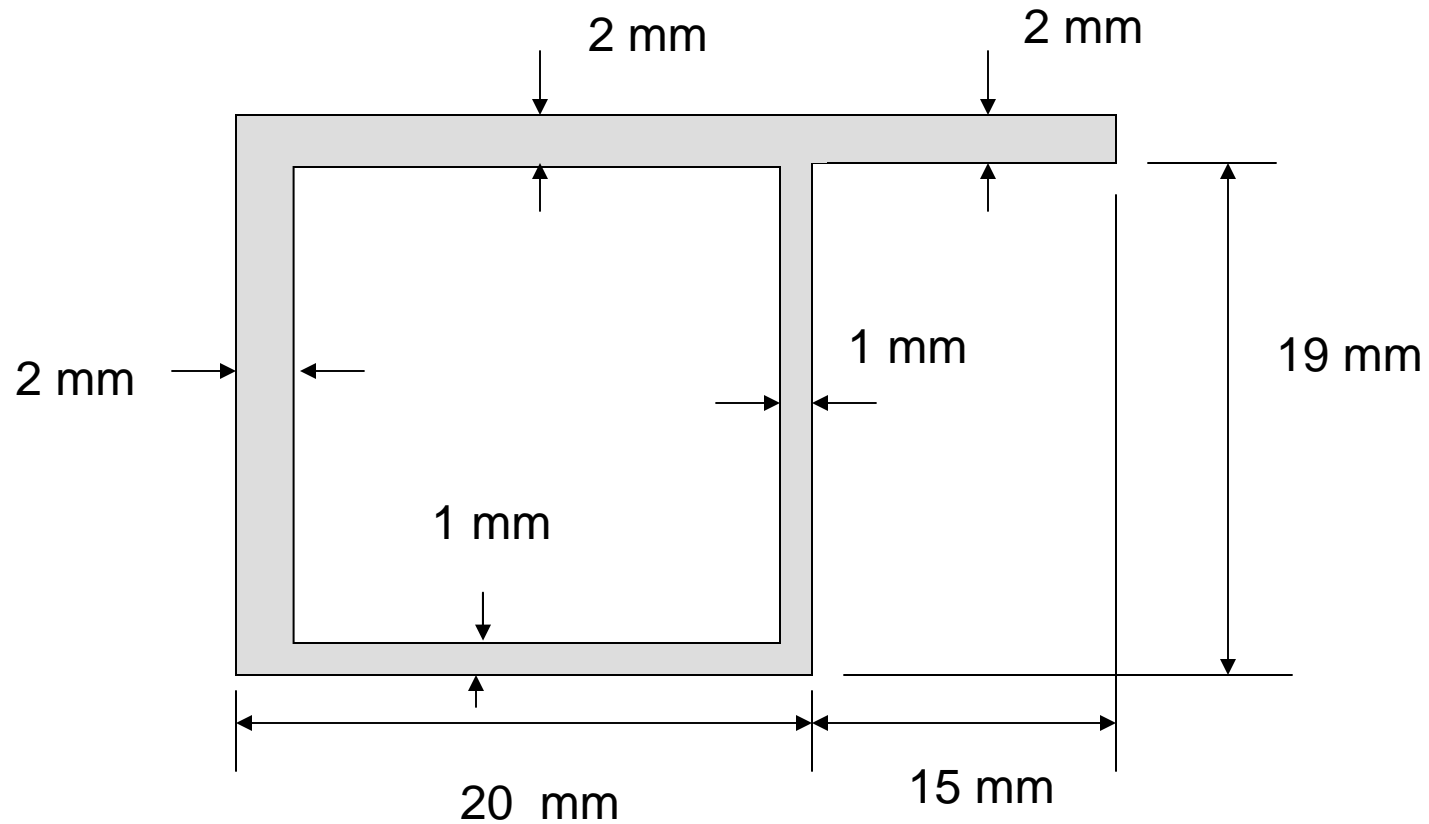
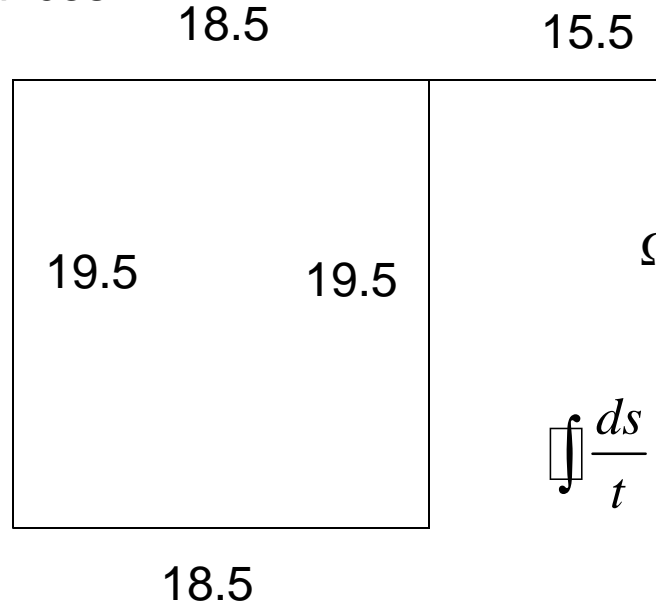


If $T = 6000 \text{ N}\cdot\text{mm}$, $G = 80 \text{ GPa}$, compute the angle of twist/unit length and the maximum shearing stresses (neglecting stress concentrations) in the closed section and the fin



Center line distances



$$\Omega = (18.5)(19.5) = 360.75 \text{ mm}^2$$

$$\oint \frac{ds}{t} = \frac{18.5}{1} + \frac{18.5}{2} + \frac{19.5}{1} + \frac{19.5}{2} = 57$$

$$T = G \phi' \left[\frac{4\Omega^2}{\oint ds/t} + \frac{1}{3} \oint_{closed} t^3 ds + \frac{1}{3} \int_{fin} t^3 ds \right]$$

$$6000 = 80,000 \phi' \left[\frac{(4)(360.75)^2}{57} + \frac{(18.5)(2)^3}{3} + \frac{(19.5)(2)^3}{3} + \frac{(18.5)(1)^3}{3} + \frac{(19.5)(1)^3}{3} + \frac{(15.5)(2)^3}{3} \right]$$

closed fin

$$6000 = 80,000 \phi' [9132.67 + 49.33 + 26 + 6.17 + 6.5 + 41.33]$$

$$\underbrace{\hspace{15em}}_{9220.67 \text{ (closed)}}$$

$$6000 = 80,000 \phi' [9262]$$

$$\phi' = 8.10 \times 10^{-6} \text{ rad / mm}$$

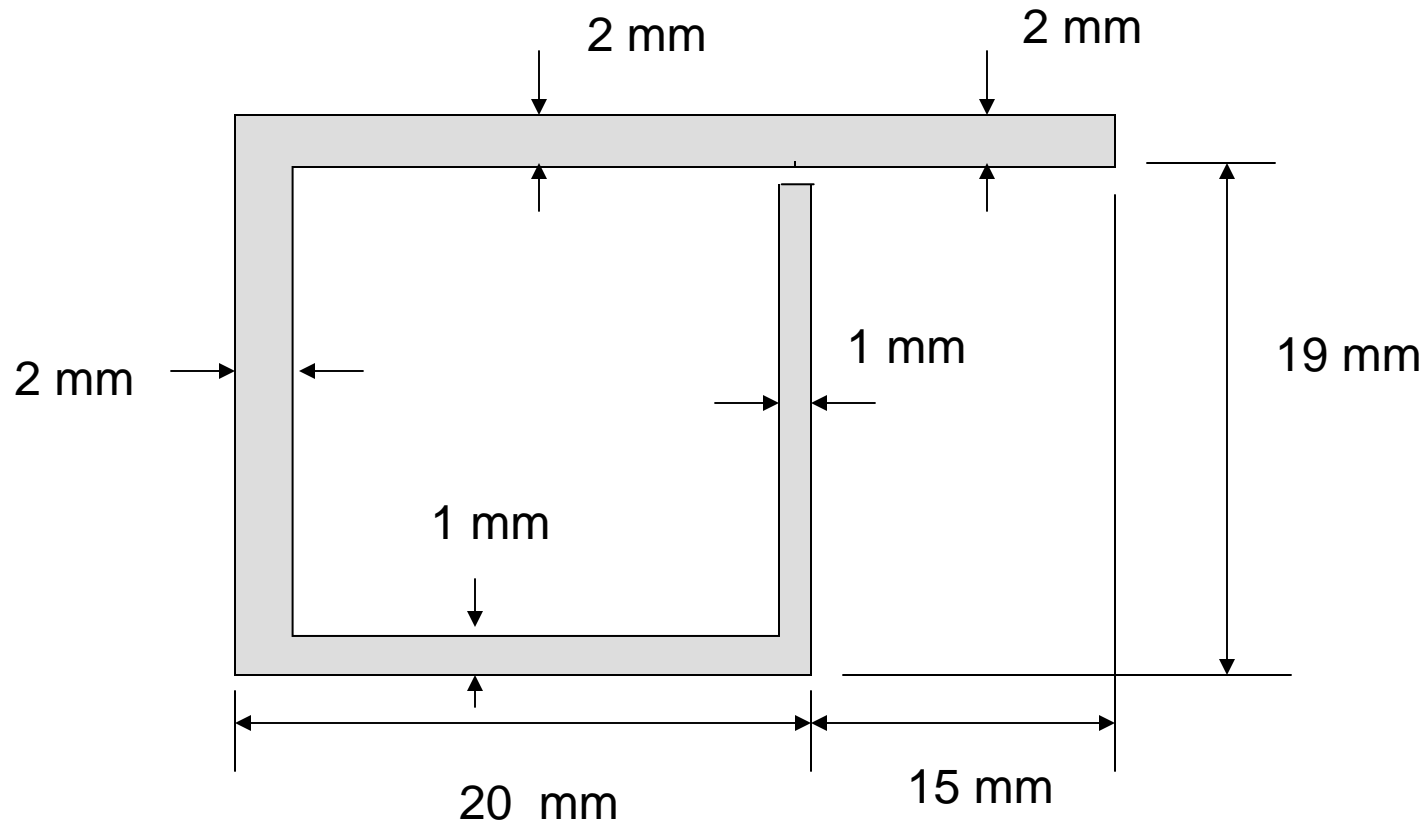
Torque carried by closed section is $T_c = (80,000)(8.1 \times 10^{-6})(9220.67)$
 $= 5975 \text{ N} - \text{mm}$

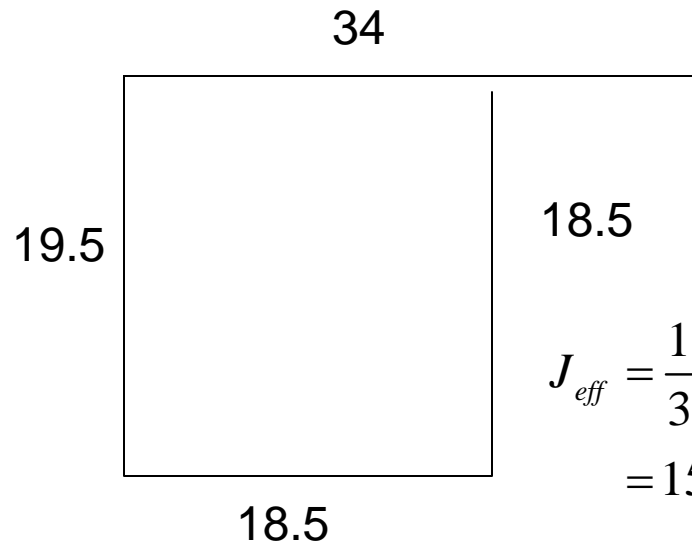
so the fin contributes very little

In the closed section $\tau_{max} = \frac{T_c}{2\Omega t_{min}} = \frac{5975}{2(360.75)(1)} = 8.28 \text{ MPa}$

In the fin $\tau_{max} = \frac{T_f t_{max}}{J_f} = \frac{(6000 - 5975)(2)}{(15.5)(2)^3 / 3} = 1.2 \text{ MPa}$

Now, consider the same geometry where we slit the section as shown. Again determine the twist/ unit length and maximum shearing stress





$$J_{eff} = \sum \frac{1}{3} b_i t_i^3$$

$$J_{eff} = \frac{1}{3} \left[(18.5)(1)^3 + (18.5)(1)^3 + (19.5)(2)^3 + (34)(2)^3 \right]$$

$$= 155 \text{ mm}^4$$

$$\phi' = \frac{T}{GJ_{eff}} = \frac{6000}{(80,000)(155)} = 484 \times 10^{-6} \text{ rad / mm}$$

$$\tau_{max} = \frac{Tt_{max}}{J_{eff}} = \frac{(6000)(2)}{155} = 77.4 \text{ MPa}$$

so slitting causes:

ϕ' to increase by a factor of 59.8

τ_{max} to increase by a factor of 9.3