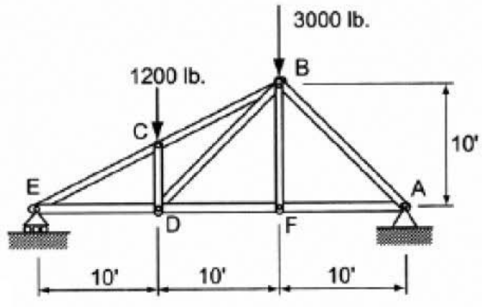
Examples:
Trusses and Columns

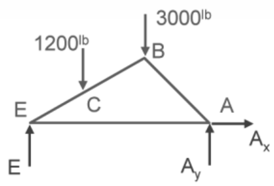
Example 1

Example Problem 4.1 (Method of Joints)

An asymmetrical roof truss, shown in Figure 4.4, supports two vertical roof loads. Determine the support reactions at each end, then, using the method of joints, solve for all member forces. Summarize the results of all member forces on a FBD (this diagram is referred to as a *force summation diagram*).



1. FBD

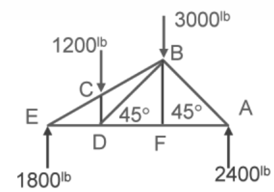


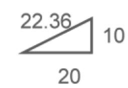
2. solve for support forces

$$\sum F_x = A_x = \boxed{0}$$

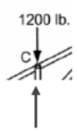
$$\sum M_A = 3000^{lb}\cdot 10^{ft} + 1200^{lb}\cdot 20^{ft} - E\cdot 30^{ft} = 0 \qquad E = \frac{54000^{lb-ft}}{30^{ft}} = \boxed{1800^{lb}}$$

$$\sum F_y = 1800^{lb} - 1200^{lb} - 3000^{lb} + A_y = 0 \qquad A_y = \boxed{2400^{lb}}$$





3. look for special cases:

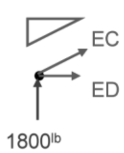


C, so CE = BC and CD = -1200lb

F, so DF = AF and BF = 0

4. choose a joint with 2 or less unknowns: E or A will work (C won't)

E:



$$\sum F_y = 1800^{lb} + EC\left(\frac{10}{22.36}\right) = 0$$

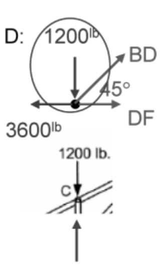
$$EC = -1800^{lb}\left(\frac{22.36}{10}\right) = \boxed{-4025^{lb}} = BC$$

$$\sum F_x = ED + (-4025^{lb})\left(\frac{20}{22.36}\right) = 0 \qquad ED = 4025^{lb}\left(\frac{20}{22.36}\right) = \boxed{3600^{lb}}$$

need BD, AB, (AF or DF) which leaves joints B, D & A (F won't work)

5. choose a joint with 2 or less unknowns: B, D or A will work (F won't)

D:



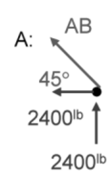
$$\sum F_y = -1200^{lb} + BD\sin 45 = 0 \quad BD = \frac{1200^{lb}}{\sin 45} = \boxed{1697^{lb}}$$

$$\sum F_x = -3600^{lb} + DF + (1697^{lb})\cos 45 = 0$$

$$DF = \boxed{2400^{lb}} = AF$$

6. last joint needs only one equation

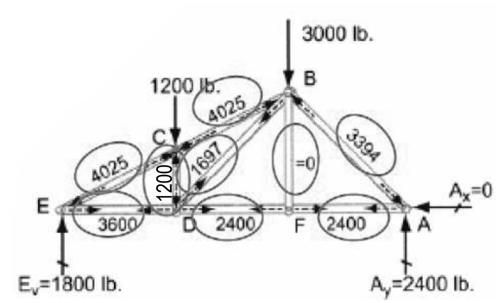
A:



$$\sum F_y = 2400^{lb} + AB\sin 45 = 0$$

$$AB = \frac{-2400^{lb}}{\sin 45} = \boxed{-3394^{lb}}$$

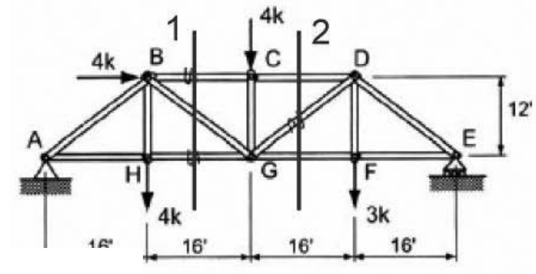
$$(\sum F_x = -2400^{lb} - (-3394^{lb})\cos 45 = 0)\ \checkmark$$



Example 2

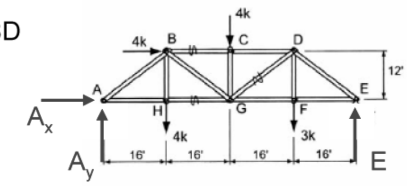
Example Problem 4.3 (Method of Sections)

A 64-foot parallel chord truss (Figure 4.30) supports horizontal and vertical loads as shown. Using the method of sections, determine the member forces *BC*, *HG*, and *GD*.



1. look for sections

2. FBD



3. solve for support forces

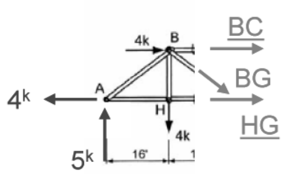
$$\sum F_x = A_x + 4^k = 0 \qquad A_x = \boxed{-4^k}$$

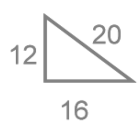
$$\sum F_y = A_y - 4^k - 4^k - 3^k + E = 0$$

$$\sum M_A = -4^k \cdot 12^{ft} - 4^k \cdot 16^{ft} - 4^k \cdot 32^{ft} - 3^k \cdot 48^{ft} + E \cdot 64^{ft} = 0$$

$$E = \frac{384^{k-ft}}{64^{ft}} = \boxed{6^k} \qquad \text{and sub:} \quad A_y = \boxed{5^k}$$

4. draw section





5. look for intersection for summing moments (B or G)

6. write equilibrium equations

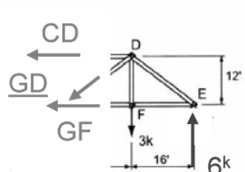
$$\sum M_B = HG \cdot 12^{ft} - 5^k \cdot 16^{ft} - 4^k \cdot 12^{ft} = 0 \qquad HG = \frac{128^{k-ft}}{12^{ft}} = \boxed{10.67^k}$$

$$\sum M_G = 4^k \cdot 16^{ft} - 5^k \cdot 32^{ft} - 4^k \cdot 12^{ft} - BC \cdot 12^{ft} = 0$$

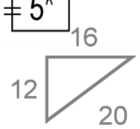
$$BC = \frac{144^{k-ft}}{-12^{ft}} = \boxed{-12^k}$$

$$\left(\sum F_y = 5^k - 4^k - BG\left(\frac{12}{20}\right) = 0 \quad BG = -1.67^k\right)$$

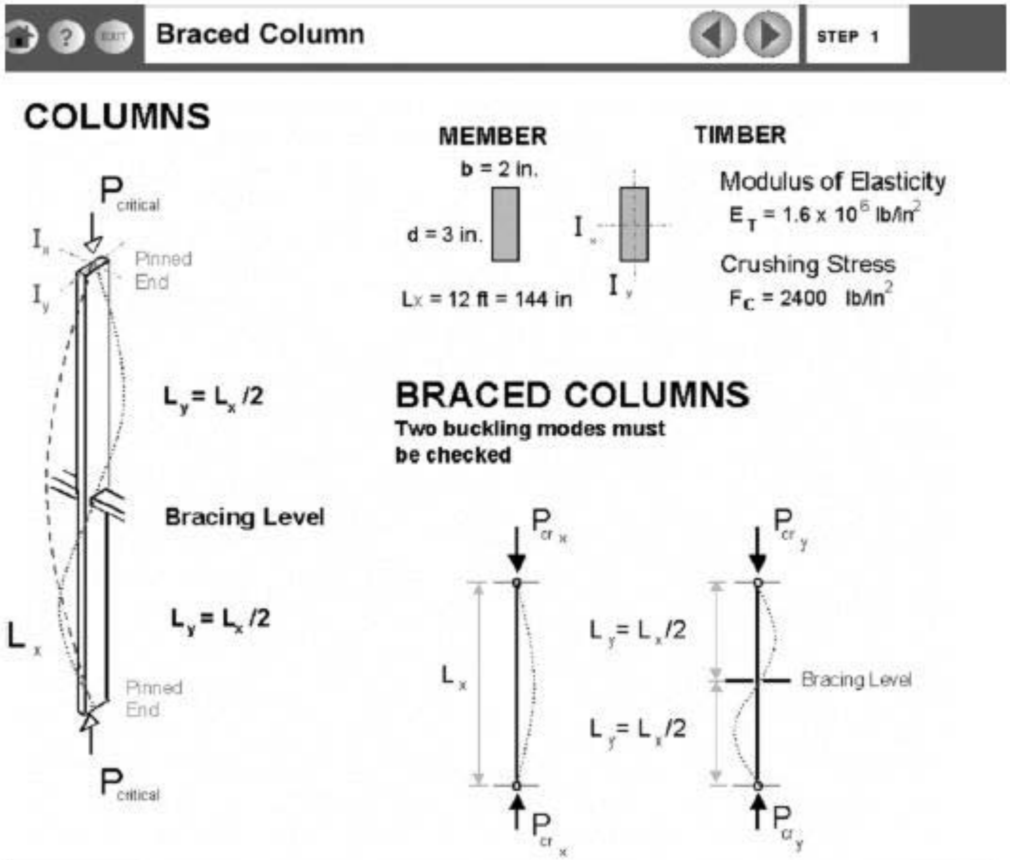
7. repeat with other section

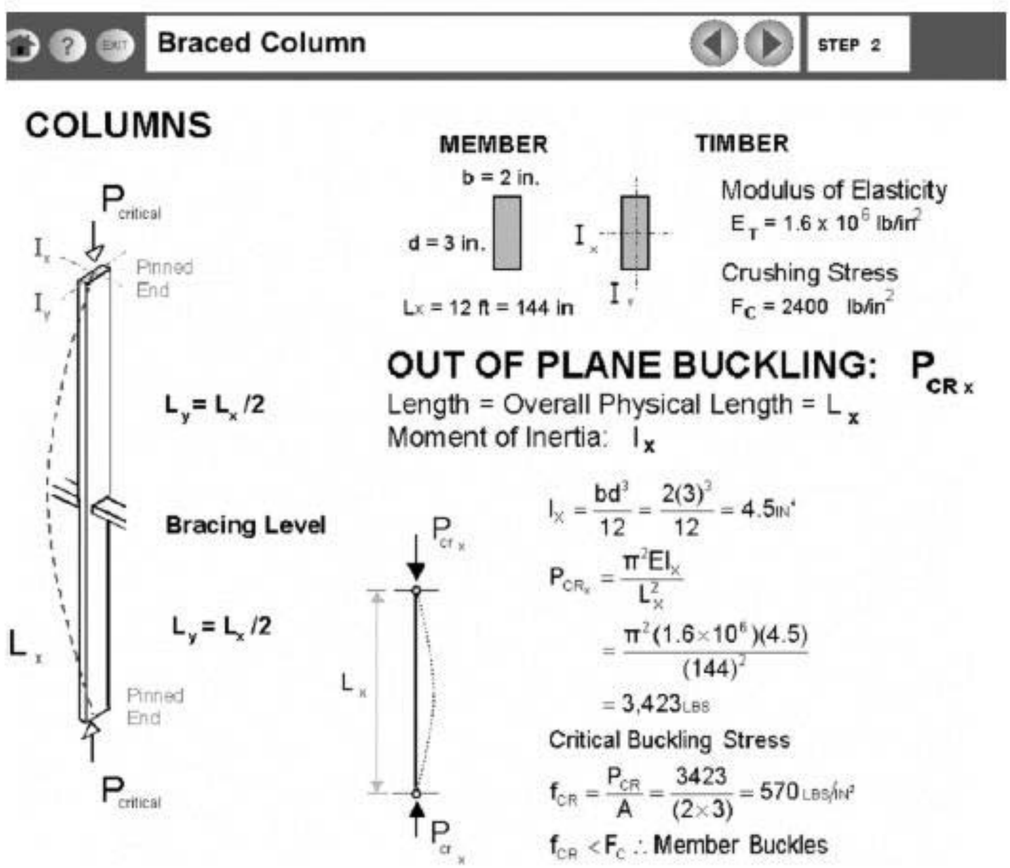


$$\sum F_y = 6^k - 3^k - GD\left(\frac{12}{20}\right) = 0 \quad GD = \boxed{5^k}$$

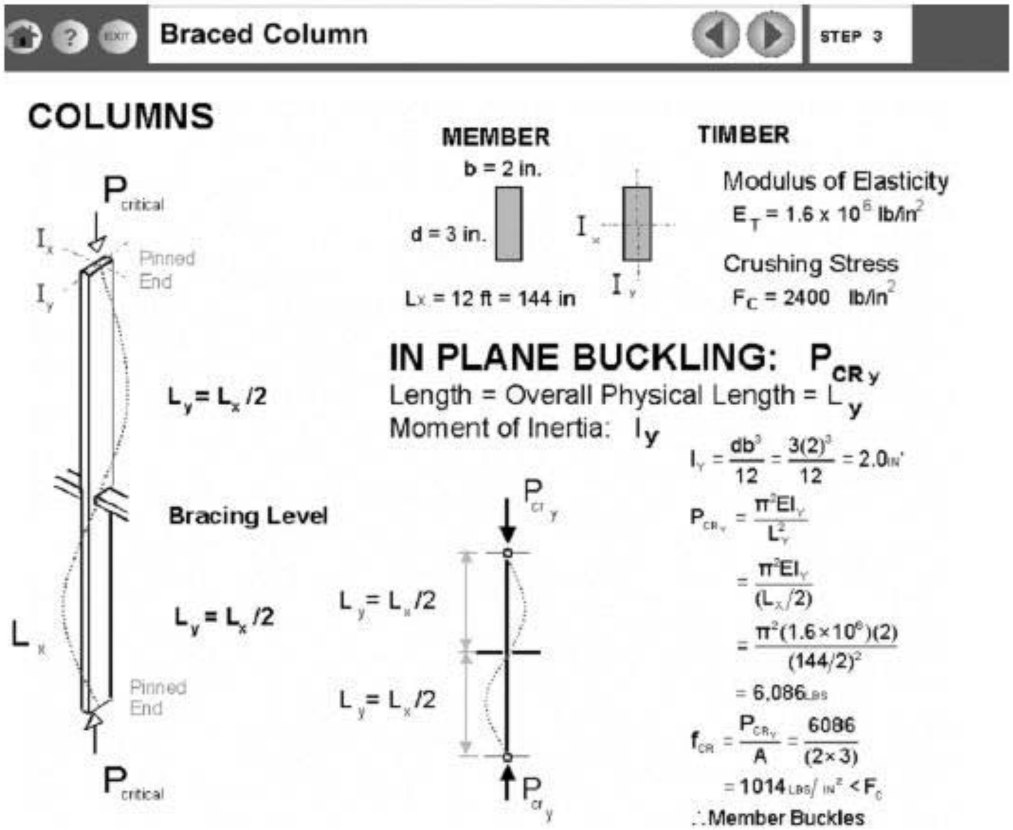


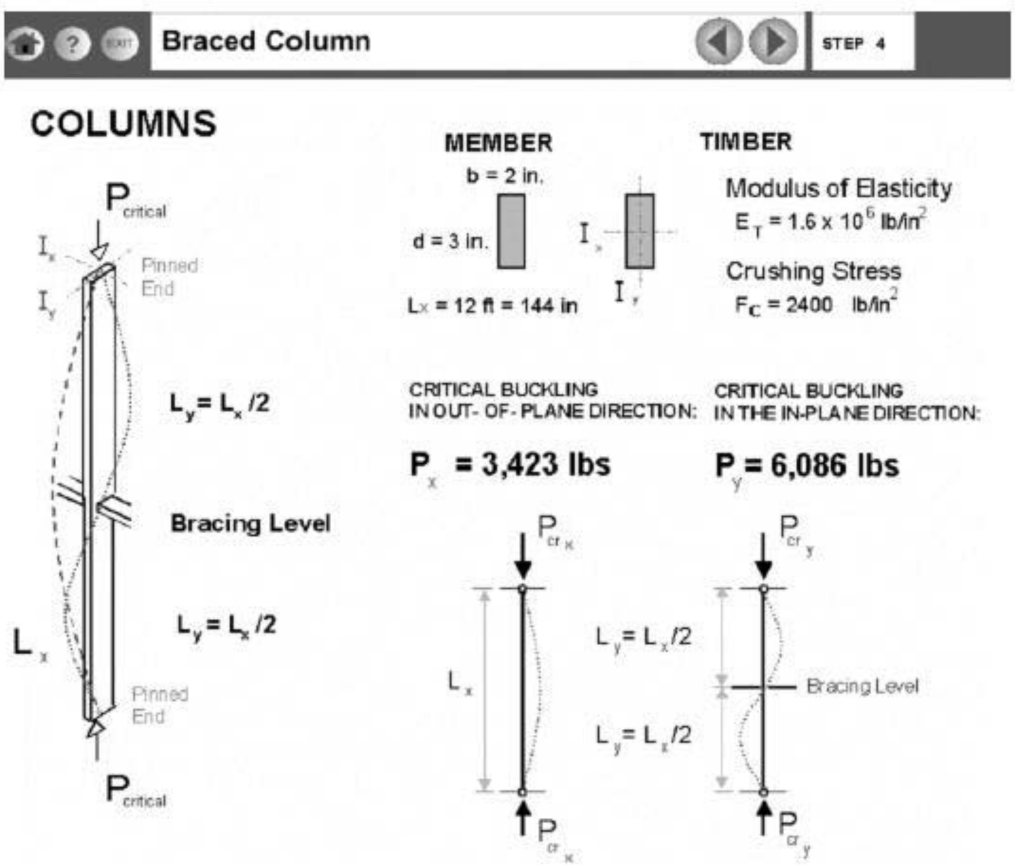
Example 3 **From eStructures v1.1, Schodek and Pollalis, 2000 Harvard College**





Example 3 (continued)





Example 3 (continued)