

## 50.4: Transverse (Shear) Stress—Torsional

The other type of transverse stress is torsional stress. This is the type of stress produced, for example, by applying a torque to a bolt with a wrench.

### Strain

For torsional transverse stress, imagine we have a right circular cylinder of length  $\ell$ , fastened in place at one end, and with a torque  $\tau$  applied to the other end. Then the strain is the arc length  $s$  through which the cylinder is twisted, divided by the length of the cylinder:  $\varepsilon = s/\ell$ . If the cylinder is twisted through an angle  $\theta$ , then this becomes

$$\varepsilon = r\theta/\ell. \quad (50.4.1)$$

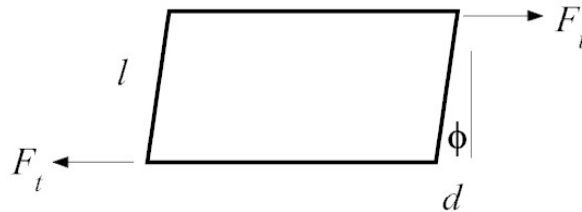


Figure 50.4.1: Transverse shear stress.

### Shear Modulus

In the case of the torsional transverse stress on a cylinder of length  $\ell$  and radius  $r$  twisted through an angle  $\theta$  by a torque  $\tau$ , it can be shown that the shear modulus is

$$S = \frac{2\tau\ell}{\pi r^4\theta} \quad (50.4.2)$$

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