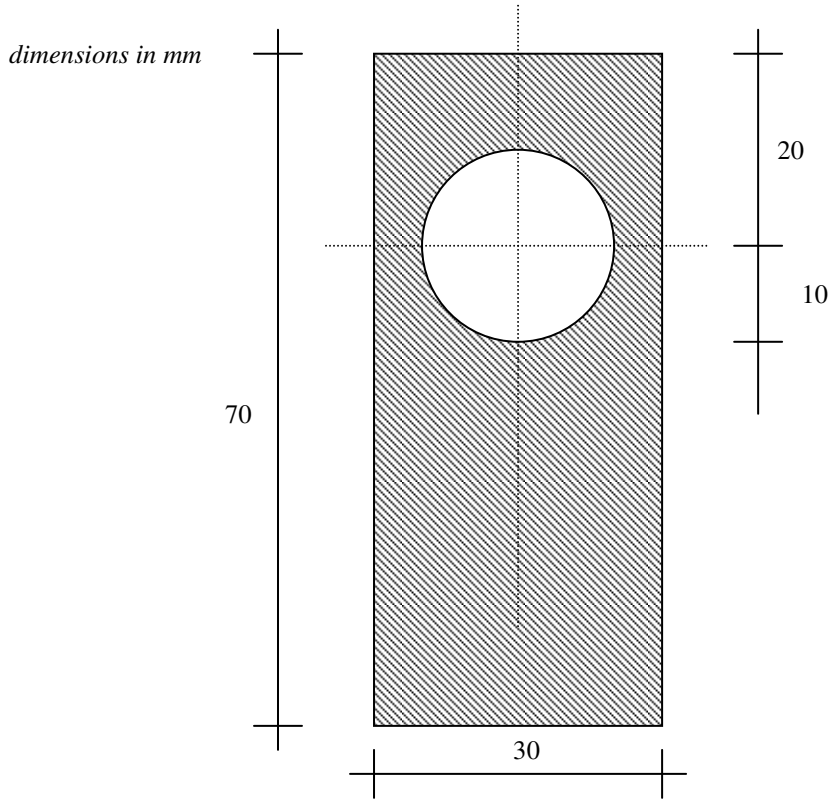
TU Delft

ASSIGNMENT 3

CROSS SECTION WITH A HOLE



THIS ASSIGNEMENT WILL BE DISCUSSED IN WEEK 7

Question:

- Find the elastic and plastic moment capacity of this cross section and the shape factor.

Answer:
$\alpha = 1{,}53$

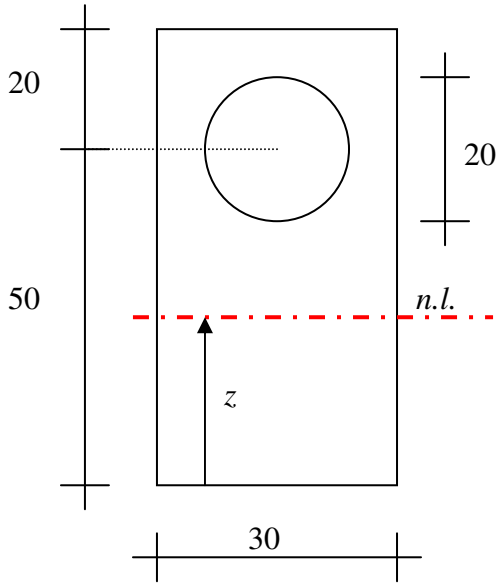
TU Delft

ANSWER

- Unsymmetrical cross section
  - Elastic capacity: - find the position of the neutral exis
    - find the moment of inertia and the elastic limit M_e
  - Plastic capacity: - find the position of the median line
    - find the plastic moment M_p

Hint: Substract the hole from the solid cross section.

Elastic:



Neutral axis:

$$z = \frac{70\times30\times35 - \pi\times10^2\times50}{70\times30 - \pi\times10^2} = 32,4 \text{ mm}$$

Moment of inertia:

$$I_{zz} = \tfrac{1}{12}\times30\times70^3 + 30\times70\times2,6^2 - \tfrac{1}{4}\times\pi\times10^4 - \pi\times10^2\times17,6^2$$

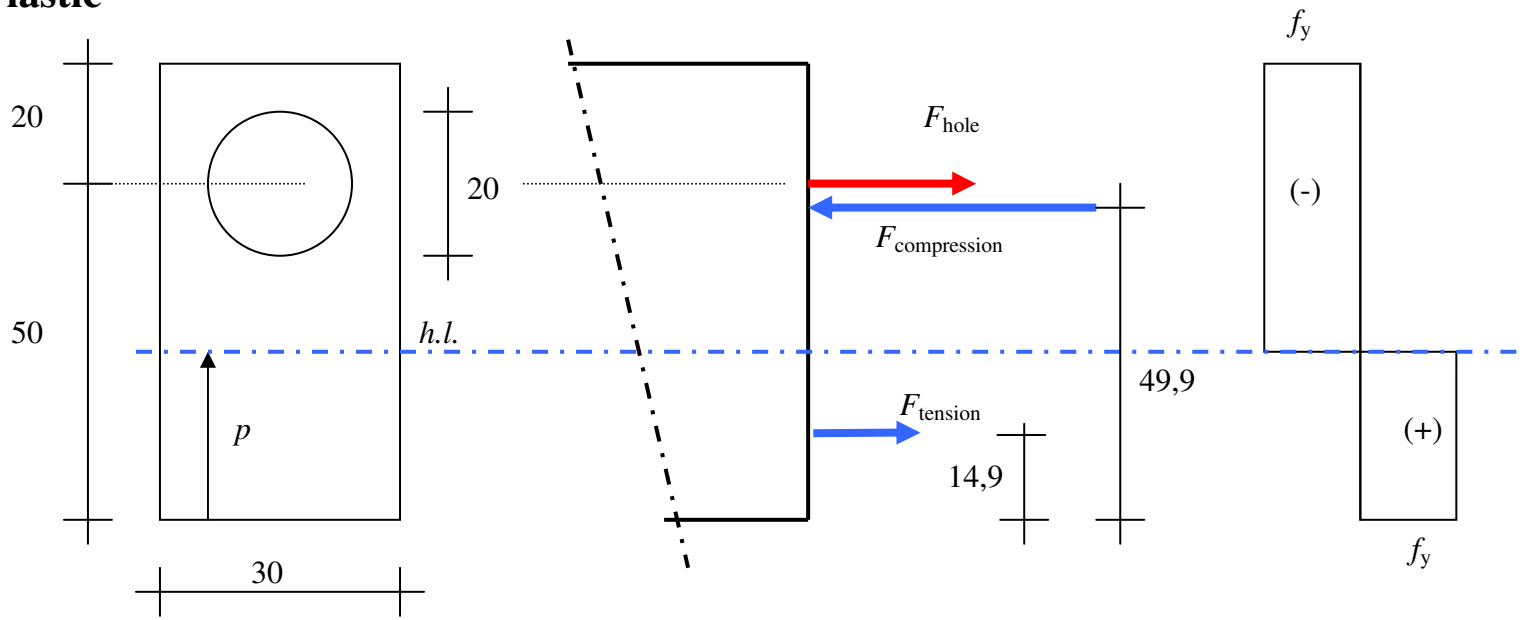
$$I_{zz} = 766525 \text{ mm}^4$$

substract the hole

Elastic limit M_e :

$$M_e = \frac{I_{zz} f_y}{(70-32,4)} = 20365\times f_y \text{ Nmm } (f_y \text{ in N/mm}^2)$$

Plastic



Find the median line ($R_{compression} = R_{tension}$) :

$$p \times 30 = (70 - p) \times 30 - \pi \times 10^2$$

$$p = 29,8 \text{ mm}$$

Plastic moment (moment with respect to lowest fiber) :

$$M_p = \left\{(70 - 29,8) \times 30 \times 49,9 - \pi \times 10^2 \times 50 - 29,8 \times 30 \times \tfrac{1}{2} \times 29,8\right\} \times f_y$$

$$M_p = 31150,8 \times f_y \text{ Nmm } (f_y \text{ in N/mm}^2)$$

Shape factor:

$$\alpha = \frac{M_e}{M_p} = \frac{31150,8 \times f_y}{20365 \times f_y} = 1,53$$