Mechanics Of Materials 2nd Edition Kiusalaas Solutions Manual

Instructor's Solutions Manual to Accompany

MECHANICS OF MATERIALS

Second Edition

Andrew Pytel
Jaan Kiusalaas

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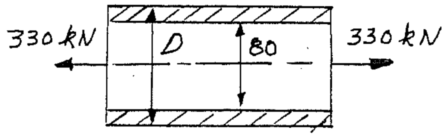
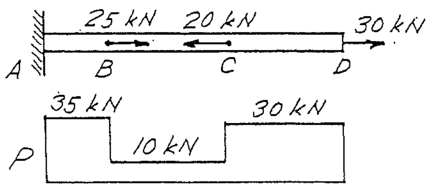
1.1



$$P = \sigma_w A \qquad 330\times 10^3 = \left(110\times 10^6\right)\frac{\pi\left(D^2-0.08^2\right)}{4}$$

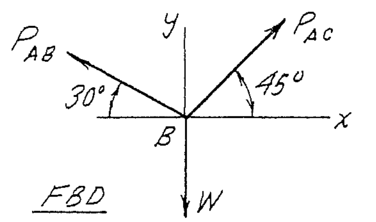
$$D = 0.1011 \text{ m} = 101.1 \text{ mm} \blacktriangleleft$$

1.2



$$\begin{aligned} P_{\max} &= P_{AB} = 35 \text{ kN} \\ \sigma_{\max} &= \frac{P_{\max}}{A} = \frac{35\times 10^3}{600\times 10^{-6}} = 58.3\times 10^6 \text{ Pa} \\ &= 58.3 \text{ MPa} \blacktriangleleft \end{aligned}$$

1.3



$$\begin{aligned} \Sigma F_x &= 0 \qquad P_{AC}\cos 45^\circ - P_{AB}\cos 30^\circ = 0 \\ \Sigma F_y &= 0 \qquad P_{AC}\sin 45^\circ + P_{AB}\sin 30^\circ - W = 0 \end{aligned}$$

The solution is

$$P_{AC} = 0.8966W \qquad P_{AB} = 0.7321W$$

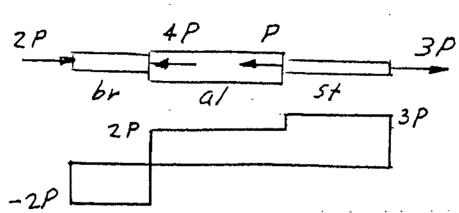
Assuming that stress in AC governs:

$$\begin{aligned} (\sigma_{AC})_w &= \frac{P_{AC}}{A_{AC}} \qquad 150\times 10^6 = \frac{0.8966W}{200\times 10^{-6}} \\ W &= 33\,500 \text{ N} = 33.5 \text{ kN} \blacktriangleleft \end{aligned}$$

Assuming that stress in AB governs:

$$\begin{aligned} (\sigma_{AB})_w &= \frac{P_{AB}}{A_{AB}} \qquad 100\times 10^6 = \frac{0.7321W}{400\times 10^{-6}} \\ W &= 54\,600 \text{ N} = 54.6 \text{ kN} \end{aligned}$$

1.4



Axial force diagram

The axial forces in the segments are

$$\begin{aligned} P_{\text{br}} &= 2P = 2(10) = 20 \text{ kN (C)} \\ P_{\text{al}} &= 2P = 2(10) = 20 \text{ kN (T)} \\ P_{\text{st}} &= 3P = 3(10) = 30 \text{ kN (T)} \end{aligned}$$

$$\begin{aligned} \sigma_{\text{br}} &= \frac{P_{\text{br}}}{A_{\text{br}}} = \frac{20\times 10^3}{400\times 10^{-6}} = 50\times 10^6 \text{ Pa (C)} \blacktriangleleft \\ \sigma_{\text{al}} &= \frac{P_{\text{al}}}{A_{\text{al}}} = \frac{20\times 10^3}{600\times 10^{-6}} = 33.3\times 10^6 \text{ Pa (T)} \blacktriangleleft \\ \sigma_{\text{st}} &= \frac{P_{\text{st}}}{A_{\text{st}}} = \frac{30\times 10^3}{300\times 10^{-6}} = 100\times 10^6 \text{ Pa (T)} \blacktriangleleft \end{aligned}$$

1.5

Axial forces in the segments are (see solution of Prob.1.4)

$$P_{\text{br}} = 2P \text{ (C)} \qquad P_{\text{al}} = 2P \text{ (T)} \qquad P_{\text{st}} = 3P \text{ (T)}$$

Assuming that stress in bronze governs:

$$\begin{aligned} (\sigma_{\text{br}})_w &= \frac{P_{\text{br}}}{A_{\text{br}}} \qquad 110\times 10^6 = \frac{2P}{400\times 10^{-6}} \\ P &= 22.0\times 10^3 \text{ N} = 22.0 \text{ kN} \end{aligned}$$

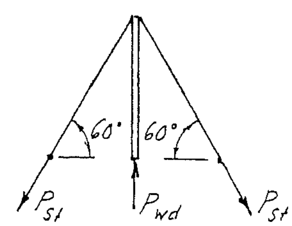
Assuming that stress in aluminum governs:

$$\begin{aligned} (\sigma_{\text{al}})_w &= \frac{P_{\text{al}}}{A_{\text{al}}} \qquad 68\times 10^6 = \frac{2P}{600\times 10^{-6}} \\ P &= 20.4\times 10^3 \text{ N} = 20.4 \text{ kN} \end{aligned}$$

Assuming that stress in steel governs:

$$\begin{aligned} (\sigma_{\text{st}})_w &= \frac{P_{\text{st}}}{A_{\text{st}}} \qquad 120\times 10^6 = \frac{3P}{300\times 10^{-6}} \\ P &= 12.0\times 10^3 \text{ N} = 12.0 \text{ kN} \blacktriangleleft \end{aligned}$$

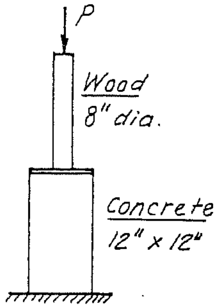
1.6



$$\begin{aligned} \Sigma F_y &= 0 \qquad P_{\text{wd}} - 2P_{\text{st}}\sin 60^\circ = 0 \\ P_{\text{wd}} &= 2P_{\text{st}}\sin 60^\circ = 2\sigma_{\text{st}}A_{\text{st}}\sin 60^\circ \\ &= 2(60\,000)\frac{\pi(0.25)^2}{4}\sin 60^\circ = 5101 \text{ lb} \end{aligned}$$

$$A_{\text{wd}} = \frac{P_{\text{wd}}}{\sigma_{\text{wd}}} \qquad \frac{\pi d^2}{4} = \frac{5101}{200} \qquad d = 5.70 \text{ in.} \blacktriangleleft$$

1.7



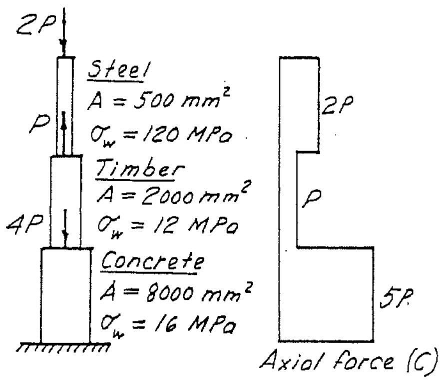
For concrete:

$$P = \sigma_{co}A_{co} = 450(12 \times 12) = 64\,800 \text{ lb}$$

For wood:

$$P = \sigma_{wd}A_{wd} = 1000\frac{\pi(8)^2}{4} = 50\,300 \text{ lb} \blacktriangleleft$$

1.8



For steel:

$$\frac{P_{st}}{A_{st}} = \sigma_{st} \qquad \frac{2P}{500 \times 10^{-6}} = 120 \times 10^6 \qquad P = 30.0 \times 10^3 \text{ N}$$

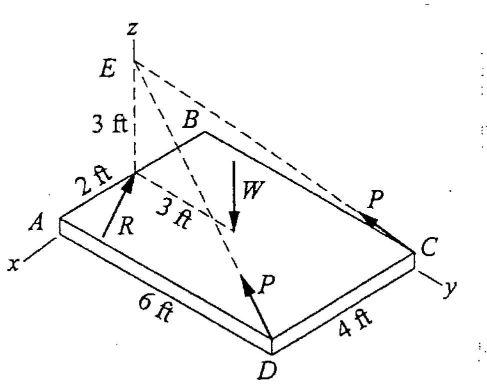
For timber:

$$\frac{P_{wd}}{A_{wd}} = \sigma_{wd} \qquad \frac{P}{2000 \times 10^{-6}} = 12 \times 10^6 \qquad P = 24.0 \times 10^3 \text{ N} \blacktriangleleft$$

For concrete:

$$\frac{P_{co}}{A_{co}} = \sigma_{co} \qquad \frac{5P}{8000 \times 10^{-6}} = 16 \times 10^6 \qquad P = 25.6 \times 10^3 \text{ N}$$

1.9

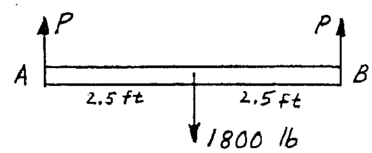


$$P_z = \frac{3}{\sqrt{2^2+6^2+3^2}}P = 0.4286P$$

$$M_{AB} = 0 \qquad 2P_z(6) - W(3) = 0$$
$$2(0.4286P)(6) - 1200(3) = 0 \qquad P = 700.0 \text{ lb}$$

$$\sigma_w\frac{\pi d^2}{4} = P \qquad d = 2\sqrt{\frac{P}{\pi\sigma_w}} = 2\sqrt{\frac{700.0}{\pi(18\,000)}} = 0.223 \text{ in.} \blacktriangleleft$$

1.10

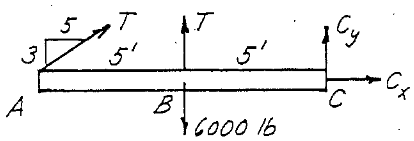


From symmetry, the axial force in each cable is $P = 900$ lb.

$$A = \frac{P}{\sigma_w} = \frac{900}{18 \times 10^3} = 0.050 \text{ in}^2 \blacktriangleleft$$

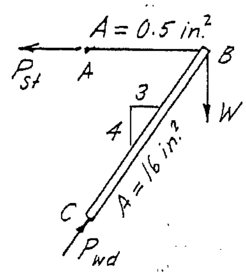
for both cables.

1.11



$$\Sigma M_C = 0 \qquad \frac{3}{\sqrt{34}}T(10) + T(5) - 6000(5) = 0$$
$$T = 2957 \text{ lb}$$
$$\sigma = \frac{T}{A} = \frac{2957}{\pi(0.6)^2/4} = 10\,460 \text{ psi} \blacktriangleleft$$

1.12



$$\Sigma F_y = 0 \qquad \frac{4}{5}P_{wd} - W = 0 \qquad P_{wd} = \frac{5}{4}W$$
$$\Sigma F_x = 0 \qquad \frac{3}{5}P_{wd} - P_{st} = 0$$
$$P_{st} = \frac{3}{5}P_{wd} = \frac{3}{5}\left(\frac{5}{4}W\right) = \frac{3}{4}W$$

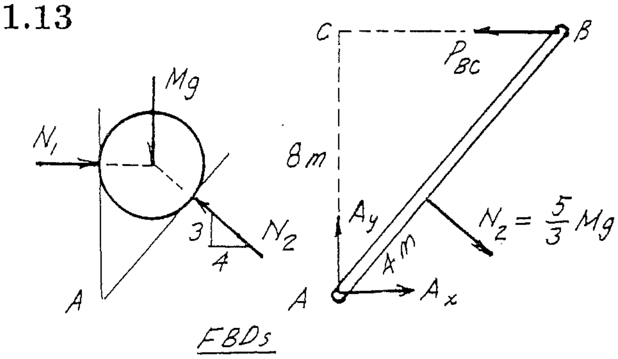
For steel cable:

$$\sigma_{st}A_{st} = P_{st} \qquad 16\,000(0.5) = \frac{3}{4}W \qquad W = 10\,670 \text{ lb}$$

For wood strut:

$$\sigma_{\text{wd}} A_{\text{wd}} = P_{\text{wd}} \qquad 720(16) = \frac{5}{4}W \qquad W = 9220 \text{ lb} \blacktriangleleft$$

1.13



From FBD of cylinder:

$$\Sigma F_y = 0 \qquad \frac{3}{5}N_2 - Mg = 0 \qquad N_2 = \frac{5}{3}Mg$$

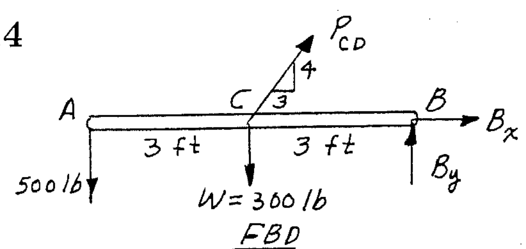
From FBD of bar AB:

$$\Sigma M_A = 0 \qquad 4\left(\frac{5}{3}Mg\right) - 8P_{BC} = 0 \qquad P_{BC} = \frac{5}{6}Mg$$

$$\sigma_w = \frac{P_{BC}}{A_{BC}} \qquad 50 \times 10^6 = \frac{(5/6)Mg}{100 \times 10^{-6}}$$

$$Mg = 6000 \text{ N} \qquad M = \frac{6000}{9.81} = 612 \text{ kg} \blacktriangleleft$$

1.14

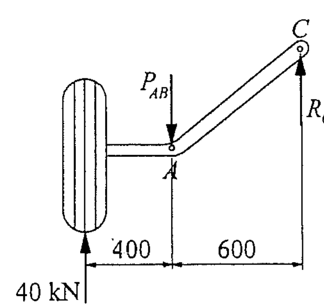


$$\Sigma M_B = 0 \qquad 3\left(\frac{4}{5}P_{CD}\right) - 3(300) - 6(500) = 0$$

$$P_{CD} = 1625 \text{ lb}$$

$$\sigma_{CD} = \frac{P_{CD}}{A_{CD}} = \frac{1625}{\pi(0.5)^2/4} = 8280 \text{ psi} \blacktriangleleft$$

1.15



$$\Sigma M_C = 0 \qquad +\circlearrowleft \qquad 600P_{AB} - 40(1000) = 0$$

$$P_{AB} = 66.67 \text{ kN}$$

$$\sigma_{AB} = \frac{P_{AB}}{A_{AB}} = \frac{66.67}{\frac{\pi}{4}(0.05^2 - 0.04^2)} = 94.3 \times 10^3 \text{ kPa}$$

$$= 94.3 \text{ MPa} \blacktriangleleft$$

1.16

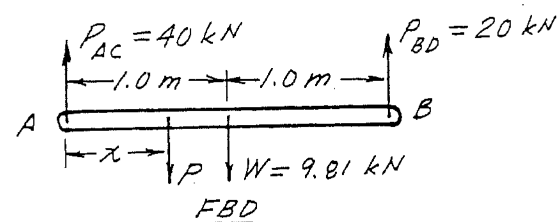
When P is maximized, both cables are stressed to the limiting values. The corresponding forces in the cables are

$$P_{AC} = (\sigma_{AC})_w A = (100 \times 10^6)(400 \times 10^{-6})$$

$$= 40 \times 10^3 \text{ N} = 40 \text{ kN}$$

$$P_{BD} = (\sigma_{BD})_w A = (50 \times 10^6)(400 \times 10^{-6})$$

$$= 20 \times 10^3 \text{ N} = 20 \text{ kN}$$

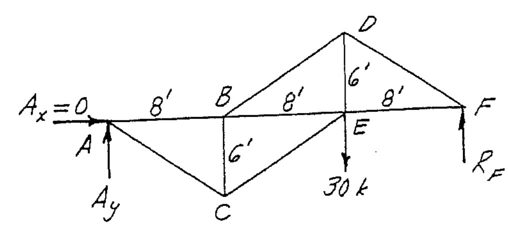


$$\Sigma F = 0 \qquad 40 + 20 - 9.81 - P = 0 \qquad P = 50.19 \text{ kN} \blacktriangleleft$$

$$\Sigma M_A = 0 \qquad 2(20) - 1.0(9.81) - x(50.19) = 0$$

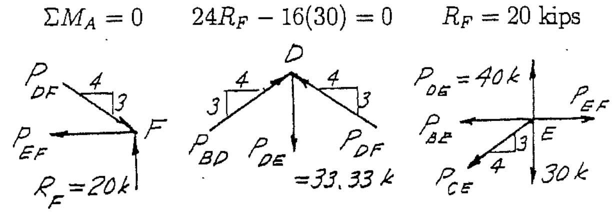
$$x = 0.602 \text{ m} = 602 \text{ mm} \blacktriangleleft$$

1.17



From FBD of truss:

$$\Sigma M_A = 0 \qquad 24R_F - 16(30) = 0 \qquad R_F = 20 \text{ kips}$$



From FBD of joint F:

$$\Sigma F_y = 0 \qquad -\frac{3}{5}P_{DF} + 20 = 0 \qquad P_{DF} = 33.33 \text{ kips}$$

$$\sigma_{DF} = \frac{P_{DF}}{A} = \frac{33.33}{1.8} = 18.52 \text{ ksi (C)} \blacktriangleleft$$

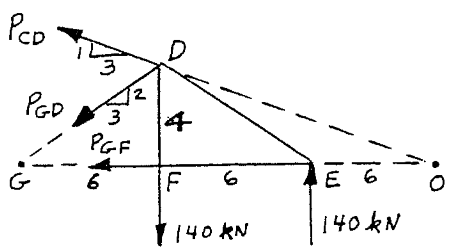
From FBD of joint D:

$$P_{BD} = P_{DF} = 33.33 \text{ kips (due to symmetry)}$$
$$\Sigma F_y = 0 \qquad 2\left[\frac{3}{5}(33.33)\right] - P_{DE} = 0$$
$$P_{DE} = 40 \text{ kips}$$
$$\sigma_{DE} = \frac{P_{DE}}{A} = \frac{40}{1.8} = 22.2 \text{ ksi (T)} \blacktriangleleft$$

From FBD of joint E:

$$\Sigma F_y = 0 \qquad 40 - 30 - \frac{3}{5}P_{CE} = 0$$
$$P_{CE} = 16.667 \text{ kips}$$
$$\sigma_{CE} = \frac{P_{CE}}{A} = \frac{16.667}{1.8} = 9.26 \text{ ksi (T)} \blacktriangleleft$$

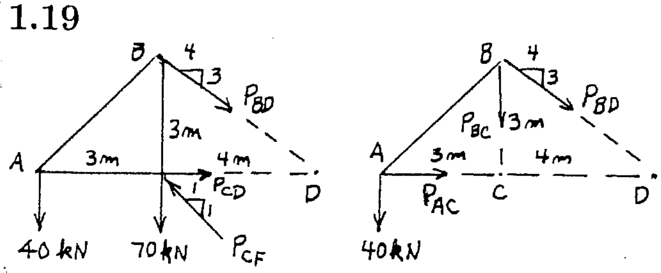
1.18



By symmetry, the reaction at the support E is 140 kN ↑. Using the FBD of the section shown:

$$\Sigma M_G = 0 \qquad \frac{3}{\sqrt{10}}P_{CD}(6) + 140(12) - 140(6) = 0$$
$$P_{CD} = -147.6 \text{ kN} = 147.6 \text{ kN (C)}$$
$$A_{CD} = \frac{P_{CD}}{\sigma_{\text{comp}}} = \frac{147.6 \times 10^3}{100 \times 10^6} = 1.476 \times 10^{-3} \text{ m}^2$$
$$= 1476 \text{ mm}^2 \blacktriangleleft$$
$$\Sigma M_D = 0 \qquad 140(6) - P_{GF}(4) = 0$$
$$P_{GF} = 210 \text{ kN (T)}$$
$$A_{GF} = \frac{P_{GF}}{\sigma_{\text{tens}}} = \frac{210 \times 10^3}{140 \times 10^6} = 1.500 \times 10^{-3} \text{ m}^2$$
$$= 1500 \text{ mm}^2 \blacktriangleleft$$
$$\Sigma M_O = 0 \qquad \frac{2}{\sqrt{13}}P_{GD}(18) + 140(12) - 140(6) = 0$$
$$P_{GD} = -84.13 \text{ kN} = 84.13 \text{ kN (C)}$$
$$A_{GD} = \frac{P_{GD}}{\sigma_{\text{comp}}} = \frac{84.13 \times 10^3}{100 \times 10^6} = 0.841 \times 10^{-3} \text{ m}^2$$
$$= 841 \text{ mm}^2 \blacktriangleleft$$

1.19



From FBD of portion ABC:

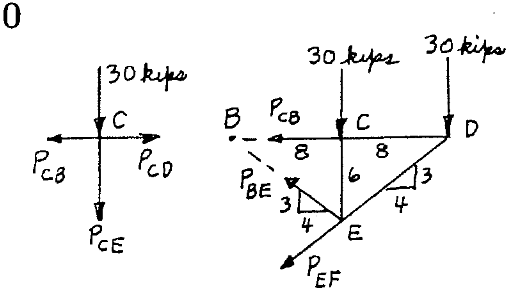
$$\Sigma M_D = 0 \qquad 7(40) + 4(70) - 4\left(\frac{1}{\sqrt{2}}P_{CF}\right) = 0$$
$$P_{CF} = 198.0 \text{ kN}$$
$$\sigma_{CF} = \frac{P_{CF}}{A} = \frac{198.0 \times 10^3}{1400 \times 10^{-6}} = 141.4 \times 10^6 \text{ Pa (C)} \blacktriangleleft$$

$$\Sigma M_C = 0 \qquad 3(40) - 3\left(\frac{4}{5}P_{BD}\right) = 0 \qquad P_{BD} = 50 \text{ kN}$$
$$\sigma_{BD} = \frac{P_{BD}}{A} = \frac{50 \times 10^3}{1400 \times 10^{-6}} = 35.7 \times 10^6 \text{ Pa (T)} \blacktriangleleft$$

From FBD of member AB:

$$\Sigma M_D = 0 \qquad 7(40) - 4P_{BC} = 0 \qquad P_{BC} = 70 \text{ kN}$$
$$\sigma_{BC} = \frac{P_{BC}}{A} = \frac{70 \times 10^3}{1400 \times 10^{-6}} = 50.0 \times 10^6 \text{ Pa (C)} \blacktriangleleft$$

1.20



Using the FBD of joint C:

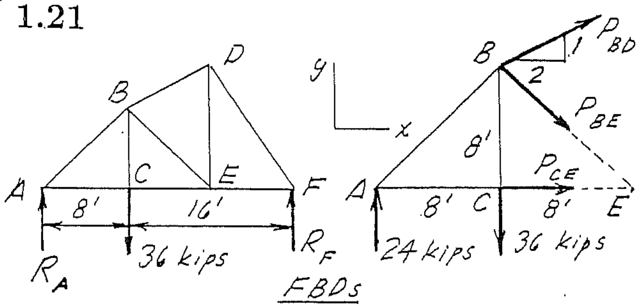
$$\Sigma F_y = 0 \qquad -30 - P_{CE} = 0$$
$$P_{CE} = -30 \text{ kips} = 30 \text{ kips (C)}$$
$$A_{CE} = \frac{P_{CE}}{\sigma_{\text{comp}}} = \frac{30\,000}{14\,000} = 2.14 \text{ in.}^2 \blacktriangleleft$$

Using the FBD of the section:

$$\Sigma M_D = 0 \qquad 30(8) - \frac{3}{5}P_{BE}(16) = 0$$
$$P_{BE} = 25 \text{ kips} = 25 \text{ kips (T)}$$
$$A_{BE} = \frac{P_{BE}}{\sigma_{\text{tens}}} = \frac{25\,000}{20\,000} = 1.25 \text{ in.}^2 \blacktriangleleft$$
$$\Sigma M_B = 0 \qquad -30(8) - 30(16) - \frac{3}{5}P_{EF}(16) = 0$$
$$P_{EF} = -75 \text{ kips} = 75 \text{ kips (C)}$$
$$A_{EF} = \frac{P_{EF}}{\sigma_{\text{comp}}} = \frac{75\,000}{14\,000} = 5.36 \text{ in.}^2 \blacktriangleleft$$

$$
\begin{aligned}
A_{BE} &= \frac{P_{BE}}{(\sigma_T)_w} = \frac{62.5 \times 10^3}{100 \times 10^6} = 625 \times 10^{-6}\ \text{m}^2 \\
&= 625\ \text{mm}^2 \blacktriangleleft \\
A_{BF} &= \frac{P_{BF}}{(\sigma_T)_w} = \frac{42.72 \times 10^3}{100 \times 10^6} = 427 \times 10^{-6}\ \text{m}^2 \\
&= 427\ \text{mm}^2 \blacktriangleleft \\
A_{CF} &= \frac{|P_{CF}|}{(\sigma_C)_w} = \frac{52.5 \times 10^3}{80 \times 10^6} = 656 \times 10^{-6}\ \text{m}^2 \\
&= 656\ \text{mm}^2 \blacktriangleleft
\end{aligned}
$$

1.21



From FBD of truss

$\Sigma M_F = 0 \qquad 24R_A - 16(36) = 0 \qquad R_A = 24$ kips

From FBD of portion ABC

$\Sigma M_B = 0$:

$$8(24) - 8P_{CE} = 0$$

$\Sigma M_E = 0$:

$$16(24) - 8(36) + 8\left(\frac{1}{\sqrt{5}}P_{BD}\right) + 8\left(\frac{2}{\sqrt{5}}P_{BD}\right) = 0$$

$\Sigma F_x = 0$:

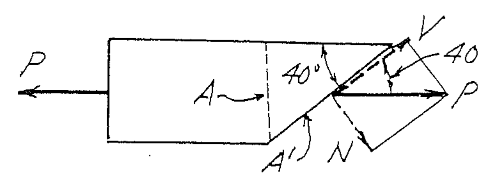
$$\frac{2}{\sqrt{5}}P_{BD} + \frac{1}{\sqrt{2}}P_{BE} + P_{CE} = 0$$

Solution is

$P_{CE} = 24.0$ kN $\quad P_{BD} = -8.944$ kN $\quad P_{BE} = -22.63$ kN

$$
\begin{aligned}
A_{CE} &= \frac{P_{CE}}{(\sigma_T)_w} = \frac{24.0 \times 10^3}{20 \times 10^3} = 1.2\ \text{in.}^2 \blacktriangleleft \\
A_{BD} &= \frac{|P_{BD}|}{(\sigma_C)_w} = \frac{8.944 \times 10^3}{12 \times 10^3} = 0.745\ \text{in.}^2 \blacktriangleleft \\
A_{BE} &= \frac{|P_{BE}|}{(\sigma_C)_w} = \frac{22.63 \times 10^3}{12 \times 10^3} = 1.886\ \text{in.}^2 \blacktriangleleft
\end{aligned}
$$

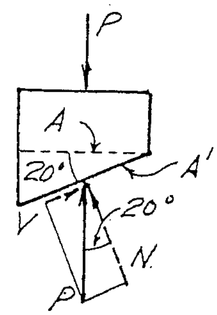
1.22



$$
\begin{aligned}
A' &= \frac{A}{\sin 40^\circ} = \frac{2 \times 4}{\sin 40^\circ} = 12.446\ \text{in.}^2 \\
V &= P\cos 40^\circ = 0.7660P
\end{aligned}
$$

$$\tau_w = \frac{V}{A'} \qquad 250 = \frac{0.7660P}{12.446} \qquad P = 4060\ \text{lb} \blacktriangleleft$$

1.23



$$
\begin{aligned}
A' &= \frac{A}{\cos 20^\circ} = \frac{0.05 \times 0.1}{\cos 20^\circ} = 5.321 \times 10^{-3}\ \text{m}^2 \\
N &= P\cos 20^\circ = 0.9397P \qquad V = P\sin 20^\circ = 0.3420P
\end{aligned}
$$

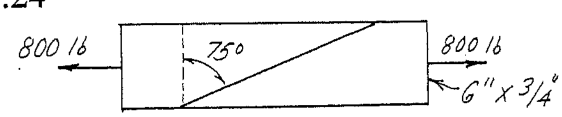
Assuming that compression governs:

$$
\begin{aligned}
\sigma_w &= \frac{N}{A'} \qquad 18 \times 10^6 = \frac{0.9397P}{5.321 \times 10^{-3}} \\
P &= 101.9 \times 10^3\ \text{N} = 101.9\ \text{kN}
\end{aligned}
$$

Assuming that shear governs:

$$
\begin{aligned}
\tau_w &= \frac{V}{A'} \qquad 4 \times 10^6 = \frac{0.3420P}{5.321 \times 10^{-3}} \\
P &= 62.2 \times 10^3\ \text{N} = 62.2\ \text{kN} \blacktriangleleft
\end{aligned}
$$

1.24

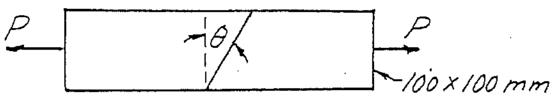


Equivalent joint

From Eqs. (1.5):

$$
\begin{aligned}
\sigma &= \frac{P}{A}\cos^2\theta = \frac{800}{6 \times 3/4}\cos^2 75^\circ = 11.91\ \text{psi} \blacktriangleleft \\
\tau &= \frac{P}{2A}\sin 2\theta = \frac{800}{2(6 \times 3/4)}\sin 150^\circ = 44.4\ \text{psi} \blacktriangleleft
\end{aligned}
$$

1.25



Assuming that tension in wood governs:

$$(\sigma_w)_{wd} = \frac{P}{A} \qquad 20 = \frac{P}{0.1^2} \qquad P = 0.2 \text{ MN}$$

Assuming that tension in glue governs:

$$\begin{aligned} (\sigma_w)_{gl} &= \frac{P}{A}\cos^2\theta \qquad 8 = \frac{P}{0.1^2}\cos^2 50^\circ \\ P &= 0.1936 \text{ MN} \end{aligned}$$

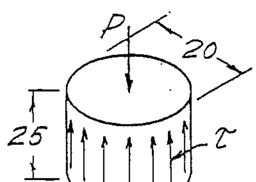
Assuming that shear in glue governs:

$$\begin{aligned} (\tau_w)_{gl} &= \frac{P}{2A}\sin 2\theta \qquad 12 = \frac{P}{2(0.1)^2}\sin 100^\circ \\ P &= 0.244 \text{ MN} \end{aligned}$$

The largest allowable P is determined by tension in glue:

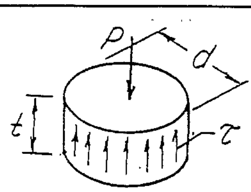
$$P = 193.6 \text{ kN} \blacktriangleleft$$

1.26



$$\begin{aligned} P &= \tau A = \tau(\pi d \times t) \\ &= \left(350 \times 10^6\right)\pi(0.02)(0.025) = 550 \times 10^3 \text{ N} \blacktriangleleft \end{aligned}$$

1.27



$$P = \tau A \qquad \sigma_w \frac{\pi d^2}{4} = \tau\,(\pi d \times t) \qquad \frac{\sigma_w d}{4} = t\tau$$

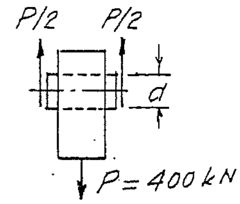
(a) $d = 2.5$ in.

$$t = \frac{\sigma_w d}{4\tau} = \frac{50\,(2.5)}{4\,(40)} = 0.781 \text{ in.} \blacktriangleleft$$

(b) $t = 0.25$ in.

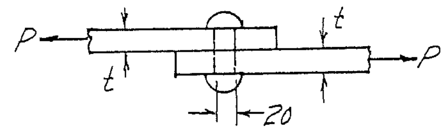
$$d = \frac{4t\tau}{\sigma_w} = \frac{4\,(0.25)\,(40)}{50} = 0.800 \text{ in.} \blacktriangleleft$$

1.28



$$\begin{aligned} \tau_w A &= \frac{P}{2} \qquad (300 \times 10^6)\frac{\pi d^2}{4} = \frac{400 \times 10^3}{2} \\ d &= 0.0291 \text{ m} = 29.1 \text{ mm} \blacktriangleleft \end{aligned}$$

1.29



Shear in rivet determines upper limit on P:

$$P = \tau A_s = \left(60 \times 10^6\right)\frac{\pi(0.02)^2}{4} = 18\,850 \text{ N}$$

Plate thickness is determined by bearing stress:

$$\begin{aligned} P &= \sigma_b A_b \qquad 18\,850 = (120 \times 10^6)(0.02t) \\ t &= 7.85 \times 10^{-3} \text{ m} = 7.85 \text{ mm} \blacktriangleleft \end{aligned}$$

1.30

(a)

$$\tau = \frac{P}{3A} = \frac{50 \times 10^3}{3\dfrac{\pi(0.02)^2}{4}} = 53.1 \times 10^6 \text{ Pa} = 53.1 \text{ MPa} \blacktriangleleft$$

(b)

$$\sigma_b = \frac{P}{3td} = \frac{50 \times 10^3}{3(0.025)(0.02)} = 33.3 \times 10^6 \text{ Pa} = 33.3\text{MPa} \blacktriangleleft$$

(c)

$$\begin{aligned} \sigma &= \frac{P}{t(w-d)} = \frac{50 \times 10^3}{0.025(0.13 - 0.02)} = 18.18 \times 10^6 \text{ Pa} \\ &= 18.18 \text{ MPa} \blacktriangleleft \end{aligned}$$

1.31

Assuming that shear in rivets governs:

$$P = 3A\tau_w = 3\frac{\pi(0.02)^2}{4}(40\times10^6)$$
$$= 37.7\times10^3 \text{ N} = 37.7 \text{ kN} \blacktriangleleft$$

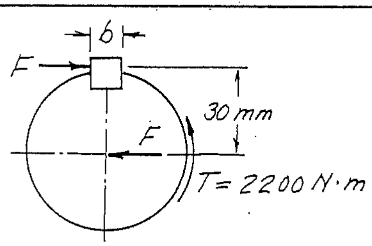
Assuming that bearing stress governs:

$$P = 3td\,(\sigma_b)_w = 3(0.025)(0.02)(90\times10^6)$$
$$= 135\times10^3 = 135 \text{ kN}$$

Assuming that tension in plates governs:

$$P = t(w-d)\sigma_w = 0.025(0.13-0.02)(120\times10^6)$$
$$= 330\times10^3 \text{ N} = 330 \text{ kN}$$

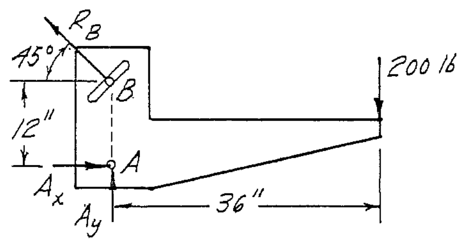
1.32



$$F = \frac{T}{r} = \frac{2200}{0.03} = 73.33\times10^3 \text{ N}$$

$$F = \tau_w A \qquad 73.33\times10^3 = (60\times10^6)\,(0.07b)$$
$$b = 0.01746 \text{ m} = 17.46 \text{ mm} \blacktriangleleft$$

1.33



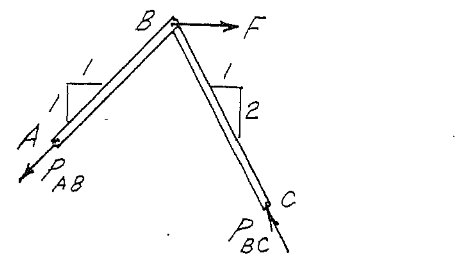
$$\Sigma M_B = 0 \qquad 12A_x - 36(200) = 0$$
$$\Sigma F_x = 0 \qquad A_x - R_B\cos 45° = 0$$
$$\Sigma F_y = 0 \qquad A_y + R_B\sin 45° - 200 = 0$$

$A_x = 600$ lb $\quad A_y = -400$ lb $\quad R_B = 848.5$ lb

$$R_A = \sqrt{600^2 + (-400)^2} = 721.1 \text{ lb}$$
$$A = \frac{\pi d^2}{4} = \frac{\pi(0.5)^2}{4} = 0.196\,35 \text{ in.}^2$$

$$\tau_A = \frac{R_A}{A} = \frac{721.1}{0.196\,35} = 3670 \text{ psi} \blacktriangleleft$$
$$\tau_B = \frac{R_B}{A} = \frac{848.5}{0.196\,35} = 4320 \text{ psi} \blacktriangleleft$$

1.34

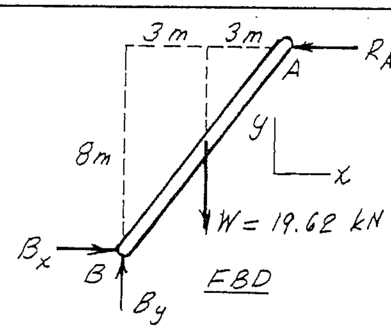


$$\Sigma F_x = 0 \qquad -\frac{1}{\sqrt{2}}P_{AB} - \frac{1}{\sqrt{5}}P_{BC} + F = 0$$
$$\Sigma F_y = 0 \qquad -\frac{1}{\sqrt{2}}P_{AB} + \frac{2}{\sqrt{5}}P_{BC} = 0$$

$$P_{AB} = \frac{2\sqrt{2}}{3}F = 0.9428F \qquad P_{BC} = \frac{\sqrt{5}}{3}F = 0.7454F$$

$$\tau_w A = P_{AB} \qquad (5000)\frac{\pi(7/8)^2}{4} = 0.9428F$$
$$F = 3190 \text{ lb} \blacktriangleleft$$

1.35



$$\Sigma F_y = 0 \qquad B_y - 19.62 = 0$$
$$\Sigma M_A = 0 \qquad 6B_y - 8B_x - 3(19.62) = 0$$

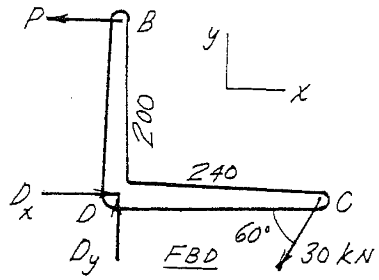
Solution is

$$B_x = 7.358 \text{ kN} \qquad B_y = 19.62 \text{ kN}$$

$$B = \sqrt{7.358^2 + 19.62^2} = 20.95 \text{ kN}$$

$$\tau_w = \frac{B}{2A} \qquad 60\times10^6 = \frac{20.95\times10^3}{2\frac{\pi d^2}{4}}$$
$$d = 14.91\times10^{-3} \text{ m} = 14.91 \text{ mm}$$

1.36



$$
\begin{aligned}
M_D &= 0 & 240(30\sin 60°) - 200P = 0 && P = 31.18 \text{ kN}\\
\Sigma F_x &= 0 & D_x - P - 30\cos 60° = 0 && D_x = 46.18 \text{ kN}\\
\Sigma F_y &= 0 & D_y - 30\sin 60° = 0 && D_y = 25.98 \text{ kN}
\end{aligned}
$$

$$D = \sqrt{46.18^2 + 25.98^2} = 52.99 \text{ kN}$$

(a)

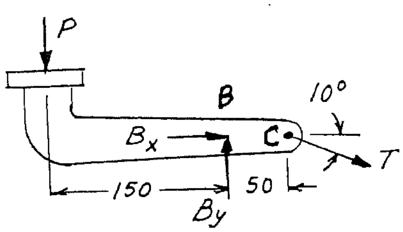
$$\sigma_w = \frac{P}{A} \qquad 100 \times 10^6 = \frac{31.18 \times 10^3}{\frac{\pi d^2}{4}}$$

$$d = 19.92 \times 10^{-3} \text{ m} = 19.92 \text{ mm} \blacktriangleleft$$

(b)

$$\tau = \frac{D}{2A} = \frac{52.99 \times 10^3}{2\frac{\pi(0.02)^2}{4}} = 84.3 \times 10^6 \text{ Pa} = 84.3 \text{ MPa} \blacktriangleleft$$

1.37



$$
\begin{aligned}
\Sigma M_B &= 0 & 150P - 50(T\sin 10°) = 0\\
\Sigma M_C &= 0 & 200P - 50B_y = 0\\
\Sigma F_x &= 0 & B_x + T\cos 10° = 0
\end{aligned}
$$

$$T = 17.276P \qquad B_x = -17.014P \qquad B_y = 4P$$

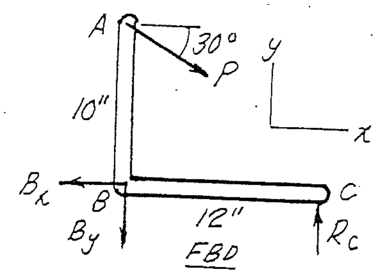
Assuming that cable governs: $T = \sigma_w A_{\text{cab}}$

$$17.276P = (140 \times 10^6)\frac{\pi(0.003)^2}{4} \qquad P = 57.3 \text{ N}$$

Assuming that pin B governs: $R_B = \tau_w A_{\text{pin}}$

$$
\begin{aligned}
P\sqrt{(-17.014)^2 + 4^2} &= (28 \times 10^6)\frac{\pi(0.006)^2}{4}\\
P &= 45.3 \text{ N} \blacktriangleleft
\end{aligned}
$$

1.38



$$
\begin{aligned}
\Sigma F_x &= 0 & P\cos 30° - B_x = 0\\
\Sigma M_C &= 0 & 10(P\cos 30°) - 12(P\sin 30°) - 12B_y = 0
\end{aligned}
$$

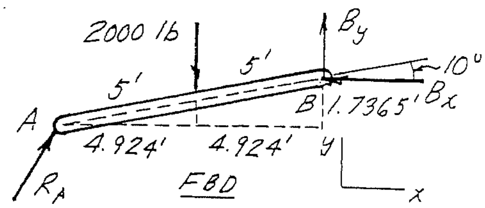
Solution is

$$B_x = 0.8660P \qquad B_y = 0.2217P$$

$$B = P\sqrt{0.8660^2 + 0.2217^2} = 0.8939P$$

$$\tau_w = \frac{B}{2A} \qquad 20\,000 = \frac{0.8939P}{2\frac{\pi(0.75)^2}{4}} \qquad P = 19\,770 \text{ lb} \blacktriangleleft$$

1.39



$\Sigma M_B = 0$

$$9.848(R_A\sin 60°) - 1.7365(R_A\cos 60°) - 4.924(2000) = 0$$

$$
\begin{aligned}
\Sigma F_x &= 0 & R_A\cos 60° - B_x = 0\\
\Sigma F_y &= 0 & R_A\sin 60° - 2000 + B_y = 0
\end{aligned}
$$

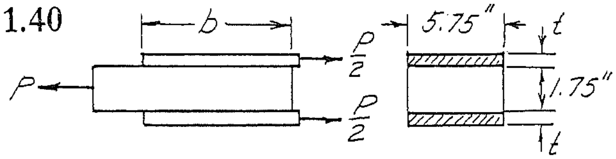
Solution is

$$R_A = 1285.6 \text{ lb} \qquad B_x = 642.8 \text{ lb} \qquad B_y = 886.6 \text{ lb}$$

$$B = \sqrt{642.8^2 + 886.6^2} = 1095.1 \text{ lb}$$

$$\tau = \frac{B}{2A} = \frac{1095.1}{2\frac{\pi(7/8)^2}{4}} = 911 \text{ psi} \blacktriangleleft$$

1.40



Strength of boards is

$$P = \sigma_{bd}A_{bd} = 700(5.75 \times 1.75) = 7044 \text{ lb}$$

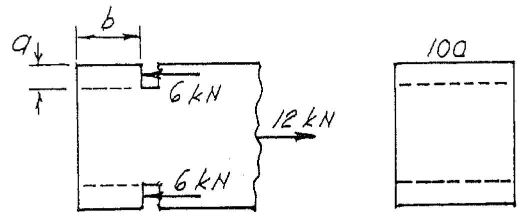
For plywood:

$$\frac{P}{2} = \sigma_{pw}A_{pw} \qquad \frac{7044}{2} = 1200(5.75t) \qquad t = 0.510 \text{ in.} \blacktriangleleft$$

For glue (double shear):

$$\frac{P}{2} = \tau A_{gl} \qquad \frac{7044}{2} = 50(5.75b) \qquad b = 12.25 \text{ in.} \blacktriangleleft$$

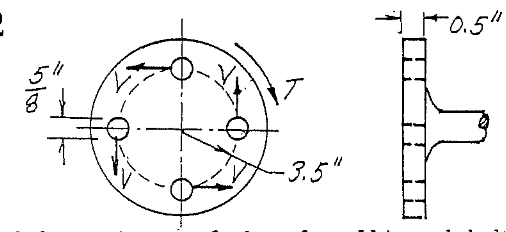
1.41



$$\begin{aligned} P &= \tau A_s \qquad 6 \times 10^3 = \left(1.8 \times 10^6\right)(0.1b) \\ b &= = 0.0333 \text{ m } = 33.3 \text{ mm} \blacktriangleleft \end{aligned}$$

$$\begin{aligned} P &= \sigma_b A_b \qquad 6 \times 10^3 = \left(5.5 \times 10^6\right)(0.1a) \\ a &= 0.01091 \text{ mm } = 10.91\text{mm} \blacktriangleleft \end{aligned}$$

1.42



First find the maximum safe shear force V in each bolt. Assuming that bearing stress governs:

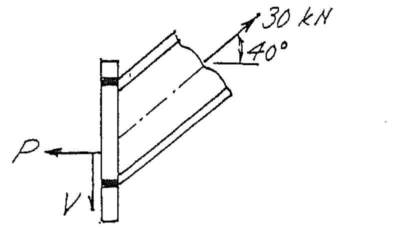
$$V = \sigma_b A_b = \left(15 \times 10^3\right)\left(\frac{5}{8} \times 0.5\right) = 4688 \text{ lb}$$

Assuming that shear stress governs:

$$V = \tau A_s = \left(12 \times 10^3\right)\frac{\pi(5/8)^2}{4} = 3682 \text{ lb}$$

$$T = 4Vr = 4(3682)(3.5) = 51\,500 \text{ lb} \cdot \text{in.} \blacktriangleleft$$

1.43

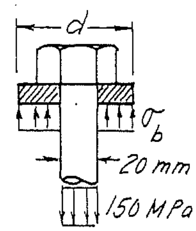


Total area of the bolts is

$$A = 4\left[\frac{\pi(0.01)^2}{4}\right] = 314.2 \times 10^{-6} \text{ m}^2$$

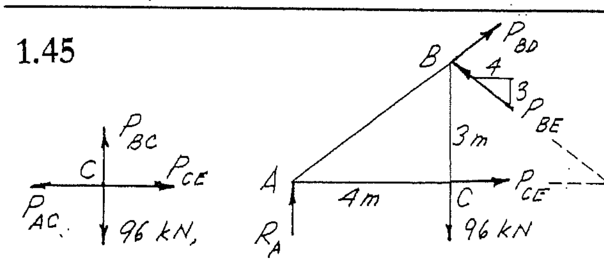
$$\begin{aligned} \sigma &= \frac{P}{A} = \frac{(30 \times 10^3)\cos 40^\circ}{314.2 \times 10^{-6}} = 73.1 \times 10^6 \text{ Pa} \blacktriangleleft \\ \tau &= \frac{V}{A} = \frac{(30 \times 10^3)\sin 40^\circ}{314.2 \times 10^{-6}} = 61.4 \times 10^6 \text{ Pa} \blacktriangleleft \end{aligned}$$

1.44



$$\begin{aligned} \sigma A &= \sigma_b A_b \\ (150 \times 10^6)\frac{\pi(0.02)^2}{4} &= (13 \times 10^6)\frac{\pi(d^2 - 0.02^2)}{4} \\ d &= 0.0708 \text{ m } = 70.8 \text{ mm} \blacktriangleleft \end{aligned}$$

1.45



d = 19 mm (rivet diameter); t = 6 mm for BC and t = 13 mm for BE (wall thickness). Because the gusset plate is thicker than the members, bearing between the rivets and the plate does not have to be considered.

(a) From FBD of joint C: $P_{BC} = 96$ kN

$$\begin{aligned} n\tau\frac{\pi d^2}{4} &= P_{BC} \qquad n(70 \times 10^6)\frac{\pi(0.019)^2}{4} = 96 \times 10^3 \\ n &= 4.84 \end{aligned}$$

$$n\sigma_b\,(td) = P_{BC} \qquad n(140\times10^6)(0.006\times0.019) = 96\times10^3$$
$$n = 6.02$$

Use 7 rivets ◄

(b) From FBD of portion ABC:

$$\Sigma M_A = 0 \qquad 8\left(\frac{3}{5}P_{BE}\right) - 4(96) = 0 \qquad P_{BE} = 80 \text{ kN}$$

$$n\tau\frac{\pi d^2}{4} = P_{BE} \qquad n(70\times10^6)\frac{\pi(0.019)^2}{4} = 80\times10^3$$
$$n = 4.03$$

$$n\sigma_b\,(td) = P_{BE} \qquad n(140\times10^6)(0.013\times0.019) = 80\times10^3$$
$$n = 2.31$$

Use 5 rivets ◄

1.46

Repeat Prob. 1.45 with $d = 22$ mm.

(a) $P_{BC} = 96$ kN (from solution of Prob. 1.45)

$$n\tau A_s = P_{BC} \qquad n(70\times10^6)\frac{\pi(0.022)^2}{4} = 96\times10^3$$
$$n = 3.61$$

$$n\sigma_b A_b = P_{BC} \qquad n(140\times10^6)(0.006\times0.022) = 96\times10^3$$
$$n = 5.19$$

Use 6 rivets ◄

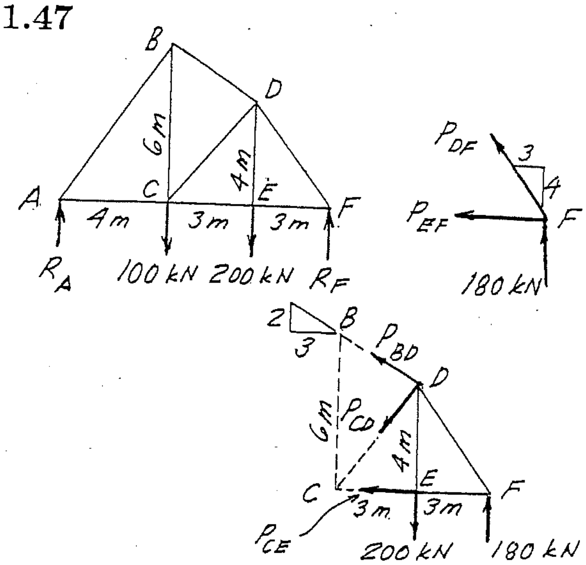
(b) $P_{BE} = 80$ kN (from solution of Prob. 1.45)

$$n\tau A_s = P_{BE} \qquad n(70\times10^6)\frac{\pi(0.022)^2}{4} = 80\times10^3$$
$$n = 3.01$$

$$n\sigma_b A_b = P_{BE} \qquad n(140\times10^6)(0.013\times0.022) = 80\times10^3$$
$$n = 2.00$$

Use 4 rivets ◄

1.47



From FBD of truss:

$$\Sigma M_A = 0 \qquad 10R_F - 4(100) - 7(200) = 0$$
$$R_F = 180 \text{ kN}$$

From FBD of joint F:

$$\Sigma F_y = 0 \qquad \frac{4}{5}P_{DF} + 180 = 0 \qquad P_{DF} = -225 \text{ kN}$$

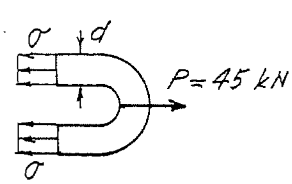
From FBD of portion EDF:

$$\Sigma M_D = 0 \qquad 4P_{CE} - 3(180) = 0 \qquad P_{CE} = 135 \text{ kN}$$

$$\Sigma M_C = 0$$
$$4\left(\frac{3}{\sqrt{13}}P_{BD}\right) + 3\left(\frac{2}{\sqrt{13}}P_{BD}\right) + 6(180) - 3(200) = 0$$
$$P_{BD} = -96.15 \text{ kN}$$

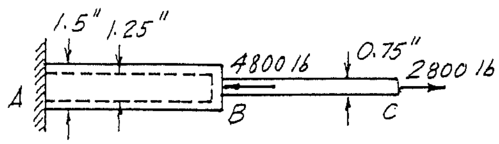
$$\sigma_{DF} = \frac{P_{DF}}{A} = -\frac{225\times10^3}{1200\times10^{-6}} = -187.5\times10^6 \text{ Pa}$$
$$= 187.5 \text{ MPa (C)} \;◄$$
$$\sigma_{CE} = \frac{P_{CE}}{A} = \frac{135\times10^3}{1200\times10^{-6}} = 112.5\times10^6 \text{ Pa}$$
$$= 112.5 \text{ MPa (T)} \;◄$$
$$\sigma_{BD} = \frac{P_{BD}}{A} = -\frac{96.15\times10^3}{1200\times10^{-6}} = -80.1\times10^6 \text{ Pa}$$
$$= 80.1 \text{ MPa (C)} \;◄$$

1.48



$$P = \sigma_w A \qquad 45\times10^3 = (300\times10^6)\left(2\frac{\pi d^2}{4}\right)$$
$$d = 9.77\times10^{-3} \text{ m} = 9.77 \text{ mm} \;◄$$

1.49

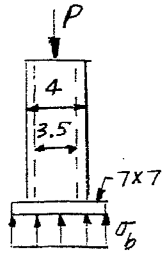


$P_{AB} = 4800 - 2800 = 2000$ lb (C) $\qquad P_{BC} = 2800$ lb (T)

$$\sigma_{AB} = \left(\frac{P}{A}\right)_{AB} = \frac{2000}{(\pi/4)\,(1.5^2 - 1.25^2)} = 3700 \text{ psi (C)} \blacktriangleleft$$

$$\sigma_{BC} = \left(\frac{P}{A}\right)_{BC} = \frac{2800}{(\pi/4)\,(0.75)^2} = 6340 \text{ psi (T)} \blacktriangleleft$$

1.50



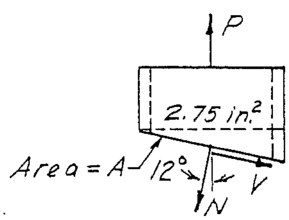
Assuming that stress in steel column governs:

$$P = \sigma_{st}A_{st} = (26\,000)\,\frac{\pi(4^2 - 3.5^2)}{4} = 76\,600 \text{ lb}$$

Assuming that bearing stress on concrete governs:

$$P = \sigma_b A_{pl} = 1200(7)^2 = 58\,800 \text{ lb} \blacktriangleleft$$

1.51



$$A = \frac{2.75}{\cos 12°} = 2.811 \text{ in.}^2 \text{ (inclined cross-sectional area)}$$

(a)

$$\sigma = \frac{N}{A} \qquad 12 = \frac{P\cos 12°}{2.811} \qquad P = 34.49 \text{ kips} \blacktriangleleft$$

(b)

$$\tau = \frac{V}{A} = \frac{P\sin 12°}{A} = \frac{34.49\sin 12°}{2.811} = 2.55 \text{ ksi} \blacktriangleleft$$

1.52

Maximum axial force equals weight of cable:

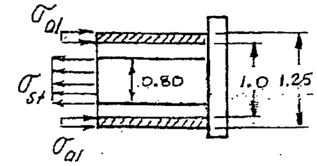
$$P_{max} = \rho g A L \qquad \sigma_{max} = \frac{P_{max}}{A} = \rho g L$$

$$390 \times 10^6 = 2700(9.81)L$$

$$L = 14\,720 \text{ m} = 14.72 \text{ km} \blacktriangleleft$$

Result is independent of diameter of cable.

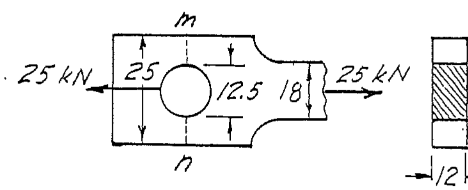
1.53



$$\sigma_{st}A_{st} = \sigma_{al}A_{al} \qquad (12\,000)\,\frac{\pi(0.8)^2}{4} = \sigma_{al}\frac{\pi(1.25^2 - 1.00^2)}{4}$$

$$\sigma_{al} = 13\,700 \text{ psi} \blacktriangleleft$$

1.54



(a) Largest bearing stress is between pin and 12-mm thick member.

$$\sigma_b = \frac{P}{td} = \frac{25 \times 10^3}{0.012(0.0125)} = 166.7 \times 10^6 \text{ Pa} \blacktriangleleft$$

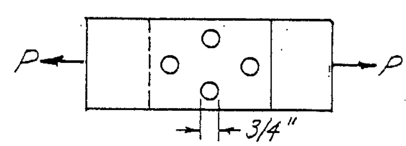
(b) Pin is in double shear.

$$\tau = \frac{P}{2\,(\pi d^2/4)} = \frac{25 \times 10^3}{2\pi(0.0125)^2/4} = 101.9 \times 10^6 \text{ Pa} \blacktriangleleft$$

(c) Largest normal stress is in 12-mm thick member at section m-n.

$$\sigma = \frac{P}{t\,(b-d)} = \frac{25 \times 10^3}{0.012(0.025 - 0.0125)} = 166.7 \times 10^6 \text{ Pa} \blacktriangleleft$$

1.55



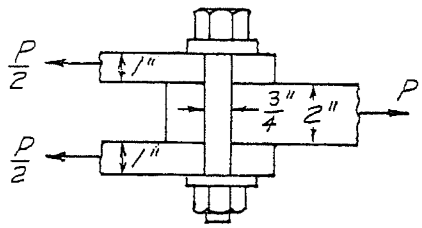
Assuming that shear stress in rivets governs:

$$P = 4\tau\frac{\pi d^2}{4} = 4(14)\frac{\pi(3/4)^2}{4} = 24.7 \text{ kips} \blacktriangleleft$$

Assuming that bearing stress governs:

$$P = 4\sigma_b(td) = 4(18)\left(\frac{7}{8} \times \frac{3}{4}\right) = 47.3 \text{ kips}$$

1.56



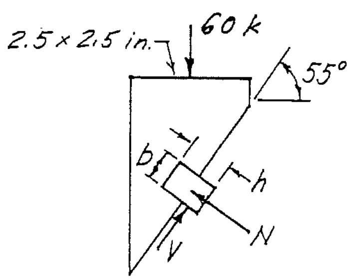
Assuming that normal stress in wood governs:

$$P = \sigma(tb) = 800\,(2 \times 4) = 6400 \text{ lb}$$

Assuming that bearing stress on wood governs:

$$P = \sigma_b(td) = 1500\left(2 \times \frac{3}{4}\right) = 2250 \text{ lb} \blacktriangleleft$$

1.57

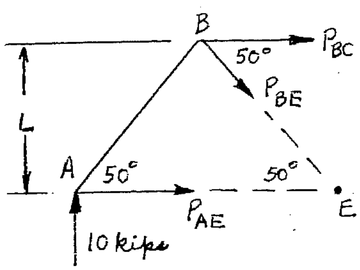


N is carried by surface between cast iron pieces; V is carried by key.

$$V = 60 \sin 55° = 49.15 \text{ kips}$$

$$\begin{aligned} V &= \tau(wb) \qquad 49.15 = 50(2.5b) \qquad b = 0.393 \text{ in.} \blacktriangleleft \\ V &= \sigma_b\left(w\frac{h}{2}\right) \qquad 49.15 = 40\left(2.5\frac{h}{2}\right) \\ h &= 0.983 \text{ in.} \blacktriangleleft \end{aligned}$$

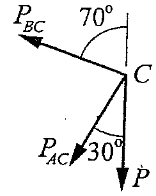
1.58



By symmetry, the reaction at the support A is 10 kips ↑. Using the FBD of the section shown:

$$\begin{aligned} \Sigma M_E &= 0 \qquad -10(2L/\tan 50°) - P_{BC}\,(L) = 0 \\ P_{BC} &= -20/\tan 50° = -16.78 \text{ kips} \\ \sigma_{BC} &= \frac{P_{BC}}{A_{BC}} = \frac{16\,780}{4.2} = 4000 \text{ psi (C)} \blacktriangleleft \\ \Sigma F_y &= 0 \qquad 10 - P_{BE} \sin 50° = 0 \qquad P_{BE} = 13\,050 \text{ kips} \\ \sigma_{BC} &= \frac{P_{BC}}{A_{BC}} = \frac{13\,050}{4.2} = 3110 \text{ psi (T)} \blacktriangleleft \end{aligned}$$

1.59



$$\begin{aligned} \Sigma F_x &= 0 \qquad +\leftarrow \qquad P_{AC} \sin 30° + P_{BC} \sin 70° = 0 \\ \Sigma F_y &= 0 \qquad +\downarrow \qquad P_{AC} \cos 30° - P_{BC} \cos 70° + P = 0 \end{aligned}$$

$$P_{AC} = -0.9542P = 0.9542P \text{ (C)} \qquad P_{BC} = 0.5077P \text{ (T)}$$

Boom in compression:

$$\begin{aligned} \sigma_w A &= P_{AC} \qquad 18(4^2 - 3.5^2) = 0.9542P \\ P &= 70.74 \text{ kips} \end{aligned}$$

Cable in tension:

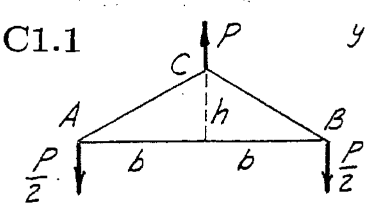
$$\begin{aligned} \sigma_w A &= P_{BC} \qquad 25\frac{\pi(0.375)^2}{4} = 0.5077P \\ P &= 5.439 \text{ kips} \end{aligned}$$

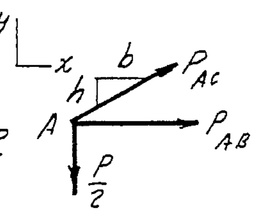
Pin in double shear:

$$\begin{aligned} 2\tau_w A &= P_{AC} \qquad 2(13.6)\frac{\pi(0.5)^2}{4} = 0.9542P \\ P &= 5.597 \text{ kips} \end{aligned}$$

The largest safe load is $P = 5.44$ kips determined by cable tension. ◀

C1.1





From FBD of joint A:

$$\begin{aligned} \Sigma F_y &= 0 \qquad P_{AC}\frac{h}{\sqrt{b^2+h^2}} - \frac{P}{2} = 0 \\ \Sigma F_x &= 0 \qquad P_{AC}\frac{b}{\sqrt{b^2+h^2}} + P_{AB} = 0 \end{aligned}$$

$$P_{AC} = P\frac{\sqrt{b^2+h^2}}{2h} \text{ (T)} \qquad P_{AB} = -P\frac{b}{2h} = P\frac{b}{2h} \text{ (C)}$$

Mechanics Of Materials 2nd Edition Kiusalaas Solutions Manual

C1.1 MathCad worksheet

Given:

$P := 120\cdot 10^3\cdot \text{lbf}$ $\qquad b := 6\cdot \text{ft}$

$\sigma_t := 18\cdot 10^3\cdot \text{psi}$ $\qquad \sigma_c := 12\cdot 10^3\cdot \text{psi}$

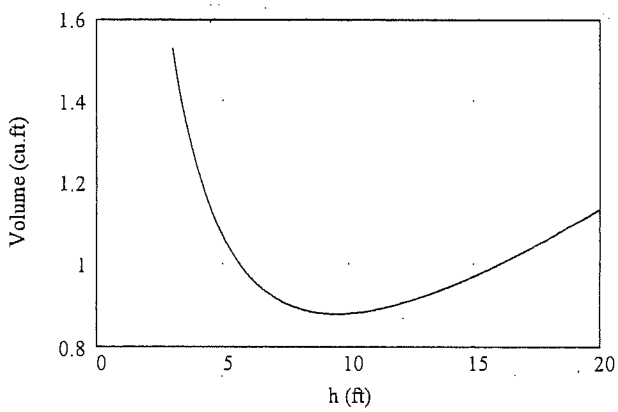
Computations:

$P_{AC}(h) := P\cdot\dfrac{\sqrt{b^2+h^2}}{2\cdot h}$ $\qquad P_{AB}(h) := P\cdot\dfrac{b}{2\cdot h}$ $\qquad$ Axial forces (from equilibrium)

$A_{AC}(h) := \dfrac{P_{AC}(h)}{\sigma_t}$ $\qquad A_{AB}(h) := \dfrac{P_{AB}(h)}{\sigma_c}$ $\qquad$ Required cross-sectional areas

$V(h) := 2\cdot A_{AC}(h)\cdot\sqrt{b^2+h^2} + 2\cdot A_{AB}(h)\cdot b$ $\qquad$ Volume of material

$h := 0.5\cdot b, 0.52\cdot b..4\cdot b$ $\qquad$ Plot range and increment



Find optimal value of *h*:

$h := 3\cdot b$ (initial value used in solution)

Given $\dfrac{d}{dh}V(h) = 0$ $\qquad h_{opt} := \text{Find}(h)$ $\qquad h_{opt} = 9.487\,\text{ft}$

C1.2

The forces computed in the solution of Prob. C1.1 are reversed. Thus

$$P_{AC} = P\frac{\sqrt{b^2+h^2}}{2h}\ \text{(C)} \qquad P_{AB} = P\frac{b}{2h}\ \text{(T)}$$

C1.2 MathCad worksheet

Given:

$P := 120\cdot 10^3\cdot \text{lbf}$ $\qquad b := 6\cdot \text{ft}$

$\sigma_t := 18\cdot 10^3\cdot \text{psi}$ $\qquad \sigma_c := 12\cdot 10^3\cdot \text{psi}$

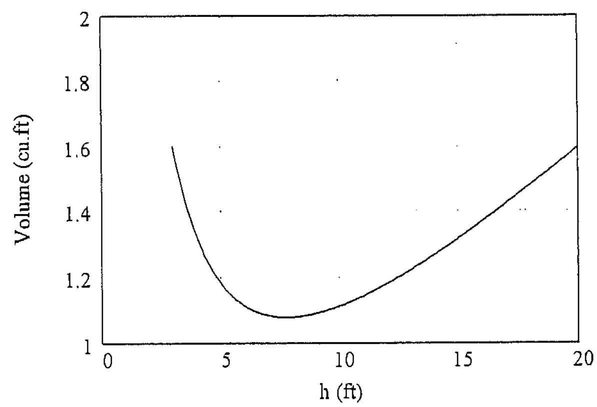
Computations:

$P_{AC}(h) := P\cdot\dfrac{\sqrt{b^2+h^2}}{2\cdot h}$ $\qquad P_{AB}(h) := P\cdot\dfrac{b}{2\cdot h}$ $\qquad$ Axial forces (from equilibrium)

$A_{AC}(h) := \dfrac{P_{AC}(h)}{\sigma_c}$ $\qquad A_{AB}(h) := \dfrac{P_{AB}(h)}{\sigma_t}$ $\qquad$ Required cross-sectional areas

$V(h) := 2\cdot A_{AC}(h)\cdot\sqrt{b^2+h^2} + 2\cdot A_{AB}(h)\cdot b$ $\qquad$ Volume of material

$h := 0.5\cdot b, 0.52\cdot b..4\cdot b$ $\qquad$ Plot range and increment

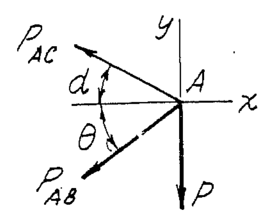


Find optimal value of *h*:

$h := 3\cdot b$ (initial value used in solution)

Given $\dfrac{d}{dh}V(h) = 0$ $\qquad h_{opt} := \text{Find}(h)$ $\qquad h_{opt} = 7.746\,\text{ft}$

C1.3



From FBD of joint *A*:

$$\begin{aligned}\Sigma F_x &= 0 & -P_{AB}\cos\theta - P_{AC}\cos\alpha &= 0\\ \Sigma F_y &= 0 & -P_{AB}\sin\theta + P_{AC}\sin\alpha - P &= 0\end{aligned}$$

$$\begin{aligned}P_{AB} &= -\frac{P}{\cos\theta\tan\alpha+\sin\theta} = \frac{P}{\cos\theta\tan\alpha+\sin\theta}\ \text{(C)}\\ P_{AC} &= \frac{P}{\cos\alpha\tan\theta+\sin\alpha}\ \text{(T)}\end{aligned}$$

C1.3 MathCad worksheet

Given:

$P := 530\cdot 10^3\cdot \text{N}$ $\qquad b := 1.8\cdot \text{m}$ $\qquad \alpha := 30\cdot \text{deg}$

$\sigma_t := 125\cdot 10^6\cdot \text{Pa}$ $\qquad \sigma_c := 85\cdot 10^6\cdot \text{Pa}$

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