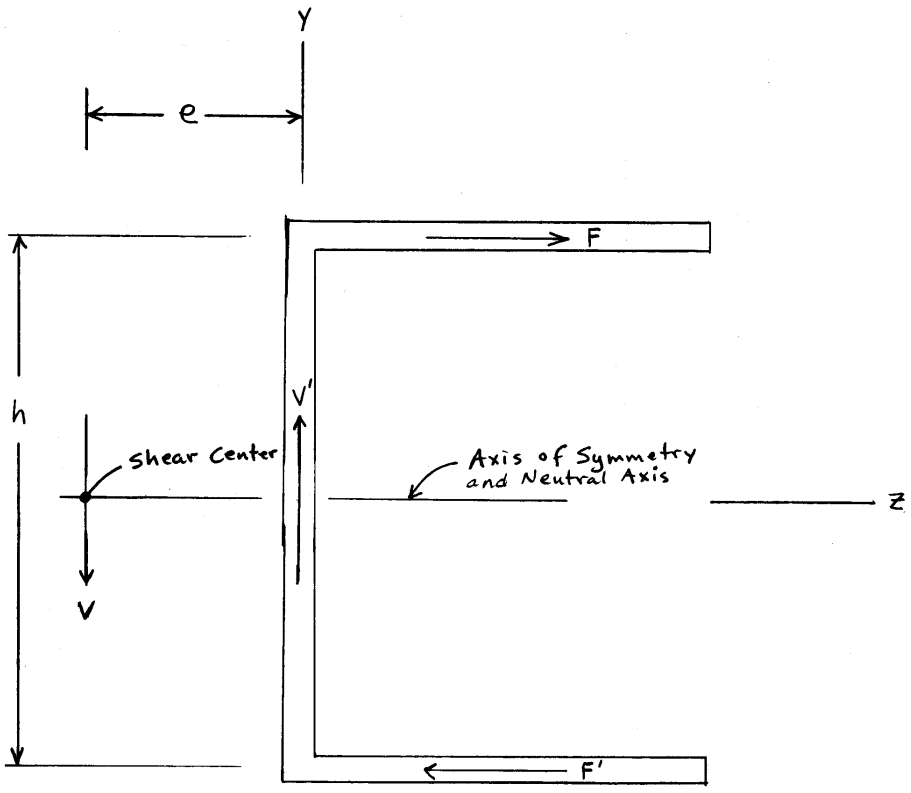
FREE BODY DIAGRAM ILLUSTRATING SHEAR CENTER

In Figure 6.47 on p. 403 of the textbook, the directions of the shearing stresses, and hence the directions of the shearing forces, generated ***by*** the shearing force (V) are shown. These are internal stresses and forces. The external stresses and forces that resist the applied shearing force are in the opposite directions to the internal shearing stresses and forces generated by the shearing force. In a free body diagram, only external forces acting ***on*** the body are shown. Therefore, a free body diagram illustrating the location of the shear center for the channel shown in Figure 6.47 is as follows:



Summing forces in the y and z directions shows that $V' = V$ and $F' = F$.

The location of the shear center can be found by summing moments about the point of intersection of the line of action of V' and the neutral axis, setting the sum of the moments equal to zero, and solving for e.

$$\sum M = -Ve + F \cdot \frac{h}{2} + F' \cdot \frac{h}{2} = 0 \quad \Rightarrow \quad e = \frac{2Fh/2}{V} = \frac{FH}{V}$$

It can be verified that applying V at the shear center results in zero twisting moment by summing moments about any other point. Let's sum moments about the shear center:

$$\sum M_{sc} = -V'e + F \cdot \frac{h}{2} + F' \cdot \frac{h}{2} = -Ve + \frac{2FH}{2} = -V \cdot \frac{FH}{V} + FH = -FH + FH = 0 \quad (Verified)$$