ENSC 2113
Engineering Mechanics: Statics

Stresses

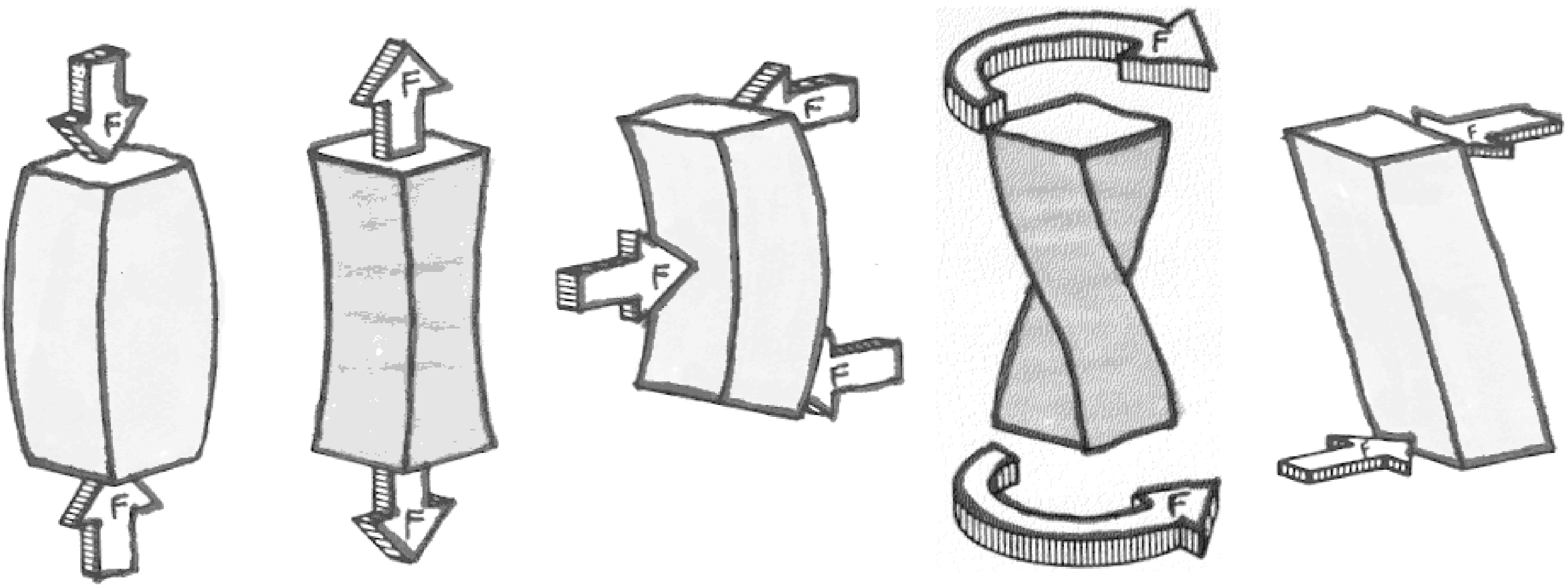
College of Engineering, Architecture & Technology

Stresses in Structural Members:

What you have learned this semester will be applied in future engineering courses, such as *Strength of Materials* …

Stresses are based on type of applied loading & structural properties of a member ...

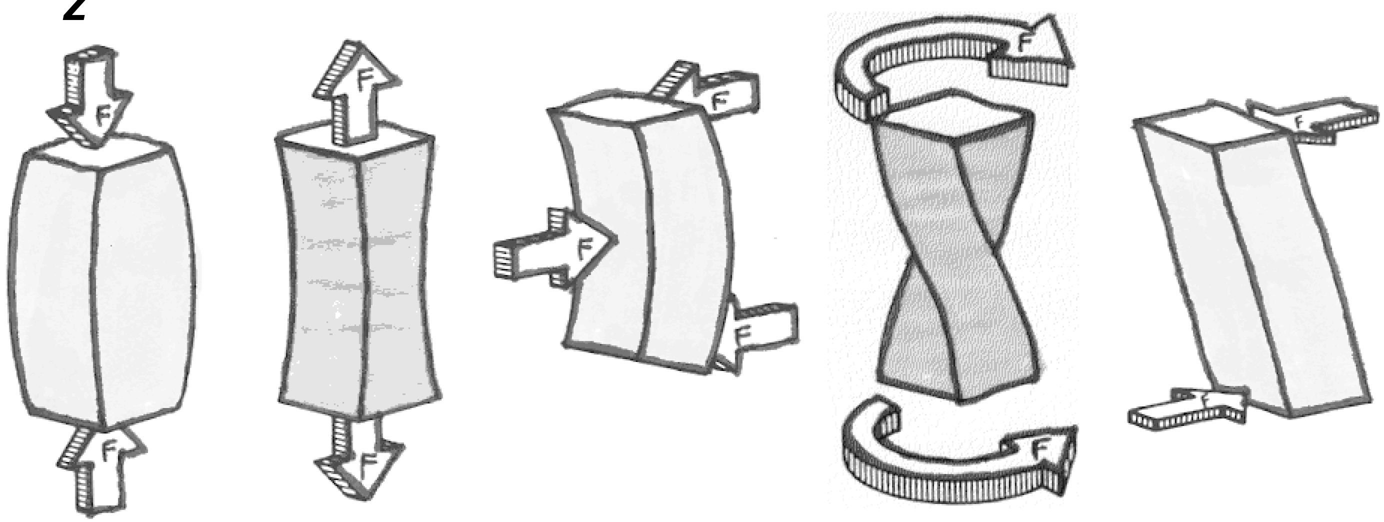
Stresses have units of **force per unit area** (k/in^2, N/m^2, …) …



Stresses & Degrees of Freedom:

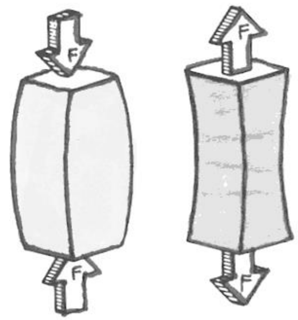
6 types of stress can exist in a structural member. These stresses correspond to the 6 internal forces & moments:

Internal Force	Associated Stress	Symbol
P_z	Axial (T or C)	f_a
V_x, V_y	Shear	f_{vx} f_{vy}
M_x, M_y	Bending	f_{bx} f_{by}
M_z	Torsion	T

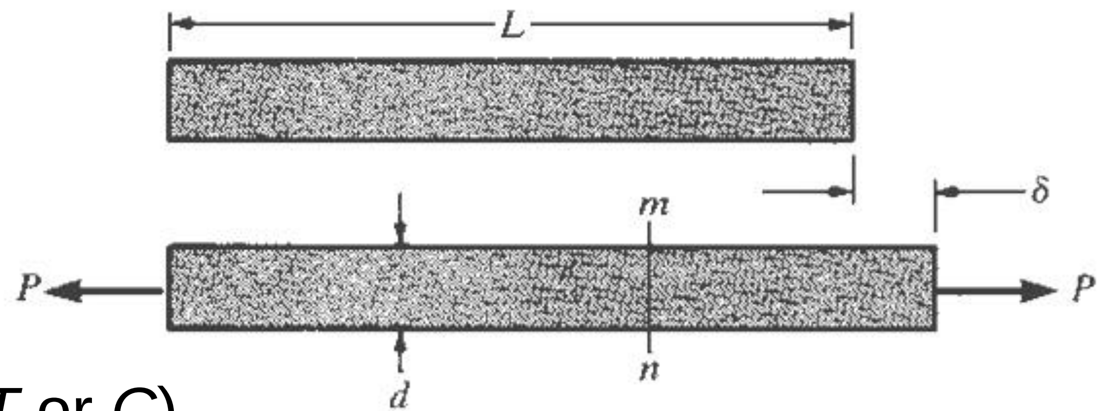


<u>Axial Stress</u>:

<u>*Axial stress*</u> is the force per unit area (*T* or *C*) along the length of the structural member and is found using the eqn:

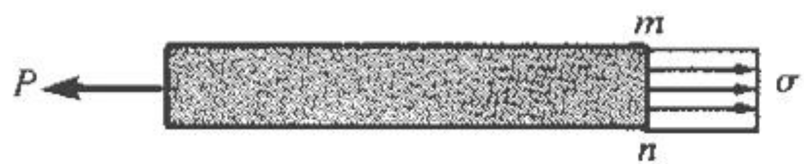


$$f_a = \frac{P}{A}$$



where,

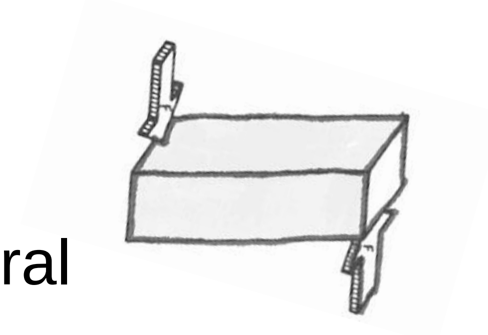
$\boldsymbol{P}$ = axial force (*T* or *C*)
$\boldsymbol{A}$ = cross-sectional area



Axial Stress is constant across depth of section …

Shear Stress:

Shear stress is the force per unit area perpendicular to the direction of the structural mbr and is found using the eqn:



$$f_v = \frac{VQ}{I\,t}$$

where,

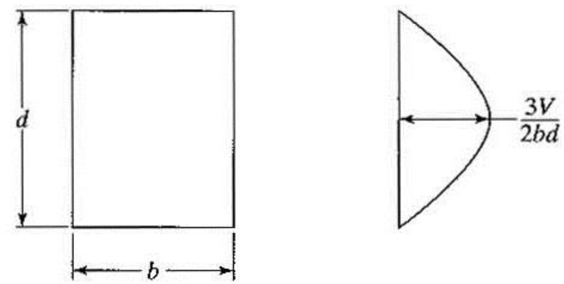
V = shear force
Q = 1st moment of the cross-sectional area
I = moment of inertia
t = thickness of web

Shear stress ***is not*** constant across depth of section…

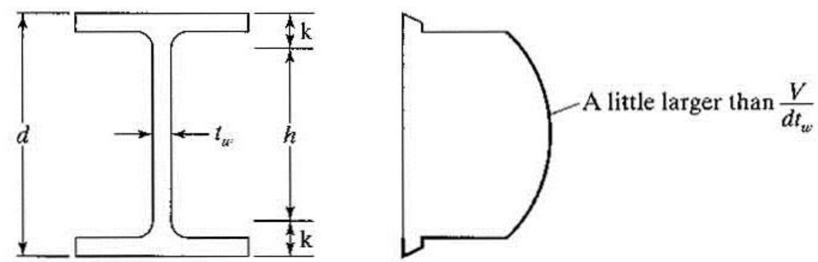
Shear Stress is dependent on cross- section:

Shear stress distribution across depth of a mbr is dependent on the shape of the section …

Rectangular shape

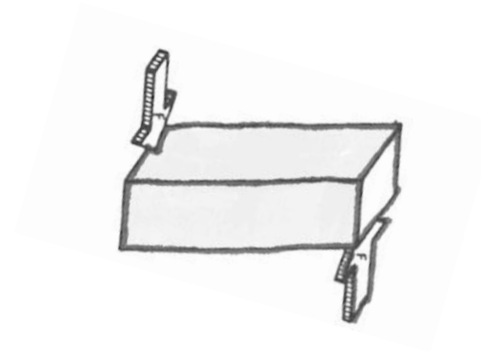


I - shape



Each of these *shear stress* distributions can be found using the eqn:

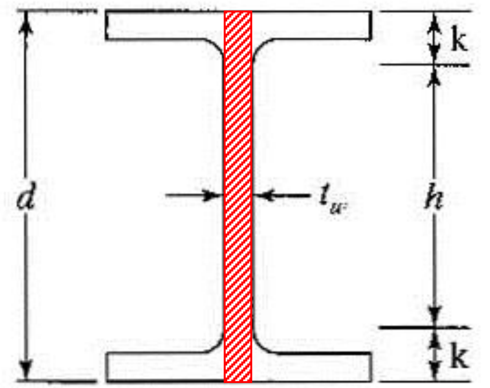
$$f_v = \frac{VQ}{I\,t}$$

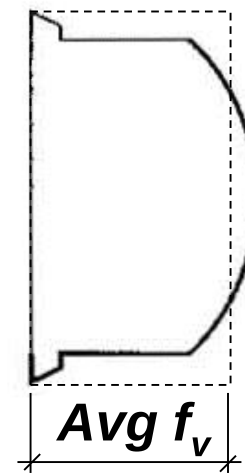


Shear Stress:

For W-shapes and T-shapes, the *average shear stress* (Direct stress) can be found using eqn:

$$f_v = \frac{V}{A_{web}}$$





where,

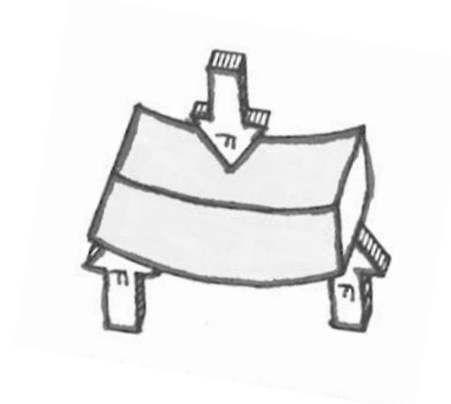
V = shear force

A_{web} = area of the web

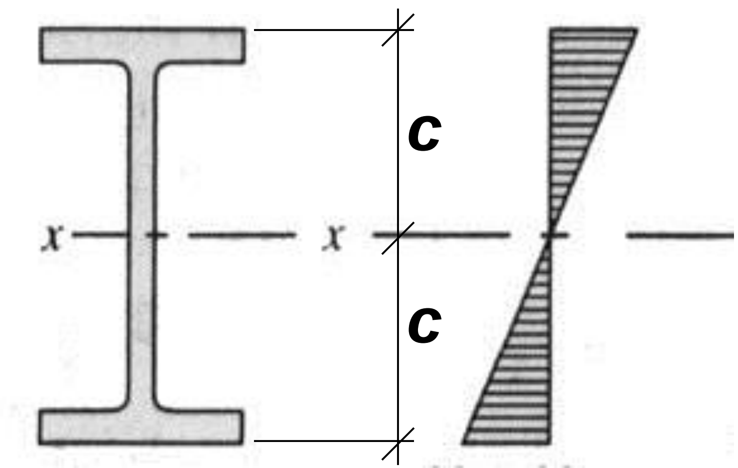
$= d \cdot t_w$

Bending Stress:

The bending stress in a structural mbr is based on the moment and section modulus and can be found using eqn:



$$f_b = \frac{M}{S} = \frac{M}{(I/c)}$$



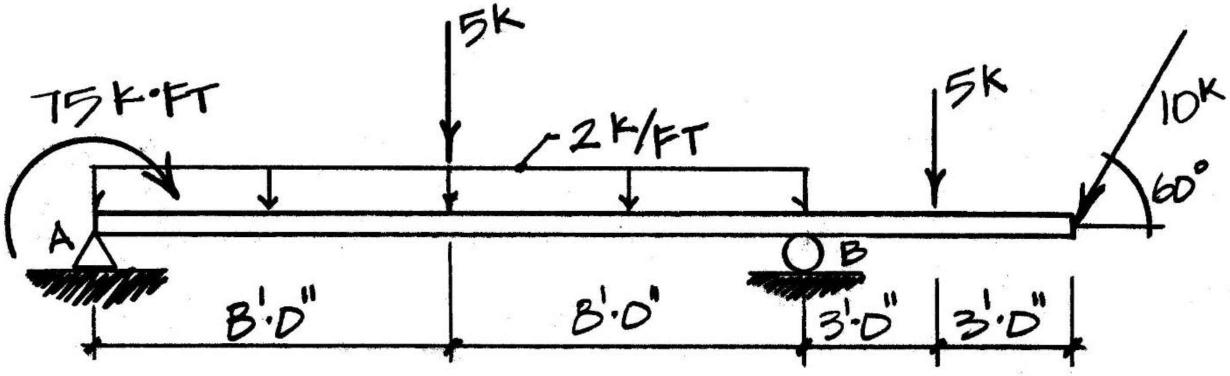
where,

M = moment
S = section modulus
= ***I/c***
I = Moment of Inertia
c = distance from centroid to extreme fiber

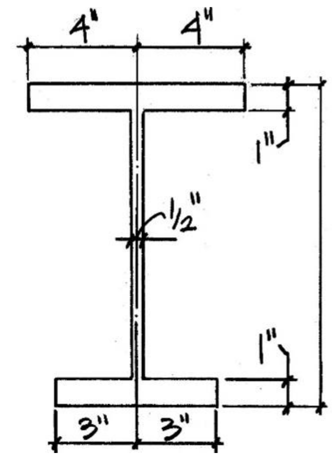
Bending stress varies linearly across depth…

Homework : BONUS Homework - 40 pts possible ...

Determine the max. average shear stress, the max. bending stress, and the max. axial stress in the structural mbr shown. The supports are a hinge at ***A****, and a roller at* ***B****.*



LOADED STRUCTURAL MEMBER



SECTION

Procedures for solving for stresses:

1. Draw **FBD** and solve for support reactions
2. Draw Shear & Moment Diagrams
3. Determine max. axial & shear force and max. moment
4. Determine centroid location of structural section
5. Determine distance to extreme fiber, ***c***
6. Calculate Area & Moment of Inertia for section
7. Calculate axial, shear and bending stresses ...