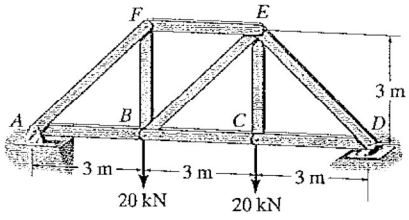
EXAMPLE 9.1

Determine the vertical displacement of joint C of the steel truss shown in Fig. 9–8*a*. The cross-sectional area of each member is $A = 300\ \text{mm}^2$ and $E = 200\ \text{GPa}$.



(a)

Solution

Virtual Forces n. Only a vertical 1-kN load is placed at joint C, and the force in each member is calculated using the method of joints. The results are shown in Fig. 9–8*b*. Positive numbers indicate tensile forces and negative numbers indicate compressive forces.

Real Forces N. The real forces in the members are calculated using the method of joints. The results are shown in Fig. 9–8*c*.

Virtual-Work Equation. Arranging the data in tabular form, we have

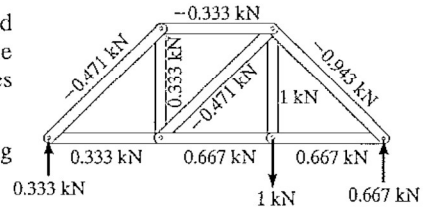
Member	n (kN)	N (kN)	L (m)	$n\,NL$ (kN²·m)
AB	0.333	20	3	20
BC	0.667	20	3	40
CD	0.667	20	3	40
DE	−0.943	−28.3	4.24	113
FE	−0.333	−20	3	20
EB	−0.471	0	4.24	0
BF	0.333	20	3	20
AF	−0.471	−28.3	4.24	56.6
CE	1	20	3	60
				Σ369.6

Thus
$$1\ \text{kN} \cdot \Delta_{C_v} = \sum \frac{nNL}{AE} = \frac{369.6\ \text{kN}^2\cdot\text{m}}{AE}$$

Converting the units of member length to inches and substituting the numerical values for A and E, we have

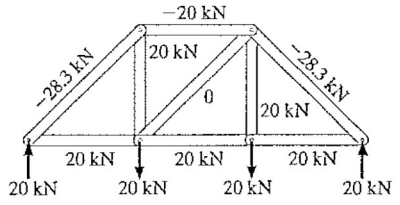
$$1\ \text{kN} \cdot \Delta_{C_v} = \frac{396.6\ \text{kN}^2\cdot\text{m}}{[300(10^{-6})\ \text{m}^2][200(10^6)\ \text{kN/m}^2]}$$

$$\Delta_{C_v} = 0.00616\ \text{m} = 6.16\ \text{mm} \cdot \qquad \textit{Ans.}$$



virtual forces **n**

(b)



real forces **N**

(c)

Fig. 9–8