*KD(1)

Strength Of Materials [KD]

Mechanics

- Engineering Mechanics [Mechanics of Rigid Body]
  i.e → Effect of external force on Rigid body
  - Static
  - Dynamic
    - Kinitic
    - Kinematic
- Strength of Materials [Mechanics of Deformable Body.]
  i.e → Effect of force at deformable body.
  - Theory of Elasticity
  - Theory of Plasticity
- Fluid Mechanics [Mechanics of Stationary & flowing fluid.]

Mechanics is the branch of Science which deals with Study of force & their effect on structure.

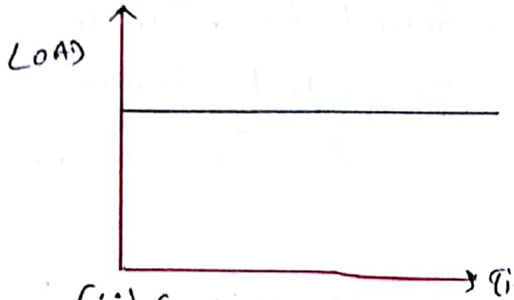
SOM Deals with study of internal resisting force which are developed due to external force.

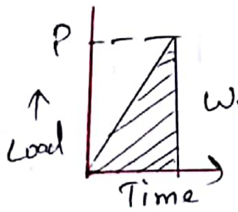
Assumptions in SOM

1. Material is assume to be homogeneous & Isotropic.
2. Member is assume to be Prismatic [Uniform crossection].
3. Material is Subjected to Static loading.
4. Meterial obeys hooks law.
5. Effect of true stress & true strain is negligible & Analysis is carried out by Engineering stress & Engineering strain.

① (i) Static Load

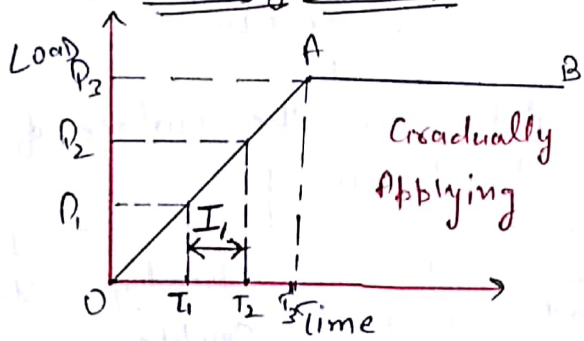
These are the loads whose magnitude & direction remains constant with respect to time.





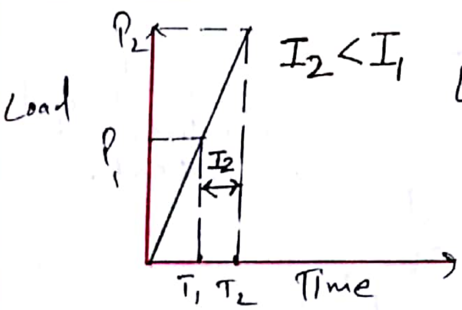
For a gradual load
Workdone = Area Under curve
$W \cdot D = \frac{1}{2} \times B \times A \Rightarrow \frac{1}{2} \times \delta \times P$
$\Rightarrow \frac{1}{2} \times$ Lengthchange $\times$ AH.

(ii) Gradually Applied.



Gradually Applied Load is a load whose magnitude inc. gradually & reaches at its maximum value. (O-A) is load even it is varying with respect to time but variation is very small.

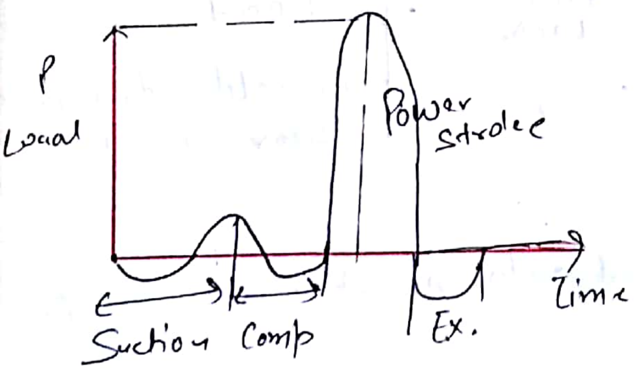
② Dynamic



Dynamic or Impact Load

Impact Loads are those Loads which are acting for a short interval of time ex. springs used in shock absorber, Shaft transmitting power at higher velocity with spur gear.

Let us take an example of a Internal Combustion Engine.



t = time of applied Load applied on a body or time for which a body is under the impact of Load. Now time decides that the Load is static or impact. In the graph of Dynamic (impact) & gradually ~~time Period~~ LOAD is same but still one is impact & other is gradual static. So there will be another thing with the relation with time

(2)

That decides the load is static or dyname & that realation is with T = Time period of vibration. More the value of T corrsponds to the static load. & lesser T will give rise to impact ∴ In Impact load vibration will be after the impact & in static the vibration will continue as the load aplied. The reation is

$t = \frac{T}{2}$ [Impact loading] ⇒ $t < \frac{T}{2}$

$t = 3T$ [Static loading.] ⇒ $t > 3T$

T = time of Vibration

*And in b/w the value of T/2 & 3T i.e. $\boxed{\frac{T}{2} \le t \le 3T}$ In can be either Impact or static load

Now Static & Impact ~~load~~ Stresses relates with each other with a term Impact factor i.e. [I.F.].

$$\text{Impact factor} \times \sigma_{Static} = \sigma_{Impact}$$

& $$I.F = 1 + \sqrt{1 + \frac{2h}{\delta_{static}}}$$

Now the value of $\delta_{static} = WL/AE$ where it comes

i.e. $\sigma \propto \varepsilon$ ⇒ [Stress is directly proportional to Strain]

So $\sigma = E\varepsilon$ [Where E is a constant named as Modulus of Elasticity]. ⇒ $\varepsilon = \frac{\sigma}{E}$

Now stress = Force/Area ⇒ Weight/Area So-

$$\varepsilon = \frac{W}{AE} \Rightarrow \frac{\delta L}{L} = \frac{W}{AE}$$ [Strain is change in length devide by length]

*KD (2) $$\boxed{\delta_{Static} = \frac{WL}{AE}}$$ δ_{Static} = Static Elongation

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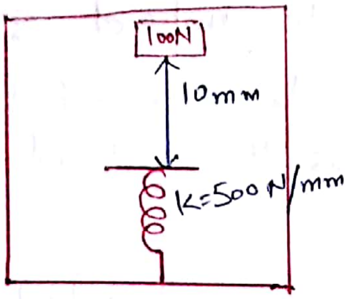
Question For the Loading as shown in figure. Determine impact deflection of spring?



Solution Weight = 100N K [Stiffness of spring] = 500N/mm
height [h] = 10mm.

Now stifness - force required in a spring for per Unit deflection.

$$\delta_{impact} = ?$$

$$\Rightarrow \delta_{impact} = \delta_{static} \times \text{Impact factor.}$$

$$\delta_{static} = \frac{\text{Weight}}{\text{Stiffness}} \Rightarrow \frac{100}{500} = 0.2\text{mm.}$$

Now Impact factor

$$I.f = 1+\sqrt{1+\frac{2h}{\delta_{static}}} \Rightarrow 1+\sqrt{1+\frac{2\times 10}{0.2}}$$

$$I.f = 1+\sqrt{1+\frac{20\times 10}{2}} \Rightarrow 1+\sqrt{110} = 11.049$$

So

$$\delta_{impact} = 0.2 \times 11.049 = 2.209\text{mm}$$

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(*) Type of LOAD

(2) Impact LOAD

Impact factor $= 1 + \sqrt{1 + \frac{2h}{\delta_{static}}}$ [here h is the height of Load from which it is acting.]

If $\sigma_{induced} > \sigma_{permissible} \Rightarrow$ faluire

$\sigma_{induced} < \sigma_{permissible} \Rightarrow$ Safe condition

& $\sigma_{impact} = I.f \times \sigma_{induce}$

When $h = 0$

$$I.f. = 1 + \sqrt{1 + \frac{2h}{\delta_{static}}} = 1 + \sqrt{1 + \frac{0}{\delta_{static}}} = 2$$

$I.f = 2$

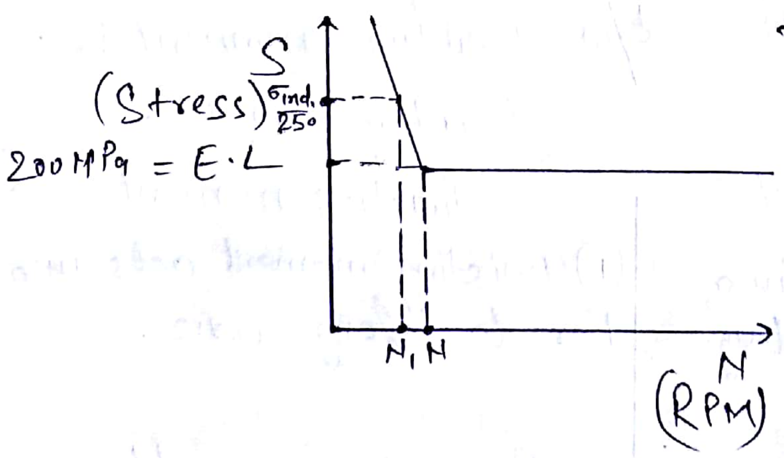
So $\sigma_{impact} = 2 \times \sigma_{Induced}$ or $\sigma_{impact} = 2\,\sigma_{static}$

So $\boxed{\sigma_{impact} \geq 2\,\sigma_{static}}$ when h is given. from which load is acting.

also $\boxed{\delta_{impact} = I.f \times \delta_{induced}}$.

(*) (3) If elastic limit of steel $E.L = 200$ MPa

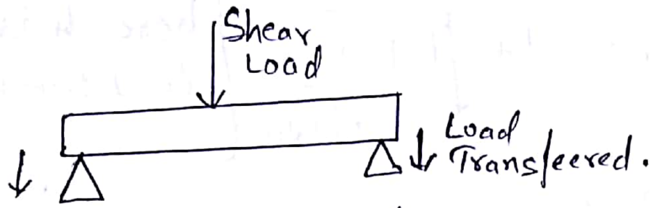
& Stress induced $\sigma_{induced} = 250$ MaPa



The graph states that the W/p of steel will fail at N_1 (RPM). instead of its elastic limit which is given for N no. of Revolutions.

KD* (4)

Beam A Beam is defined as a structural member Subjected to Transfeer shear load



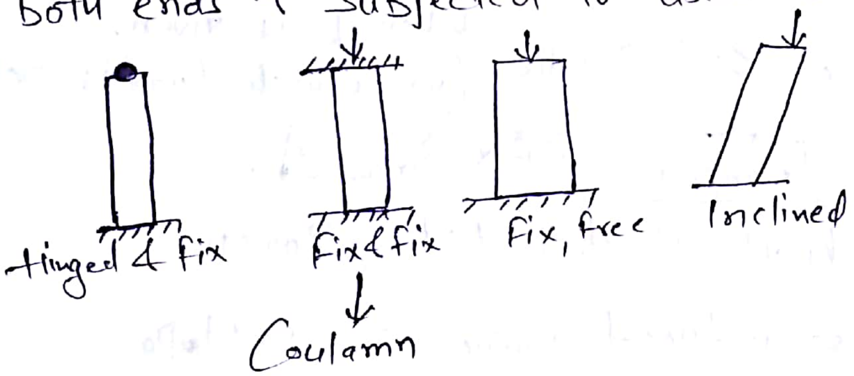
A beam is Used to transfeer the load applied on it.

Coulamn & Sturt

A Coulamn is a type of sturt.

Sturt is a structural member Subjected to axial Compressive load.

Coumn is defined as sturctural member which fix at both ends & subjected to axial Compressive load.



KD* (5)

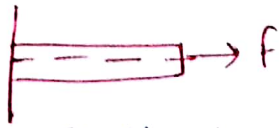
Differentiate b/w Bending moment & Twisting moment.

Bending moment	Twisting moment.
(1) Bending Couple Acts in a plane passes through long. axis.	(1) Twisting moment acts in a plane ⊥'ar to long. axis.
(2) It acts in a plane ⊥'ar to plane of Crossection.	(2) It acts in a plane Parallel to plane of Crossection.

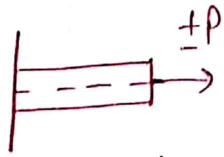
③

Fatigue Load

Fatigue loads are those loads whose Magnitude & direction or one from the two changes with respect to time & these loads are repeatedly applied with respect to time.

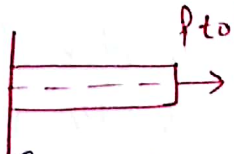
① 
f

Static Load

② 
±P

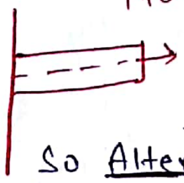
This is called as Completly reversed fatigue Loads. [only direction changing].

Continously changing

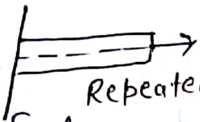
③ 
P to P/2

Fluctuating

Only magnitude changing so Fluctuating fatigue loads.

④ 
P to −P/2

Alternativly both magnitude & direction change so Alternating Fatigue Load.

⑤ 
0 to P.

Repeated LOAD.

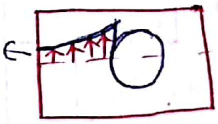
ENDURANCE LIMIT

Endurance limit is defined as the maximum value of Completly reversed stress that a material can withstand [Endure] for a infinite no. of cycles with-out a fatigue falilure. [Without a crack initiation].

A crack formation take place.

① Stress Concentration [Stress will concentrated at the hole & weakest region of the body].

② Defects in the body.


Stress Conc. ←

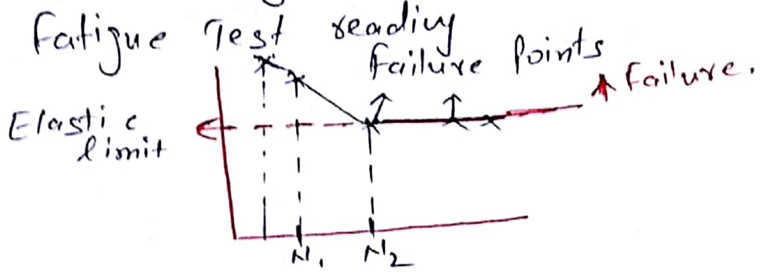
③ Irregularity present.

Fatigue life of a Component is defined as the no. of revolution that a Compound Undergone before the evidence of first fatigue crack formation.

Fatigue limit It is the limit upto which a material withstand the force or Conciding point where Crack formation & elastic limit reads.

It is obtained from S-N curves which is drawn by using fatigue test readings i.e. S[stress] & N[no. of cycles].

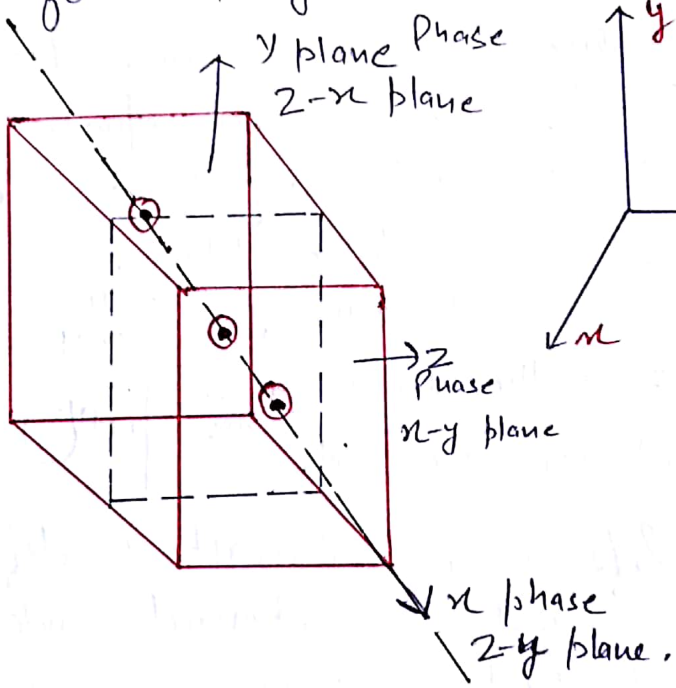
No.	S	N
1	S_1	N_1
2	S_2	N_2
3	S_3	N_3
4	S_4	N_4

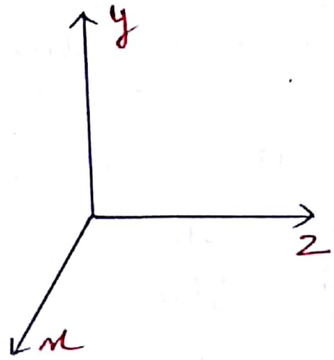


$\boxed{* \text{ KD } ③}$

Endurance Strength is defined is the maximum value of completly reversed stress that a material can withstand for a finite no. of cycles with out a fatigue failure.

Endurance strength is always represected by the corresponding value of stress followed by the no. of cycles.





Axis notations

$x - x \rightarrow$ Horizontal

$y - y \rightarrow$ Vertical

$z - z \rightarrow$ Longitudenal Axis.
or Polar Axis.