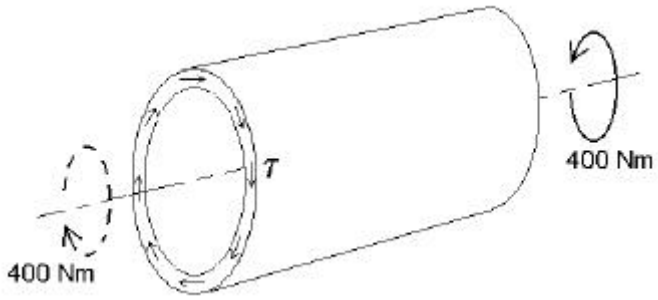
Example 2

Consider the torsion of a thin cylinder 50 mm diameter by 1 mm thick under the action of a twisting moment of 400 Nm. Show that a shear stress of 102 MPa is set up and show this on a biaxial element.

Hence demonstrate that this 'pure shear' is equivalent to a system of tensile and compressive stresses of magnitude equal to t and orientated at 45^o to the cylinder axis.



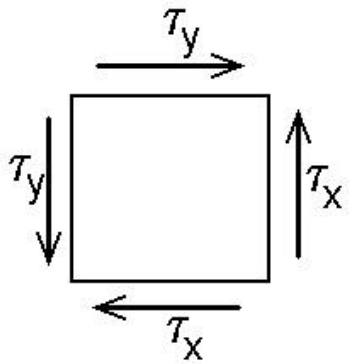
For rotational equilibrium:

400 = stress x area x radius

$= \tau_x$ x 2πr t x r

Hence:

$$t_x = \frac{400}{2p\,0.025^2 \times 0.001} = 102 \times 10^6\, N/m^2$$



Also $\tau_y = \tau_x$ (complementary shear stress)

Hence, $\tau_y = \tau_x = \tau$ **= 102 MPa**

Then, from equations (1) and (2):-

$\sigma_\phi = \tau \sin 2\phi$

$\tau_\phi = \tau \cos 2\phi$

When $\phi = 45^o$ and 135^o,

$\sigma_{45} = \tau$ and $\sigma_{135} = -\tau$

$\tau_{45} = 0$ and $\tau_{135} = 0$