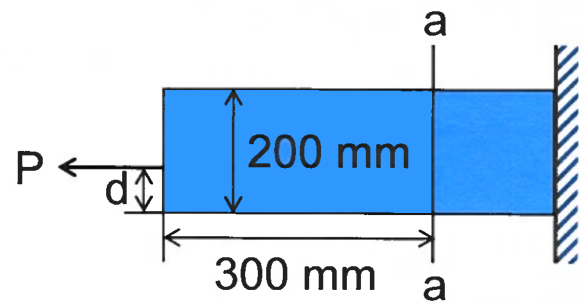
Additional example 1

Determine the smallest distance **d** to the edge of the plate at which the force **P** can be applied so that it produces no compressive stresses in the plate at section *a-a*. The plate has a thickness of 20 mm and **P** acts along the centerline of this thickness.



$\overset{\rightarrow}{\sum} F_x = 0, \quad N + (-P) = 0, \quad N = P$

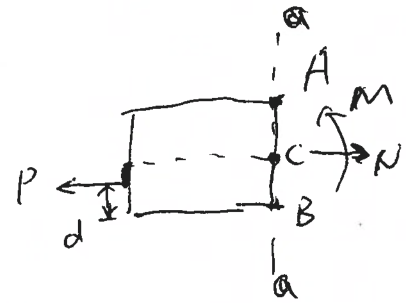
$\overset{\curvearrowleft}{\sum} M_C = 0, \quad M - P\cdot(0.1-d) = 0, \quad M = P(0.1-d)$

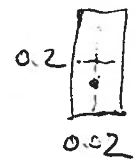
top $\sigma_A = \frac{N}{A} - \frac{My}{I} =$ bottom $\sigma_B = \frac{N}{A} + \frac{My}{I}$ $\quad I = \frac{1}{12}(0.02)\times 0.2^3 = 13.3333\times 10^{-6}\,m^4$

$\sigma_A = 0 \Rightarrow 0 = \frac{N}{A} - \frac{My}{I} = \frac{P}{0.2\times 0.02\,m^2} - \frac{P(0.1-d)\cdot 0.1}{13.3333\times 10^{-6}\,m^4}$

$\Rightarrow 0 = 250P - 7500P(0.1-d)$

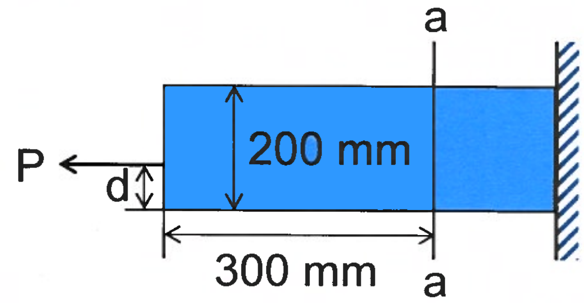
$\Rightarrow d = 0.06667\,m = 66.7\,mm$





Additional example 2

The horizontal force of **P** = 80 kN acts at the end of the plate. The plate has a thickness of 10 mm and **P** acts along the centerline of this thickness such that **d** = 50 mm. Plot the distribution of normal stress acting along section *a-a*.



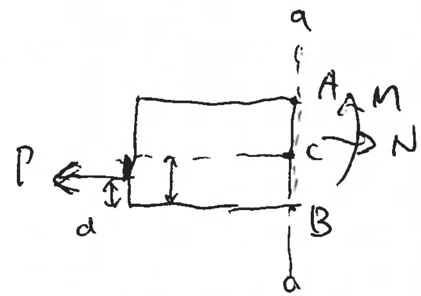
$\xrightarrow{+}\sum F_x = 0$, $N + (-P) = 0$, $N = P = 80\,kN$

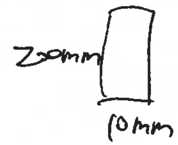
$\sum M_C = 0$, $M - P\cdot(0.1 - 0.05) = 0$, $M = 80\,kN \times 0.05\,m = 4\,kNm$

$A = 0.01 \times 0.2 = 0.002\,m^2$, $I = \frac{1}{12}0.01 \times 0.2^3 = 6.667 \times 10^{-6}\,m^4$

$$\sigma_A = \frac{N}{A} - \frac{My}{I} = \frac{80\times10^3}{0.002} - \frac{4\times10^3\times0.1}{6.667\times10^{-6}} = -20.0\,MPa$$ compressive

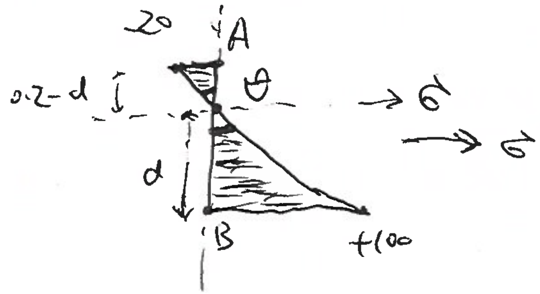
$$\sigma_B = \frac{N}{A} + \frac{My}{I} = \frac{80\times10^3}{0.002} + \frac{4\times10^3\times0.1}{6.667\times10^{-6}} = 100\,MPa$$ tensile





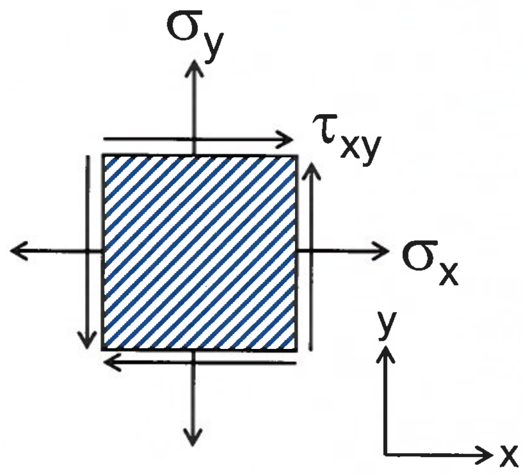
neutral axis

$$\tan\theta = \frac{20}{0.2-d} = \frac{100}{d}$$



Additional example 3

At a point on the surface of a machine component the stresses acting on the *x* face of a stress element are σ_x = 45 MPa and τ_{xy} = 15 MPa (see figure). What is the allowable range of values for the stress σ_y if the maximum shear stress is limited to τ_{max} = 20 MPa?



$\sigma_x = 45\,MPa$, $\tau_{xy} = 15\,MPa$, σ_y ? , $\tau_{max} = 20\,MPa$

$$R = \tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\Rightarrow \tau_{max}^2 = \left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2$$

$$\Rightarrow \sigma_y = \sigma_x \pm 2\sqrt{\tau_{max}^2 - \tau_{xy}^2}$$

$$= 45 \pm 2\sqrt{20^2 - 15^2} = 45 \pm 26.5$$

$$18.5 \le \sigma_y \le 71.5 \quad MPa$$