Solution 109

For wire *AB*:
By sine law (from the force polygon):

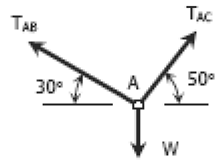
$$\frac{T_{AB}}{\sin 40°} = \frac{W}{\sin 80°}$$

$T_{AB} = 0.6527W$

$\sigma_{AB}A_{AB} = 0.6527W$

$30(0.4) = 0.6527W$

$W = 18.4$ kips



FBD of knot A

For wire *AC*:

$$\frac{T_{AC}}{\sin 60°} = \frac{W}{\sin 80°}$$

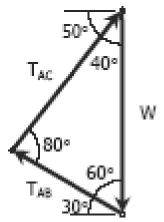
$T_{AC} = 0.8794W$

$T_{AC} = \sigma_{AC}A_{AC}$

$0.8794W = 30(0.5)$

$W = 17.1$ kips

Safe load W = **17.1 kips**



Force polygon of forces on knot A

Problem 110

A 12-inches square steel bearing plate lies between an 8-inches diameter wooden post and a concrete footing as shown in Fig. P-110. Determine the maximum value of the load P if the stress in wood is limited to 1800 psi and that in concrete to 650 psi.

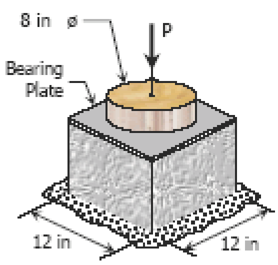


Figure P-110

Solution 110

For wood:

$P_w = \sigma_w A_w$

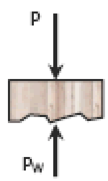
$= 1800[\frac{1}{4}\pi(8^2)]$

$= 90\ 477.9$ lb

From *FBD* of Wood:

$P = P_w = 90\ 477.9$ lb

FBD of Wood



For concrete:

$P_c = \sigma_c A_c$

$= 650(12^2)$

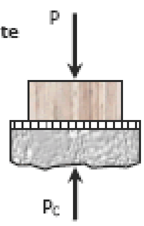
$= 93\ 600$ lb

From FBD of Concrete:

$P = P_c = 93\ 600$ lb

Safe load P = **90 478 lb**

FBD of Concrete



Problem 111

For the truss shown in Fig. P-111, calculate the stresses in members CE, DE, and DF. The crosssectional area of each member is 1.8 in^2. Indicate tension (T) or compression (C).

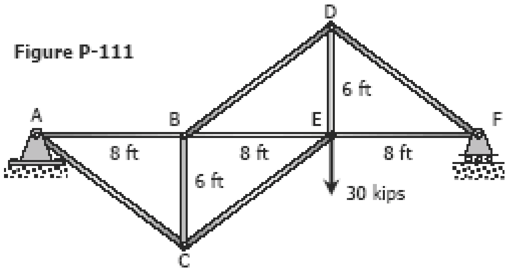
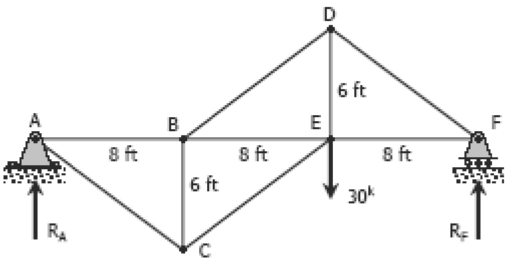


Figure P-111

Solution 111



Free Body Diagram of Truss

From the *FBD* of the truss:

$\Sigma M_A = 0$

$24R_B = 16(30)$

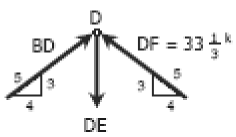
$R_F = 20^k$

At joint *F*:

$\Sigma F_V = 0$

$\frac{3}{5} DF = 20$

$DF = 33\frac{1}{3}{}^k\ (C)$



Joint D

At joint *D*: (by symmetry)

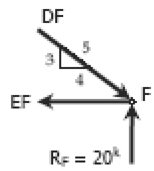
$BD = DF = 33\frac{1}{3}{}^k\ (C)$

$\Sigma F_V = 0$

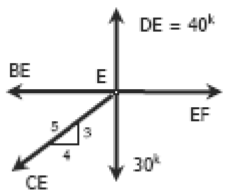
$DE = \frac{3}{5} BD + \frac{3}{5} DF$

$= \frac{3}{5}(33\frac{1}{3}) + \frac{3}{5}(33\frac{1}{3})$

$= 40^k\ (T)$



Joint F



Joint E

At joint *E*:

$\Sigma F_V = 0$

$\frac{3}{5} CE + 30 = 40$

$CE = 16\frac{2}{3}{}^k\ (T)$

Stresses:

Stress = Force/Area

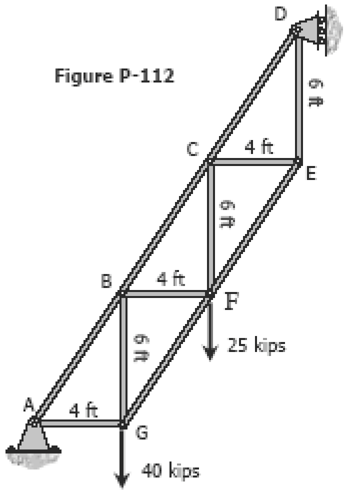
$\sigma_{CE} = \dfrac{16\frac{2}{3}}{1.8} = \mathbf{9.26\ ksi}\ (T)$

$\sigma_{DE} = \dfrac{40}{1.8} = \mathbf{22.22\ ksi}\ (T)$

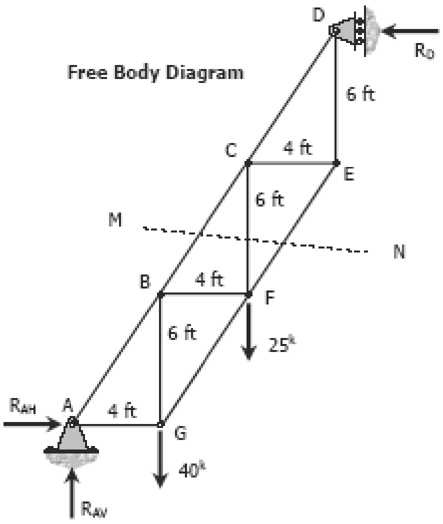
$\sigma_{DF} = \dfrac{33\frac{1}{3}}{1.8} = \mathbf{18.52\ ksi}\ (C)$

Problem 112

Determine the crosssectional areas of members AG, BC, and CE for the truss shown in Fig. P-112 above. The stresses are not to exceed 20 ksi in tension and 14 ksi in compression. A reduced stress in compression is specified to reduce the danger of buckling.



Solution 112

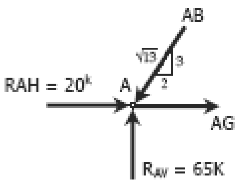


$\Sigma F_V = 0$
$R_{AV} = 40 + 25$
$= 65^k$

$\Sigma M_A = 0$
$18R_D = 8(25) + 4(40)$
$R_D = 20^k$

$\Sigma F_H = 0$
$R_{AH} = R_D = 20^k$

Check:
$\Sigma M_D = 0$
$12R_{AV} = 18(R_{AH}) + 4(25) + 8(40)$
$12(65) = 18(20) + 4(25) + 8(40)$
$780 \text{ ft·kip} = 780 \text{ ft·kip}$ (OK!)



Joint A

For member AG:

At joint A:

$\Sigma F_V = 0$

$\frac{3}{\sqrt{13}} AB = 65$

$AB = \frac{65\sqrt{13}}{3}$

$= 78.12^k$

$\Sigma F_H = 0$

$AG + 20 = \frac{2}{\sqrt{13}} AB$

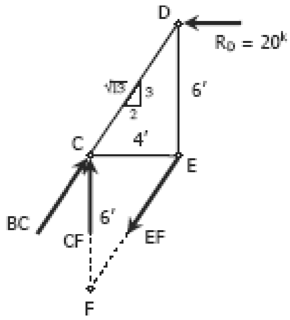
$AG = \frac{2}{\sqrt{13}}(78.12) - 20$

$= 20.33^k$ Tension

$AG = \sigma_{tension} A_{AG}$

$20.33 = 20\, A_{AG}$

A_{AG} **= 1.17 in²**



Section through MN

For member BC:

At section through MN

$\Sigma M_F = 0$

$6(\frac{2}{\sqrt{13}} BC) = 12(20)$

$BC = 20\sqrt{13}$

$= 72.11^k$ Compression

$BC = \sigma_{compression} A_{BC}$

$72.11 = 14\, A_{BC}$

A_{BC} **= 5.15 in²**

For member CE:

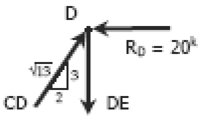
At joint D:

$\Sigma F_H = 0$

$\frac{2}{\sqrt{13}} CD = 20$

$CD = 10\sqrt{13}$

$= 36.06^k$



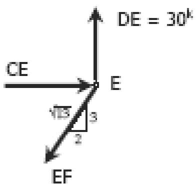
Joint D

$\Sigma F_V = 0$

$DE = \frac{3}{\sqrt{13}} CD$

$= \frac{3}{\sqrt{13}}(36.06)$

$= 30^k$



Joint E

At joint E:

$\Sigma F_V = 0$

$\frac{3}{\sqrt{13}} EF = 30$

$EF = 10\sqrt{13} = 36.06^k$

$\Sigma F_H = 0$

$CE = \frac{2}{\sqrt{13}} EF$

$= \frac{2}{\sqrt{13}}(36.06)$

$= 20^k$ Compression

$CF = \sigma_{compression} A_{CE}$

$20 = 14\, A_{CE}$

A_{CE} **= 1.43 in²**

Problem 113

Find the stresses in members BC, BD, and CF for the truss shown in Fig. P-113. Indicate the tension or compression. The cross sectional area of each member is 1600 mm^2.

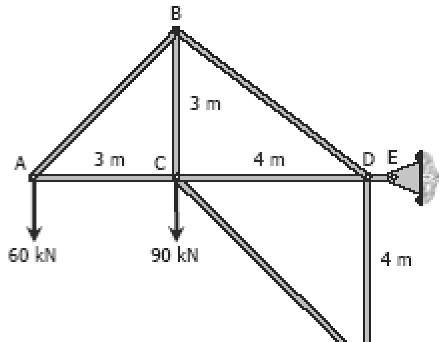
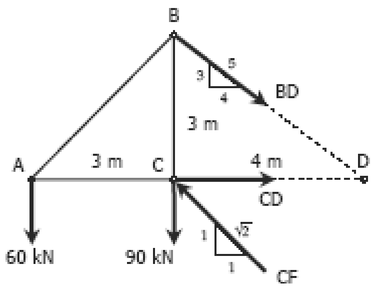
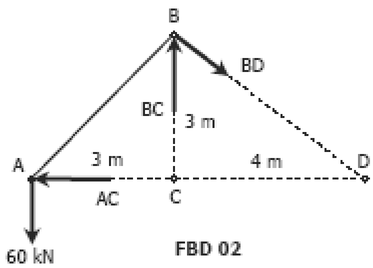


Figure P-113

Solution 113



FBD 01



FBD 02

For member *BD*: (See FBD 01)

$\Sigma M_C = 0$

$3(\frac{4}{5}BD) = 3(60)$

$BD = 75$ kN Tension

$BD = \sigma_{BD} A$

$75\ (1000) = \sigma_{BD}\ (1600)$

$\sigma_{BD} = 46.875$ MPa (Tension)

For member *CF*: (See FBD 01)

$\Sigma M_D = 0$

$4(\frac{1}{\sqrt{2}}CF) = 4(90) + 7(60)$

$CF = 195\sqrt{2}$

$= 275.77$ kN Compression

$CF = \sigma_{CF} A$

$275.77\ (1000) = \sigma_{CF}\ (1600)$

$\sigma_{CF} = 172.357$ MPa (Compression)

For member *BC*: (See FBD 02)

$\Sigma M_D = 0$

$4BC = 7(60)$

$BC = 105$ kN Compression

$BC = \sigma_{BC} A$

$105\ (1000) = \sigma_{BC}\ (1600)$

$\sigma_{BC} = 65.625$ MPa (Compression)

Problem 114

The homogeneous bar ABCD shown in Fig. P-114 is supported by a cable that runs from A to B around the smooth peg at E, a vertical cable at C, and a smooth inclined surface at D. Determine the mass of the heaviest bar that can be supported if the stress in each cable is limited to 100 MPa. The area of the cable AB is 250 mm^2 and that of the cable at C is 300 mm^2.