# MECHANICAL ENGINEERING SCIENCE

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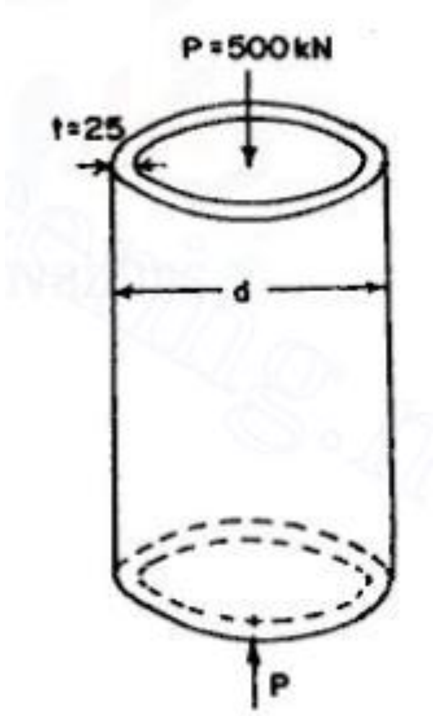
## NUMERICALS

A short hollow circular cast iron cylinder shown in Figure below is to support an axial compressive load of P = 500 kN. The ultimate stress in compression for the material is 240 $N/mm^2$. Determine the minimum required outside diameter d of the cylinder of 25 mm wall thickness, if the factor of safety is to be 3.0 with respect to ultimate strength.



**NUMERICALS**

**Solution:**

Allowable stress $p_{allow.} = \frac{p_u}{F} = \frac{240}{3} = 80\ \text{N/mm}^2$

$\therefore$ Required area of cross-section,

$$A = \frac{P}{p_{allow}} = \frac{500 \times 10^3}{80} = 6250\ \text{mm}^2$$

Now, for a hollow cylinder of outside diameter $d$ and thickness $t$

$$A = \frac{\pi}{4} d^2 - \frac{\pi}{4}(d - 2t)^2 = \pi t (d - t)$$

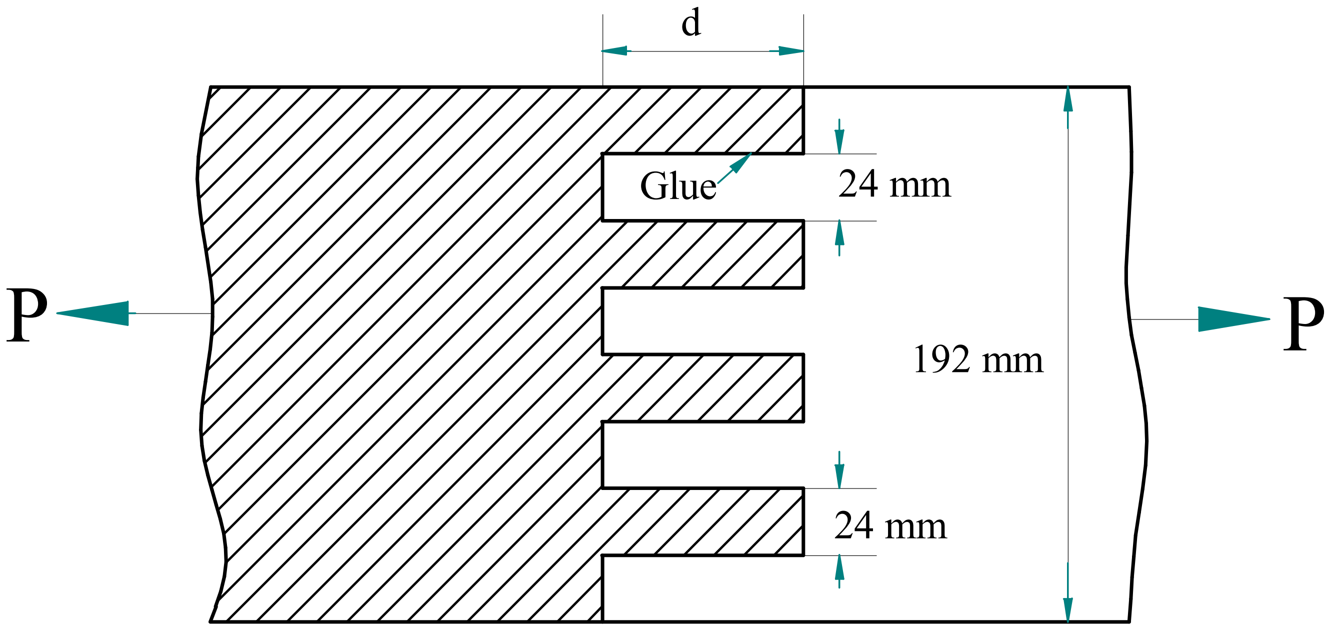
or

$$d = t + \frac{A}{\pi t} = 25 + \frac{6250}{\pi (25)}$$

$$= 104.58\ \text{mm} \approx \mathbf{105\ mm}$$

## NUMERICALS

**Two wooden planks, each 20 mm thick and 192 mm wide, are joined by the glued mortise joint shown. Knowing that the joint will fail when the average shearing stress in the glue reaches 800 KPa, determine the smallest allowable length d of the cut if the joint is to withstand an axial load of magnitude P = 6 KN**



**NUMERICALS**

**Solution:** Given t = 20 mm, P = 6 KN

From Fig., seven surfaces carry the applied axial load P = 6 KN = $6 \times 10^3$ N

Area of each glue is A = dt

Shear stress $\tau = \frac{P}{7A}$

$$A = \frac{P}{7\tau} = \frac{6 \times 10^3}{7 \times 800 \times 10^3} = 1.0714 \times 10^{-3}\ m^2$$

$$\boldsymbol{A = 1.0714 \times 10^3\ mm^2}$$

w.k.t

$$d = \frac{A}{t} = \frac{1.0714 \times 10^3}{20}$$

$$\boldsymbol{d = 53.57\ mm}$$

## NUMERICALS

**A bar of steel has rectangular cross – section 30 mm×20 mm. Determine the dimensions of the sides and percentage decrease of area of cross – section, when it is subjected to a tensile force of 120 kN in the direction of its length. Take E = $2\times10^5$ N/mm$^2$ and $\nu = 0.3$**

## NUMERICALS

## Solution:

Strain in the direction of pull $e_1 = \frac{P}{AE} = \frac{120 \times 10^3}{30 \times 20 \times 2 \times 10^5} = 10 \times 10^{-4}$

Lateral strain $= -\frac{e_1}{m} = -\frac{3}{10} \times 10 \times 10^{-4} = 3 \times 10^{-4}$

Hence 30 mm side is decreased by $30 \times 3 \times 10^{-4} = 0.009$ mm

and 20 mm side is decreased by $20 \times 3 \times 10^{-4} = 0.006$ mm

Hence dimension of 30 mm side $= 30 - 0.009 \approx 29.991$ mm

and dimension of 20 mm side $= 20 - 0.006 = 19.994$ mm.

New area of cross-section $= (30 - 0.009)(20 - 0.006) \approx 600 - 0.36$

% decrease of area of cross-section $= \frac{0.36}{600} \times 100 =$ **0.06%**

# THANK YOU

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