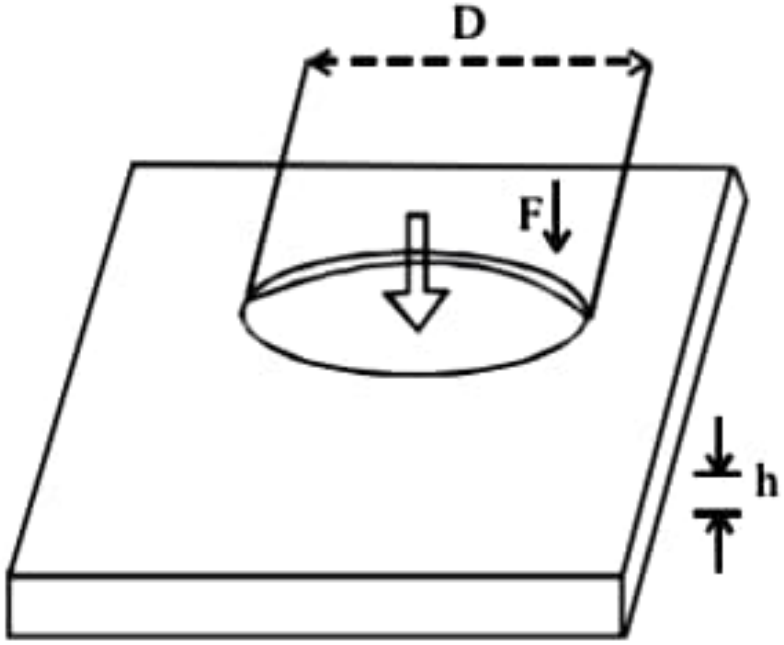
26. Steel ruptures when a shear of $3.5 \times 10^8\ \text{N m}^{-2}$ is applied. The force needed to punch a 1 cm diameter hole in a steel sheet 0.3 cm thick is nearly: **[Online April 12, 2014]**

(a) $1.4 \times 10^4\ \text{N}$ (b) $2.7 \times 10^4\ \text{N}$

(c) $3.3 \times 10^4\ \text{N}$ (d) $1.1 \times 10^4\ \text{N}$

26. (c)



Shearing strain is created along the side surface of the punched disk. Note that the forces exerted on the disk are exerted along the circumference of the disk, and the total force exerted on its center only.

Let us assume that the shearing stress along the side surface of the disk is uniform, then

$$F = \int_{\text{surface}} dF_{max} = \int_{\text{surface}} \sigma_{max} dA = \sigma_{max} \int_{\text{surface}} dA$$

$$= \int \sigma_{max} . A = \sigma_{max} . 2\pi \left(\frac{D}{2}\right) h$$

$$= 3.5 \times 10^{8} \times \left(\frac{1}{2} \times 10^{-2}\right) \times 0.3 \times 10^{-2} \times 2\pi$$

$$= 3.297 \times 10^{4} \simeq 3.3 \times 10^{4}\ \text{N}$$