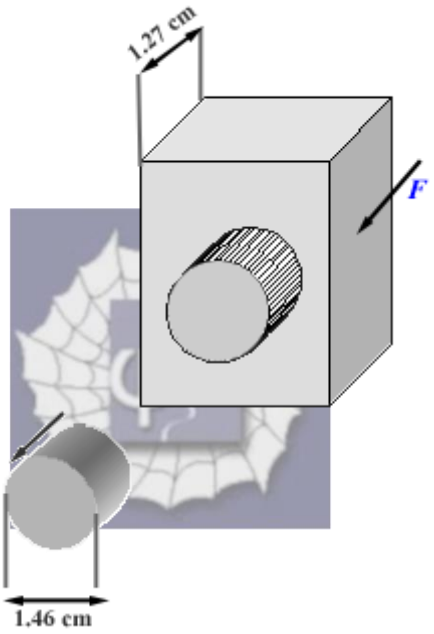
54.

Problem 14.45 (RHK)

We have to calculate the force F needed to punch a 1.46 cm *diameter hole in a steel plate* 1.27 cm *thick. The ultimate shear strength of steel is* 345 MN/m^2.



Solution:

When shearing stress is applied the force vector lies in the plane of the area rather than at right angles to it. For this problem the relevant surface is the outer surface of the cylinder that is pushed out of the metal plate. Its area A is

$A = \pi d \times w$, d is the diameter of the cylindrical hole and w is its width.

$d = 1.46 \times 10^{-2}$ m,

and

$w = 1.27 \times 10^{-2}$ m.

$$\text{Shearing stress} = \frac{F}{\pi d \times w}.$$

As the ultimate shear strength of steel is 345×10^{6} N m^{-2}, the force F required for punching the hole in the steel plate will be

$$F = 345 \times 10^{6} \times \pi \times 1.46 \times 10^{-2} \times 1.27 \times 10^{-2} \text{ N}$$
$$= 201 \text{ kN}.$$