Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

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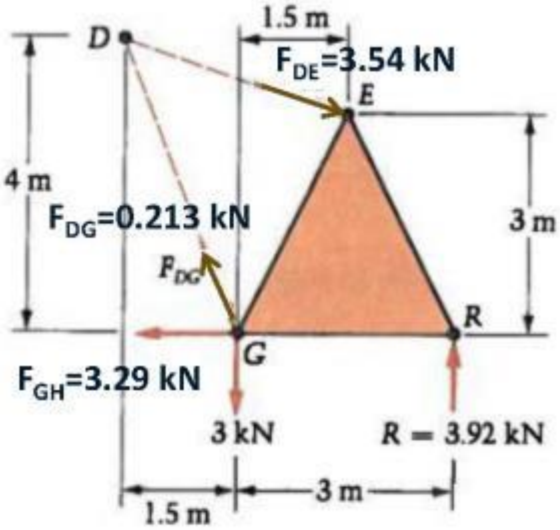
Module 3 Learning Outcomes

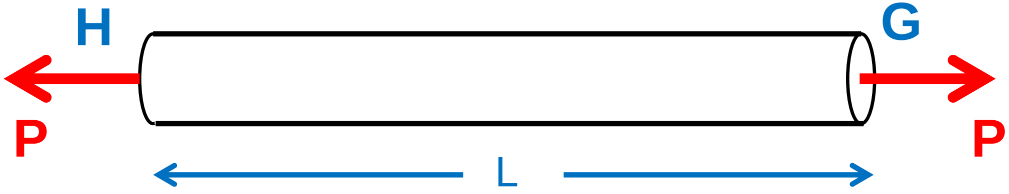
- Define/Discuss Normal Stress
- Define/Discuss Shear Stress

Axial Centric Loading

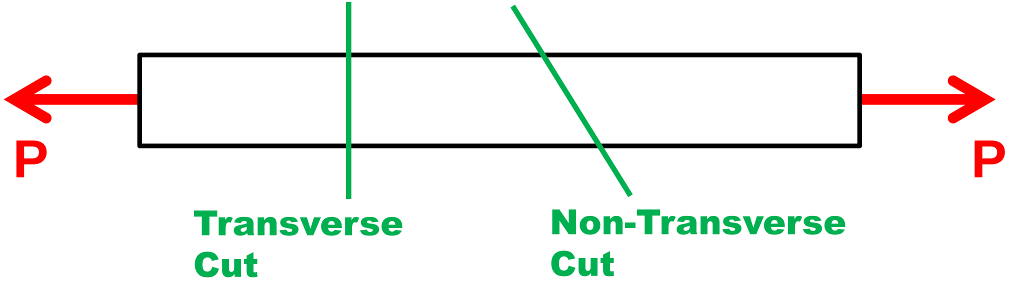
Axial Loading – Loading parallel to longitudinal axis of the member

Centric Loading – Line of action of resultant force passes through the centroid of section

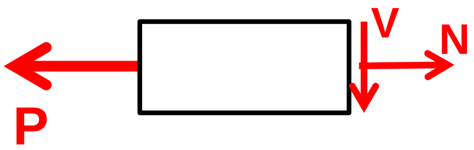




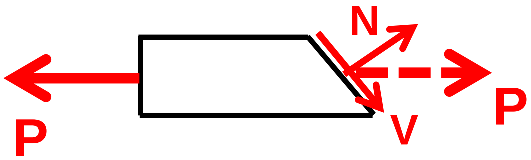
Axial Centric Loading



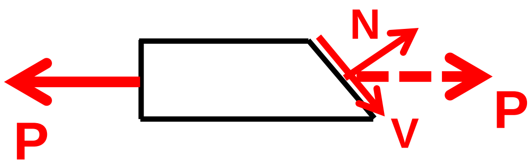
Transverse Cut



Non-Transverse Cut



Non-Transverse Cut (Stresses on an Inclined Section/Plane)



Normal Stress, σ

Force per unit area
perpendicular to the cut surface

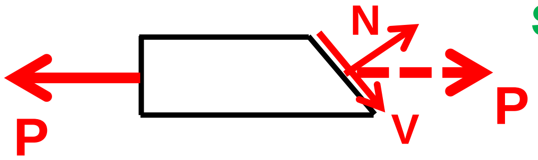
Assume
Uniformly
Distributed

$$\sigma = \frac{N}{A}$$

Sign Convention

(+) Tension
(-) Compression

Non-Transverse Cut (Stresses on an Inclined Section/Plane)



Shear Stress, τ

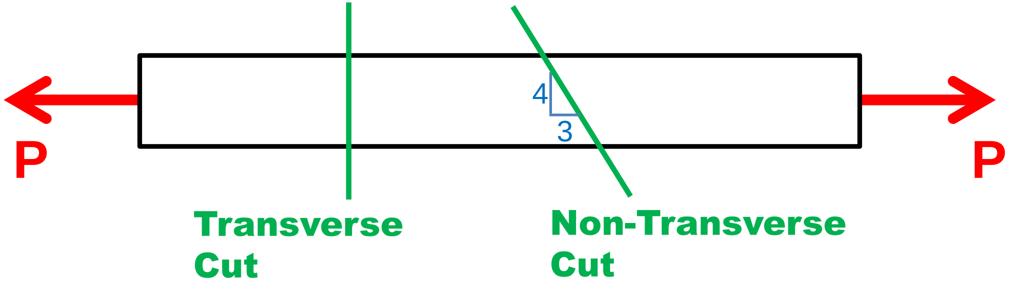
Force per unit area parallel to the cut surface

Assume Uniformly Distributed

$$\tau = \frac{V}{A}$$

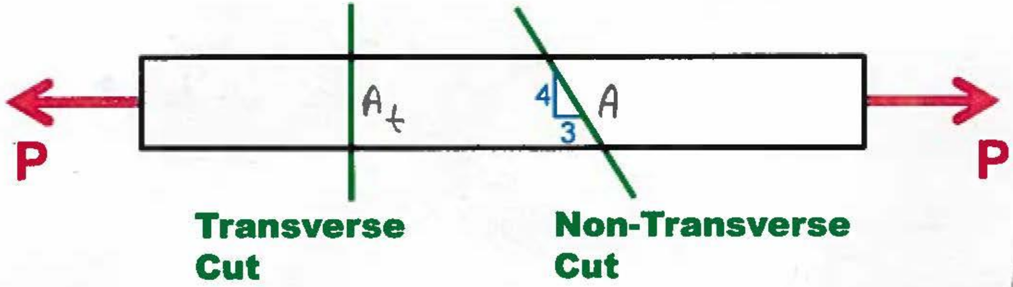
Worksheet:

A flat steel alloy bar has an thickness of 10 mm and an width of 60 mm. It is subjected to an axial centric load in tension of 60 kN.
Determine the normal stress and the shear stress in the bar on both the transverse plane and the inclined plane.



Worksheet Solution:

A flat steel alloy bar has an thickness of 10 mm and an width of 60 mm. It is subjected to an axial centric load in tension of 60 kN. Determine the normal stress and the shear stress in the bar on both the transverse plane and the inclined plane.

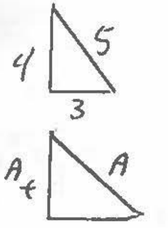


TRANSVERSE AREA

$A_t = (10\ mm)(60\ mm) = \underline{600\ mm^2}$

AREA ON INCLINED PLANE

BY SIMILAR TRIANGLES

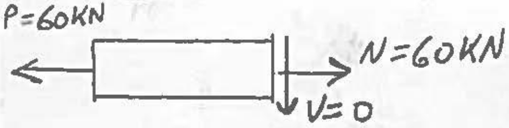


$\frac{4}{5} = \frac{A_t}{A}$

$\therefore A = \frac{5}{4} A_t$

$A = \frac{5}{4}(600\ mm^2) = \underline{750\ mm^2}$

TRANSVERSE PLANE



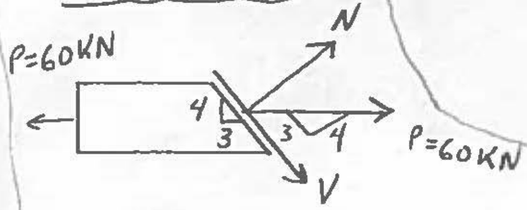
$\sigma = \frac{N}{A} = \frac{60\ KN}{600\ mm^2} = \underline{\underline{0.1\ \frac{KN}{mm^2}\ (T)}}$ ANS

$\underline{\underline{\sigma = 100\ MPa\ (T)}}$ ANS

NOTE: $1\ KN/mm^2 = 1000$ Megapascals (MPa)

$\tau = V/A = \underline{\underline{0}}$ ANS

INCLINED PLANE



PARALLEL (∥) AND PERPENDICULAR (⊥) COMPONENTS

(SEE MODULE 3 FROM "INTRODUCTION TO ENGINEERING MECHANICS")

$N = \frac{4}{5}P = \left(\frac{4}{5}\right) 60\ KN = 48\ KN$

$V = 3/5\ P = (3/5)\ 60\ KN = 36\ KN$

$\sigma = \frac{N}{A} = \frac{48\ KN}{750\ mm^2} = \underline{\underline{65\ MPa\ (T)}}$ ANS

$\tau = \frac{V}{A} = \frac{36\ KN}{750\ mm^2} = \underline{\underline{48\ MPa}}$ ANS