Université d'Ottawa | University of Ottawa

CVG2140 Winter 2015

Mechanics of Materials

Lecture 9

Stresses on Inclined Sections

Course Instructor

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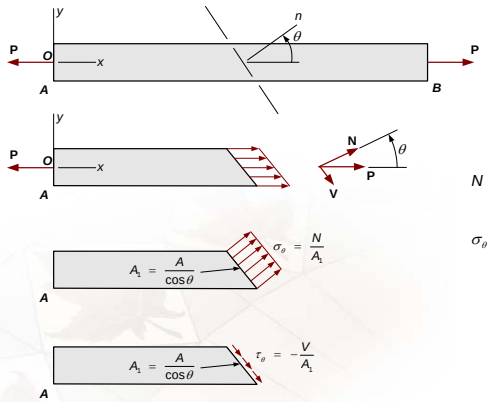
Stresses on Inclined Sections (I)

- **Axially loaded members**

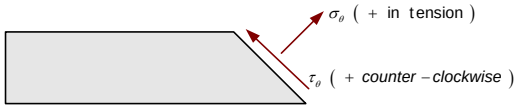


$$N = P\cos\theta \quad ; \quad V = P\sin\theta$$

$$\sigma_\theta = \frac{N}{A_1} \quad ; \quad \tau_\theta = -\frac{V}{A_1} \quad ; \quad A_1 = \frac{A}{\cos\theta}$$

Stresses on Inclined Sections (I)

- **Axially loaded members**



$$\sigma_\theta = \frac{N}{A_1} = \frac{P}{A}\cos^2\theta \quad ; \quad \tau_\theta = -\frac{V}{A_1} = -\frac{P}{A}\sin\theta\cos\theta$$

$$\boxed{\sigma_\theta = \frac{P}{A}\cos^2\theta = \sigma_x\cos^2\theta = \frac{\sigma_x}{2}(1 + \cos 2\theta)}$$

$$\boxed{\tau_\theta = -\frac{P}{A}\sin\theta\cos\theta = -\frac{\sigma_x}{2}\sin 2\theta}$$

Stresses on Inclined Sections (I)

- **Axially loaded members**

$$\boxed{\sigma_\theta = \frac{P}{A}\cos^2\theta = \sigma_x\cos^2\theta = \frac{\sigma_x}{2}(1 + \cos 2\theta)}$$

$$\boxed{\tau_\theta = -\frac{P}{A}\sin\theta\cos\theta = -\frac{\sigma_x}{2}\sin 2\theta}$$

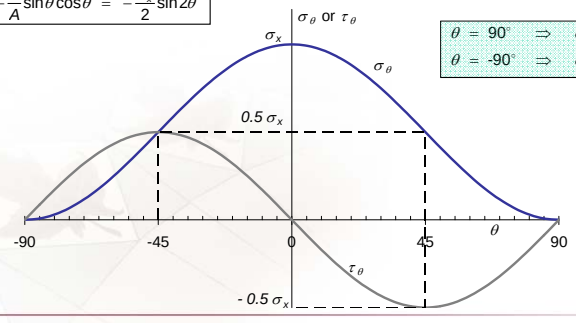
$\theta = 0^\circ \Rightarrow \sigma_\theta = \sigma_x \; ; \; \tau_\theta = 0$

$\theta = 45^\circ \Rightarrow \sigma_\theta = \frac{\sigma_x}{2} \; ; \; \tau_\theta = -\frac{\sigma_x}{2}$

$\theta = -45^\circ \Rightarrow \sigma_\theta = \frac{\sigma_x}{2} \; ; \; \tau_\theta = \frac{\sigma_x}{2}$

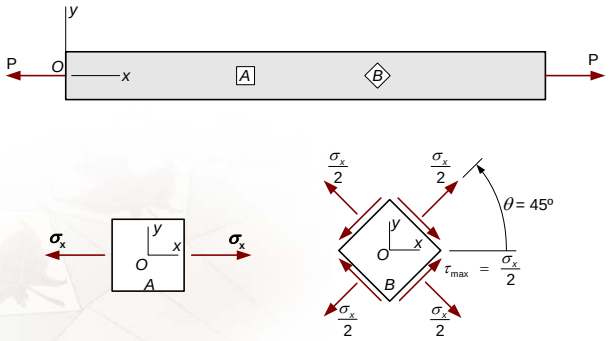
$\theta = 90^\circ \Rightarrow \sigma_\theta = 0 \; ; \; \tau_\theta = 0$

$\theta = -90^\circ \Rightarrow \sigma_\theta = 0 \; ; \; \tau_\theta = 0$



Stresses on Inclined Sections (I)

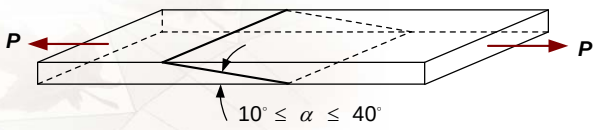
- Axially loaded members
  - ✓ Maximum normal and shear stresses



Stresses on Inclined Sections (I)

- **Example 9.1**

Two boards are connected by a glued joint at an angle α ranging from 10 to 40 degrees. The applied axial stress is 4.9 MPa. Determine (a) the normal and shear stresses when the angle = 20°, (b) the maximum angle when the allowable shear stress is 2.25 MPa, and (c) calculate the angle when the shear stress is twice the normal stress.

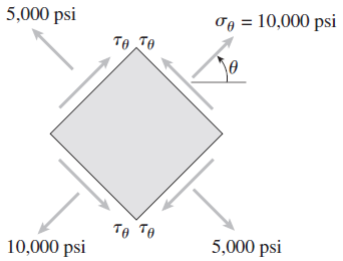


$\sigma_x = 4.9$ MPa

Stresses on Inclined Sections (I)

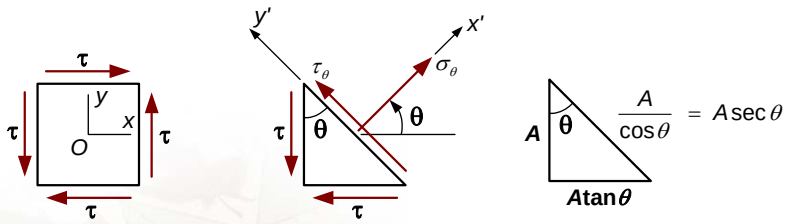
- **Example 9.2**

Acting on the sides of a stress element cut from a bar in uniaxial stress are tensile stresses of 10,000 psi and 5,000 psi, as shown in the figure. (a) Determine the angle θ and the shear stress τ_θ and show all stresses on a sketch of the element. (b) Determine the maximum normal stress σ_{max} and the minimum shear stress τ_{max} in the material.



Stresses on Inclined Sections (I)

- **Pure shear**



Stresses on Inclined Sections (I)

- **Pure shear**
  - ✓ **Maximum normal and shear stresses**