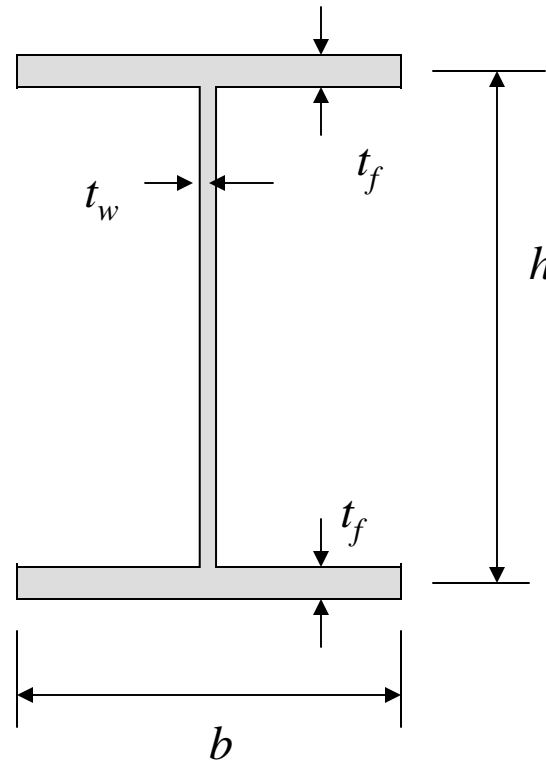
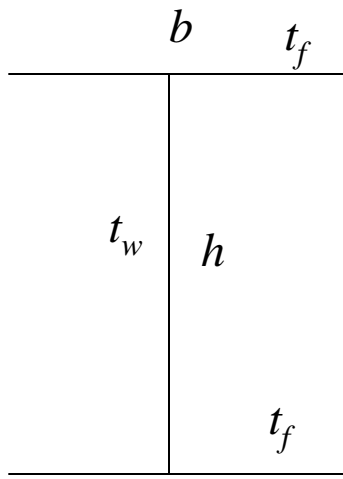


For torsion of the I-beam shown below, determine the effective polar area moment of the cross section, the maximum shearing stress (neglecting stress concentrations) and the warping displacement of the center lines. All distances are center line distances

Assume: $t_w < t_f$

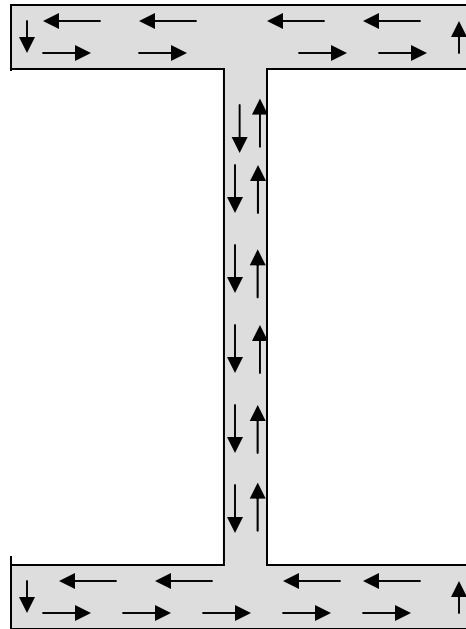




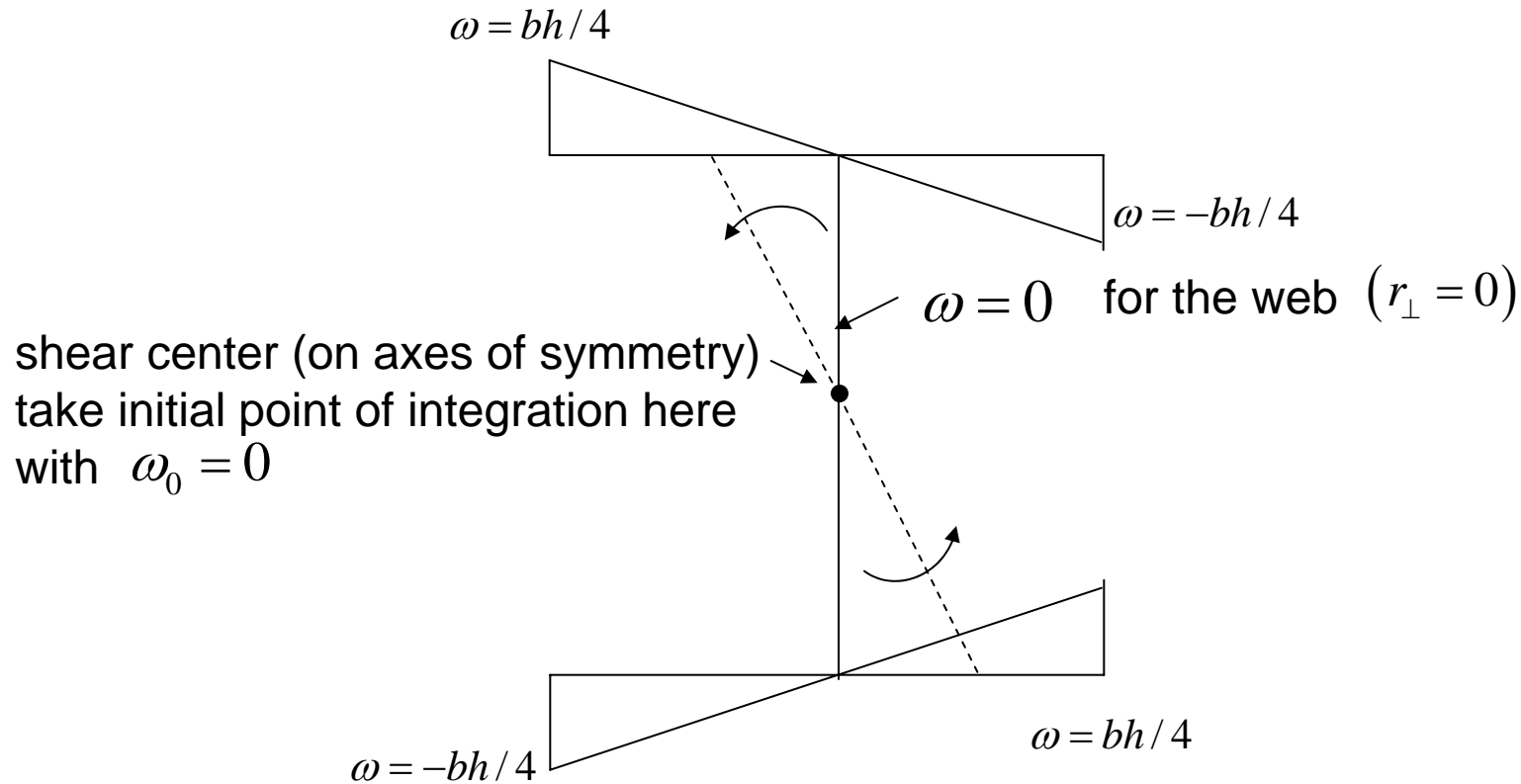
$$J_{eff} = \frac{1}{3}bt_f^3 \times 2 + \frac{1}{3}ht_w^3$$

$$= \frac{2bt_f^3 + ht_w^3}{3}$$

$$\tau_{max} = \frac{Tt_{max}}{J_{eff}} = \frac{Tt_f}{J_{eff}}$$



sectorial area function $\omega = 2\Omega$



Note: $\int \omega dA = 0$ is satisfied automatically by our choice $\omega_0 = 0$

(If we had let the constant to be non-zero, we could show it is zero by this condition)

Since the warping displacement $u_x = -\phi' \omega_p$

the warping of the center lines of the flanges looks like:

