Example 9-19:

The cross section is composed of two channels back to back to form an H-section. One C-shape has the following parameters:

$A = 8.82\ in^2$, $I_x = 103\ in^4$, $I_y = 3.94\ in^4$, $x_c = 0.649$ in (distance from outer face of web to centroid), E = 29,000ksi, $\sigma_y = 36$ ksi.

- Where will the truss fail?
- How and under which load will it fail when the factor of safety for yield is 1.75 and for buckling is 4?

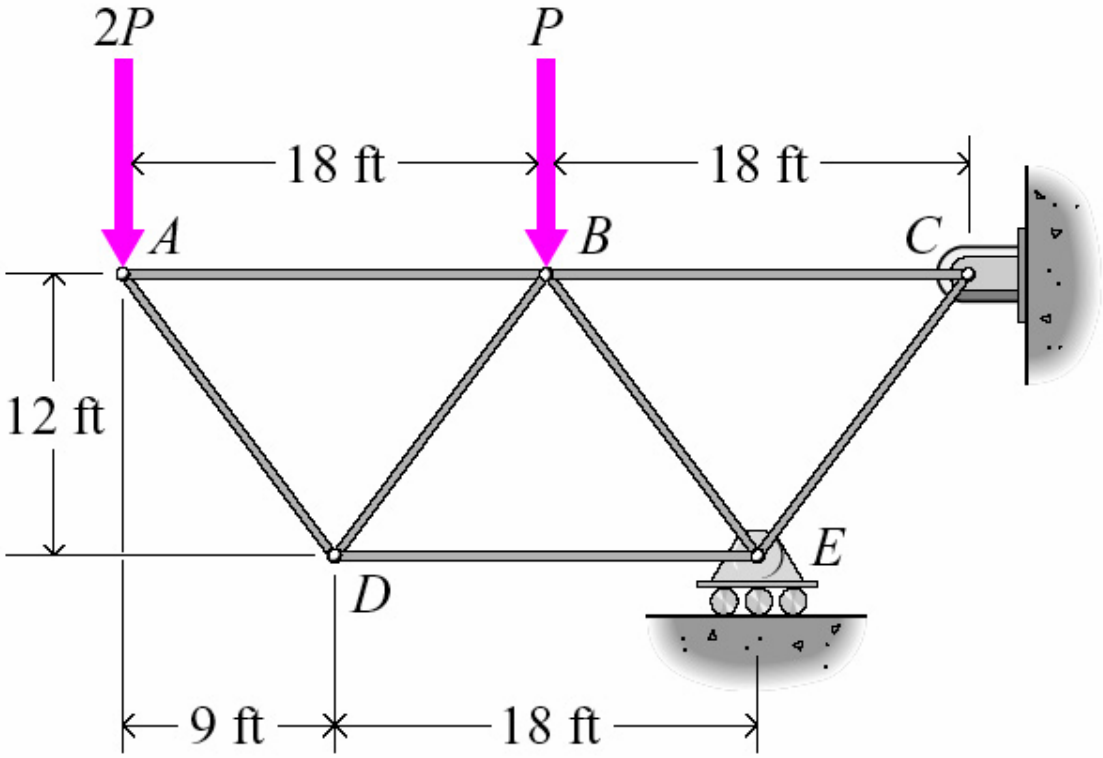
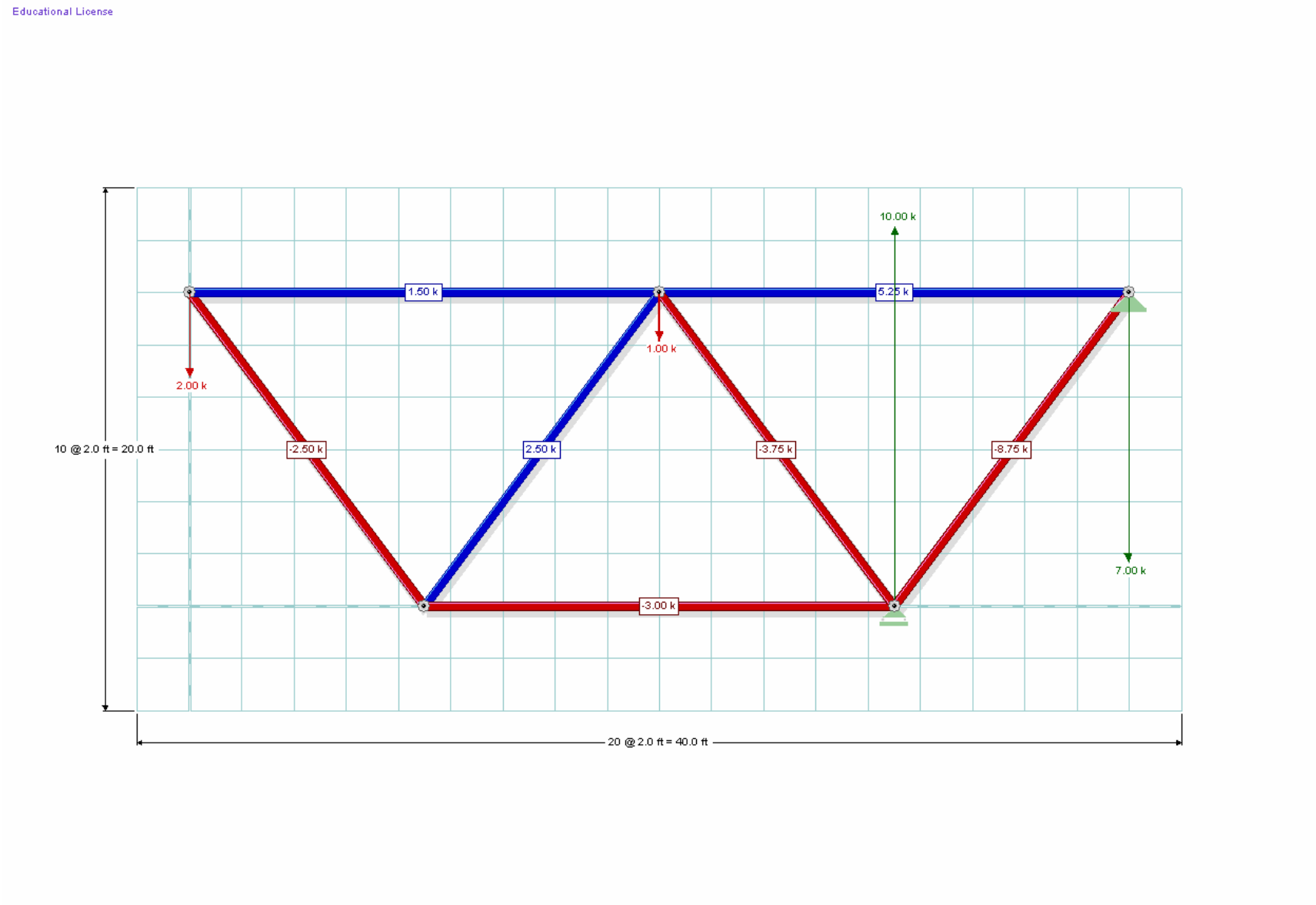
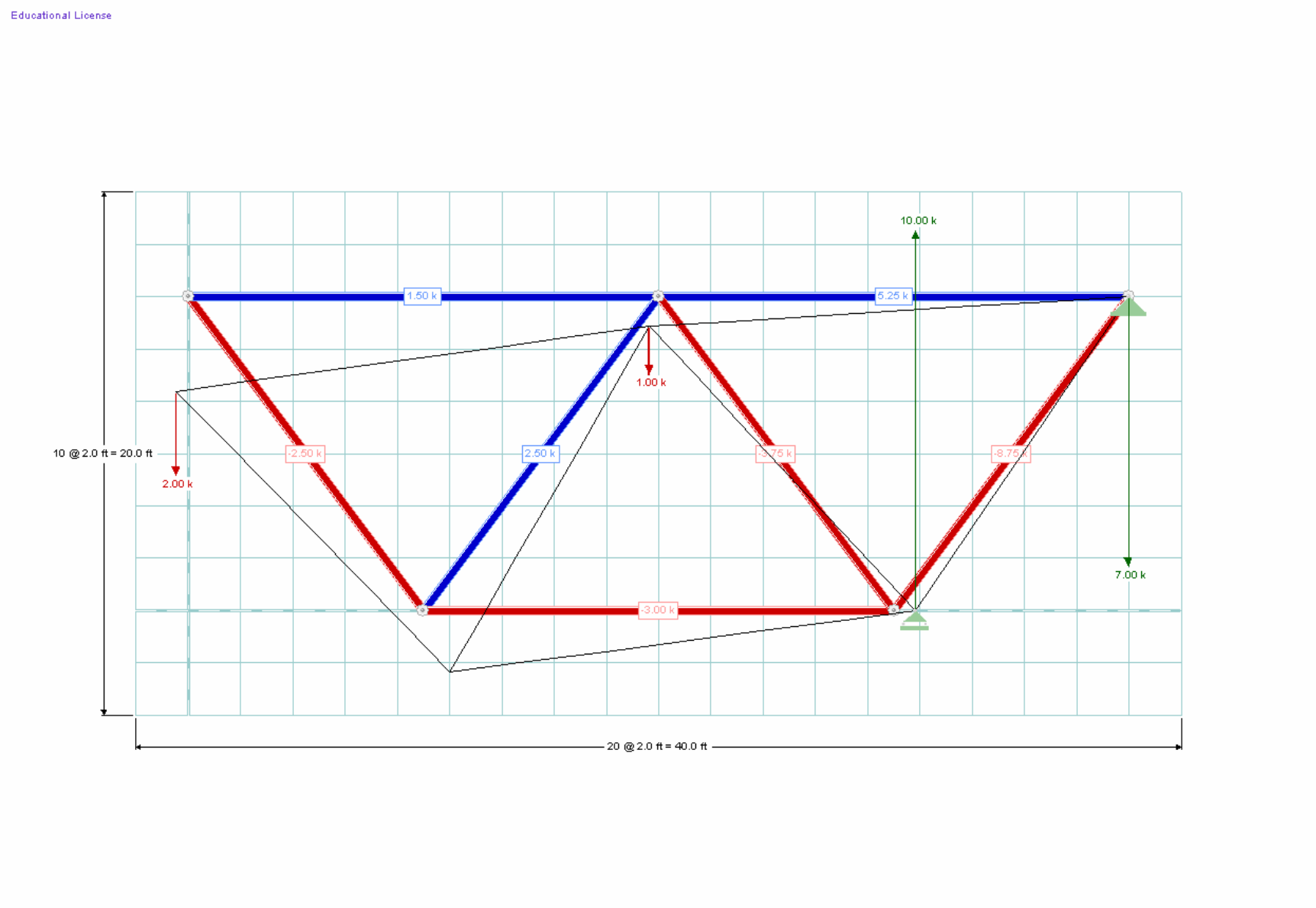


Figure P9-19

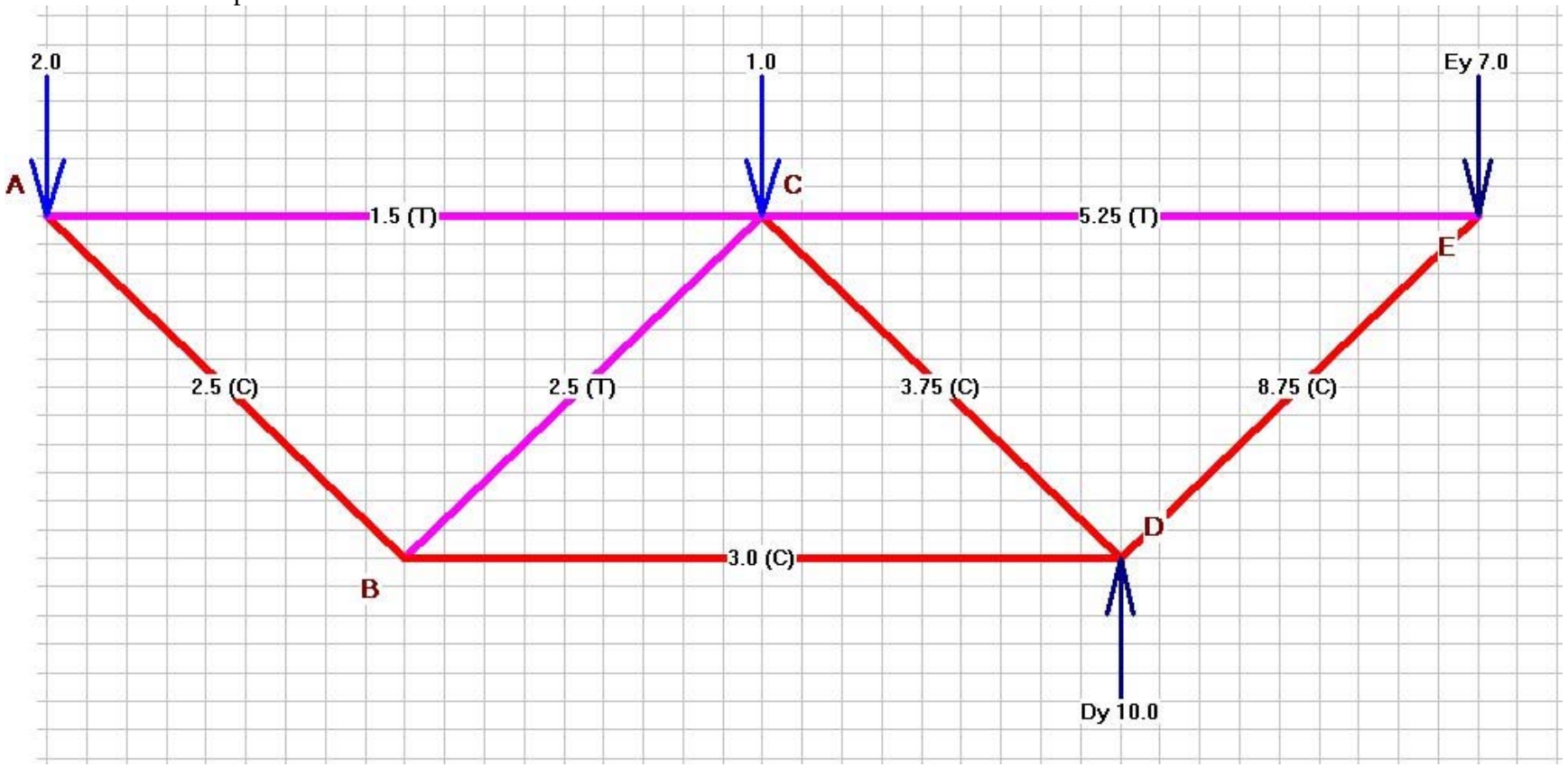
member forces computed with DrFrame:



deflections computed with DrFrame:



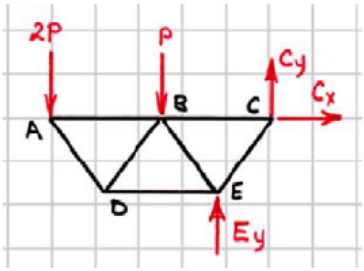
member forces computed with MDSolids:



Textbook solution see next page (long hand computation with calculator):

9-19

From the overall free-body diagram:



$$\circlearrowleft \Sigma M_C = 0: \qquad 2P(36) + P(18) - R_E(9) = 0$$

$$R_E = 10P$$

From a free-body diagram of pin A:

$$\theta = \tan^{-1}(12/9) = 53.13°$$

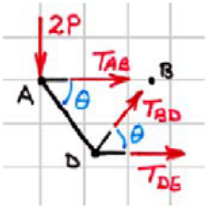
$$\uparrow \Sigma F_y = 0: \qquad -T_{AD}\sin 53.13° - 2P = 0$$

$$T_{AD} = -2.50P = 2.50P \text{ (C)}$$

$$\rightarrow \Sigma F_x = 0: \qquad T_{AB} + T_{AD}\cos 53.13° = 0$$

$$T_{AB} = +1.50P = 1.50P \text{ (T)}$$

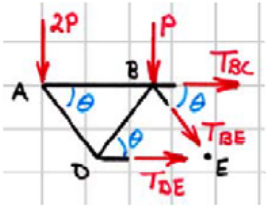
From a free-body diagram of the part of the truss to the left of pin B:



$$\uparrow \Sigma F_y = 0: \qquad T_{BD}\sin 53.13° - 2P = 0$$

$$T_{BD} = +2.50P = 2.50P \text{ (T)}$$

From a free-body diagram of the part of the truss to the left of pin E:



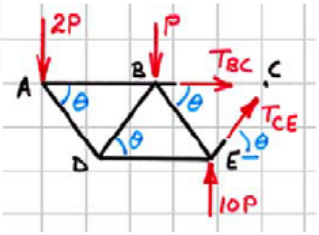
$$\uparrow \Sigma F_y = 0: \qquad -T_{BE}\sin 53.13° - 3P = 0$$

$$T_{BE} = -3.75P = 3.75P \text{ (C)}$$

$$\circlearrowleft \Sigma M_B = 0: \qquad T_{DE}(12) + 2P(18) = 0$$

$$T_{DE} = -3.00P = 3.00P \text{ (C)}$$

From a free-body diagram of the part of the truss to the left of pin C:



$$\uparrow \Sigma F_y = 0: \qquad T_{CE}\sin 53.13° + 10P - 3P = 0 \qquad T_{CE} = -8.75P = 8.75P \text{ (C)}$$

$$\circlearrowleft \Sigma M_E = 0: \qquad 2P(27) + P(9) - T_{BC}(12) = 0 \qquad T_{BC} = +5.25P = 5.25P \text{ (T)}$$

From Table B-5 for a C 10×30 section: $A = 8.82 \text{ in.}^2$ $x_C = 0.649 \text{ in.}$

$I_x = 103 \text{ in.}^4$ $I_y = 3.94 \text{ in.}^4$

From Table B-17: $E = 29{,}000 \text{ ksi}$ $\sigma_y = 36 \text{ ksi}$

For member BC: $F_{max} = \sigma_y A = (36)(2 \times 8.82) = 635.0 \text{ kip}$

$$T_{BC} = 5.25P \le \frac{F_{max}}{FS} = \frac{635.0}{1.75} \qquad P \le 69.1 \text{ kip}$$

For the bolted channels: $I_y = I_{min} = 2\left[3.94 + 8.82(0.649)^2\right] = 15.31 \text{ in.}^4$

For member CE: $$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 (29{,}000)(15.31)}{(15 \times 12)^2} = 135.25 \text{ kip}$$

$$T_{CE} = 8.75P \le \frac{P_{cr}}{FS} = \frac{135.25}{4} \qquad P \le 3.86 \text{ kip}$$

Therefore $P_{max} = 3.86 \text{ kip}$ ..... **Ans.**