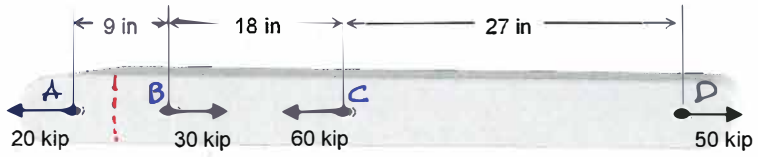
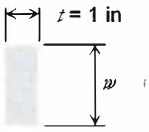
Example

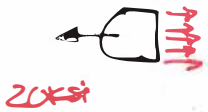
A one-inch-thick 0.4% C hot-rolled steel bar is subjected to four different axial forces as shown in the figure. If the factor of safety by yielding is to be 1.75, find the minimum width w of the bar.

$\sigma_y = 53$ ksi



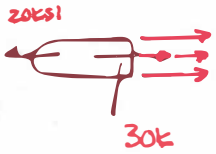


FBD 1



$\sigma_{AB} = \frac{20k}{A} = \frac{20k}{tw}$

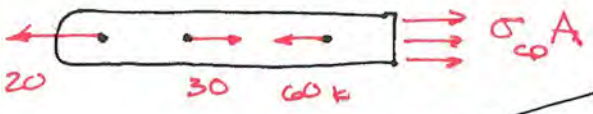
FBD2



$\sigma_{BC} A + 30k - 20k = 0$ ← COMPRESSION

$\sigma_{BC} = \frac{-10k}{A} = \frac{-10k}{tw}$

FBD 3



$-20 + 30 - 60 + \sigma_{CD} A = 0$

$\sigma_{CD} = \frac{50 \text{ kip}}{A} = \frac{50 \text{ kip}}{tw}$

THIS IS THE BIGGEST. SET

$\frac{\sigma_y}{FOS} = \sigma_{CD} \Rightarrow \frac{53 \text{ ksi}}{1.75} = \frac{50 \text{ kip}}{(1")(w)}$

$w = \frac{50 \text{ kip}\,(1.75)}{(1")\,53 \frac{\text{kip}}{\text{in}^2}} = \boxed{1.65 \text{ in}}$