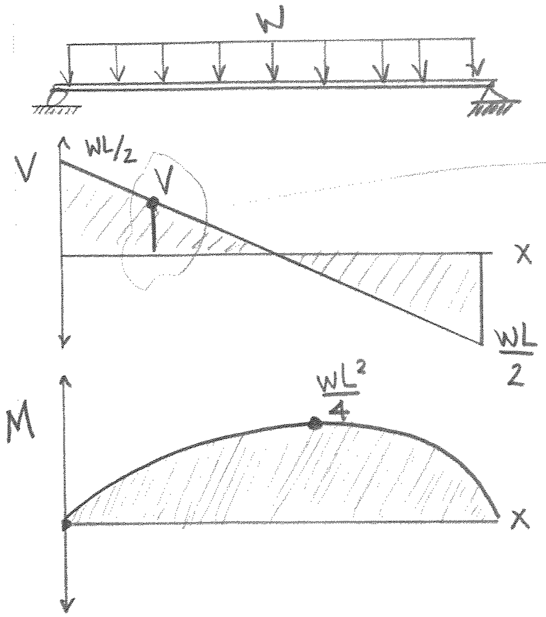
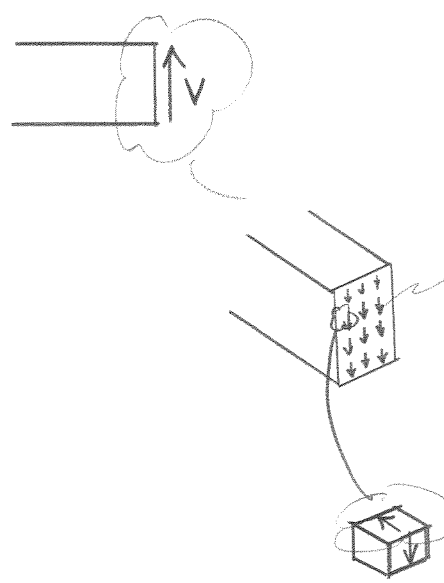
CLASS #20 - INTRODUCTION TO TRANSVERSE SHEAR

OBJECTIVE: ① DEFINE SHEAR IN STRAIGHT MEMBERS
② DERIVE SHEAR FORMULA

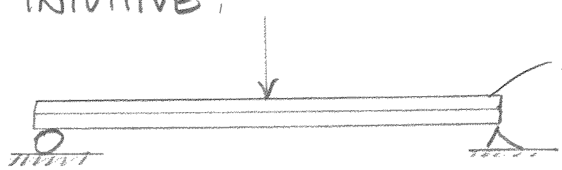
① CONSIDER A LOADED BEAM

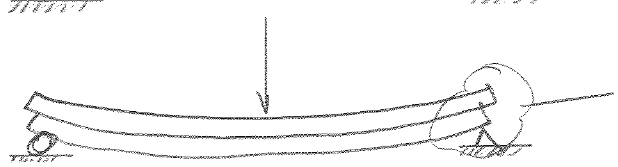




SHEAR STRESS RESULTS IN STRESS (SHEAR) ON PLANE'S PARALLEL TO LONGITUDINAL AXIS.

→ INTUITIVE!





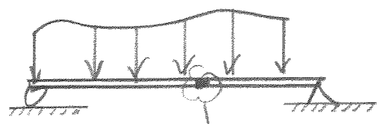
SLIDING....
BUT IN HOMOGENEOUS BEAM NO SLIDING

SHEAR IS FUNNY B/C CAN NOT DERIVE ITS DISTRIBUTION ON CROSS SECTIONS EASILY (UNLIKE FLEXURE FORMULA).

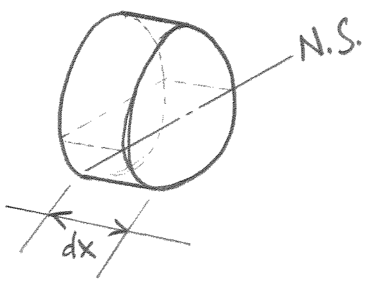
— WILL USE "INDIRECT" METHODS

② SHEAR FORMULA

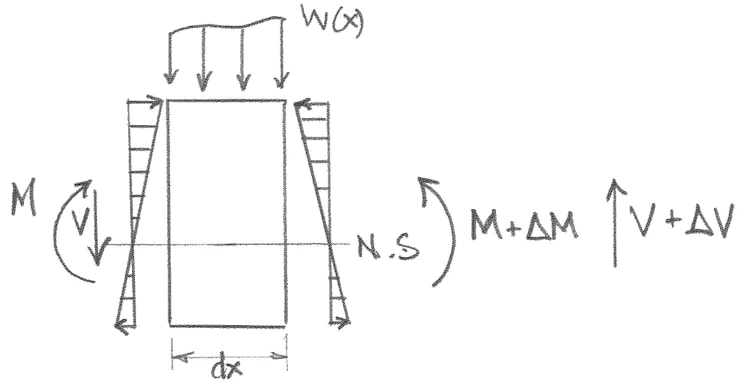
CONSIDER STANDARD BEAM:



CONSIDER INFINTESIMALLY SMALL SLIVER

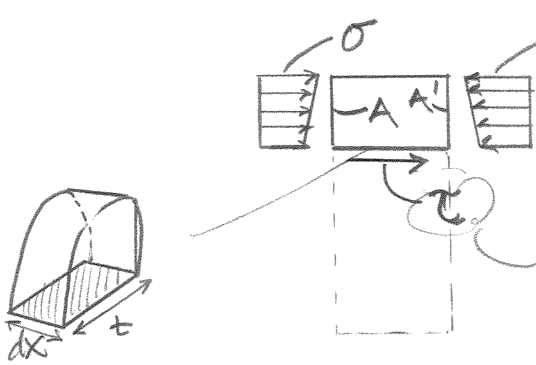


PERSPECTIVE



SIDE-VIEW

EQUILIBRIUM: $\sum F_x = 0$



(NOTE, $\sigma \neq \sigma'$ B/C OF ΔM)

SHEAR STRESS HOLDS THE TOP SEGMENT OF SLICE IN EQUILIBRIUM

$$\sum F_x: \quad \int_A \sigma \, dA - \int_{A'} \sigma' \, dA + \tau t \, dx = 0$$

FLEXURE FORMULA

$$\int_A \left(\frac{M}{I}\right) y \, dA - \int_{A'} \left(\frac{M+\Delta M}{I}\right) y \, dA + \tau t dx = 0$$

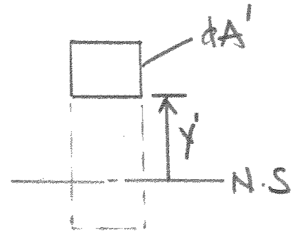
$$\int_A \frac{dM}{I} y \, dA = \tau t dx$$

$$\tau = \frac{1}{I} \cdot \frac{1}{t} \cdot \frac{dM}{dx} \cdot \int_A y \, dA$$

REMEMBER $\frac{dM}{dx} = ?$ ...... $= V$

$$\tau = \frac{V}{It} \int_{A'} y \, dA'$$

$$Q = \int_{A'} y \, dA'$$



$$\boxed{\tau = \frac{VQ}{It}}$$

SHEAR FORMULA

$= \bar{y}' A'$

HEIGHT TO CENTROID

③ GIVES US ALSO SHEAR ON FACE: