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Assigment :- (1)

Subject :- Advance Mechanic of Material :

Teacher :- Engr Sir Fawad Ahmed.

Date : 1/10/2020

IQRA National University Peshawar.

Assigment # 1

Q1) Explain the following topic in detail with neat sketches in detail.

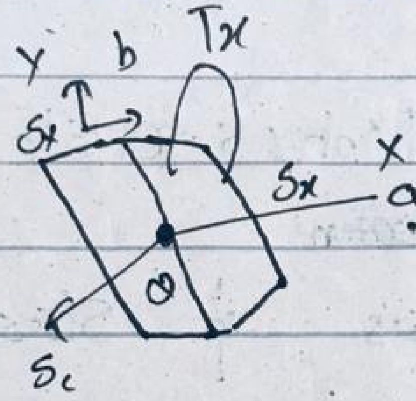
1. Application of Mohr's circle to the three-
2. dimensional Analysis of Stress.

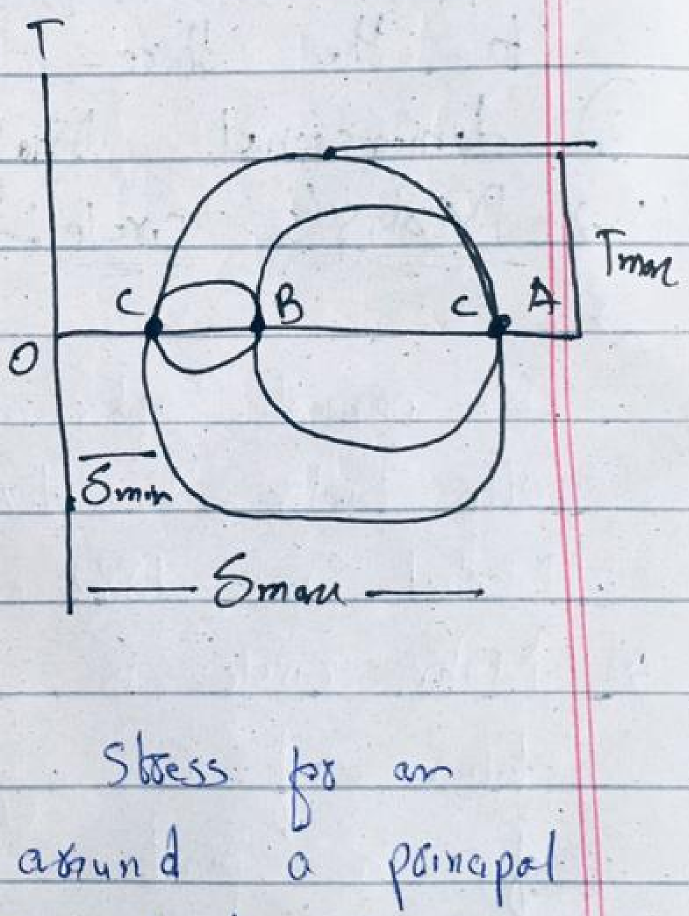
(Ans) **Mohr's circle :-**

→ Mohr's circle is named after a german civil Engineer otto Mohr - He developed the graphical Method in 1882.

→ Mohr circle is a graphical represen-tation of a ~~gern~~ general state of a point - it is graphical method used for evalution of principal stresses maximum shear stress normal and tangential stresses on ~~any~~ any given plan-

→ the Mohr's circle describe the normal and shear stress acting on plan of all possible orientation through a point in the rock.





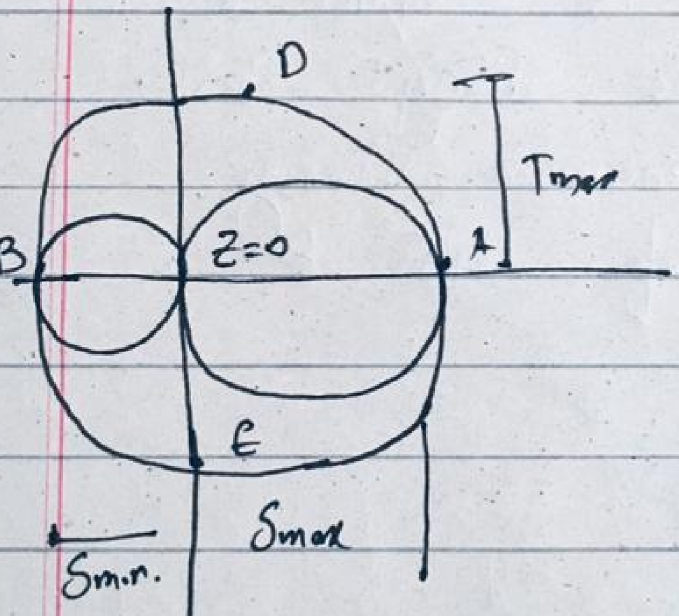
* transformation of stress for an element rotated around a principal axis may be represent by Mohr circle.
→ point A, B and C represent the principal stresses on the principal planes (shearing stress is zero)

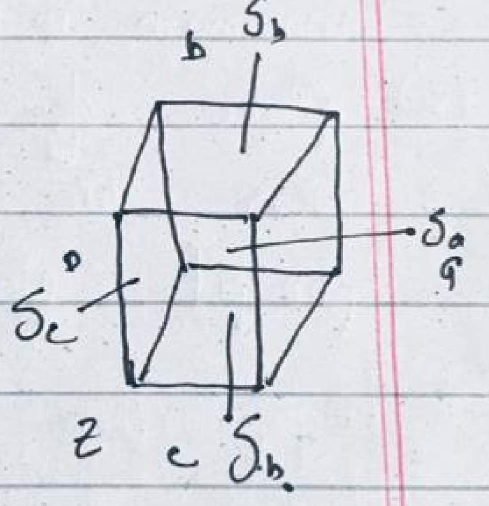
3

→ The three dimensional represent the normal and shearing stresses for rotation around each principal axis.

→ Radius of the largest circle yield the maximum shearing stress

$$T_{max} = \frac{1}{2} \left| \delta_{max} - \delta_{min} \right|$$





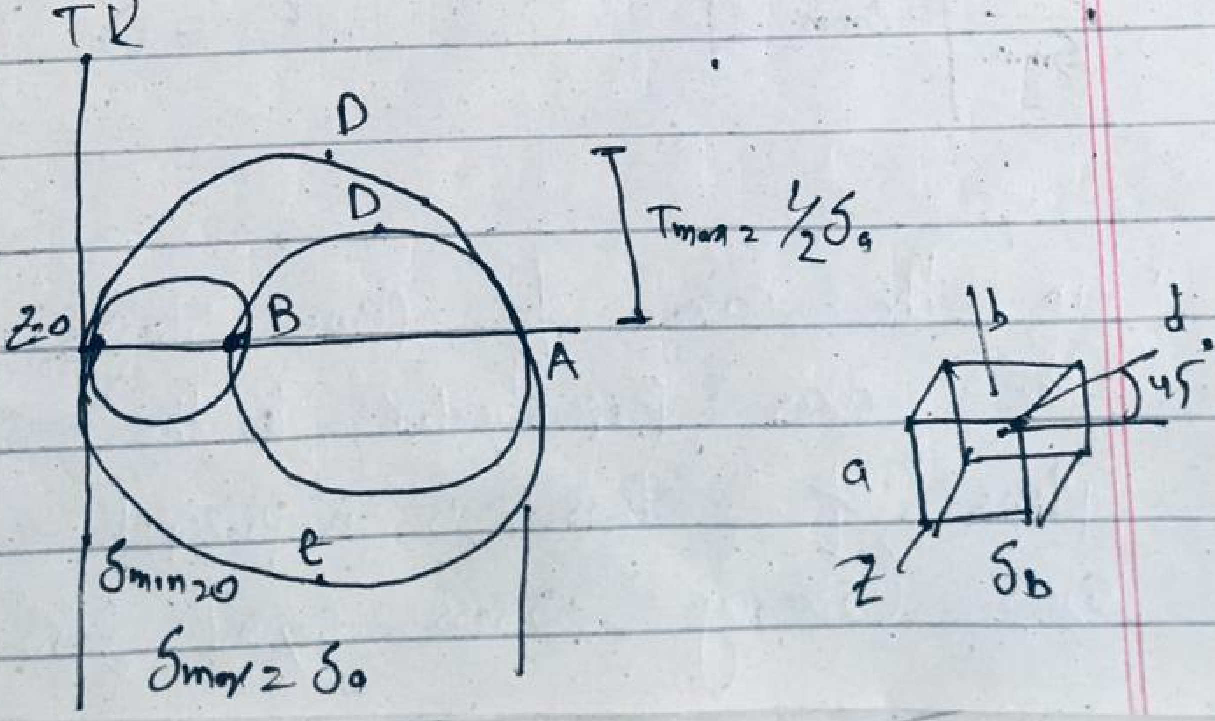
→ in the case of plane stress. the axis perpendicular to the plane of stress is a principal axis (shearing stress equal zero)

→ If the point A and B (representing the principal planes are on opposite sides of the origin than

(a) the corresponding principal stresses are the maximum and minum normal stresses for the element

(b) the maximum shearing stress for the element is equal to the maximum in plane shering stress.

(c) plane of maximum shearing stress are of 45° to the principal plane



$\textcircled{5}$

- if A and B are on the same side of the origin (i.e have the same sign) than

(a) the circle defining σ_{max}, σ_{min} and τ_{max} for the element is not in the circle corresponding to transformation within the plane of stress.

(b) maximum shearing stress for the element is equal to half of the maximum stress.

(c) plane of maximum shearing stress are at 45 degree to the plane.

(3) Simple Bending and pure Bending'

(Ans) Bending Stressess:-

The Stresses introduced by bending moment are Known as Bending Stresses -

→ Pure Bending and Simple Bending:

If a length of Beam is subjected to constant bending moment and no shear force (zero shear force) Stresses will be setup in that length of Beam due to B.M only that length of Beam is Said to be in pure Bending or Simple Bending And the Stresses Setup in that length are Known as bending Stresses.

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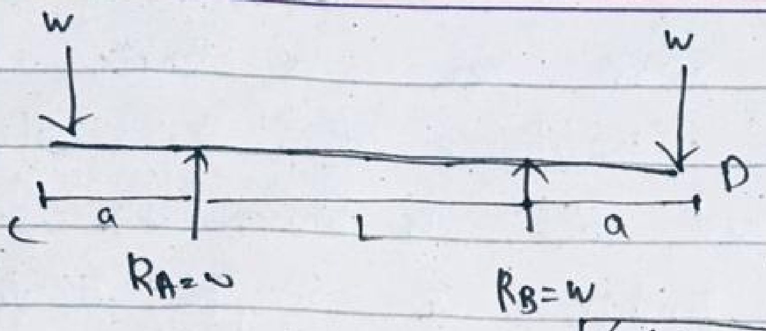

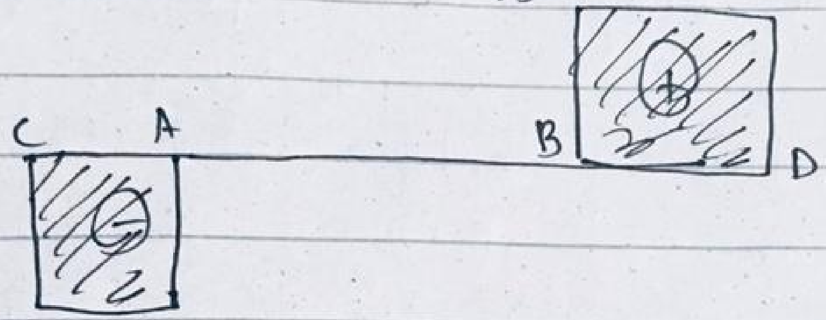

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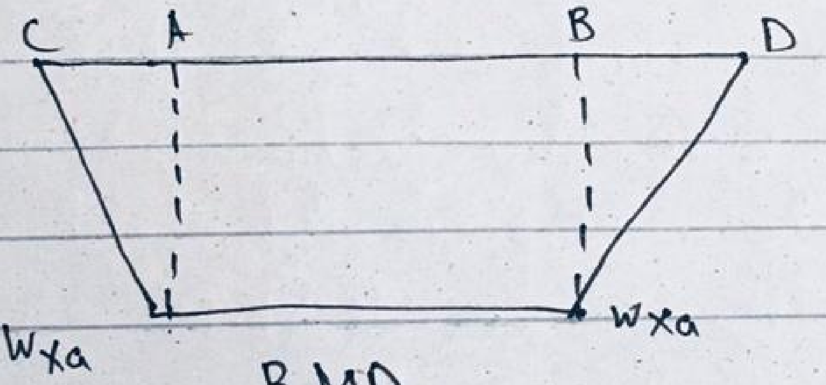


B.MD

→ There is no shear force b/w A and B as shown.

→ But Bending Moment is constant b/w A and B

→ Beam is subjected to constant B.M b/w A and B and

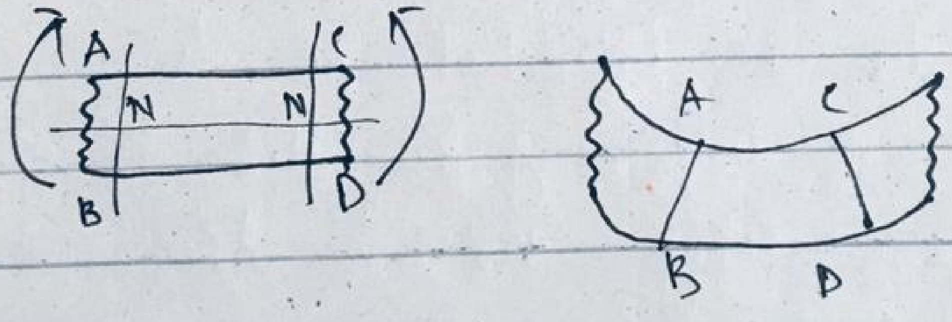
no shear force is there
this condition of Beam b/w
A and B is known as
pure Bending or Simple Bending.

(4) Assumption made in theory of Pure Bending'

(1) The material of the Beam is homogenous and Isotropic.
Homogenous → Material is of same kind throughout.

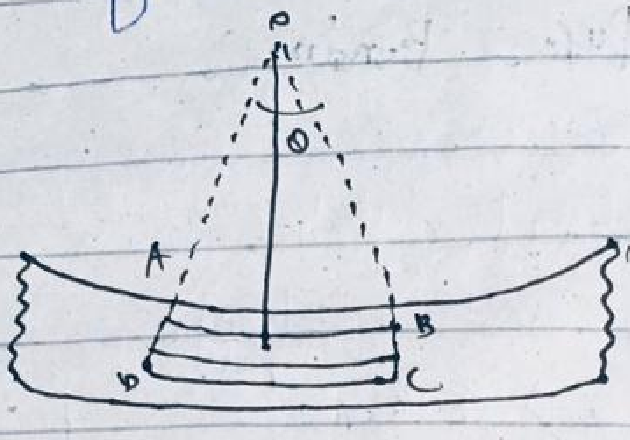
(2) In the value of young's Moduls of elasticity is same in tension as well as in compression.

(3) The transverse section of beam which were plane before bending remain plane after Bending also



(4) The Beam is initially Straight and all longitudinal Bend into

circular arc with common center of ~~arc~~ curvature



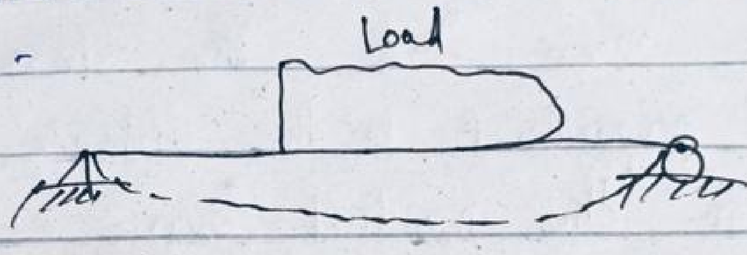
(5) The radius of curvature is large as compared with dimension of cross section.

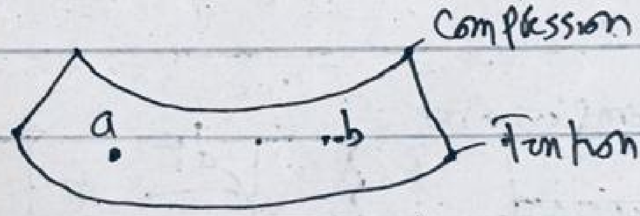
(6) each layer of the Beam is free as expand as contract indenpently of the layer above or below it.

(5) classic fluxure Equation2

(Ans) Stresses caused by the Bending moment are known as flexural or Bending Stresses -

consider a Beam to be loaded as shown -





consider a fiber at a distan y from nutral axis because of the Beam curvature as the effect of Bending moment, the fiber is streched by an amount of cd since the curvature of the Beam is very small, bcd and oba are considered as smillar traingle the strain on this fiber is.

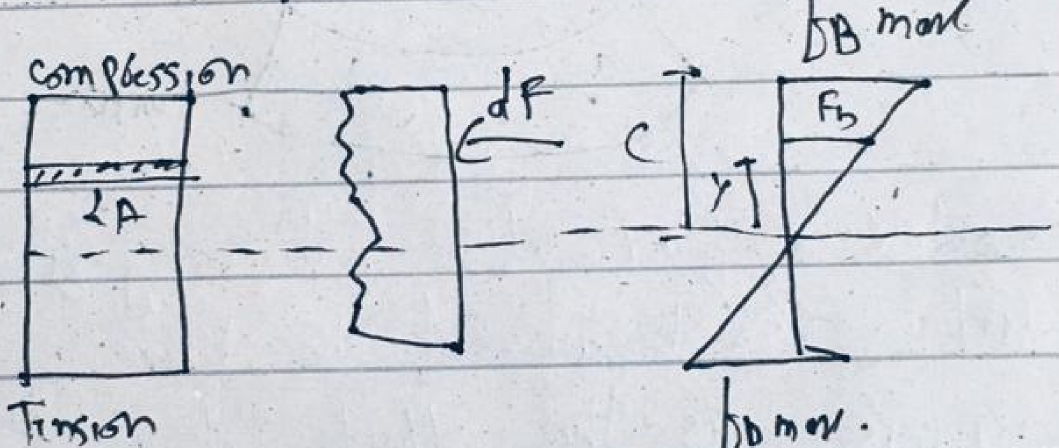
$$\varepsilon = \frac{cd}{ab} = y/\rho$$

by Hook Law

$\varepsilon = S/E$ than

$$\frac{S}{E} = y/\rho \therefore S = y/\rho \, E$$

which mean that the stress is proportional to the distance y from the neutral axis.



consider a differential are dA at a distance y from N.A the force acting over the Area is

$$dF = f_b \, dA = y/\rho \, E \, dA = E/\rho \, y \, dA$$

The resultant of all elemtal moment about N.A must be equal to bending moment on the Section -

$$M = \int dM = \int y\, dF = \int y \left(\frac{E}{\rho}\right) y\, dA$$

$$M = \frac{E}{\rho} \int y^2\, dA$$

but

$$\int y^2\, dA = I \text{ then:}$$

$$M = \frac{EI}{\rho} \text{ or } \rho = \frac{EI}{M}$$

Substituting $\rho = Ey/f_b$

$$\frac{Ey}{f_b} = \frac{EI}{M}.$$

then

$$f_b = \frac{My}{I}$$

and,

$$f_b = \frac{Mc}{I}$$

The Bending stress due to Beam curvature is

$$f_b = \frac{Mc}{I} = \frac{EI}{\rho} c \Big/ I/\rho$$

(14)

$$f_b = \frac{Ec}{\rho}$$

the Beam curvature is

$$K = 1/\rho$$

where ρ is the radius of curvature of the Beam in (mm) (in) M is the Bending moment f_b is the flexural stress in MPa I is the centroidal moment of inertia and C is the distance from the neutral axis to the outermost fiber is mm -

6 Section Modolus 2

Section modulus is a geomatric property for a given cross-section used in the design of Beam or flexural member. other geometric property used in the design include area for tension and shear, radius of gyration for compression and moment of inertia and polar moment of inetra for stiffness.

Section Modulus formula 2

$$\sigma_{b(max)} = \frac{Mc}{I} = \frac{M}{I/c}$$

the ration I/c is called section modulus and is usually denoted by S with units of mm^3. the maximum bending stress may be than written as.

$$\sigma_{b(max)} = M/S$$

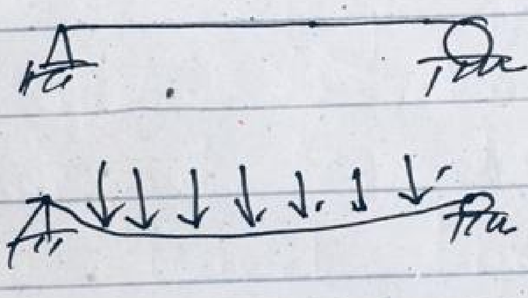
$$S_{min} = \frac{|M|_{max}}{\sigma_{all}}$$

some of the table are -

Shape	$S \cdot mm^3$
$W410 \times 38.8$	637
$W360 \times 32.9$	474
$W310 \times 38.7$	549
$W250 \times 44.8$	535
$W200 \times 46.1$	448

(7) Application of Bending Equation in any object.

A bending moment is a measure of the Bending effect due to forces acting on a beam - it is measured in term of force and distance -



→ The Bending moment equation indicate the Bending moment resisted by the beam Section along the length of the beam -

→ Using these equation the type and Size of a member of a given material Can be easily determined -

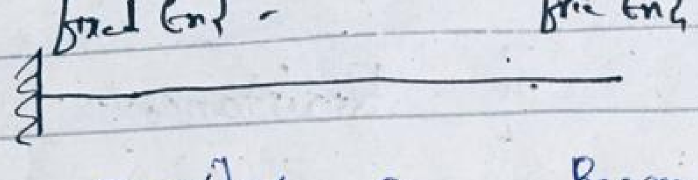
→ Another application of shear and moment equation is that the deplication can be easily determined using either the moment are method on the conjugate beam method -

5 Moment of Resistance:

when a beam bends under load the horizental fiber will change in length. In technical term it is reffered to as the internal moment of resistance. the tensile and compressive stresses result in a turning effect about the neutral axis there are called moment M_T and M_c respectivly.

In technical term, the maximum bending moment a section can resist is called moment of resistance.

whenever a force acts at a distance from fix point a moment is produced and this moment tries to bend it from that point this is moment.

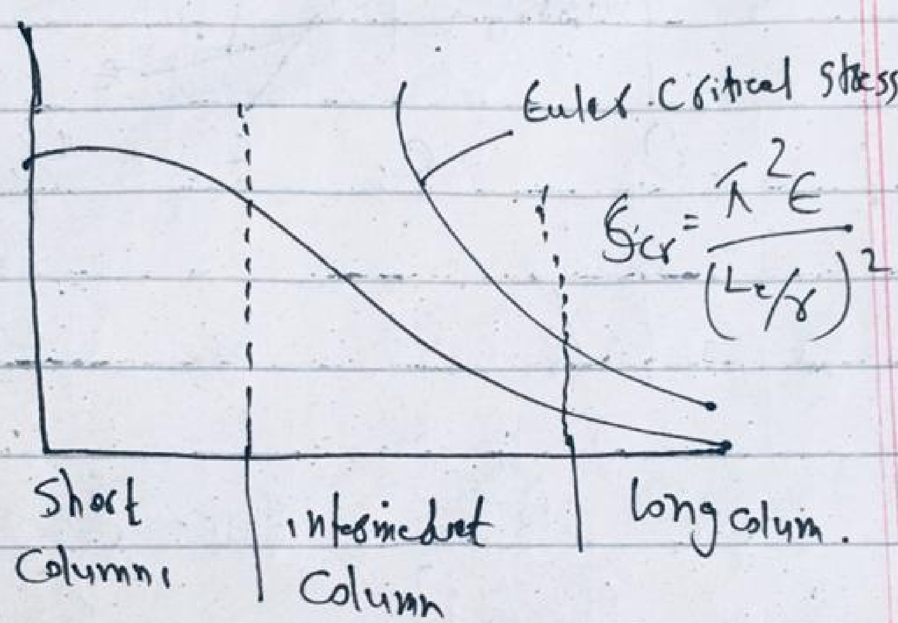


Now consider a Beam, when a force is Applied at the free end. moment is produce

As the force is incresed - moment increase -

At a certain Value of moment the beam fails at the fixed End which means that the moment at the Section (fixed End) has reached its max value -

(a) Design of Column Under Centric Load 2.



Experimental data demonstrate -

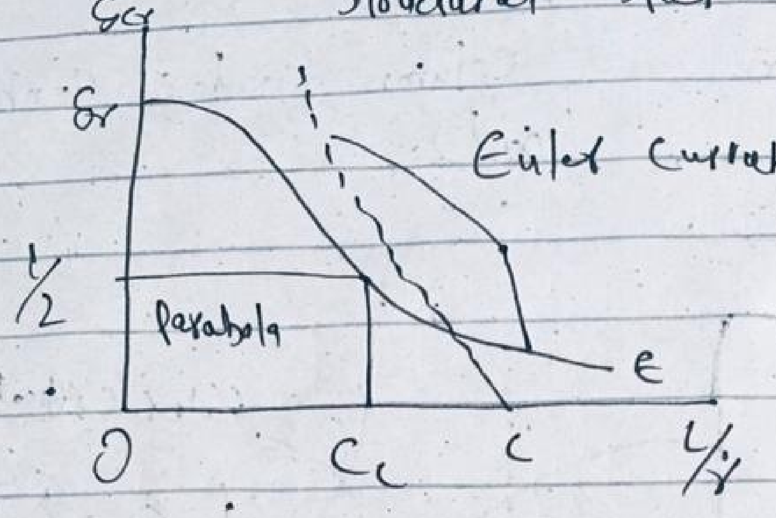
→ for large L_e/r σ_{cr} follow Euler formula and depends upon E but not σ_Y -

→ for small L_e/r σ_{cr} is determine by the yield strength σ_Y and not E.

→ for intermediet L_e/r σ_{cr} depend on both σ_Y and E

(22)

Structural Steel-



for $L_e/r > C_c$

$$\sigma_{cr} = \frac{\pi^2 E}{(L_e/r)^2} \qquad \sigma_{all} = \frac{\sigma_{cr}}{FS}$$

$FS = 1.92$

for $L_e/r > C_c$

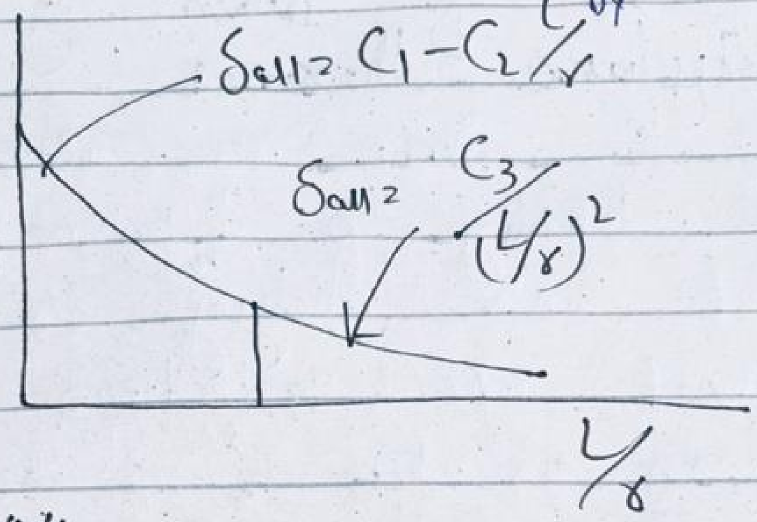
$$\sigma_{cr} = \sigma_y \left[1 - \frac{(L_e/r)^2}{2C_c^2} \right] \qquad \sigma_{all} = \frac{\sigma_{cr}}{FS}$$

$$FS = \frac{5}{3} + \frac{3}{8}\frac{L_e/r}{C_c} - \frac{1}{8}\left(\frac{L_e/r}{C_c}\right)^3$$

at $L_e/r = C_c$

(23)

$\delta_{cr} = \frac{1}{2}\delta_y \cdot \quad C_c^2 = \frac{2\pi^2 E}{\delta_y}$



Allumenum

$L_e/r < 55$

$\delta_{all} = [30.7 - 0.22 (L_e/r)]$ ksi

$[212 - 1.589 (L_e/r)]$ MPa

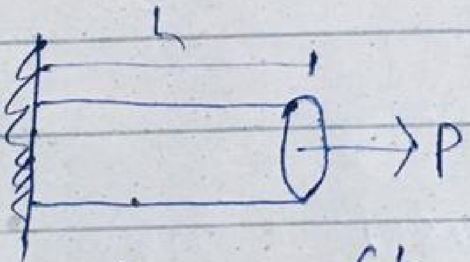
$L_e/r > 66$

$\delta_{all} = \frac{54000 \text{ ksi}}{(L_e/r)^2} = \frac{372 \times 10^3 \text{ MPa}}{(L_e/r)^2}$

(13) Deflection of Beams by Castigliano theorms?

Ans. The theorm also allow for the determing of deflection for object with changing cross sectional area castigliano thoorm is given as where δ is the deflection U is the strain energy and P is the force or torque at a certen paint.

→ different loading condition required strain energies for axial loading



$$U = \int_0^L \frac{P^2 dx}{2EA}$$

where P is the load E is the material Young madulus A is the cross sectional Area, and L is the length