CE - 2214

1. Determination of the tensile strength of Mild Steel (MS) bar

Mild steel – Steel which contains only a small percentage of carbon and is strong and easily worked but not readily tempered or hardened.

MS steel – amount of carbon <2.5% . It helps to soften the steel and increase the ductile property. So when earthquake load arise, it will not break along it's length .

Definition–

Elasticity

– A property – regain its shape – after remove the load

Plasticity

– A property – can't regain its shape - after remove the load

Stress

– Internal resisting force per unit area

Strain

– deformation per unit length – for applied load

Proportional limit –

limiting value of the stress up to **which stress is proportional to strain**.

Elastic limit –

The limit at when load gone and strain gone, length regained

Elastic Recovery –

The recovered deformation after removal of load.

Yield Stress –

cause an increase in deformation without increase in loa

Ultimate strength –

The ultimate stress that can a material can withstand

Strain hardening

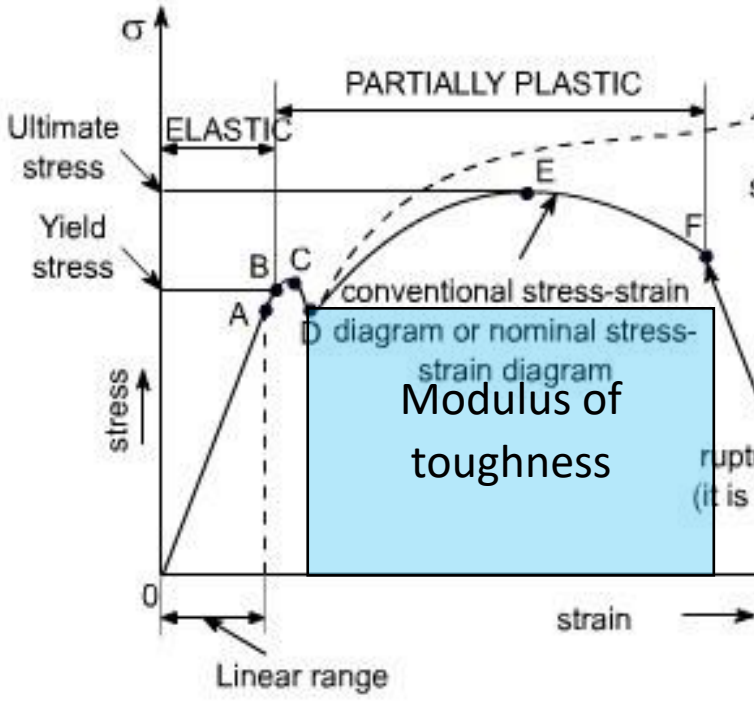
When a metal is strained beyond yield point.

Necking –

Near the Ultimate stress, the reduction in area

Rapture Strength –

The stress at which the specimen finally fails



Modulus of rigidity –

ratio of shear stress to shear strain

Modulus of toughness –

Entire area under stress strain diagram. It is the ability of a material to absorb energy in plastic deformation.

Modulus of Resilience –

The area under stress strain curve till elastic limit. The amount of strain energy per unit volume that a material can absorb without permanent deformation.

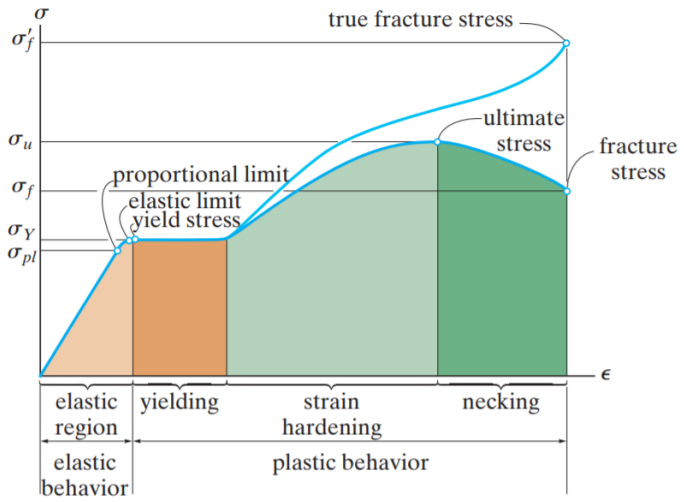
True stress strain

Stress strain at original cross section.

Hook's law –

A law stating that the strain in a solid is proportional to the applied stress, within the elastic limit of that solid. Stress = E strain.

Graph -



Conventional and true stress-strain diagrams for ductile material (steel) (not to scale)

Point A -Proportional limit

Point B – Elastic limit

After yield point, shape regain not possible

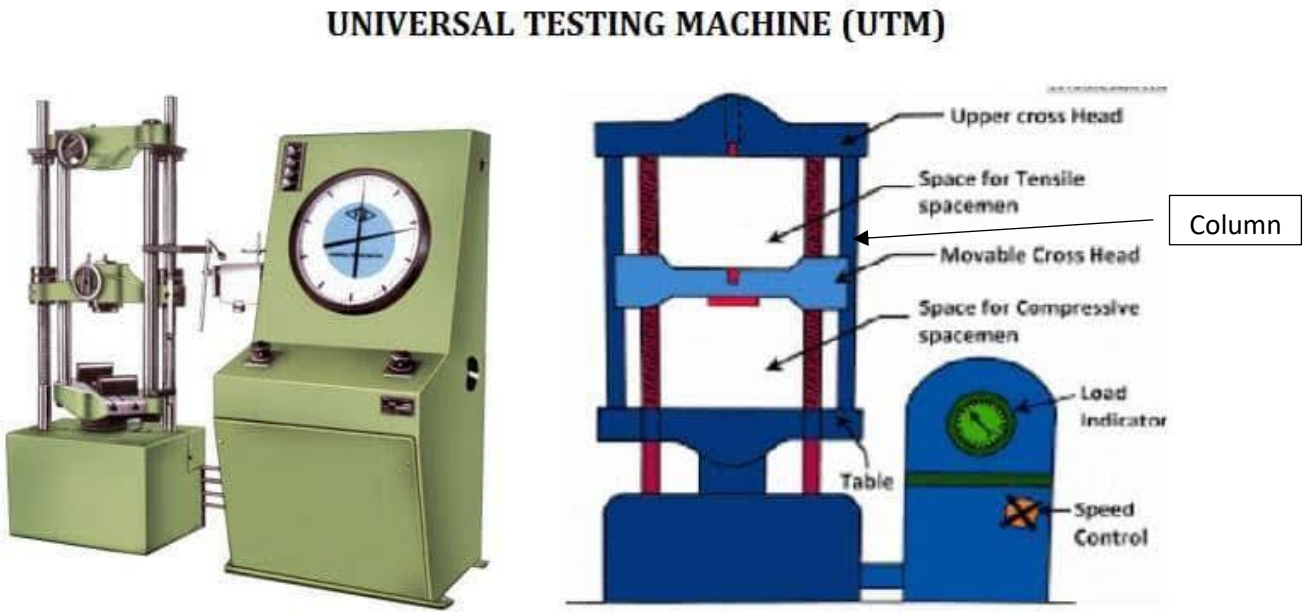
Point C, D are upper and lower yield point. We can take a .2% displacement from (0,0) and a parallel line of proportional line to determine the yield point.

Dy/dx = 0 at ultimate strength point.

%elongation = $\frac{Final\ gauge\ length - initial\ gauge\ length}{Initial\ gauge\ length}$

For MS Bar, yield point can be 40-50 ksi. Now-a-days it's 400-500 ksi which helps to resist earthquake load. Elongation should be 30-40% of mild steel, must not less than 11%.

UTM Machine –



This machine can be analog, or computer based. In computer based system, UTM machine do it's job and show the results graph on computer. From there we can take the ultimate strength of the specimen.

Tension test – We will tap the switch to start moving "Movable cross head". Then we will put the specimen in the space for tensile specimen. Then we will lock the system. Then we will lock the pressure valve and on the switch. Then the machine will do tension test. The compute screen will show the results of Ultimate load, breaking load, Ult. Strength, breaking strength etc.

2. Determination of Direct Shear Test Of Mild Steel (MS Bar).

Definition

Shear Force –

Summation of all vertical force at any section

Shearing stress –

Resistance per unit area offered when a rivet tends to shear off

Bearing Stress:

The resistance offered by a rivet to be crushed

Mathematically, $P_b = S_b \times t \times d$

S_b= Safe permissible bearing stres
t= Thickness of the main plate
d= Diameter of the rivet

Tearing Stress:

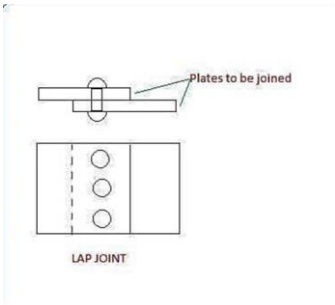
The resistance offered by the plate against tearing off

Single shear –

Single cover butt joint

Double shear –

Double cover butt joint



Lap joint –

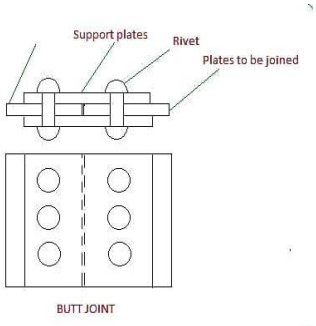
Plates are connected by lapped over one another and joint by rivets

Butt joint –

The plates are butted together and joined by cover plates

Discussion -

- The shearing stress of = single shear < double shear because of cross sectional area. The more stress the safer it will be. That's why Double shear is better.
- The strength of the plate was higher than that of rivet strength.
- Failure type = crushed



Objectives -

- To determine the average yield stress of MS bar.
- To determine the average ultimate stress of MS bar.
- To determine the actual diameter of MS bar.
- To determine the unit weight of MS bar.
- To determine the elongation of MS bar.
- To determine the bending and re-bending of MS bar.

3. Determination of static bending test of a wooden beam

Definition –

Beam : a structural element that is capable of withstanding load primarily by resisting against bending.

Bending Moment – The summation of all moments of vertical force at any section

bending or flexure stress - The stresses caused by the bending moment are known as

Objectives –

1.To determine the maximum shearing stress.

2.To determine the maximum deflection.

3.To determine the maximum bending moment.

4.To determine the modulus of elasticity.

5.To determine the modulus of elasticity from graph.

6.To draw the corresponding load vs deflection curve of the beam.

Formula –

Maximum Bending– MC/I

Flexural Stress – VQ/Ib

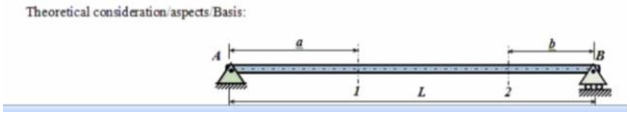
Graph –

Load vs Deflecction

Determination – Max deflection, bending, shearing stress, bending stress, E

Discussion –

1. We can use two point load to creating constant moment which occurs failure due to moment. Code – ASTM E-43
2. Difference between buckling and bending – bending undergoes internal stresses but then recovers back after the load is removed. Buckling is a permanent failure of beam.
3. Laws of reciprocal or Maxwell reciprocal theorem –



Assumptions –

Nevier assumptions – The assumptions by which we determine the beam theory

1. We will take homogeneous wooden beam, tension and compression are same.
2. Hook's law applicable, we will take two segments for elastic limit, before and after
3. Plane section remain plane after and before bending
4. Radius of curvature large compared to depth of beam
5. Shear deformation is neglected.
6. Localized load is neglected
7.

Procedure – Video

4. Determination of impact test of Mild Steel

Definition –

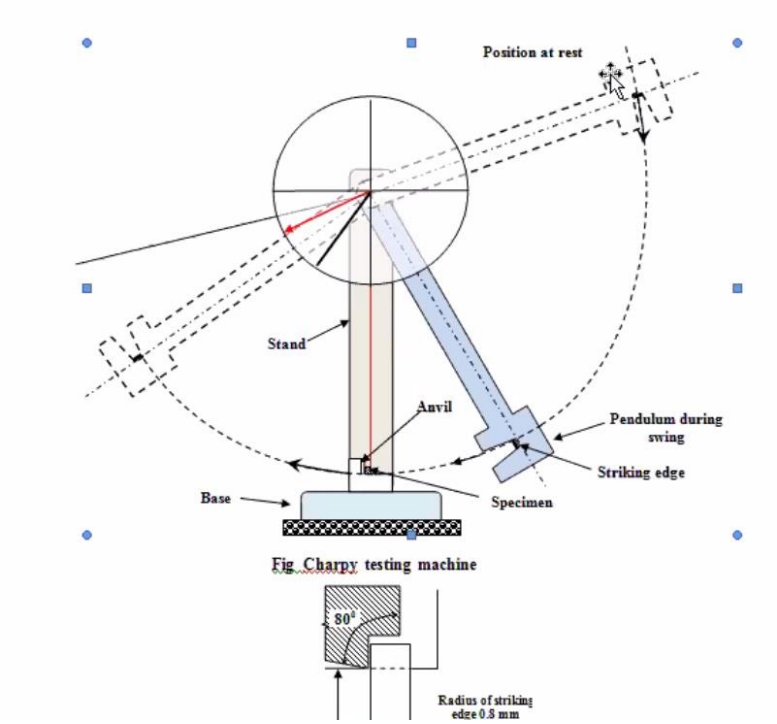
Impact: A high force or shock over a short time period

Impact test -It is test to evaluate the toughness and notch sensitivity of materials

Objectives –

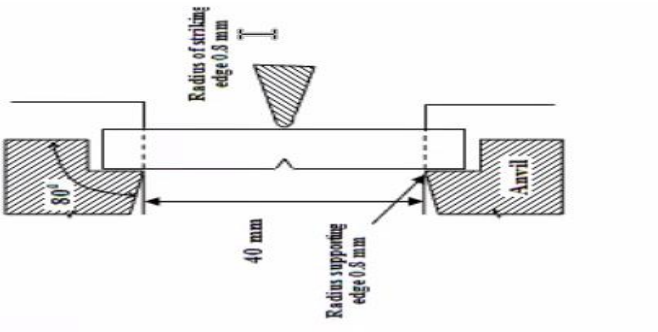
- To determine the absorbed energy capacity of mild steel.

Setup Description –



Charpy energy level = 220 ft-lb/sec. Machine check – when we release the pendulum with no specimen, it will show the meter 220 lb-ft full, Means 0 energy loss. The error of checking the machine can be for wind or friction.

Izod energy level 120 lb-ft/sec.



The support end edge will be 80 deg. To slip out the beam easily.

Discussion –

1. Test for determine toughness and notch sensitivity of materials.
2. Code- ASTM E23 and ISIBS standards (or E307)
3. Brittleness – lots of dots; Ductile – ash
4. The notch will in the opposite face of striking face.
5. In this test failure is of two types – brittle and ductile failure.
6. Energy absorption capacity = charpy > izod (bcz, high fall, horizontal placement etc)

7.
8.

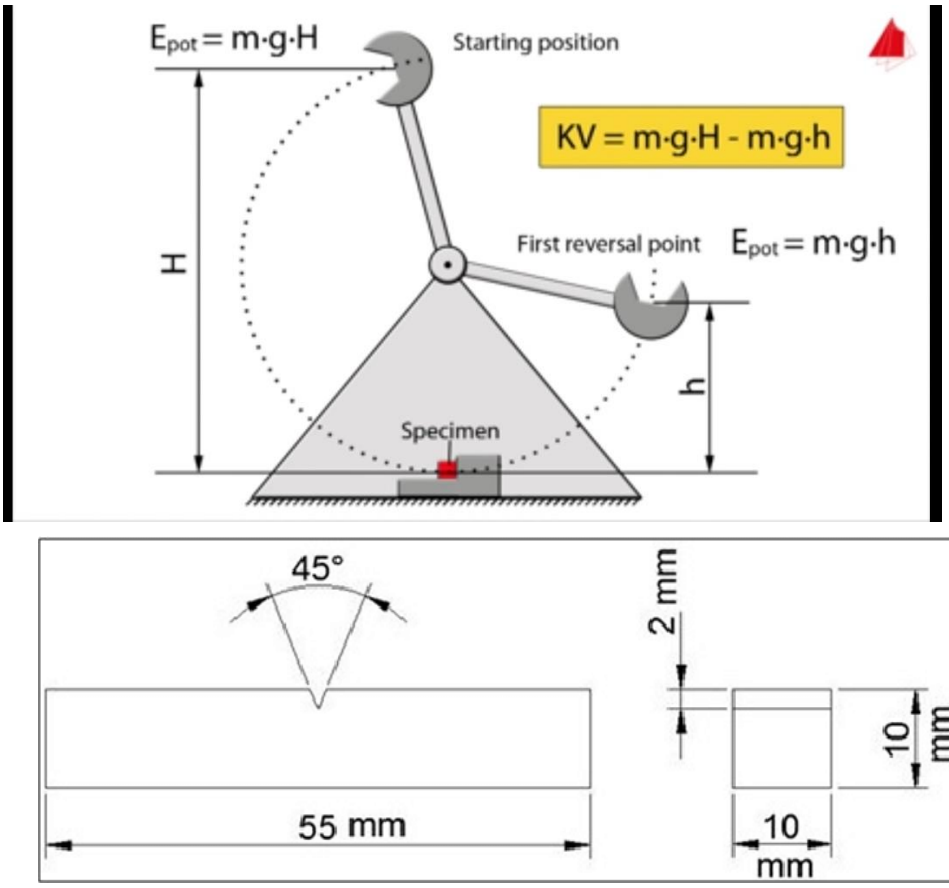


Figure 1: Charpy Test Specimen

Difference –

Charpy Impact Test	Izod Impact Test
The specimen was set to be simply supported.	The specimen is set to be cantilever.
Both 'V' notch and 'U' notch is used.	Only 'V' notch is used.
The length of the specimen is 55mm and the notch is equidistance from both ends.	The length of the specimen is 75mm and the notch is 47mm from one end and 28mm from the other end.
V-notch or U-notch is set in position in the opposite direction of load/ Horizontal	V-notch is set in position, in the direction of load/ Vertical

The pendulum is set to 120-140 deg.	90 deg.

5. Determination of the properties of helical spring

Spring –

An elastic body whose function is to distort when loaded and regain shape when load removed

Objectives –

Ss_{max}, $Deflection_{max}$, modulus of rigidity, spring constant, modulus of rigidity from graph.

Uses –

- Absorb shock
- Store energy
- Measure force
- Clock
- Control of vibration

Classification –

Based on shape –

Helical compression, Helical extension, torsion, laminated leaf spring, disc spring

Helical Spring –

- Open coil or compression helical – pen, lock, lighter
- Closed coil or tension helical – lever, weight machine
- Torsions spring – mouse trap, cloth pin, door hinge
- Spiral spring – release constant amount of force – watch, DC motors

Leaf Spring –

Vehicle suspension

Belleville spring

Volute and conical spring

Special purpose spring

In general form –

- Linear – load and deformation proportional
- Hard – load increase, deflection decrease
- Soft – Load increase, deflection increase

Discussion –

1. Spring has very high yield strength material.
2. Spiral constant - $\frac{D}{d}$

3. Resislence of spring – store energy of spring due to compression or tension

6. Determination of buckling test of slender column

Definition –

Column – A vertical member intended to transfer compressive load

Slenderness ratio – the ratio of l/r of column

Effective Length: The bending portion of a column

Critical Load: the maximum axial load to which a column can be subjected and still remain straight, although in such an unstable condition that a slight sideways thrust will cause it to bow out.

Objectives –

(1) To determine the critical load of slender column experimentally.
(2) To compare critical load between experimentally and theoretically

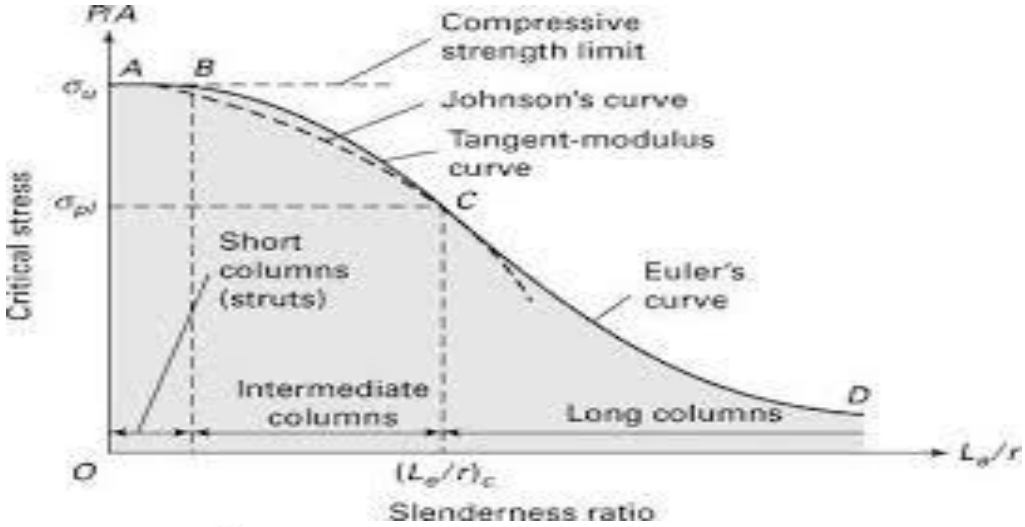
Classification

According to length column are 3 types –

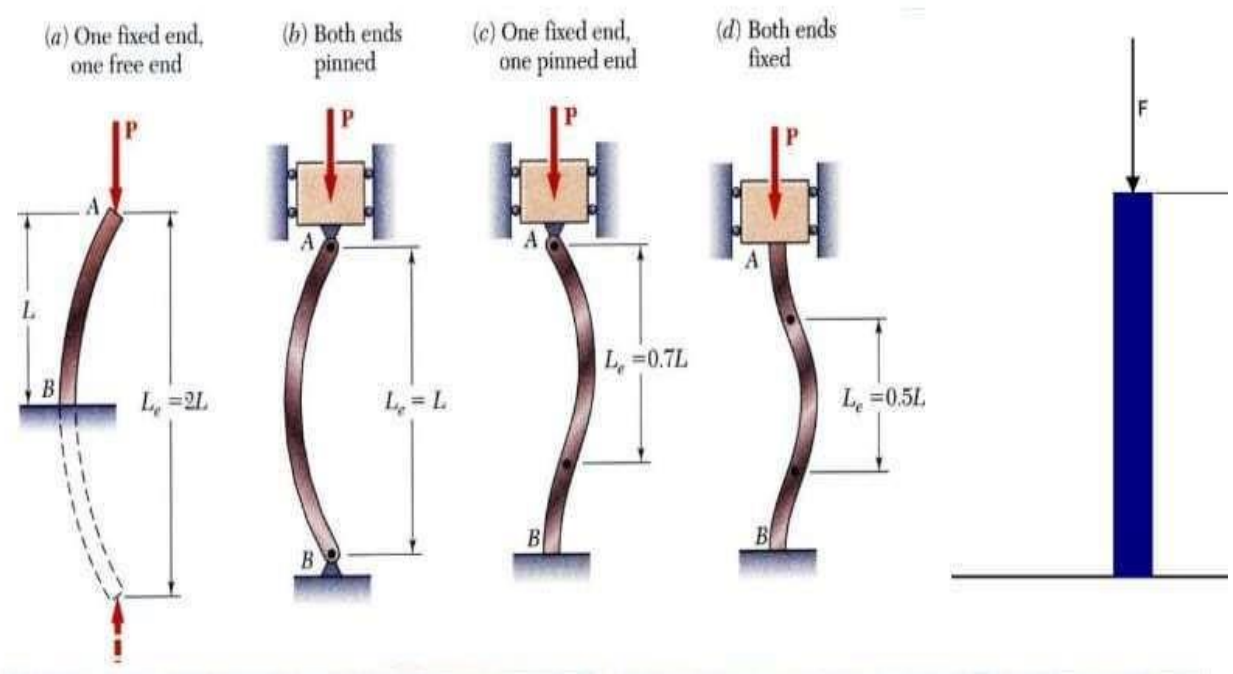
	Failure modes	L/r
Long Column	Buckling	>100
Intermediate Column	Buckling or crushing	=100
Short Column	crushing	<30

Ideal column – load will go through centroid, no extra load before, material isotropic

Discussion –

1. Column tends to buckle about the axis of the least moment of inertia.
2. Graph is Critical Stress vs Slenderness ratio
3. 

4. $$P = \frac{EI\pi^2}{Le^2}$$

5. 

6. Load power – Both fixed > fixed and hinged > both hinged