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AIR-2 Notes

Short Notes
(Civil Engineering Paper-I)
by

RADHE SHAYAM TIWARI
AIR-2 ESE 2021
IES MASTER CLASSROOM STUDENT

Short Notes
By Radhe Shyam Tiwari
AIR-2 (CE) ESE 2021
CIVIL ENGINEERING - Paper I

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F-126, Katwaria Sarai, New Delhi - 110 016 **Ph:** 011-41013406, Mobile: 8130909220, 9711853908
Web: www.iesmaster.org | E-mail: info@iesmaster.org

A - proportional limit
B - Elastic limit
C - Upper Yield Point
D - lower Yield Point
E → beginning of strain hardening
G → fracture point

Zone O A

(i) $\sigma \propto \epsilon \Rightarrow \boxed{\sigma = E\epsilon}$
(ii) Volume of specimen ↑ due to tension
(iii) Volume changes due to Normal stress

Zone AD

- Upper yield point is a transient | temporary point.
- Stress corresponding to lower yield point is called Yield stress (f_y)
- Specimen volume ↑ bcz of Normal stress

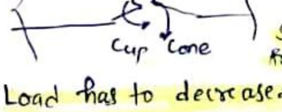
Zone DE (Plastic Zone)

- Shear is responsible for deformation.
- Specimen volume does not change.
- Strains are permanent in nature.

Zone EF (Strain hardening Region)

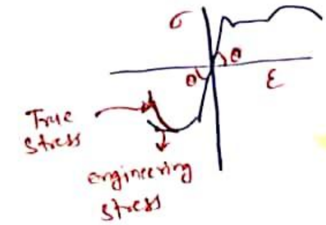
- Beyond point E, material starts offering resistance against deformation. This is due to the crystaline str. of the material.

Region FG (Necking Region)



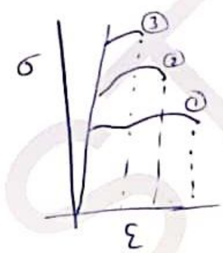
- fracture plane is a 45° plane. Hence Shear is responsible for fracture keep
- Load has to decreased to Control strain rate fixed
- At point G, fracture occurs, this fracture is termed as Cup-Cone fracture.

Mild Steel in Compression



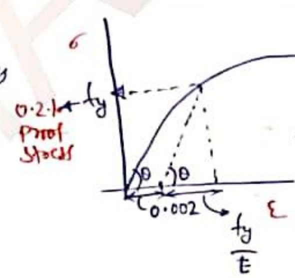
- No necking occurs in compression
- True stress will be smaller than engineering stress.

Stress-strain Curve for other grades of steel



- E is same for all grades of steel
- As the strength ↑, ductility ↓

σ - ε Curve for Cu, Al

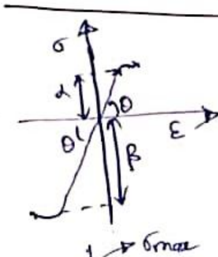


$\boxed{E_{Al} = \frac{1}{3} E_{st}}$

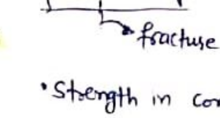
→ offset method

$\boxed{\sigma_{per} = \frac{f_y}{F.S}}$ → for Ductile material

Stress Strain Curve for Brittle material



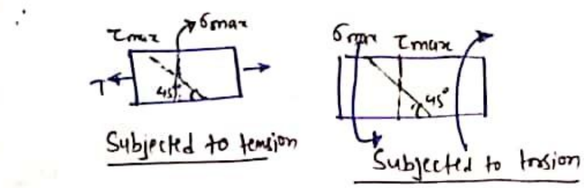
- No plastic zone
- fracture strain is elastic in nature
- Normal stress is responsible for fracture
- $\beta > \alpha$



- fracture plane is 90° pln
- Rupture stress is ultimate stress.
- Strength in compression is high as compared to that of tension.

$\boxed{\sigma_{per} = \frac{f_{ultimate}}{F.O.S}}$

Margin of safety = FOS − 1



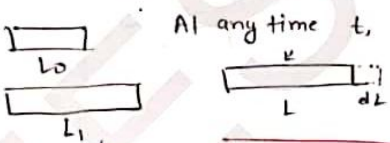
Ductile material → fails due to shear	failure plane is 45° plane	failure plane is 90° plane
Brittle Material → fails due to normal stress.	failure plane is 90° plane	failure plane is 45° to plane

Brittle fracture

- A material which is ductile at normal temp may behave as brittle material under sub-zero temp and this can fail at a very small strain. This fracture is called brittle fracture
- Another reason may b. is presence of Notch.

Brittleness is not an absolute property.

True strain due to finite increment of loading



$$\varepsilon_t = \int_{L_0}^{L_1} \frac{dL}{L} = \ln \frac{L_1}{L_0} = \varepsilon_t$$

$$\varepsilon_t = \ln(1+\varepsilon)$$ → ε → engineering strain

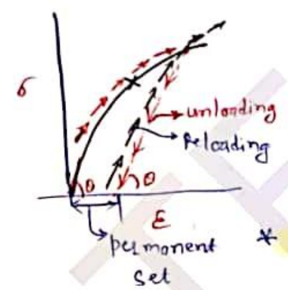
$\sigma = \sigma_0(1+\varepsilon)$ → tension

$\sigma = \sigma_0(1-\varepsilon)$ → compression

Endurance limit → It is a stress level below which even infinite no. of stress cycles cannot cause fatigue failure.

Properties of Material

(1) Elasticity – property by virtue of which material regains its original shape & dimension before elastic limit.



- on reloading, proportional limit extended although ultimate strength is not affected.
- Ductility however decreases.

2.) Plasticity – Ability of material to be strain beyond elastic limit is called plasticity.

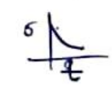
3. Ductility – It is measure of amount by which material can be drawn out in tension before it fractures. (Can also be done using bend test)

4.) Malleability – deformed or strained in different direction due to application of compressive forces. Cu, → ductile → malleable; Pb → malleable ✗ ductile

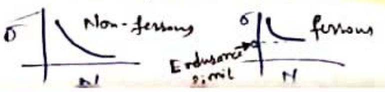
5.) Creep – additional deformation with passage of time under sustained loading within elastic limit.

- It is actually a plastic strain.

6.) Relaxation – Decrease in stress in steel as a result of creep under prolonged strain is called relaxation.



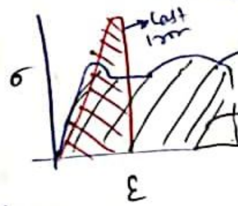
7.) Fatigue – Deterioration of material under repeated cycling of stress resulting in a progressive cracking that eventually produces fracture is called fatigue.



(8.) Resilience → It is property by virtue of which a material absorbs energy when deform elastically.

$\frac{1}{2} \times f_y \times \frac{f_y}{E}$ = modulus of Resilience = Area under strain-stress curve upto Elastic limit = $\frac{\text{Strain energy absorbed}}{\text{Volume of material}}$.

9.) Toughness - It is the ability to absorb mechanical energy upto fracture.



(Mild steel more tough than cast Iron)

→ area = Modulus of Toughness

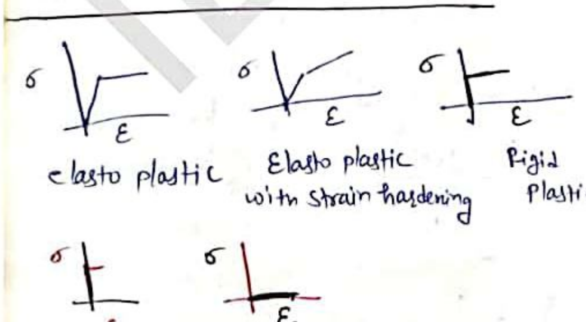
larger is the modulus of toughness better is the material for the Impact loading.

10.) Hardness → ability to resist scratch or abrasion is called hardness. Generally larger is the value of fy, harder is the material.

11) Tenacity - ability to resist fracture under tension is called Tenancity.

12) Visco elastic material → have time dependent Stress-Strain Curve.

Approximate Stress-Strain Curve



elasto plastic — Elasto plastic with strain hardening — Rigid Plastic

ideal Rigid — Ideal fluid

Axial Stress

Hooke's law

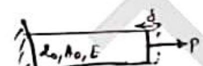
$\sigma = \epsilon E$

Valid for:

(i) homogeneous - similar property throughout the volume
(ii) Isotropic - property in all direction at a point is same.
(iii) linearly elastic material

Deformation of Members under Axial forces

(I) Bars of uniform strength



$\delta = \frac{P L_0}{A_0 E}$

$\frac{AE}{l} \rightarrow k \rightarrow$ Stiffness

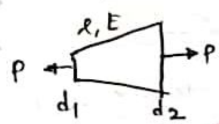
$\frac{l}{AE} = f \rightarrow$ flexibility

- Rigid body translation does not have an effect on of elongation of body

$$\delta = \int \frac{P_x \, dx}{A_x \, E_x}$$

$\left(k = \frac{P}{\delta}\right) \rightarrow$ Stiffness

(II) Tapered bar



$$\delta = \frac{Pl}{\frac{\pi d_1 d_2}{4} E} = \frac{Pl}{\frac{\pi d_{eq}^2}{4} \cdot E}$$

$$d_{eq} = \sqrt{d_1 d_2}$$

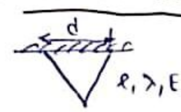
(III) Elongation due to self weight

$W_0 = \gamma A l$

$$\delta = \frac{\gamma l^2}{2E}$$ → independent of shape & size of c/s.

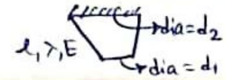
$$\delta = \frac{\gamma l^2}{2E} = \frac{W_0 l}{2AE} = \frac{1}{2}\left(\frac{W_0 l}{AE}\right)$$

(IV) Conical bar



$$\delta = \frac{\gamma l^2}{6E}$$

(V) Frustum of Cone



$$\delta = \frac{\gamma l^2}{6E}\left(1 + \frac{2 d_1}{d_2}\right)$$

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CIVIL ENGINEERING - Paper II

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FLUID MECHANICS

P. year

1st chapter

(22) Flow of a fluid in a narrow pipe is relatable to both reynolds number & weber no

* Flow over the d/s slope of an ogee spillway cannot be affected by surface tension

(2) Capillary tube

$$h = \frac{4\sigma}{\gamma d}$$

tube of Internal bore 1mm means radius = 1mm

(15) Surface energy is fluid property & is responsible for phenomenon such as surface tension, capillarity.

* Fluid Kinematics

Tornado → forced vortex at core & free vortex at outside

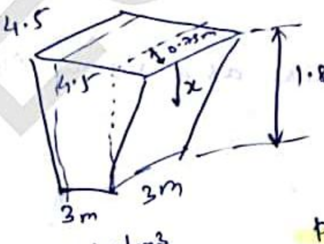
(20) In cavitation, energy is released with the start of a high intensity wave due to noise & vibration of machine.

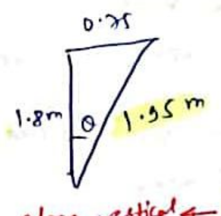
Chapter 2

(13) • At boiling point, the vapour pressure of a fluid becomes to the atmospheric pressure. [for water at 100°c, V.P = atmospheric pressure].

(11) Multi- U- tube manometer with different fluids are used to measure High pressure.

(20). 4.5





along plane $\bar{x} = \frac{2\times3+4.5}{7.5} \times \frac{1.95}{3} = 0.91\,m$

along vertical ← $\frac{x}{0.91} = \frac{1.8}{1.95} \Rightarrow x = 0.84\,m$

$\rho = 936\ kg/m^3$

pressure force = [pressure at C.G] × Area

$= \gamma_w x \times \left[\frac{3+4.5}{2}\right] \times 1.95$

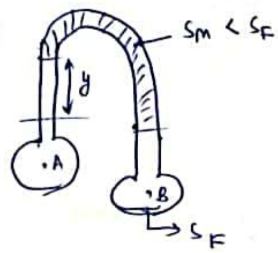
$= 9.81 \times \rho \times 0.84 \times \frac{7.5}{2} \times 1.95$

=

1 N = 0.102 kgf

1 kgf = 9.81 N

(9.) ✱



$P_A - y \times S_f \times \gamma_w + y \times S_m \times \gamma_w = P_B$

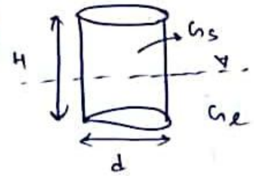
$P_A - P_B = y \times \gamma_w [S_f - S_m]$

Since $S_m < S_f$ ⇒ measure positive pressure

✱ For measuring pressure in liquids only

Chapter 3 — Liquid in Relative equilibrium

(7)



For stable eq^{lm}

$$\frac{h}{d} \le \frac{1}{\sqrt{8 \times \frac{S_s}{S_l} \left[1 - \frac{S_s}{S_l}\right]}} = \frac{S_l}{\sqrt{8 \times S_s (S_l - S_s)}}$$

(5) Fluid Kinematics

(3) ✱ Vorticity & Stream f^n exist both in rotational & irrotational flow.

✱ velocity potential exist only for ideal flow & irrotational flow.

(27) ~~In an open cylindrical tank~~

Movement of air mass in the case of Tornado

→ Rankine vortex motion

→ Forced vortex at core & free vortex outside.

(29.) → Flow of bloods in veins & arteries occurs as a viscous flow hence laminar.

(30.) Flow measurement with Prandtl - Pitot tube showed that tip readings varied only across the flow while the side opening readings varied only in direction of flow — This type of flow is

Non uniform rotational

(35) Euler eq^n of Motion based on Momentum Conservation