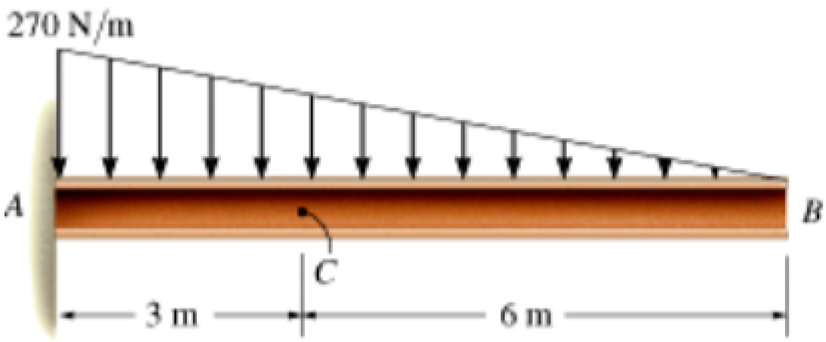
EX_1

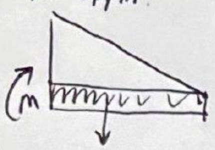
EX 1.1

Determine internal forces acting on cross section at C of beam



(a)

180 N/m   take BC for consideration



$\therefore F = \frac{1}{2} \times 180 \times 6 = 540N$ $V = F = 540N \uparrow$

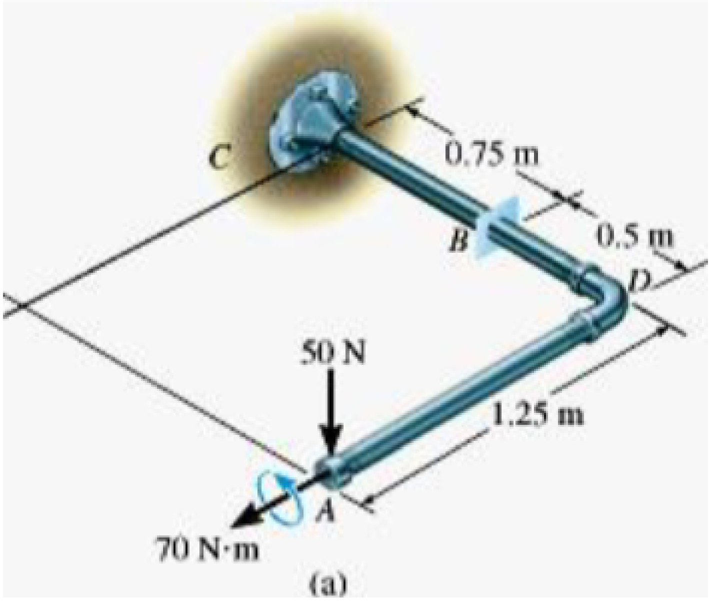
$\bar{x} = \frac{1}{3} \cdot 6 = 2m$ $N_c = 0\ N$

$\therefore M = 540 \times 2 = 1080\ N \cdot m$ CW

which means $M < 0$ then $M_c = -1080\ N \cdot m$

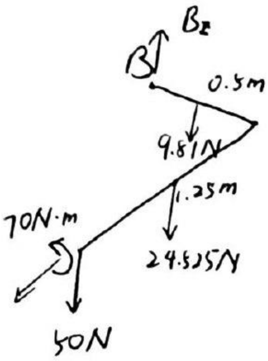
EX 1.2

Determine internal forces acting on cross section at B of pipe



(a)

mass of pipe = 2kg/m



$$\Sigma F_z = 0$$

$$B_z = 9.81 + 24.525 + 50 = 84.335\,N$$

$$\Sigma M_x = 0$$

$$M_{Bx} + 70 = (50 + 24.525) \cdot 0.5 + 9.81 \cdot 0.25$$

$$M_{Bx} = -30.285\,N \cdot m$$

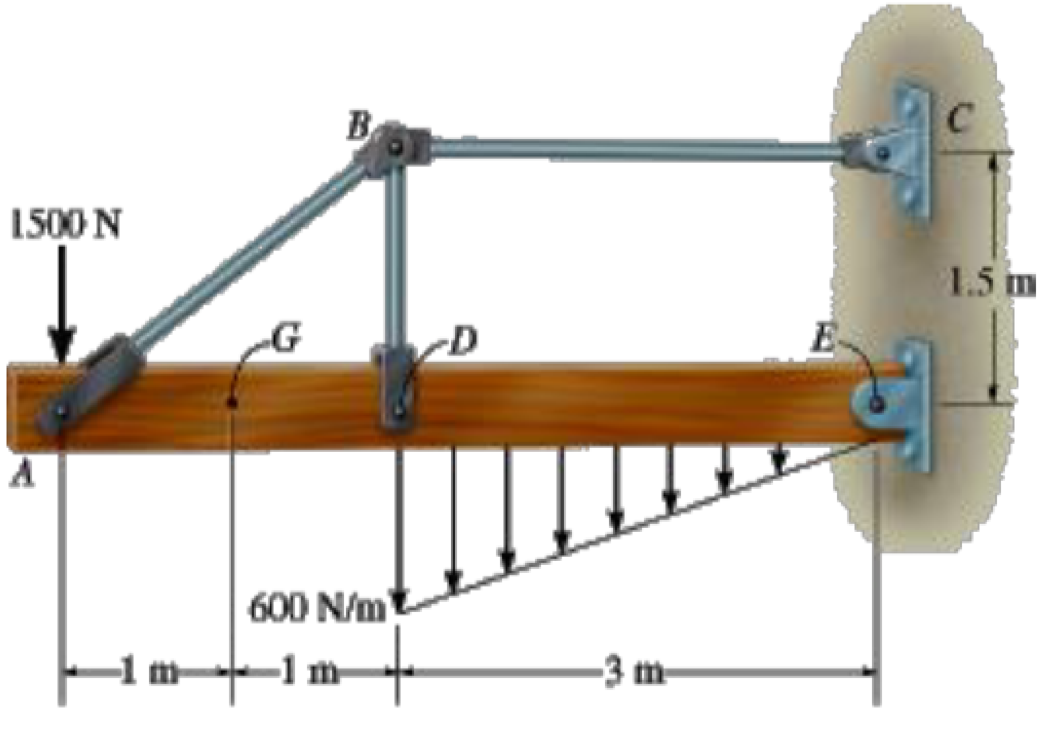
which means M_{Bx} CCW

for F
$$\begin{cases} B_x = 0 \\ B_y = 0 \\ B_z = 84.34N \end{cases}$$

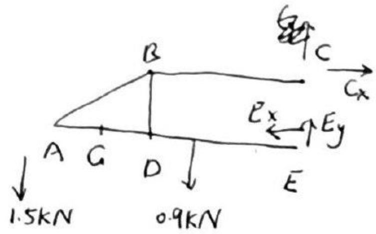
for M
$$\begin{cases} M_{Bx} = -30.29\ N \cdot m \\ M_{By} = 0\ N \cdot m \\ M_{Bz} = 0\ N \cdot m \end{cases}$$

EX 1.3

Determine the resultant loadings acting on the cross section at G of the wooden beam shown in the following figure. Assume the joints at A, B, C, D and E are pin connected



(a)



$\Sigma F_y = 0$

$E_y = 1500 + \frac{1}{2}\times 600 \times 3$

$\Sigma F_x = 0$

$C_x = E_x$

$\Sigma M_C = 0$

$1.5\ E_x = 1500\times 5 + 900\times 2$

$E_x = 6200\ N$

$\cancel{\Sigma M_E = 0}$

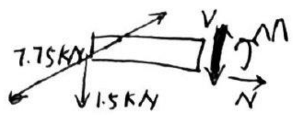
$\cancel{\Sigma M_A = 0}$

$\Rightarrow \begin{cases} E_y = 2.4kN \\ E_x = C_x = 6.2kN \end{cases}$

for cross section G

since $AB:BD:AD = 5:3:4$

$F_{AB} = \frac{5}{4}E_x = 7.75kN$



$V = -1.5 + 7.75\times\frac{3}{5} = 3.15\ kN$

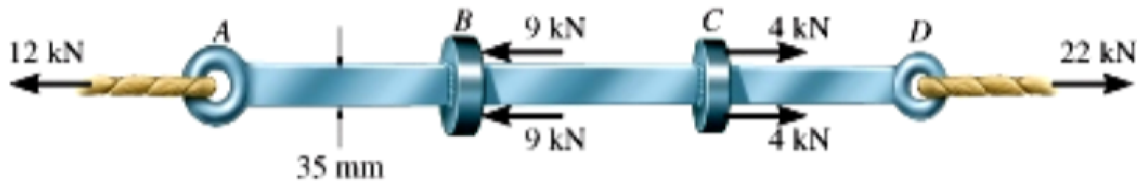
$N = -7.75\times\frac{4}{5} = -6.2kN$

$M_G = V\cdot 1m = 3.15\ kN\cdot m$ CCW

EX 1.4

bar width = 35 mm, thickness = 10 mm

Determine max, average normal stress in bar when subjected to loading shown



for AB $F = 12\ kN$

$$\sigma = \frac{F}{d \cdot t} = \frac{12 kN}{(35 \times 10) \times 10^{-6}\ \cancel{mm^2}} = 34.29 MPa$$

for BC $F = 30\ kN$

$$\sigma = \frac{F}{dt} = 85.71 MPa$$

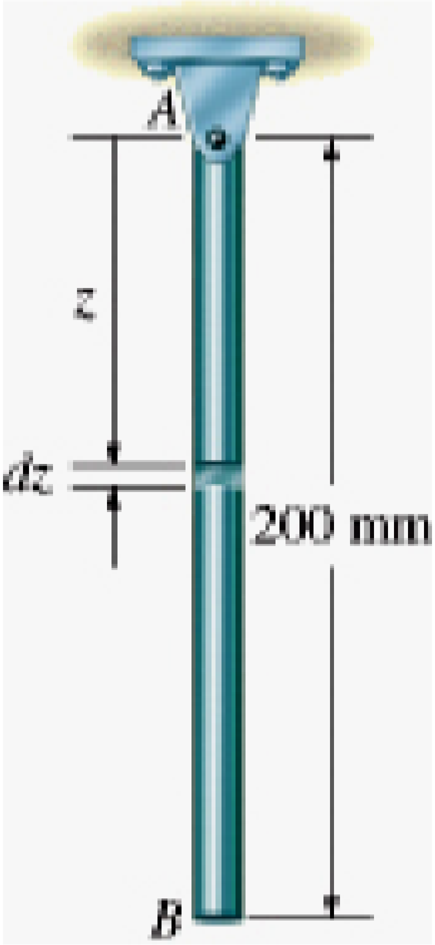
for CD $F = 22\ kN$

$$\sigma = \frac{F}{dt} = 62.86 MPa$$

EX 1.5 (specific weight skipped)

EX 1.6

Rod below is subjected to temperature increase along its axis, creating a normal strain of $\varepsilon_z = 40(10^{-3})z^{1/2}$, where z is given in meters.



Determine

- (a) displacement of end B of rod due to temperature increase
- (b) average normal strain in the rod

a) $dz' = (1 + 40(10^{-3})\, z^{\frac{1}{2}})\, dz$

$z' = \int (1 + 40(10^{-3})\, z^{\frac{1}{2}})\, dz = z + \frac{80}{3}(10)^{-3} z^{\frac{3}{2}}$

$\therefore d\Delta z = z' - z = \frac{80}{3}(10)^{-3} z^{\frac{3}{2}} = 2.39$ mm

b) $\varepsilon_{avg} = \frac{\Delta z}{z} = \frac{239}{200} = 1.2\%$

EX 1.7 (the stress-strain diagram skipped)

EX 1.8

Depth and thickness = 40 mm

Determine average normal stress and average shear stress acting along (a) section planes a-a, and (b) section plane b-b

(a)

a)

$$N = 800\,N \qquad V = 0$$

$$\therefore \sigma = \frac{N}{dt} = \frac{800N}{40\times 40\times 10^{-6}\,m^2} = 0.5\,MPa$$

$$\tau = 0.$$

b)

according to the figure above.

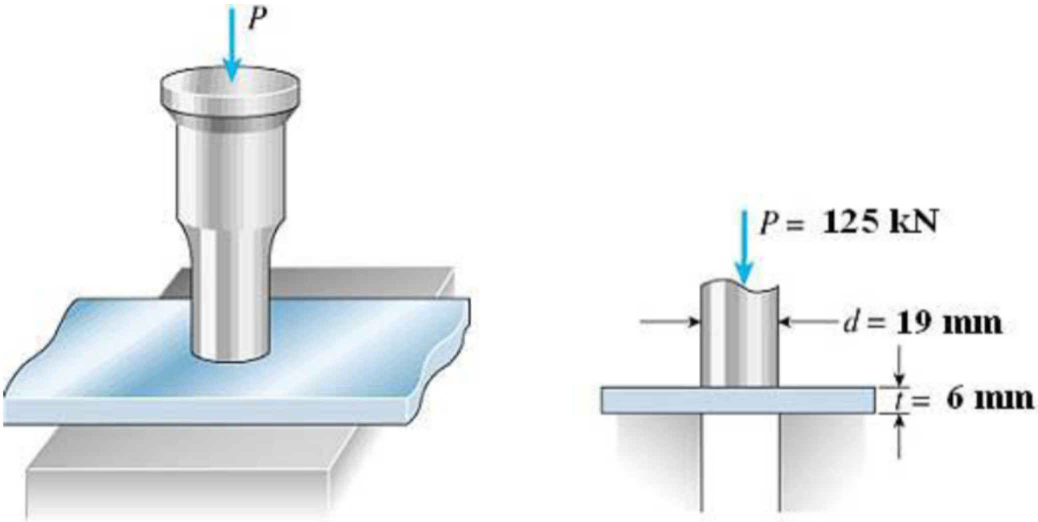
$$V = \frac{1}{2}P = 400\,N, \quad \cancel{A}N = \frac{\sqrt{3}}{2}P = 400\sqrt{3}\,N$$

$$\therefore \sigma = \frac{N}{\frac{2\sqrt{3}}{3}dt} = \frac{400\sqrt{3}}{\frac{2\sqrt{3}}{3}\cdot 0.04^2} = 0.375\,MPa$$

$$\tau = \frac{\cancel{N}V}{\frac{2\sqrt{3}}{3}dt} = \frac{400}{\frac{2\sqrt{3}}{3}\cdot 0.04^2} = 0.217\,MPa$$

EX 1.9

Punching a hole in a steel plate. If force P =125 kN is required to create the hole, what is (a) the average shear stress in the plate and (b) the average compressive stress in the punch

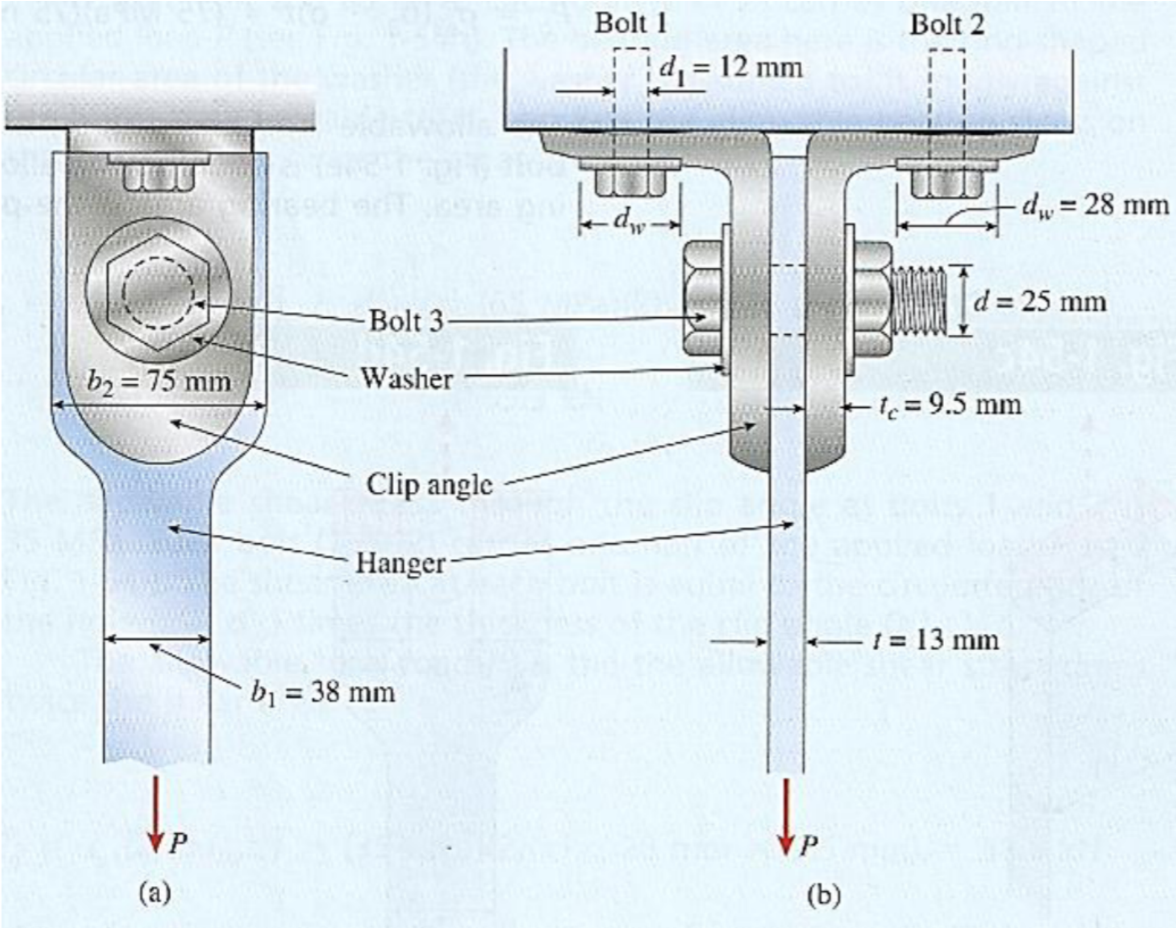


a) $$\tau = \frac{P}{\underbrace{\pi d t}_{\text{side area}}} = \frac{125 \times 10^3\ N}{\pi \times 19 \times 6 \times 10^{-6}\ m^2} = 349\ MPa$$

b) $$\sigma = \frac{P}{\underbrace{\frac{1}{4}\pi d^2}_{\text{normal area.}}} = \frac{125 \times 10^3}{\frac{1}{4}\pi \times 19^2 \times 10^{-6}\ m^2} = 441\ MPa$$

EX 1.10

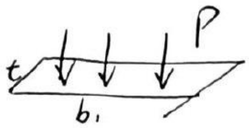
Vertical hanger subjected to a tensile load P



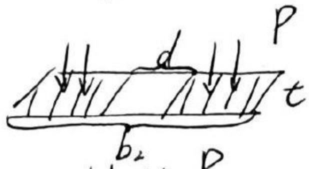
The allowable tensile load, P based on six considerations:

- (a) The allowable tensile stress in the main part of the hanger is 110 MPa.
- (b) The allowable tensile stress in the hanger at its cross section through the bolt 3 hole is 75 MPa.
- (c) The allowable bearing stress between the hanger and the shank of bolt 3 is 180 MPa.
- (d) The allowable shear stress in the bolt 3 is 45 MPa.
- (e) The allowable normal stress in bolt 1 and 2 is 160 MPa.
- (f) The allowable bearing stress between the washer and the clip angle at either bolt 1 or 2 is 65 MPa.

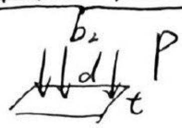
a) $P_1 = \sigma_1 b_1 t = 54.34$ kN



b) $P_2 = \sigma_2 (b_2 - d) t = 48.75$ kN



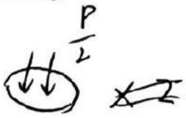
c) $P_3 = \sigma_3 d t = \cancel{18}\ 58.50$ kN



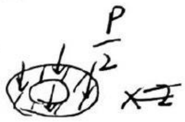
d) $\cancel{P_4 = \tau_4 \pi d t =}$ 44.18 kN

$P_4 = 2\tau_4 (\frac{1}{4}\pi d^2) = \cancel{143.14 \text{ kN}}$

e) $P_5 = 2\sigma_5 (\frac{1}{4}\pi d_1^2) = 36.19$ kN



f) $P_6 = 2\sigma_6 (\frac{1}{4}\pi d_1^2 + \frac{1}{4}\pi d_w^2) = 65.35$ kN

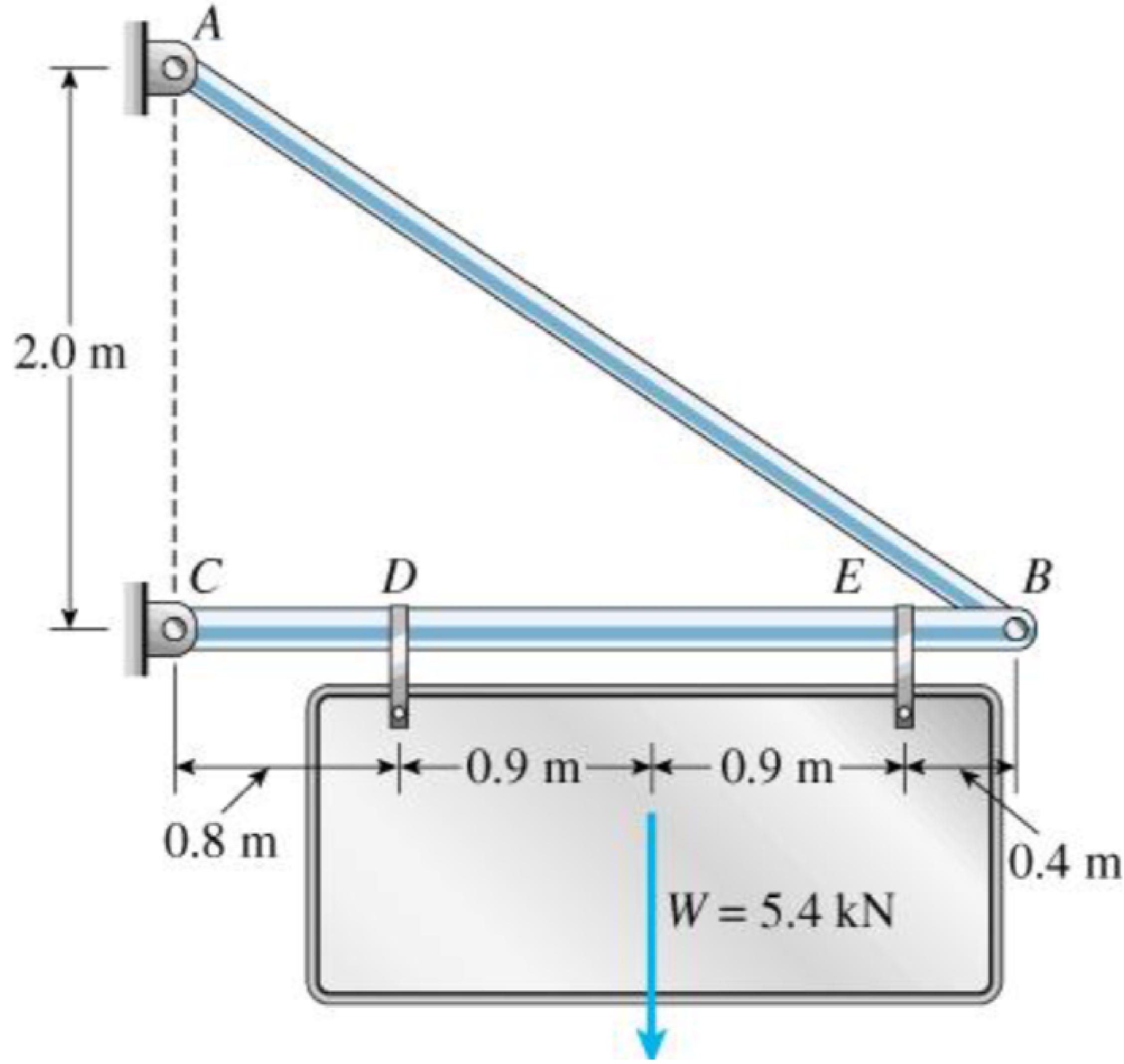


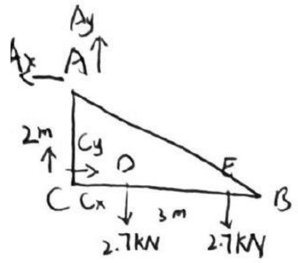
EX 1.11

Two-bar truss ABC supporting a sign of weight W.

Allowable stresses in: Tension = 125MPa, Shear = 45MPa

- The required area for member AB
- The required diameter of the pin at support C





$\Sigma F_y = 0$ $\qquad \frac{A_y}{A_x} = \frac{2}{3}$

$A_y + C_y = 5.4$

$\Sigma F_x = 0$

$A_x = C_x$

$\Sigma M_c = 0.$

$2A_x = 2.7 \cdot 0.8 + 2.7 \cdot 2.6$

$\Rightarrow \begin{cases} A_x = 4.59\ kN \\ A_y = 3.06\ kN \\ C_x = 4.59\ kN \\ C_y = 2.34\ kN. \end{cases}$

$\cancel{V_B = 3.06\ kN}$

$\therefore F_{AB} = \sqrt{A_x^2 + A_y^2} = 5.52\ kN \qquad F_c = \sqrt{C_x^2 + C_y^2} = 5.15\ kN$

$\therefore A_B = \frac{F_{AB}}{\sigma} = \frac{5.52\ kN}{125\ MPa} = 44.16\ mm^2$

$\cancel{A_2 = \frac{F_{AB}}{2\tau} = \frac{5.52}{2 \times 45 MPa}}$

$A_c = \frac{F_c}{2\tau} = \frac{5.15\ kN}{2 \times 45\ MPa} = 57.22\ mm^2$