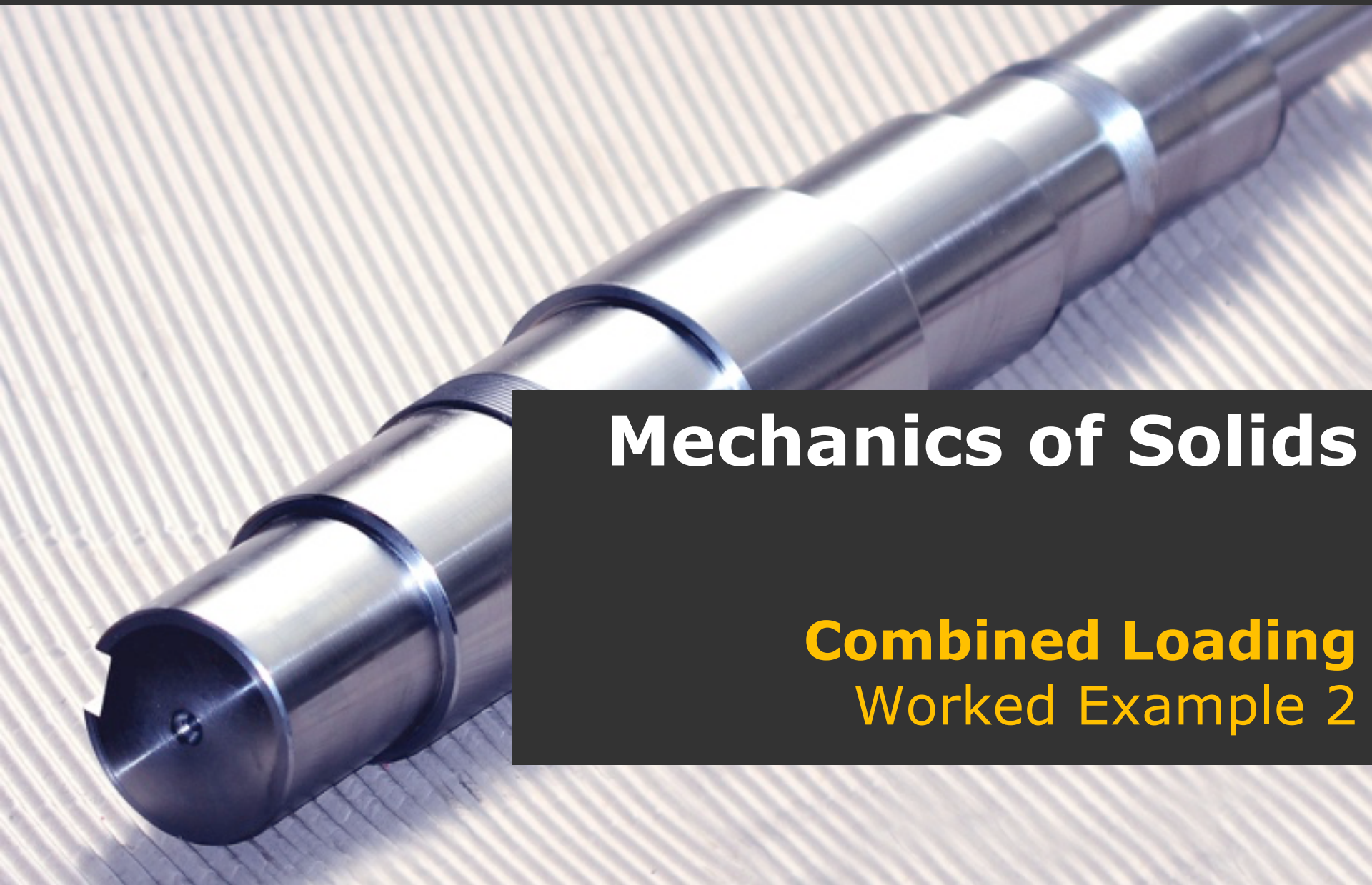

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Mechanics of Solids

Combined Loading
Worked Example 2

Summary of Methodology

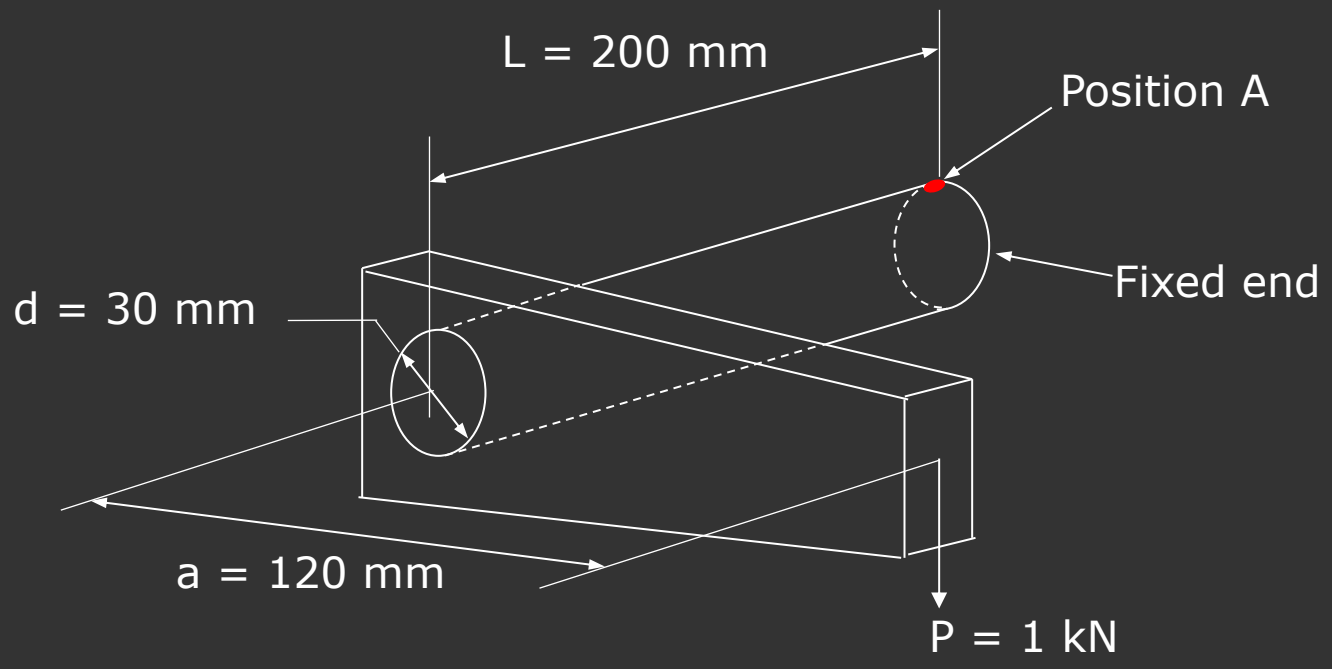
(i) Identify a 2D element at the location of interest in the component

(ii) Determine the stresses acting on the element arising from each individual load

(iii) Superpose the stresses from each individual load to obtain the combined stresses on the element

(iv) Use Mohr's circle to determine the principal stresses and the maximum shear stress on the element

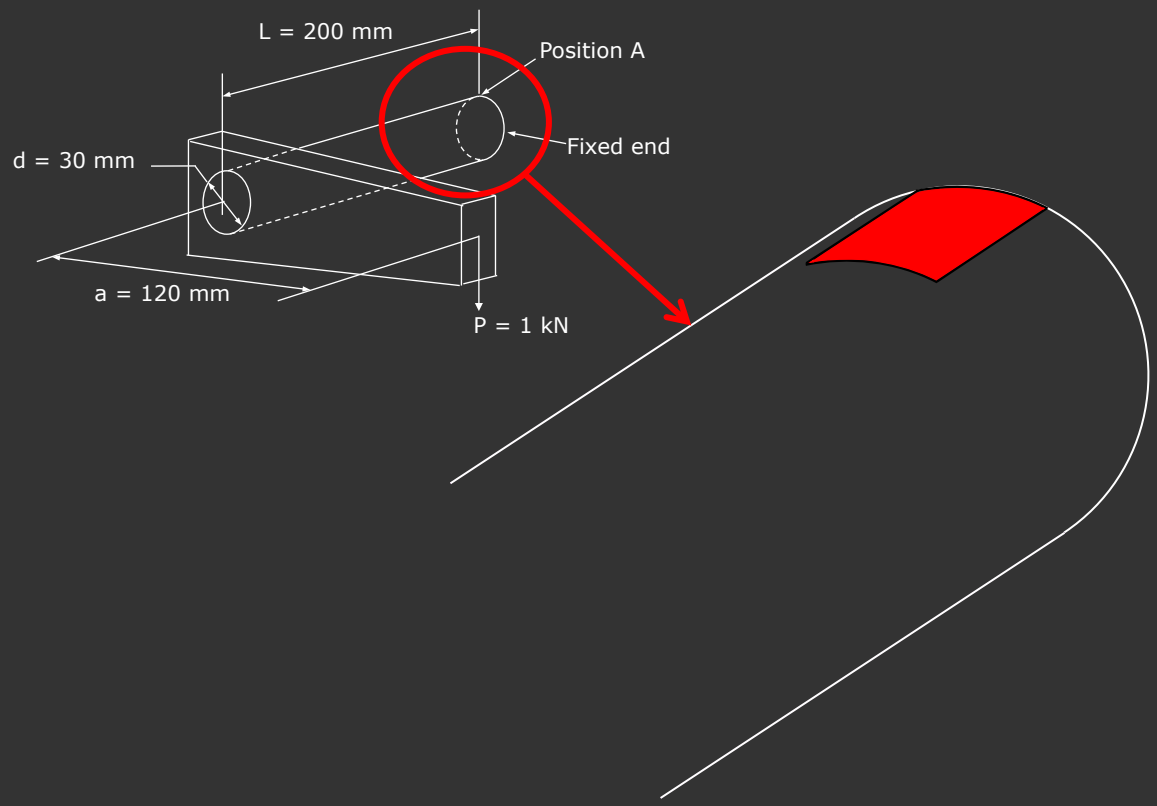
Offset Cantilever



Determine the maximum shear stress on the upper surface at position A

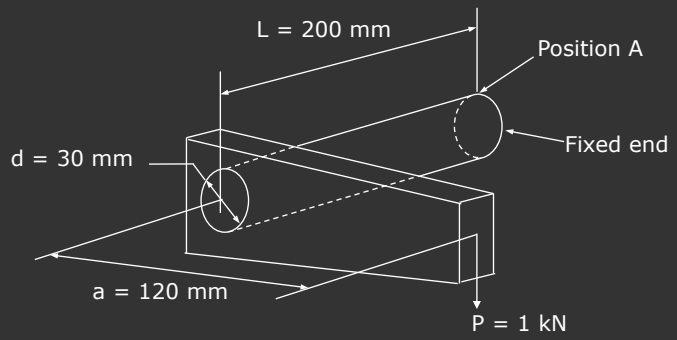
Offset Cantilever

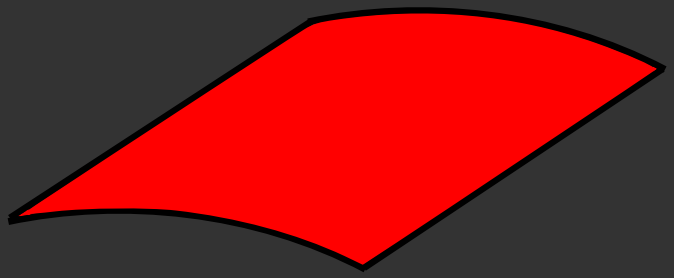
(i) Identify a 2D element at the location of interest on the component



Offset Cantilever

(ii) Determine the stresses acting on the element arising from each individual load





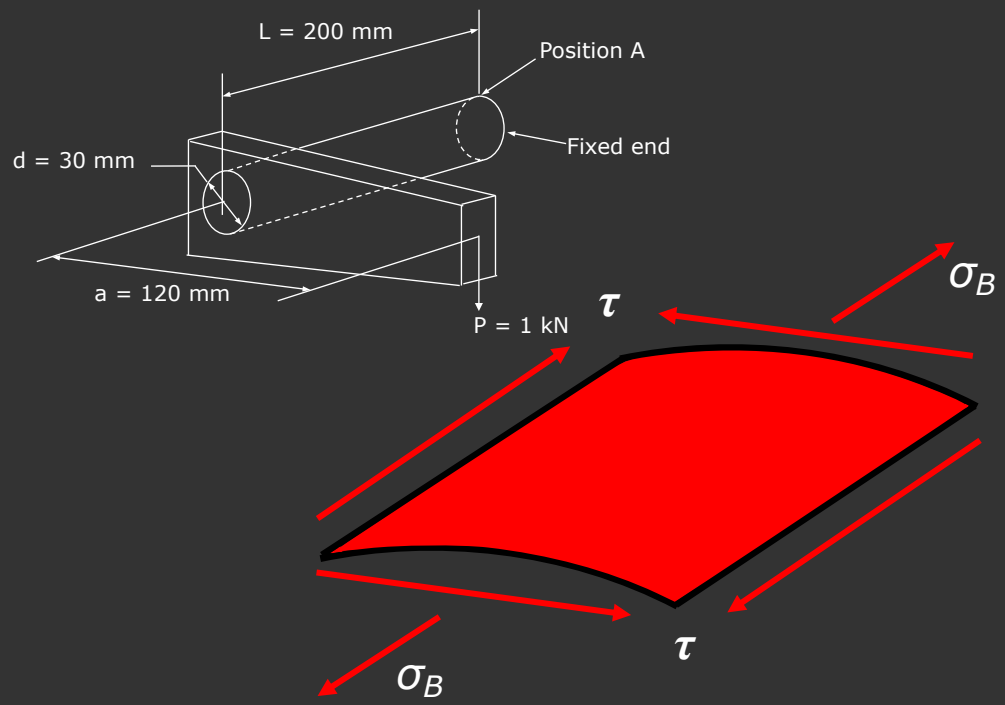
Loads:

1. Bending Moment: M=PL

2. Torque: T=Pa

Offset Cantilever

(iii) Superpose the stresses from each individual load to obtain the combined stresses on the element

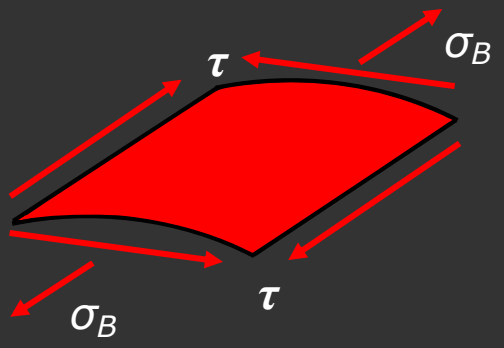


Stresses:

1. Bending Stress: $\sigma_B = \frac{My}{I}$

2. Torsional Shear Stress: $\tau = \frac{Tr}{J}$

Offset Cantilever



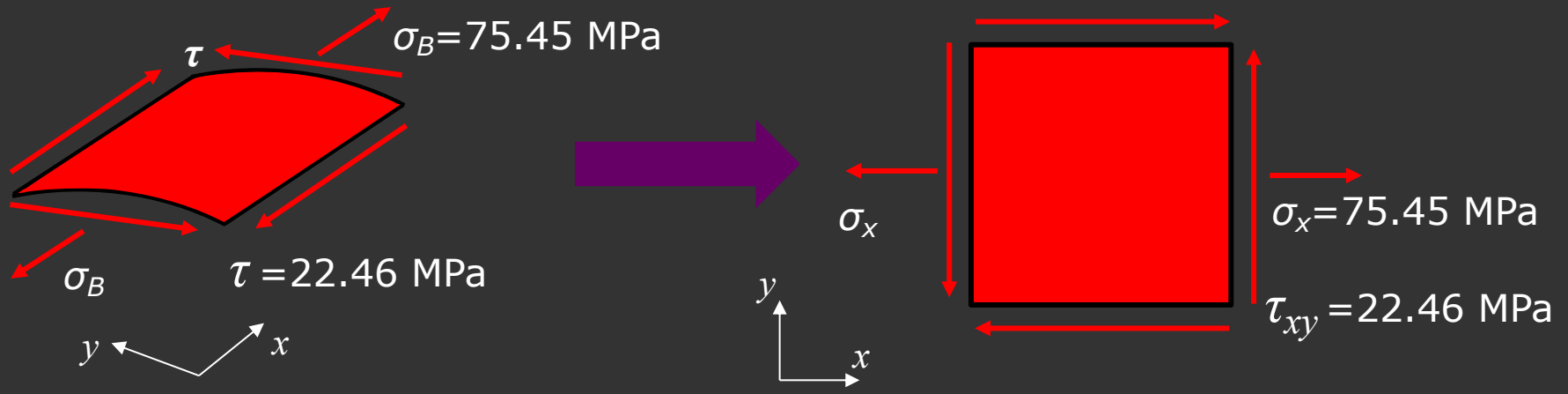
P = 1 kN
L = 200 mm
a = 120 mm
d = 30 mm

Bending stress: $\sigma_B = \frac{My}{I} = \frac{PL\frac{d}{2}}{\frac{\pi d^4}{64}} = \frac{32PL}{\pi d^3}$ = 75.45 MPa

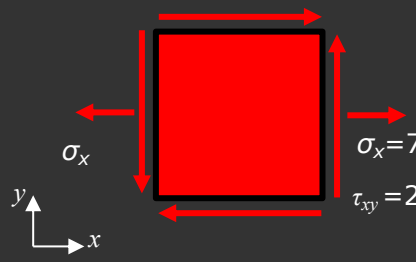
Torsional shear stress: $\tau = \frac{Tr}{J} = \frac{Pa\frac{d}{2}}{\frac{\pi d^4}{32}} = \frac{16Pa}{\pi d^3}$ = 22.46 MPa

Offset Cantilever

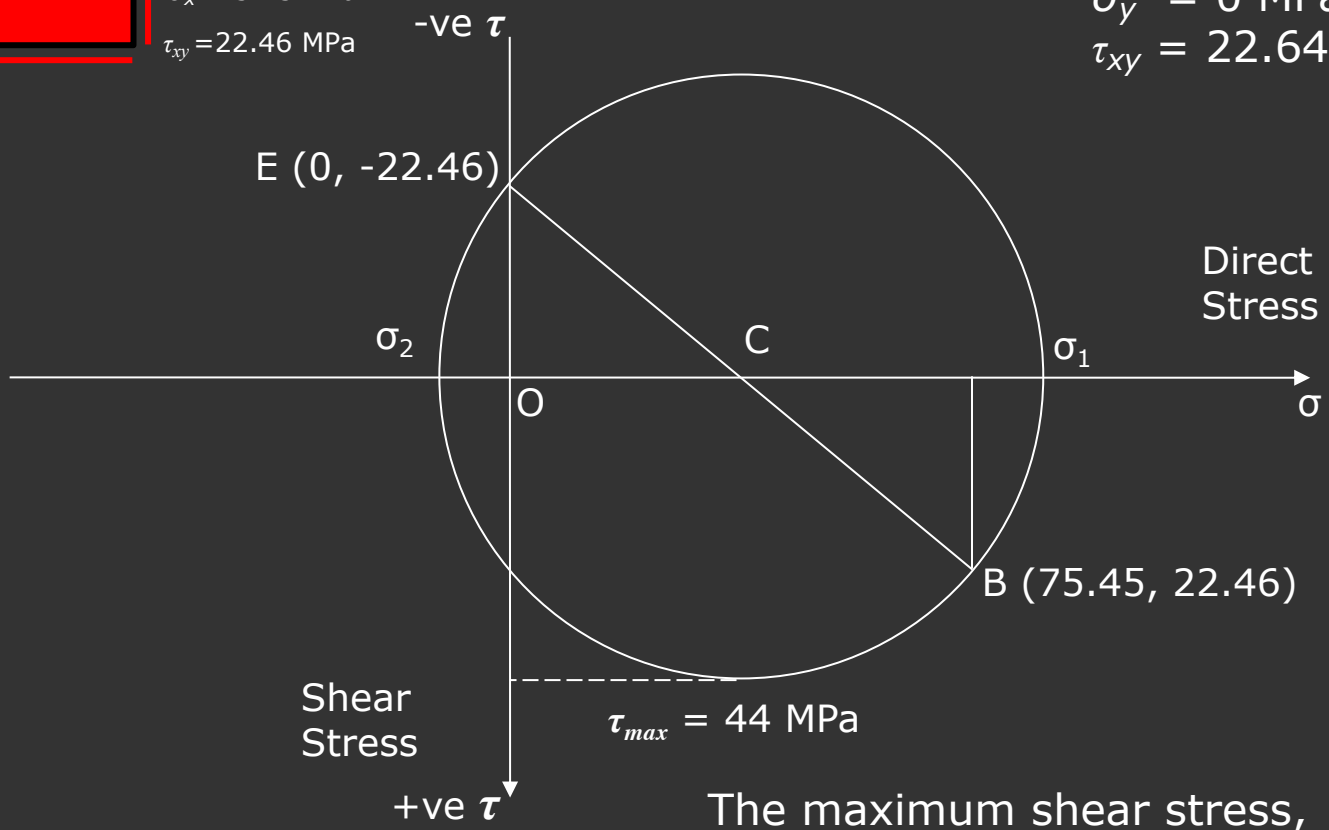
(iv) Use Mohr's circle to determine the principal stresses and the maximum shear stress on the element



Offset Cantilever



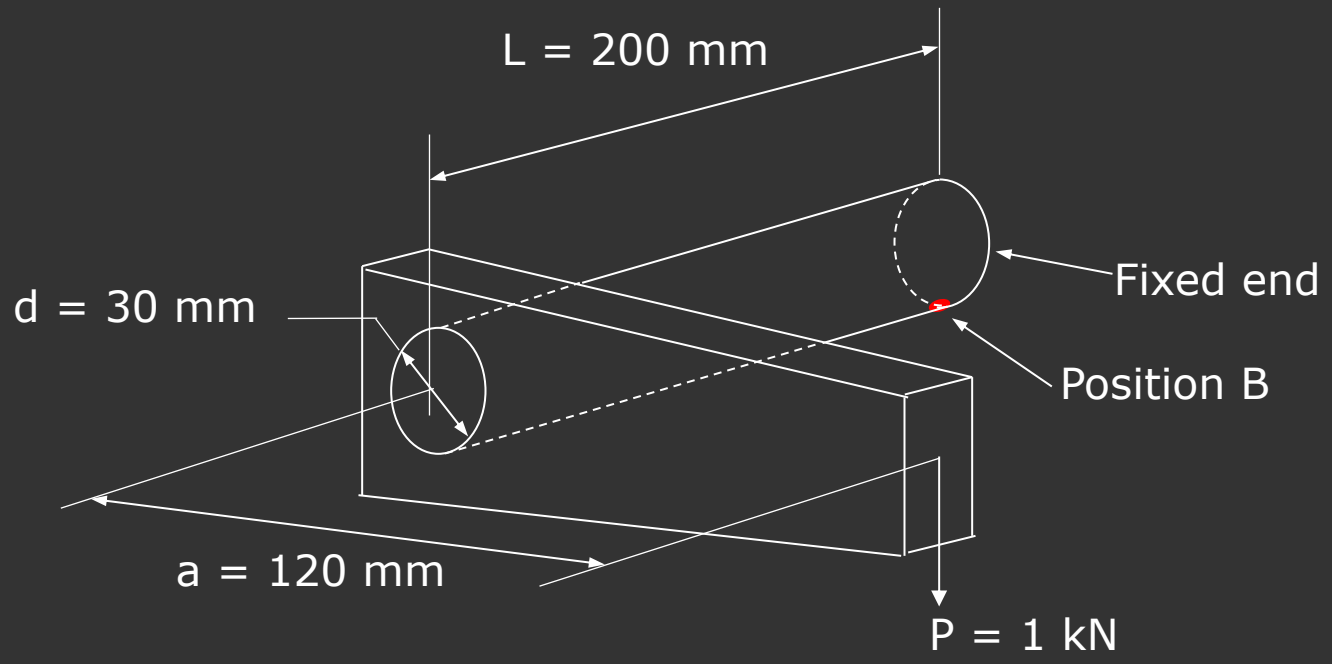
Element stresses
σ_x = 75.45 MPa
σ_y = 0 MPa
τ_{xy} = 22.64 MPa



The maximum shear stress,
τ_{max} = Radius = $\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$

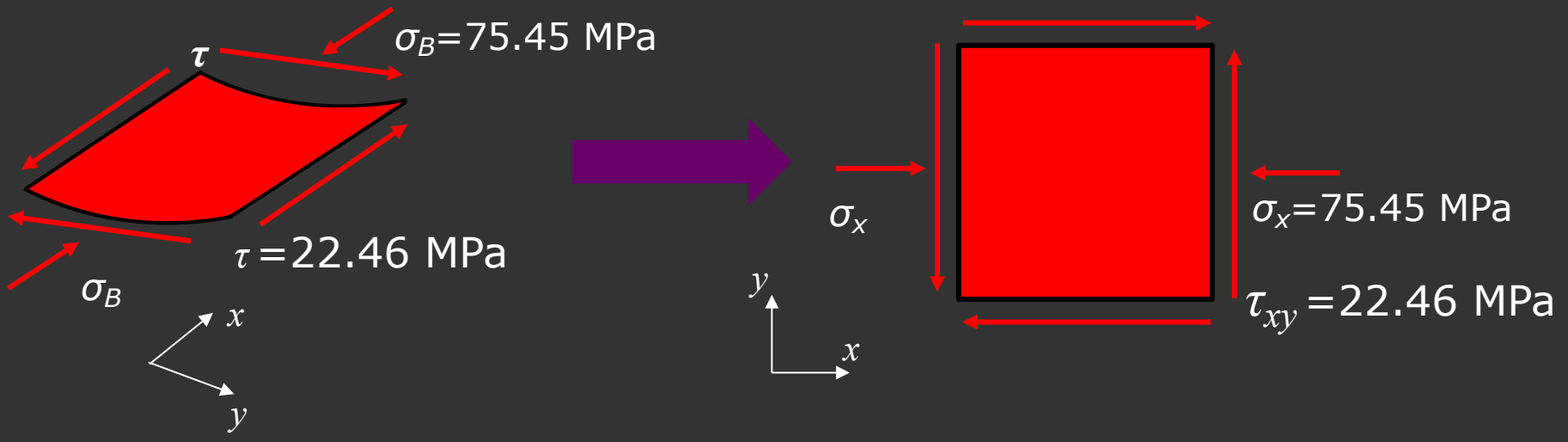
= <u>44 MPa</u>

Offset Cantilever

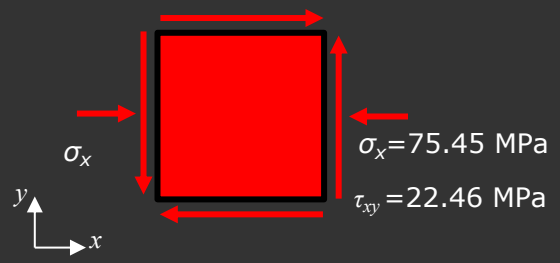


What about position B?

Offset Cantilever



Offset Cantilever



Element stresses
σ_x = -75.45 MPa
σ_y = 0 MPa
τ_{xy} = 22.64 MPa