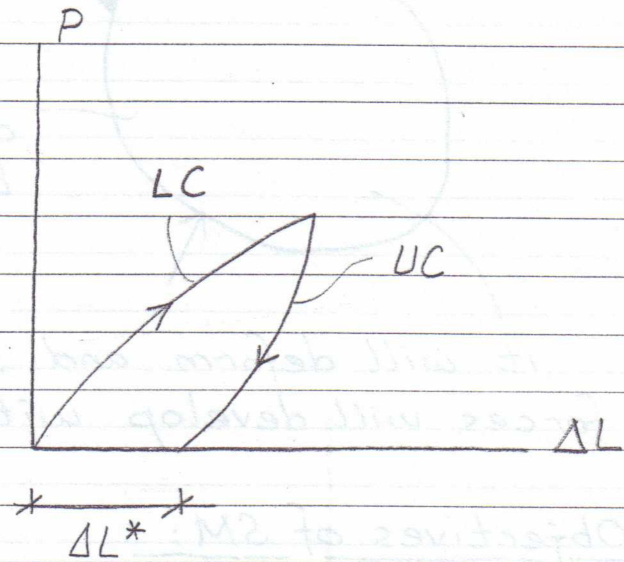
DEFINITION:

A plastic body is the one which does not retain its original shape after the loads are removed.

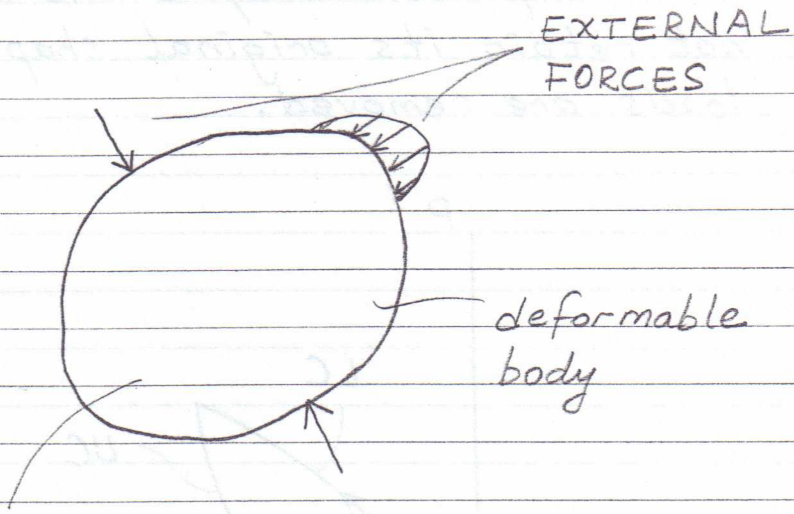


for plastic matl. LC & UC do not coincide and $\Delta L^* \neq 0$

In this course we will assume that the bodies are made of Hooke matl.

OBJECTIVES OF STRENGTH OF MATERIALS

SM



it will deform and some internal forces will develop within the body.

Objectives of SM:

1) Determination of internal forces and the design of the body so that it will resist this internal forces.

2) Determination of deformations

They can be used for:

a) the design purposes

b) the analysis of indeterminate systems.

3) Determination of stability characteristics of a body.

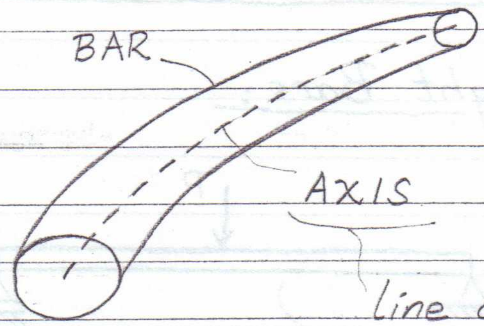
They can be used for the design of compressional elements, such as, of columns against buckling.

GEOMETRIC CLASSIFICATION OF BODIES

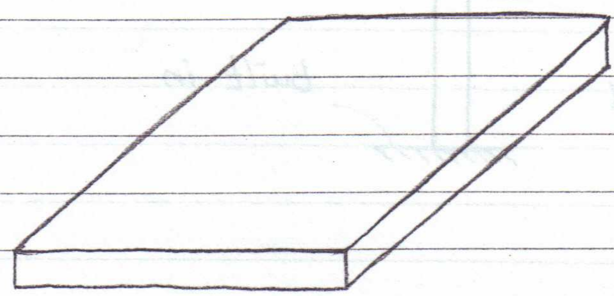
Depending upon its geometry a body is named as:

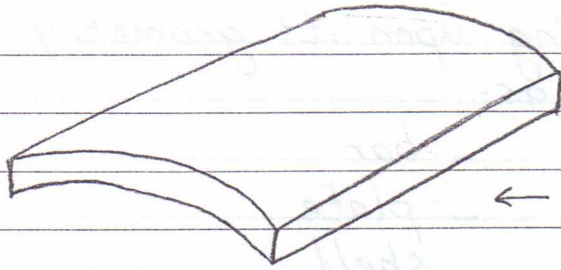
- bar
- plate
- shell
- 3-dimensional body

BAR is a body whose side in one direction is very large compared to others.



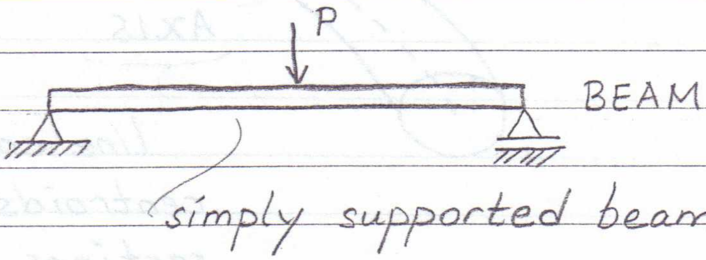
PLATES & SHELLS are some bodies whose side in one direction is small compared to others.

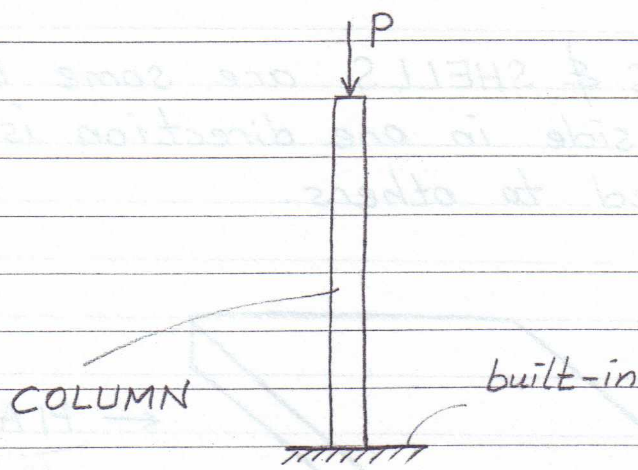




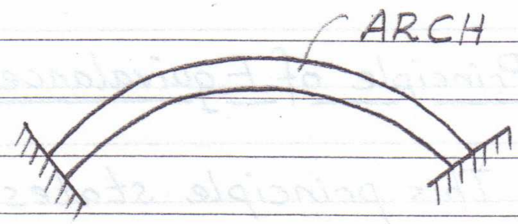
CLASSIFICATION OF BARS

Straight Bars:

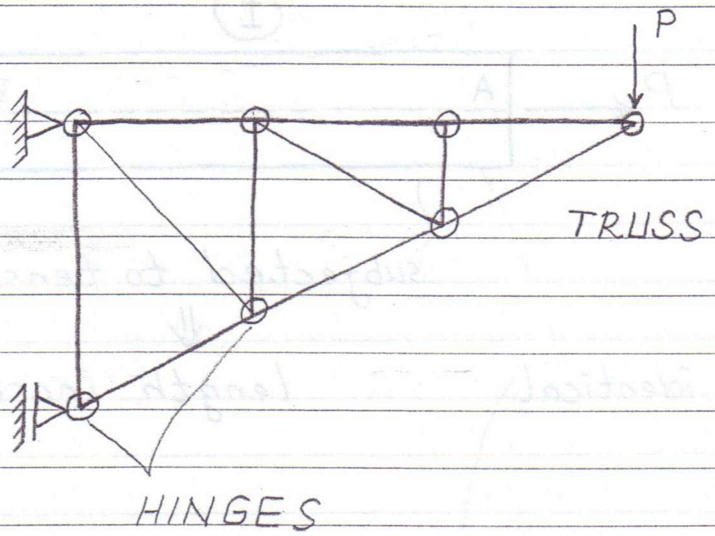


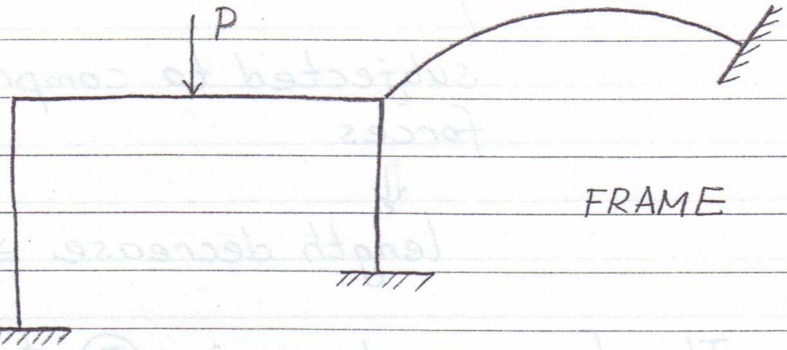


Curved Bars:



Bar Systems:





THE PRINCIPLES WHICH ARE BEING USED IN SM

The Principle of Equivalance:

This principle states that the forces which are equivalent statically may not be equivalent wrt deformation.

I

subjected to tensile forces

$\Downarrow$

identical

length increase $\Rightarrow \Delta L > 0$

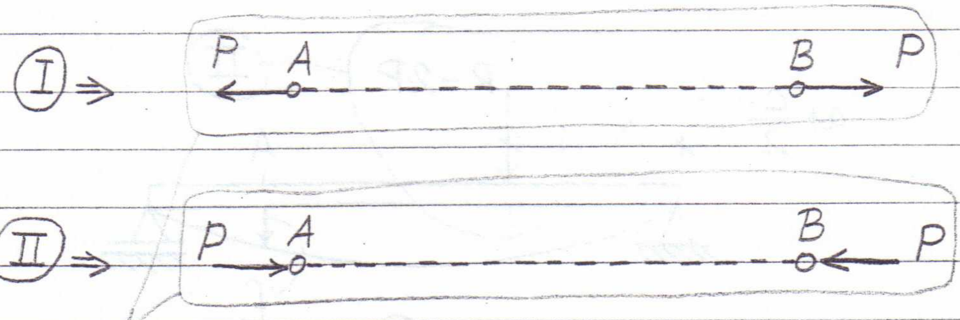
II

subjected to compressional forces

$\Downarrow$

length decrease $\Rightarrow \Delta L < 0$

The force systems in I & II are statically equivalent.



have the same resultants

$\Downarrow$

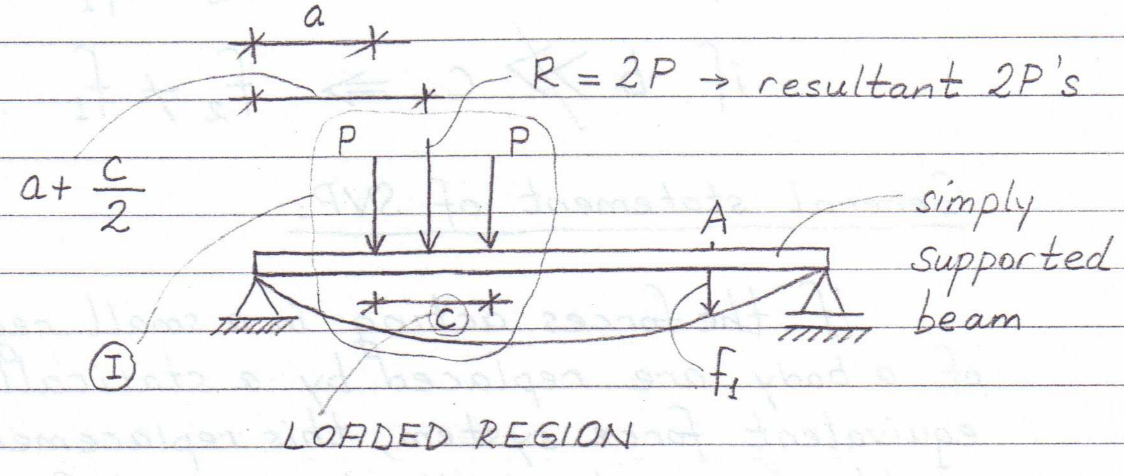
statically equivalent

(I) $\Rightarrow$ $\Delta L > 0$ $\Rightarrow$ length increase

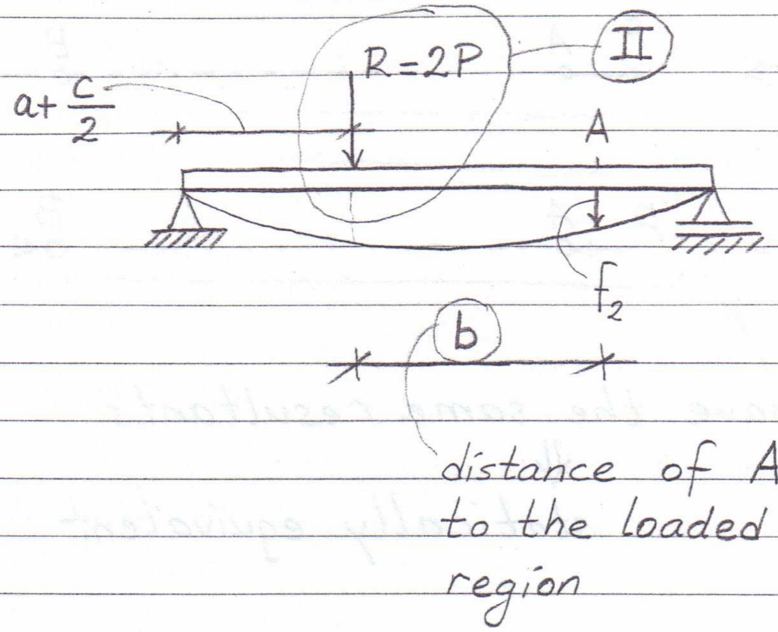
(II) $\Rightarrow$ $\Delta L < 0$ $\Rightarrow$ length decrease

not equivalent wrt deformation

Saint - Venant Principle (SVP)



$f_1 \rightarrow$ vertical displacement (deflection)



I & II → statically equivalent

we expect that $f_1 \neq f_2$

SVP states that if A is far away from the loaded region, then $f_2 \cong f_1$.

mathematically:

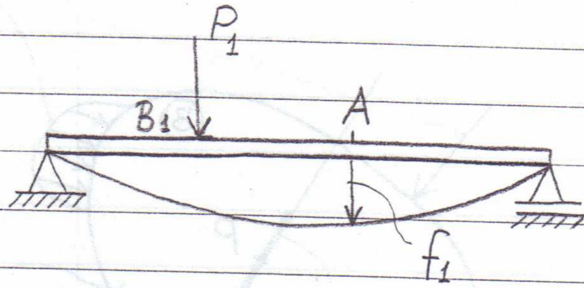
$$\text{if } b \gg c \Rightarrow f_2 \cong f_1$$

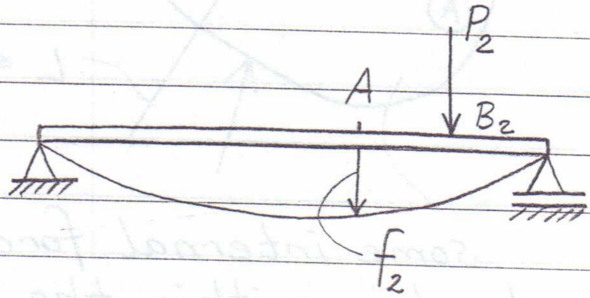
$$\text{if } b \not\gg c \Rightarrow f_2 \neq f_1$$

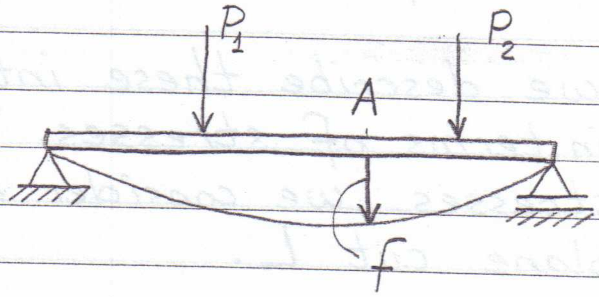
General statement of SVP:

If the forces acting in a small region of a body are replaced by a statically equivalent force system, this replacement would cause only small changes in deformation at the points which are far away from the load replacement region.

Superposition Principle (SP)





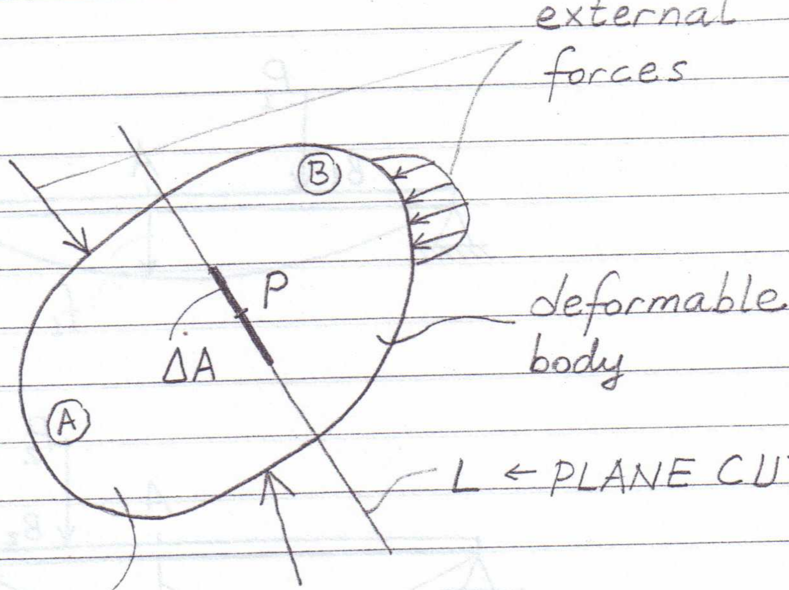


SP states that $f = f_1 + f_2$ if the beam is made of Hooke matl.

General statement of SP:

The deformation at a point of a body caused by some forces acting on it is equal to the sum of the deformations which are produced by each force seperately.

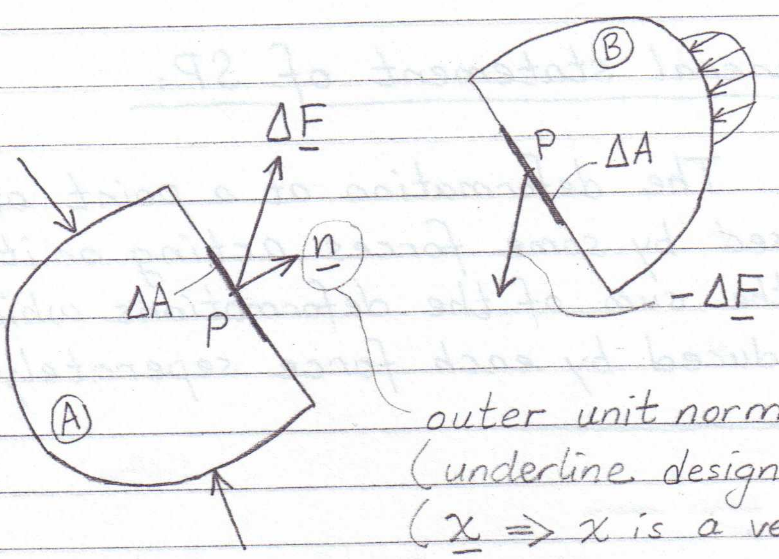
STRESS



some internal forces will develop within the body

we describe these internal forces in terms of stresses. To define stresses we consider an imaginary plane cut L.

P → is a pt. on L
ΔA → small area containing P



outer unit normal
(underline designates a vector)
($\underline{x} \Rightarrow x$ is a vector)

$\Delta \underline{F} \rightarrow$ the force acting on ΔA

the internal force exerted on part Ⓐ by part Ⓑ

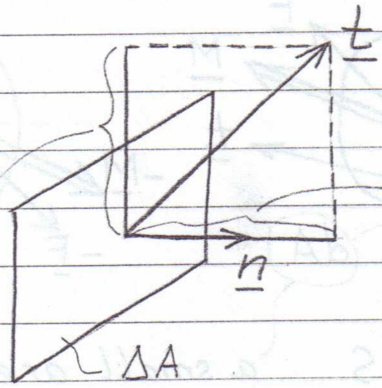
$$\underline{t} = \lim_{\Delta A \to 0} \frac{\Delta \underline{F}}{\Delta A}$$

stress vector

$\underline{t} \rightarrow$ force per unit area

$$\frac{\text{FORCE}}{\text{AREA}} \rightarrow \frac{kgf}{cm^2}, \frac{N}{m^2} (Pa) \text{ etc.}$$

Normal and tangential components of $\underline{t}$ (stress vector):



$\sigma \rightarrow$ normal stress
↓
projection of $\underline{t}$ in normal dir.

$\tau \rightarrow$ shear stress
↓
projection of $\underline{t}$ in ΔA

$\sigma \perp \Delta A$

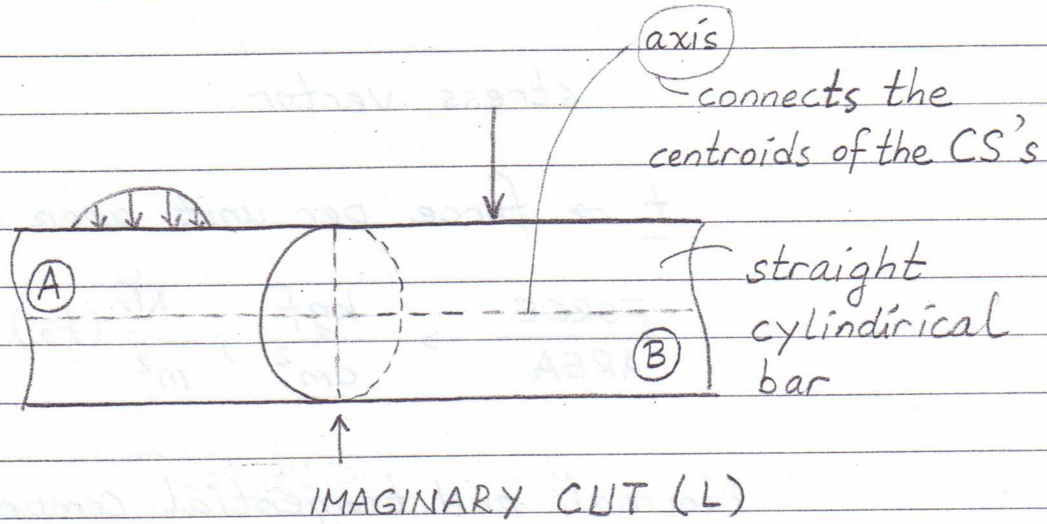
τ acts in the plane of ΔA

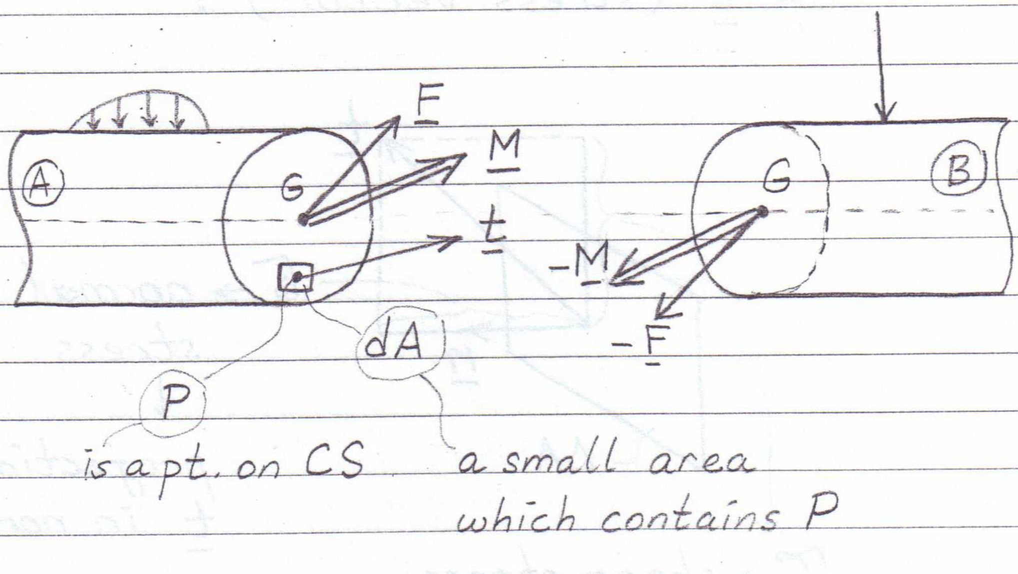
CHAPTER 2

CROSS-SECTIONAL (INTERNAL) FORCES FOR BEAMS

CS

CSF





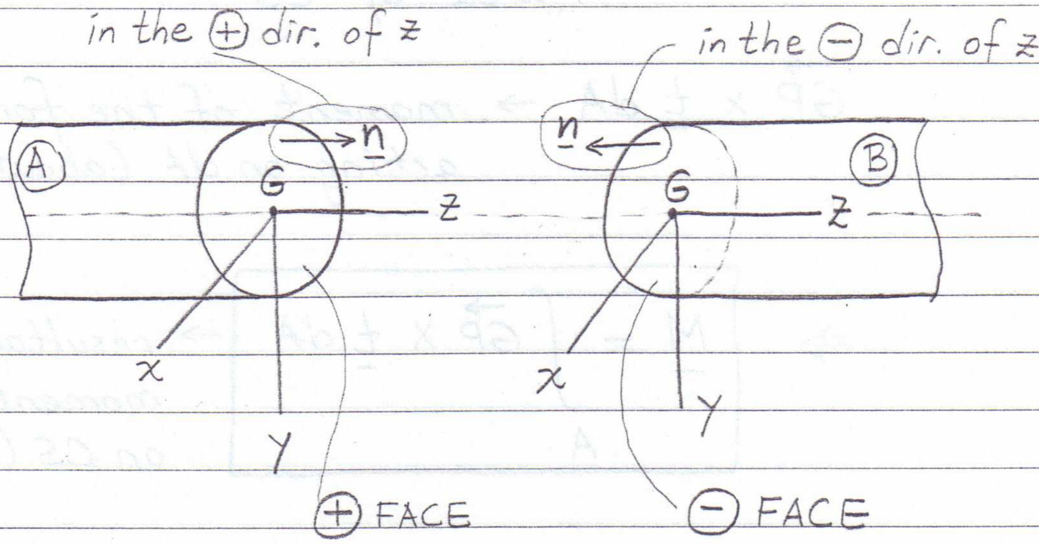
G → centroid (ctd)

$\underline{t}$ → stress vec. at P

$\underline{t}\, dA$ → force acting on dA

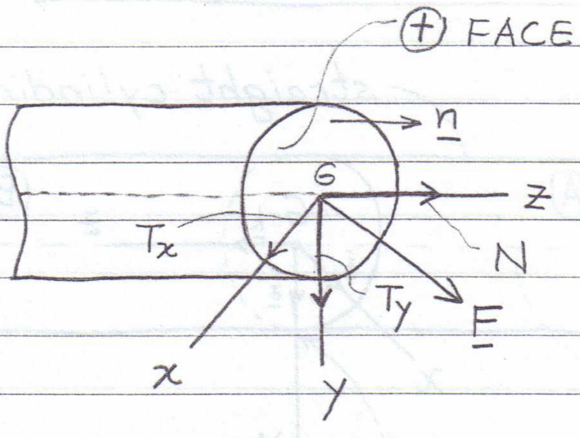
$y \to$ directed downwards

$yz \to$ vertical plane (blackboard)



$\underline{n} \to$ outer unit normal

Comps. of CSF for ⊕ face:



$$\underline{F} = T_x \underline{i} + T_y \underline{j} + N \underline{k}$$

$$= (T_x, T_y, N)$$