DIGITAL EDUCATION
MARTCOST

MECHANICAL ENGINEERING

Machine Design

Hand Notes For GATE, IES, PSUs & Competitive Exam

Hand Notes

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Note : *We also providing GATE, IES, PSUs & Competitive Exam Materials [Handnotes, Shortnotes & Books], All Reports [Seminar Reports & PPT]*

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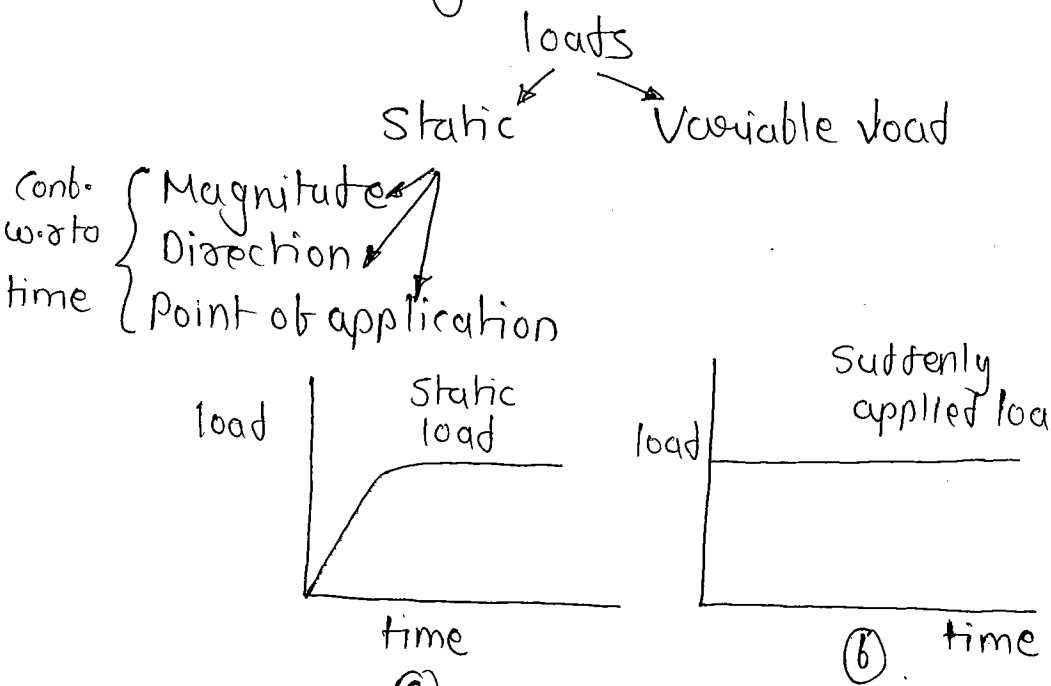
MACHINE DESIGN

Design - is a process plan to satisfy a human need.
It is a mechanism to convert an idea into reality
It is a solution to the problem.

Machnine - A m/c is a combination of resistant bodyies with successfully constrained motion (relative motion) to other form of energy into mechanical energy.
OR
To transmit and motify the available energy to do some useful work.

Machine design involve the selection of suitable material and optimum dimentions to withstand the load without failure.

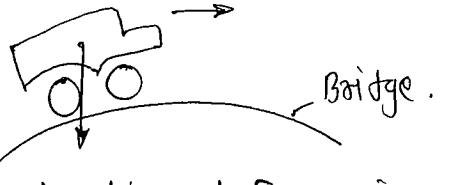
Loads - Externally applied force or moment acting on the member



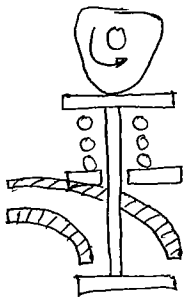
Gradually applied load
can also called as static load.

① Magnitude changes - magnitude is fluxituating but direction remain same

Ex:-



the direction of force is cont. but magnitude is changing while vehicle crossing the bridge.

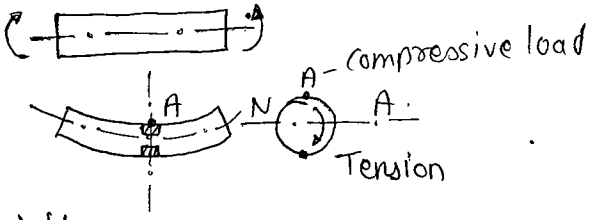


valve spring.

② Direction Changes - Constant magnitude

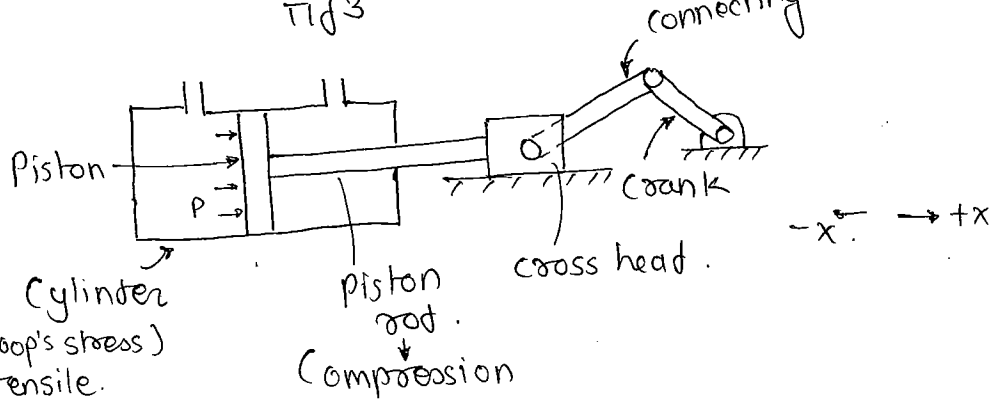
Ex:- Rack pinion., gear m/c sm.

A rotating shaft carring a const. benting movement.



$$\sigma_b = \frac{M}{I} \times y.$$

$$\sigma_b = \frac{32M}{\pi d^3}$$



Pressure P

$$\vec{F} = \text{Pres} \times \text{Area}$$

$$= P \times \pi/4 D^2.$$

$$\overleftarrow{F} = P \times \frac{\pi}{4}(D^2 - d^2)$$

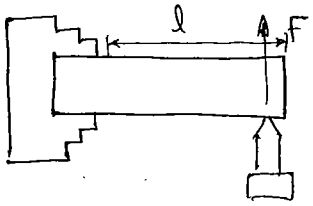
$d << D$.

$$\vec{F} = \overleftarrow{F}$$

Piston rod = $\overleftarrow{F}$ - tensile load $\vec{F}$ - comp. load.

hence piston rod come under this catagory.

③ Point of application.



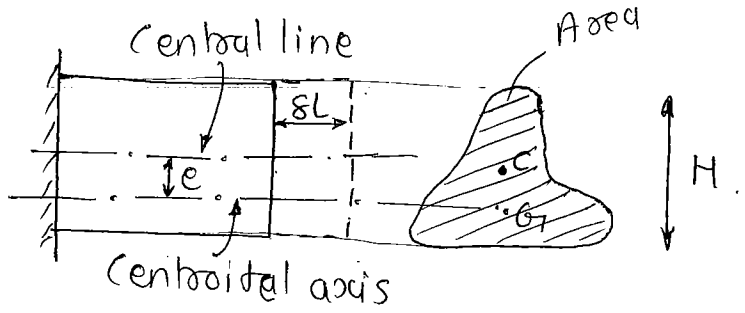
$M_{max} = F \times l$

$M_{min} = F \times 0$

Stress (σ)

$\sigma = \frac{\text{load}}{\text{area}} = \frac{F}{A}$.

$\sigma_{\text{centroidal axis}}$



$\sigma_{\text{central line}} = \frac{F}{A} + \frac{M}{I} y$.

Strain (ε)

$\varepsilon = \frac{\delta L}{L}$.

Hook's law

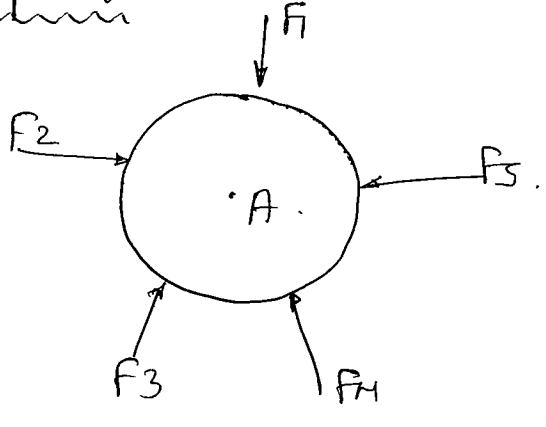
$\sigma \propto \varepsilon$ (with in the proportional limit) (No elastic limit).

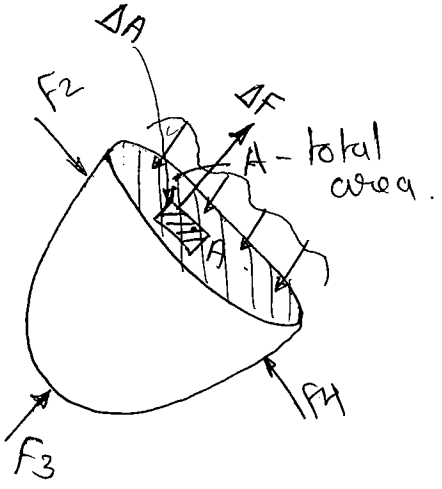
Stiffness (K)

$K = \frac{\text{load}}{\text{deflection}}$.

$= \frac{F}{\frac{Fl}{AE}} = \frac{AE}{L}$.

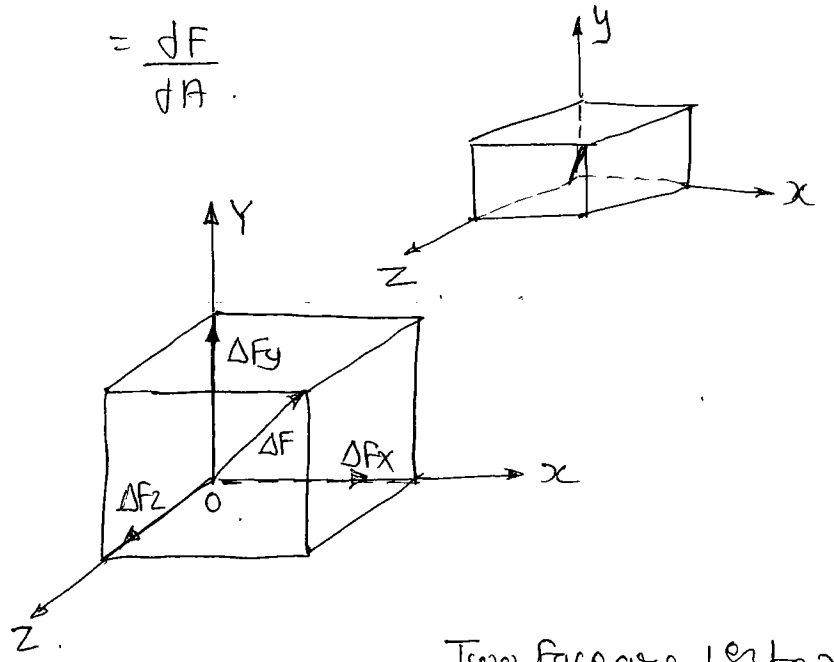
Stress at a point.





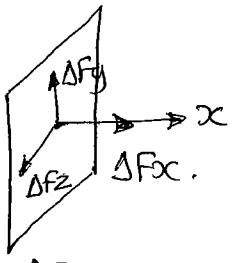
$$\sigma_t = \lim_{\Delta A \to 0} \frac{\Delta F}{\Delta A}$$

$$= \frac{dF}{dA}.$$



→ Force ⊥er to X axis

Two face are ⊥er to x axis.



Tensor

(vector qunt) $\sigma_{xx} = \lim_{\Delta A \to 0} \frac{\Delta Fx}{\Delta A}$.

- x → Force Normal to co-ordinate
- x → Force direction

$$\sigma_{xy} = \lim_{\Delta A \to 0} \frac{\Delta Fy}{\Delta A}.$$

$$\sigma_{xz} = \lim_{\Delta A \to 0} \frac{\Delta Fz}{\Delta A}.$$

→ Force ⊥er to Y axis (same).

" " " Z axis "

Direct stress
Normal stresses. (volume change)

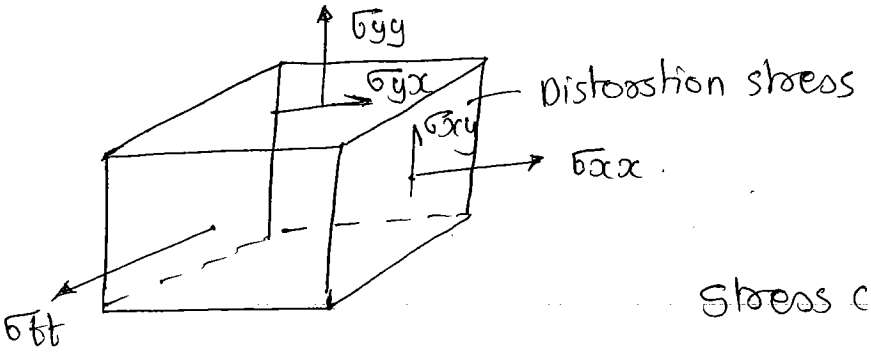
Distorsion Stress

Stress tensor

$$\sigma = \begin{array}{c} \\ x \\ y \\ z \end{array} \begin{bmatrix} \sigma_{xx} & \sigma_{xy} & \sigma_{xz} \\ \sigma_{yx} & \sigma_{yy} & \sigma_{yz} \\ \sigma_{zx} & \sigma_{zy} & \sigma_{zz} \end{bmatrix}$$

Normal stress – It changes the size (volume changes)

It is called as direct stress (No shape change)



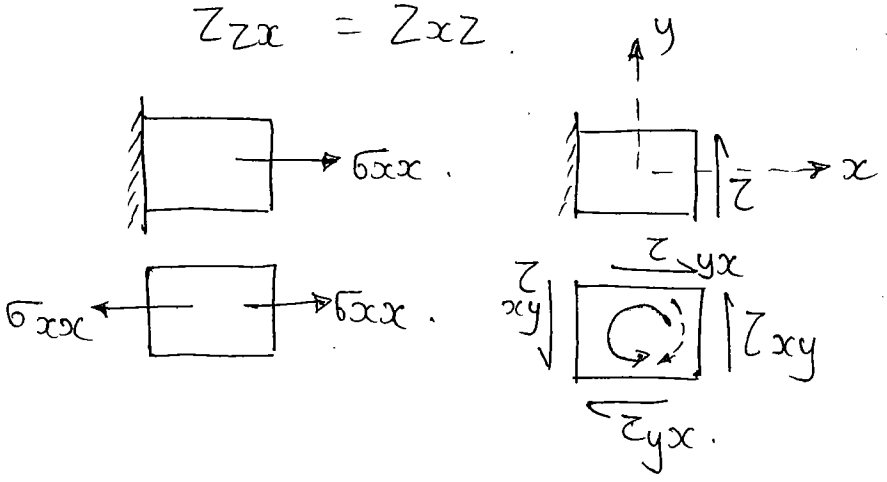
Distortion stress

Stress component – 9.

$$\sigma = \begin{bmatrix} \sigma_{xx} & \tau_{xy} & \tau_{xz} \\ \sigma_{yx} & \sigma_{yy} & \tau_{yz} \\ \tau_{zx} & \tau_{zy} & \sigma_{zz} \end{bmatrix}$$

Complementary shear stress are

$$\tau_{xy} = \tau_{yx}.$$
$$\tau_{yz} = \tau_{zy}$$
$$\tau_{zx} = \tau_{xz}.$$



6 stress components are req to define the total stress at a point in the space.

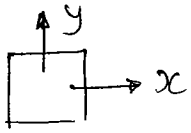
σ_{xx} τ_{xy}

σ_{yy} τ_{yz}

σ_{zz} τ_{zx}

Two dimention stress. (Plane stress)

Ex:- ① Thin sheets (laminar)



(thickness is very less)

② Thin cylindrical shell

σ_θ, σ_z and p (pressure) is neglected.

$$\sigma = \begin{bmatrix} \sigma_{xx} & \tau_{xy} \\ \sigma_{yx} & \sigma_{yy} \end{bmatrix}$$

3 stress compents are required to define the stress

σ_{xx}, σ_{yy}, $\tau_{xy} = \tau_{yx}$.

Principle Stress.

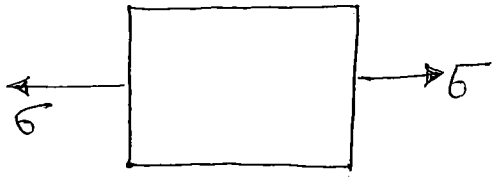
Principle plain - A plain carrying zero ~~principle~~ shear stress.

Principle Stress - The stress (normal) acting on the principle plain.

Principle palanes and stresses.

Principle plane.

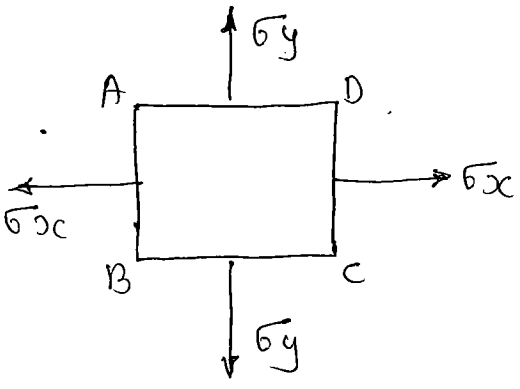
zero shear stress { AB or CD $\sigma_1 = \sigma$
AD or BC $\sigma_2 = 0$.



Principle plane.

AB or CD $\sigma_1 = \sigma_y$ Major

AD or BC $\sigma_2 = \sigma_x$ Minor



$\sigma_y > \sigma_x$.

Biaxial type