sigma F_x = \text{Zero} \qquad A_x = F_{BC}\cos 30$$

$$\boxed{A_x = 9.526\,P}$$

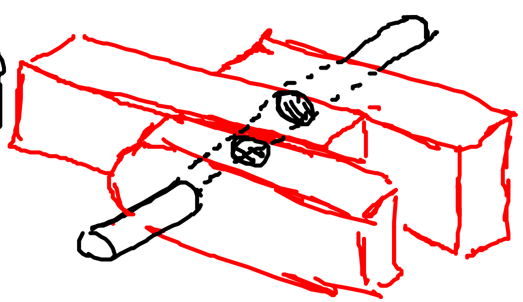
$$\Sigma F_y = \text{Zero} \qquad A_y + 11P\sin 30 - 11P = \text{Zero}$$

$$\boxed{A_y = 5.5\,P}$$

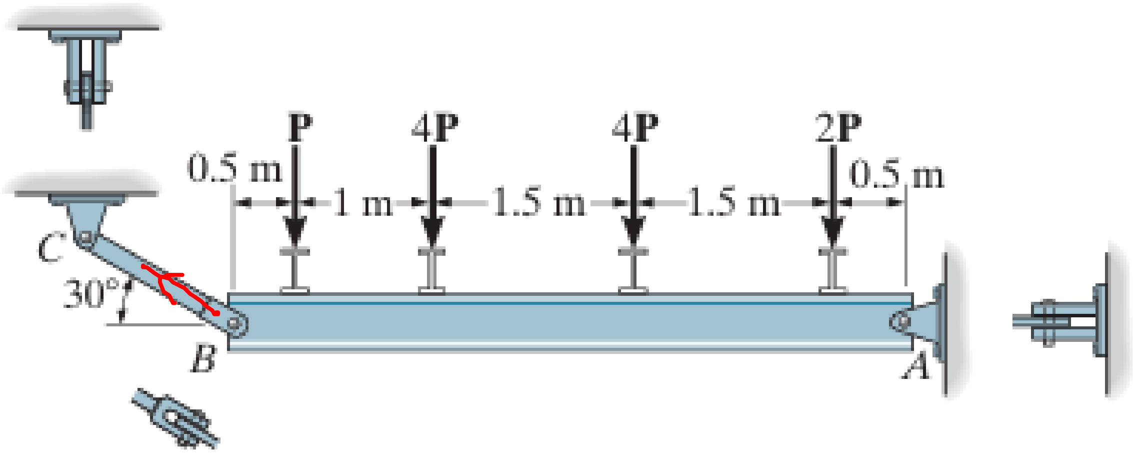
$$\tau = \frac{F}{2A}$$

$$R_A = \sqrt{(5.5P)^2 + (9.526P)^2} = 11\,P$$

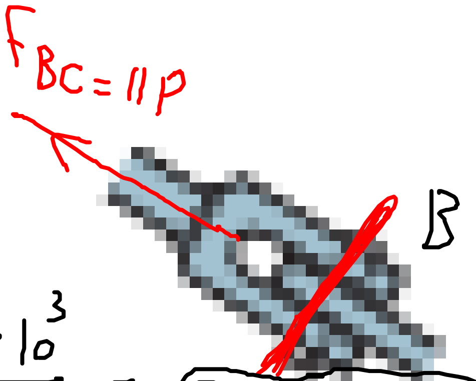
$$\tau_A = \frac{11 * 15 * 10^3}{2 * \frac{\pi}{4}(18)^2} = 324.2 \text{ MPa}$$



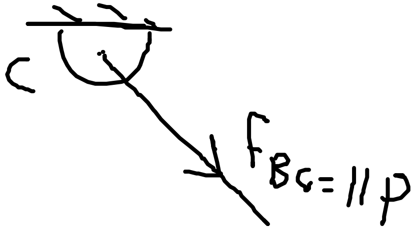
1–47. If $P = 15$ kN, determine the average shear stress in the pins at A, B, and C. All pins are in double shear, and each has a diameter of 18 mm.



Prob. 1–47

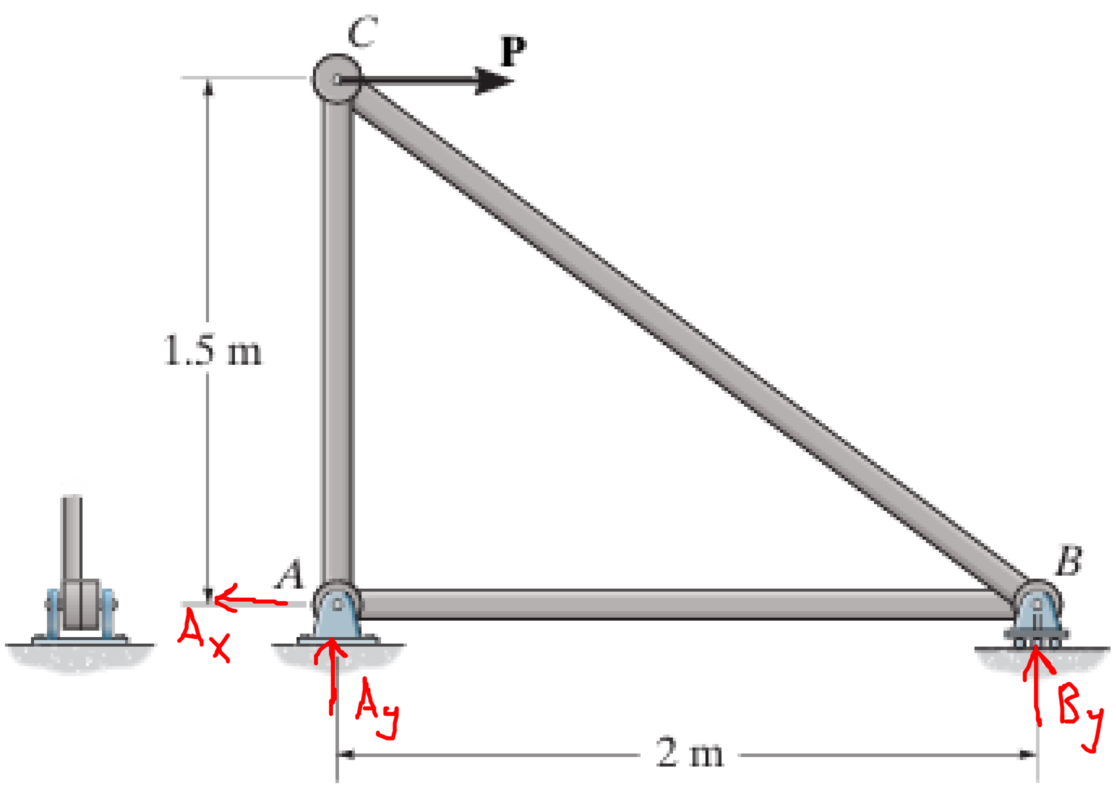


$$\tau_B = \frac{F}{2A} = \frac{11 * 15 * 10^3}{2 * \frac{\pi}{4}(18)^2} = 324,2 \text{ MPa}$$



$$\tau_C = \frac{F}{2A} = \frac{11 * 15 * 10^3}{2 * \frac{\pi}{4}(18)^2} = 324,2 \text{ MPa}$$

* Solve the truss



Probs. 1–39/40/41

$\sum M_A = \text{Zero}$

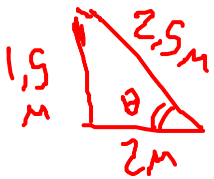
$1{,}5P - 2B_y = \text{Zero}$

$\boxed{B_y = 0{,}75P}$

$\sum F_x = \text{Zero}$ $\quad \boxed{A_x = P}$

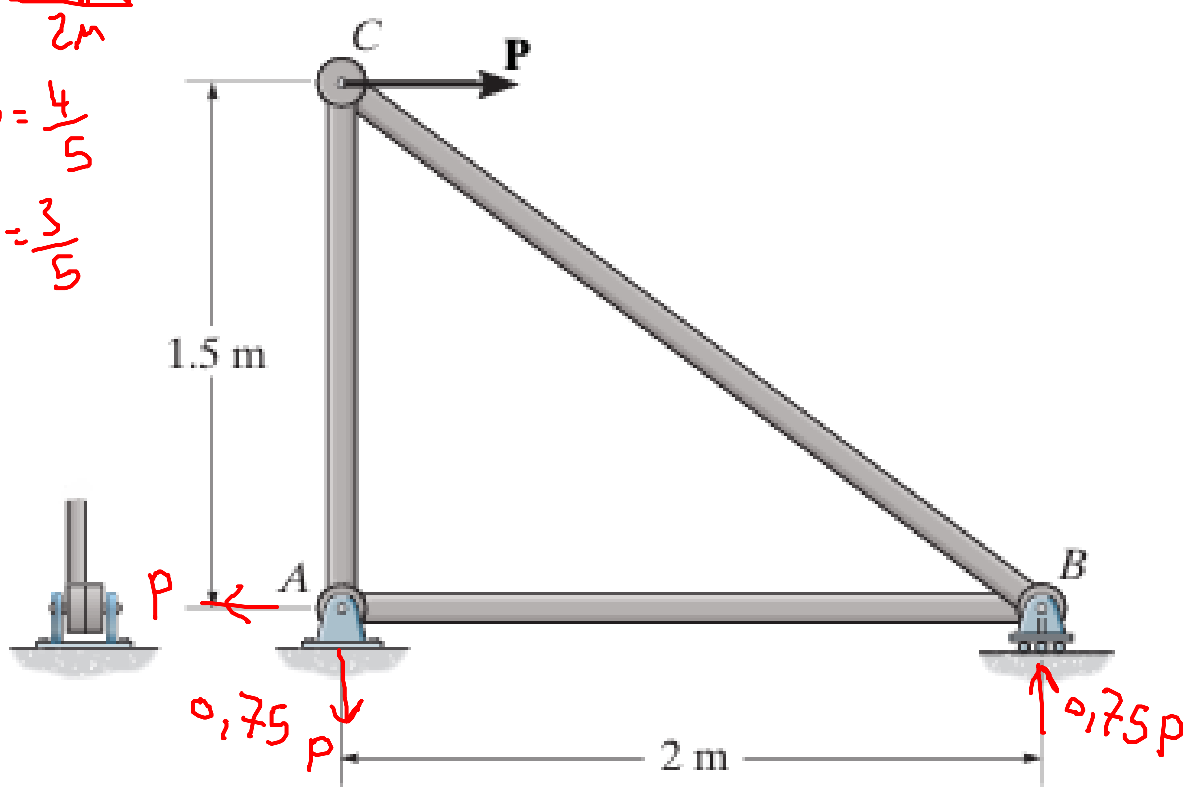
$\sum F_y = \text{Zero}$ $\quad A_y + 0{,}75P = \text{Zero}$

$\boxed{A_y = -0{,}75P}$



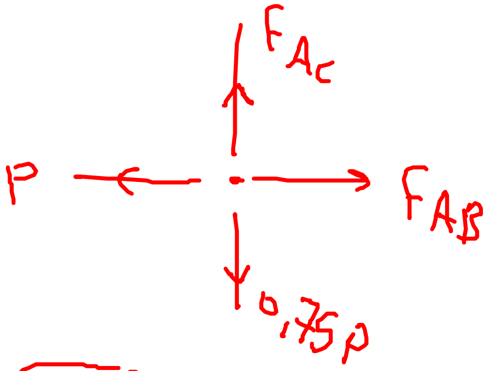
$\cos\theta = \frac{4}{5}$

$\sin\theta = \frac{3}{5}$



Probs. 1–39/40/41

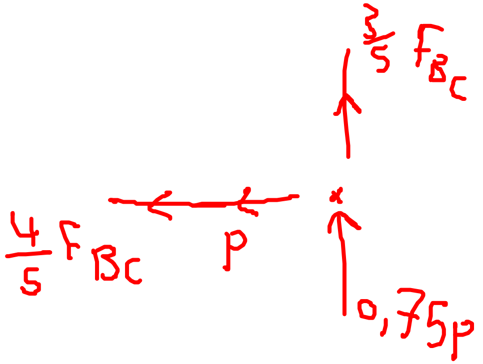
Joint A



$\Sigma F_x = \text{Zero} \rightarrow \boxed{F_{AB} = P}$

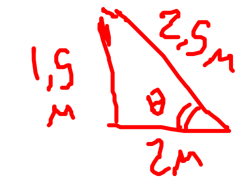
$\Sigma F_y = \text{Zero} \rightarrow \boxed{F_{AC} = 0{,}75P}$

Joint B



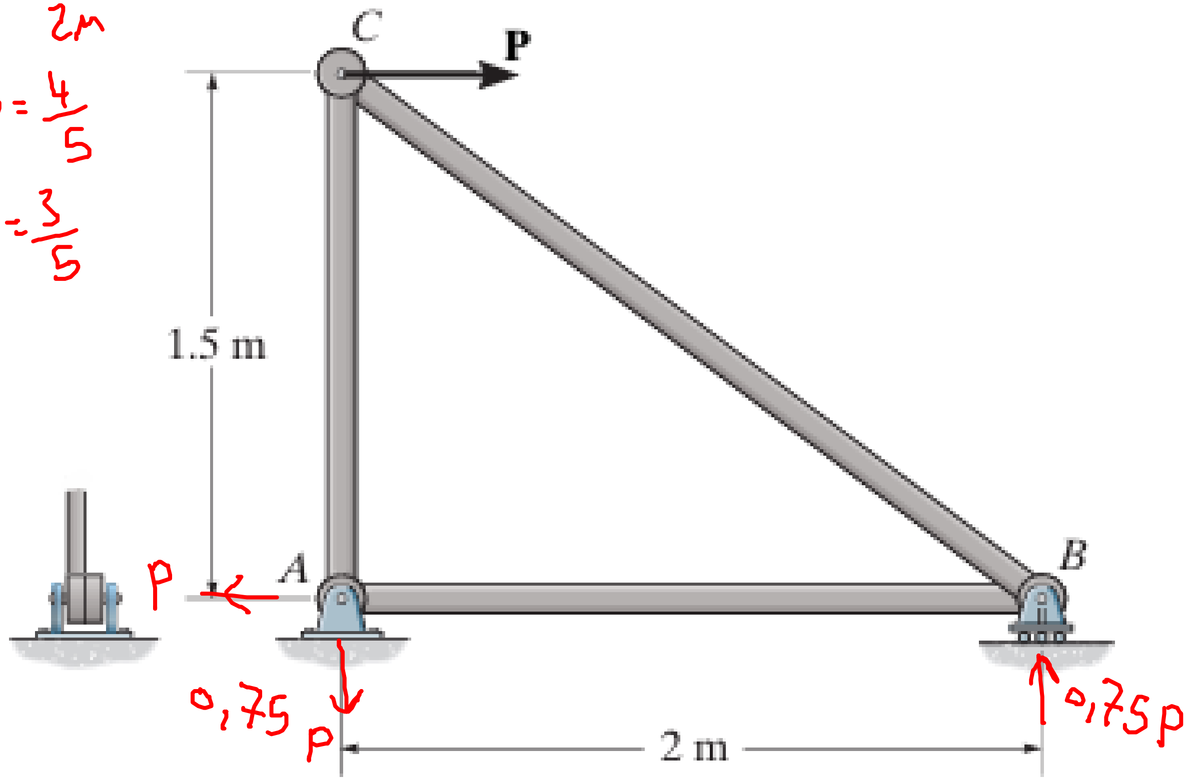
$\Sigma F_y = \text{Zero} \qquad \frac{3}{5} F_{BC} + 0{,}75P = \text{Zero}$

$$\boxed{F_{BC} = -1{,}25P}$$



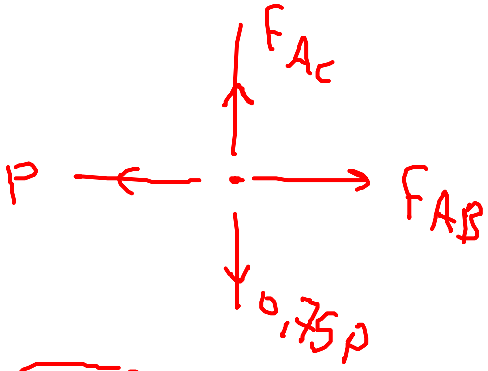
$\cos\theta = \frac{4}{5}$

$\sin\theta = \frac{3}{5}$



Probs. 1–39/40/41

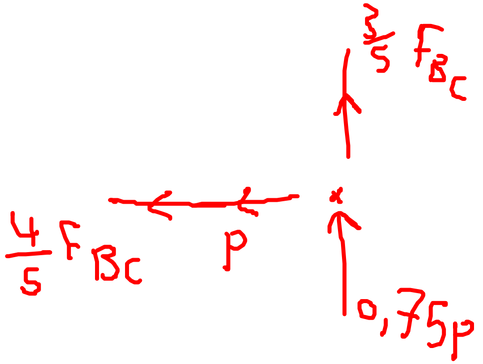
Joint A



$\Sigma F_x = \text{Zero} \rightarrow \boxed{F_{AB} = P}$

$\Sigma F_y = \text{Zero} \rightarrow \boxed{F_{AC} = 0,75P}$

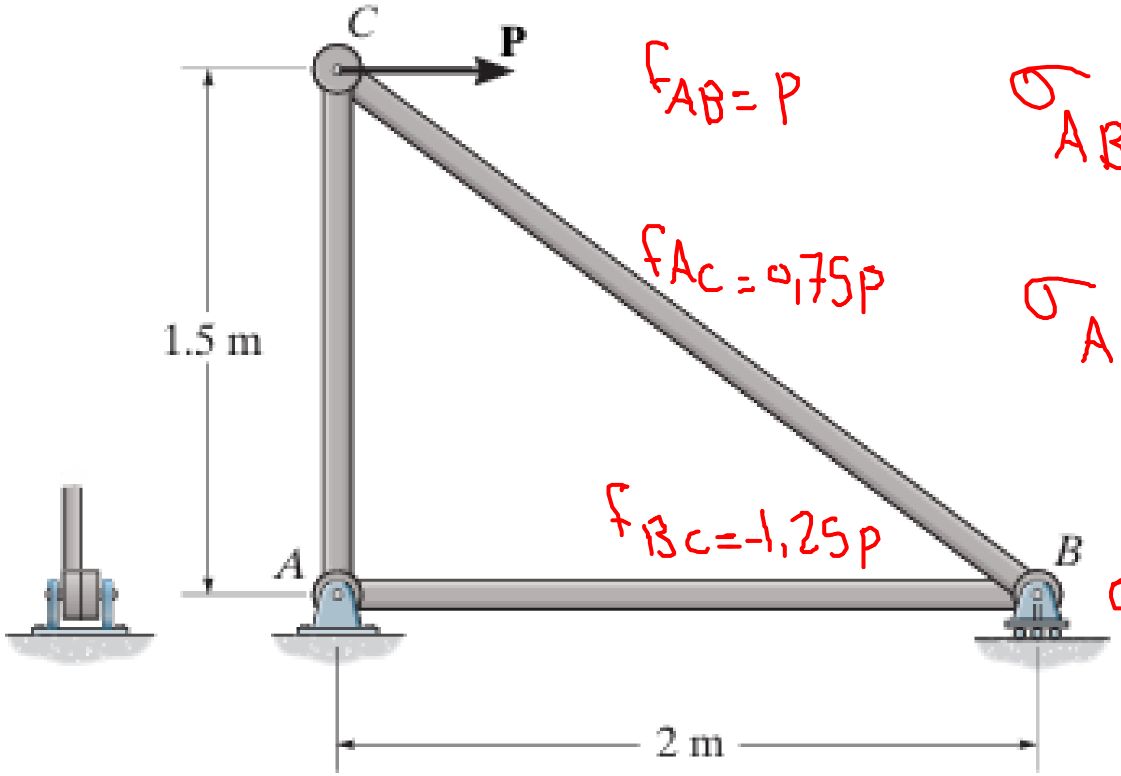
Joint B



$\Sigma F_y = \text{Zero}$ $\quad \frac{3}{5} F_{BC} + 0,75P = \text{Zero}$

$\boxed{F_{BC} = -1,25P}$

1–39. Determine the average normal stress in each of the 20-mm-diameter bars of the truss. Set $P = 40$ kN.



$F_{AB} = P$

$F_{AC} = 0{,}75P$

$F_{BC} = -1{,}25P$

Probs. 1–39/40/41

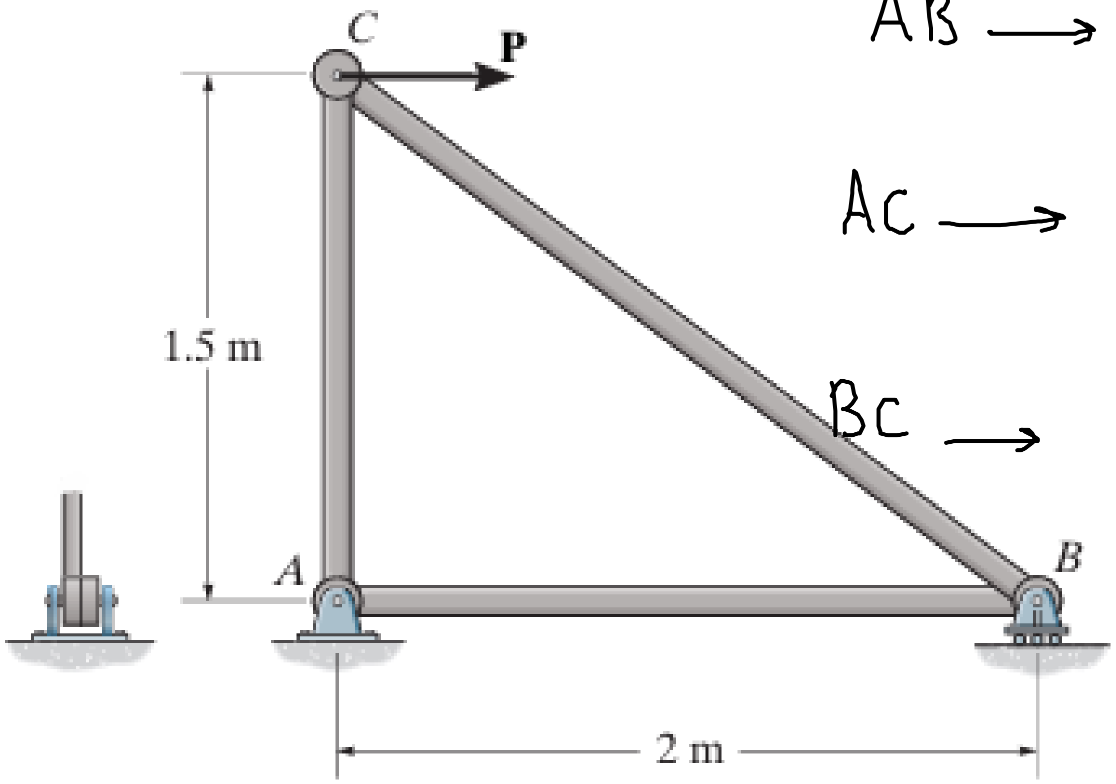
$$\sigma = \frac{F}{A}$$

$$\sigma_{AB} = \frac{40 * 10^3}{\frac{\pi}{4}(20)^2} = \square \text{ MPa (T)}$$

$$\sigma_{AC} = \frac{0{,}75 * 40 * 10^3}{\frac{\pi}{4}(20)^2} = \text{ MPa (T)}$$

$$\sigma_{BC} = \frac{1{,}25 * 40 * 10^3}{\frac{\pi}{4}(20)^2} = \text{ MPa (C)}$$

***1–40.** If the average normal stress in each of the 20-mm-diameter bars is not allowed to exceed 150 MPa, determine the maximum force **P** that can be applied to joint *C*.



Probs. 1–39/40/41

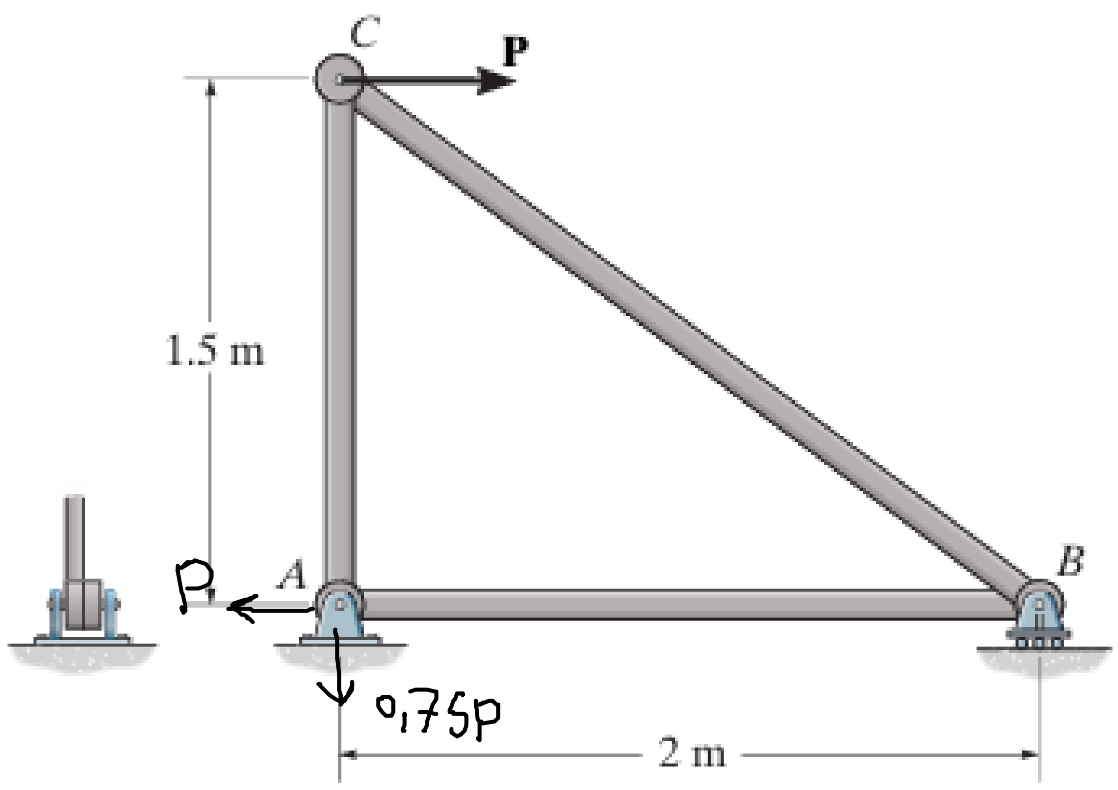
$AB \rightarrow \quad 150 = \dfrac{P}{\frac{\pi}{4}(20)^2} \qquad P = 47123{,}8\,N$

$AC \rightarrow \quad 150 = \dfrac{0{,}75\,P}{\frac{\pi}{4}(20)^2} \qquad P = 62831{,}85\,N$

$BC \rightarrow \quad 150 = \dfrac{1{,}25\,P}{\frac{\pi}{4}(20)^2} \qquad P = 37699{,}11\,N$

↳ اختار الأصغر

1–41. Determine the maximum average shear stress in pin A of the truss. A horizontal force of $P = 40$ kN is applied to joint C. Each pin has a diameter of 25 mm and is subjected to double shear.



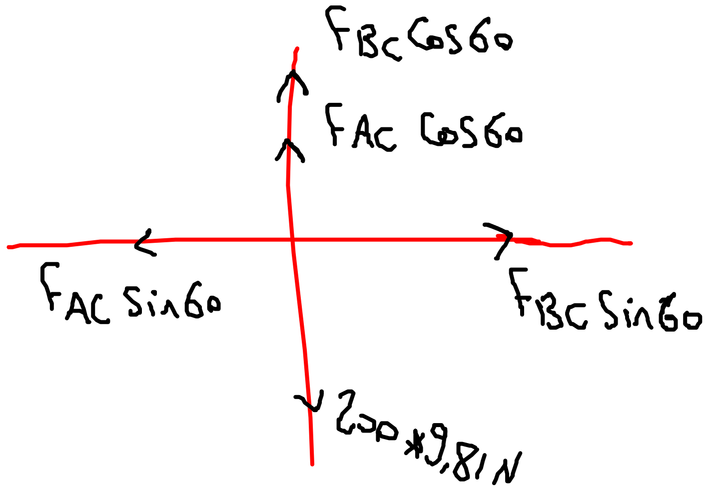
Probs. 1–39/40/41

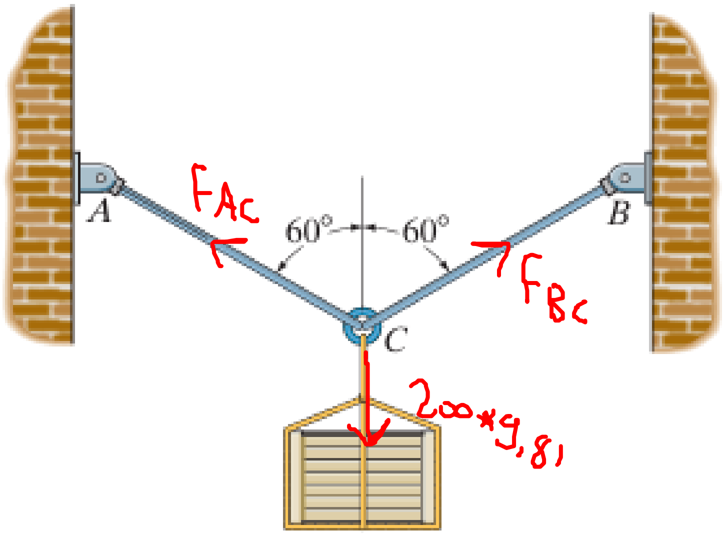
$$R_A = \sqrt{P^2 + (0{,}75P)^2} = 1{,}25\,P$$

$$\tau = \frac{F}{2A} = \frac{1{,}25 * 40 * 10^3}{2 * \frac{\pi}{4}(25)^2} = 50{,}92\,MPa$$

F1–13. Rods *AC* and *BC* are used to suspend the 200-kg mass. If each rod is made of a material for which the average normal stress cannot exceed 150 MPa, determine the minimum required diameter of each rod to the nearest mm.

Joint C





Prob. F1–13

$\Sigma F_x = \text{Zero}$ $\quad F_{AC} = F_{BC}$

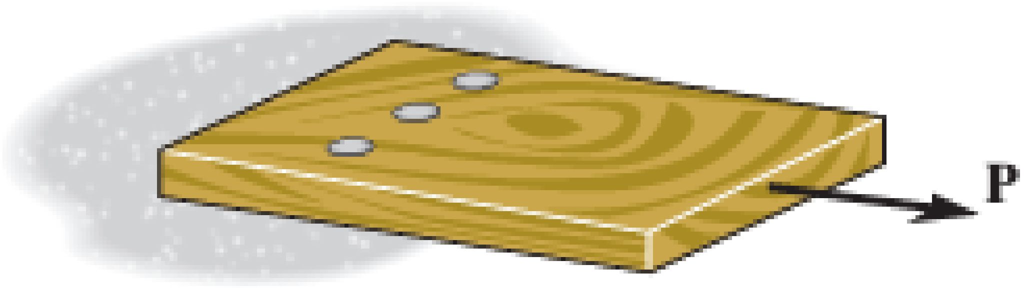
$\Sigma F_y = \text{Zero}$ $\quad 2 F_{AC} \cos 60 = 200 * 9{,}81$

$F_{AB} = F_{AC} = 1962\,N$

$\sigma = \dfrac{f}{A}$ $\quad 150 = \dfrac{1962}{\frac{\pi}{4} d^2}$ $\quad d = \sqrt{\dfrac{1962}{\frac{\pi}{4} * 150}} = 4{,}08\,mm$

$\simeq 5\,mm$

F1–16. If each of the three nails has a diameter of 4 mm and can withstand an average shear stress of 60 MPa, determine the maximum allowable force **P** that can be applied to the board.



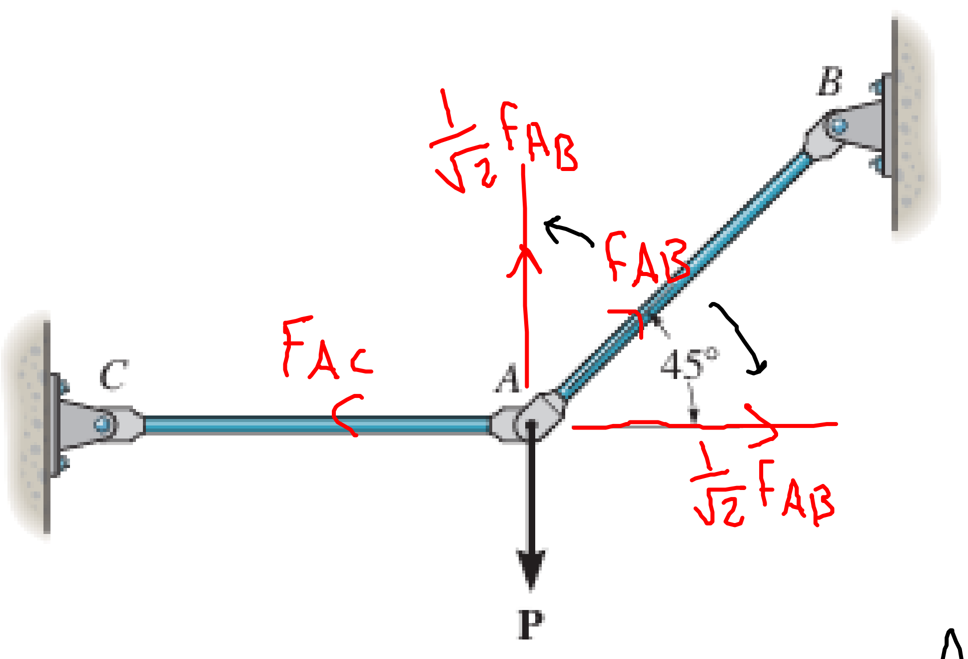
Prob. F1–16

$$\tau = \frac{P}{3A}$$

$$60 = \frac{P}{3 * \frac{\pi}{4}(4)^2}$$

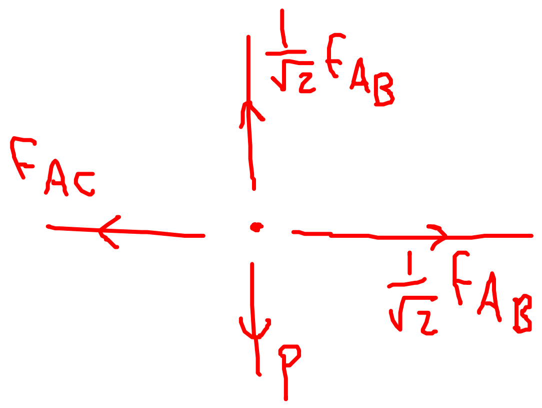
$$\boxed{P = 2261{,}94\,N}$$

1–90. The two aluminum rods support the vertical force of $P = 20$ kN. Determine their required diameters if the allowable tensile stress for the aluminum is $\sigma_{allow} = 150$ MPa.



Prob. 1–90

Joint A



$\sum F_y = \text{Zero}$ $\qquad \frac{1}{\sqrt{2}} F_{AB} = P$ $\qquad \boxed{F_{AB} = \sqrt{2}\, P}$

$\sum F_x = \text{Zero}$ $\qquad \frac{1}{\sqrt{2}} * \sqrt{2}\, P = F_{AC}$ $\qquad \boxed{F_{AC} = P}$

AB $\rightarrow$ $\quad 150 = \dfrac{\sqrt{2} * 20 * 10^3}{\frac{\pi}{4} d^2}$ $\qquad \boxed{d_{AB} = 15{,}5\ mm}$

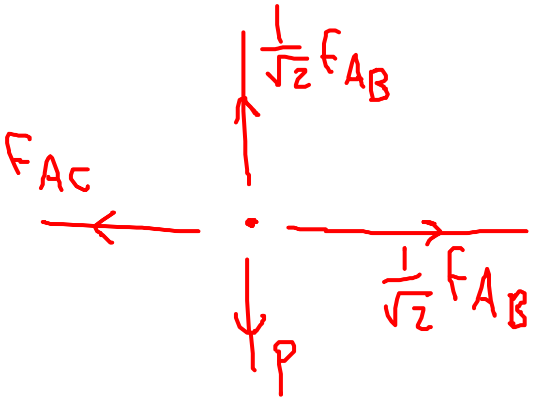
$\hookrightarrow \simeq 16\ mm$

AC $\rightarrow$ $\quad 150 = \dfrac{20 * 10^3}{\frac{\pi}{4} d^2}$ $\qquad \boxed{d_{AC} = 13{,}03\ mm}$

$\hookrightarrow \simeq 14\ mm$

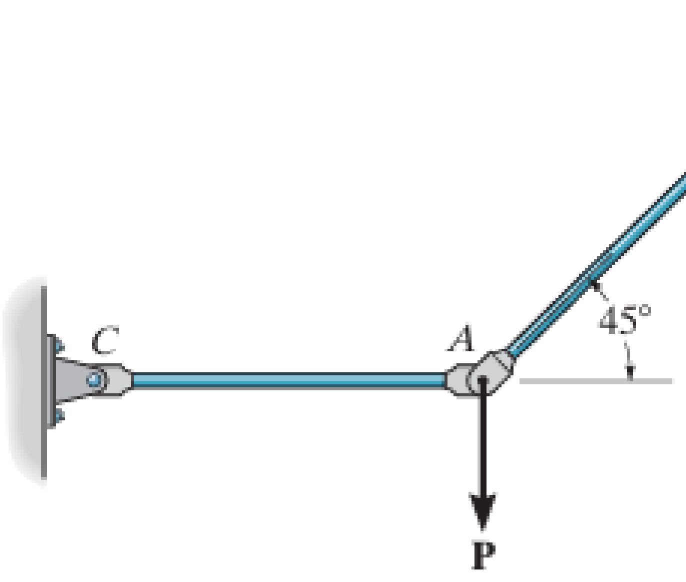
1–91. The two aluminum rods AB and AC have diameters of 10 mm and 8 mm, respectively. Determine the largest vertical force **P** that can be supported. The allowable tensile stress for the aluminum is $\sigma_{allow} = 150$ MPa.

Joint A



$\sum F_y = \text{zero}$ $\qquad \frac{1}{\sqrt{2}} F_{AB} = P \qquad \boxed{F_{AB} = \sqrt{2}\, P}$

$\sum F_x = \text{zero}$ $\qquad \frac{1}{\sqrt{2}} \times \sqrt{2}\, P = F_{AC} \qquad \boxed{F_{AC} = P}$



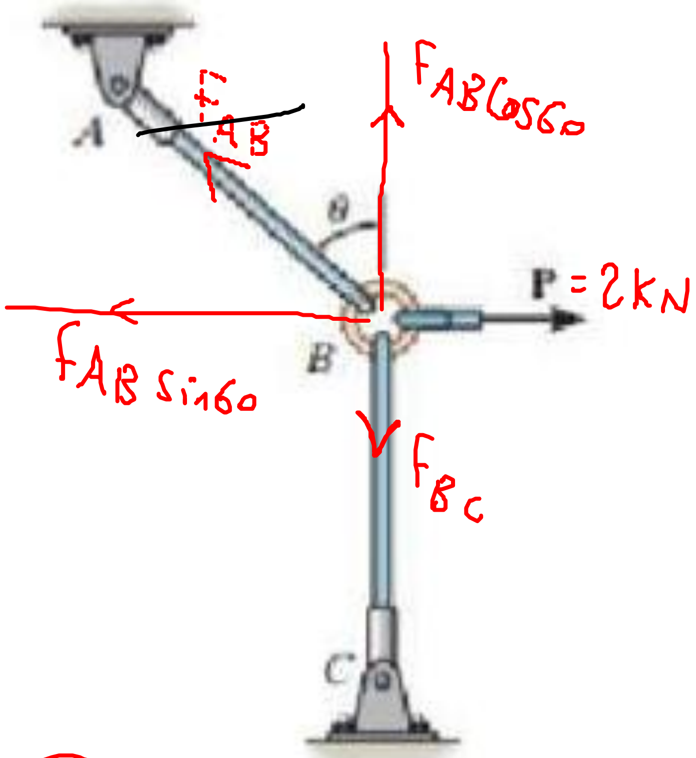
Prob. 1–91

$AB \rightarrow \quad 150 = \dfrac{\sqrt{2}\, P}{\frac{\pi}{4}(10)^2} \rightarrow \quad P = 8330{,}4 \text{ N}$

$AC \rightarrow \quad 150 = \dfrac{P}{\frac{\pi}{4}(8)^2} \rightarrow \quad \boxed{P = 7539{,}8 \text{ N}}$

اختار الأصغر

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 $\theta = 60°$.



$\Sigma F_x = \text{Zero}$

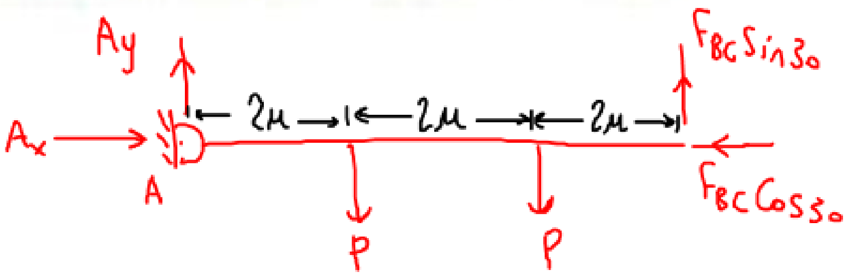
$F_{AB} \sin 60 = 2$ $\qquad$ $F_{AB} = 2,309$ kN

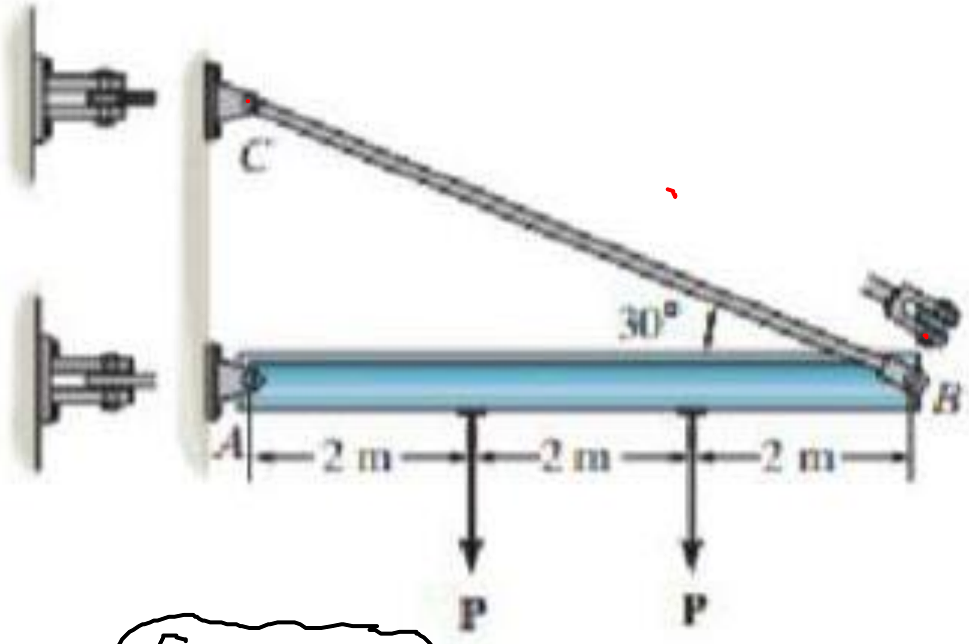
$\Sigma F_y = \text{Zero}$

$2,309 \cos 60 = F_{BC}$ $\qquad$ $F_{BC} = 1,154$ kN

$\sigma_{AB} = \dfrac{2,309 \times 10^3}{\frac{\pi}{4}(5)^2} = 117,59\,\text{MPa}$, $\quad \sigma_{BC} = \dfrac{1,154 \times 10^3}{\frac{\pi}{4}(5)^2} = 58,77\,\text{MPa}$

Determine the maximum magnitude P of the load the beam will support if the average shear stress in each pin is not to allowed to exceed 60 MPa. All pins are subjected to double shear as shown, and each has a diameter of 18 mm.





$\Sigma M_A = \text{Zero}$ $\qquad 2P + 4P - 6 * F_{BC}\sin 30 = \text{Zero} \rightarrow \boxed{F_{BC} = 2P}$

$\Sigma F_x = \text{Zero}$ $\qquad A_x = F_{BC}\cos 30 = 2P\cos 30$ $\qquad A_x = \sqrt{3}\,P$

$\Sigma F_y = \text{Zero}$ $\qquad A_y + F_{BC}\sin 30 - 2P = \text{Zero}$ $\qquad A_y = P$ $\qquad R_A = \sqrt{(\sqrt{3}\,P)^2 + P^2} = \boxed{2P}$

$$\tau = \frac{F}{2A} \rightarrow 60 = \frac{2P}{2 * \frac{\pi}{4}(18)^2}$$

$$\boxed{P = 15268.14\,N}$$