S/NO.	NAME OF EXPERIMENT	DATE OF PERFORM	DATE OF SUBMISSON	SIGNATURE
1.	Perform Compression test on cast iron on Universal Testing Machine.			
2.	Plot Stress-Strain Curve for ductile materials like Mild Steel, Aluminum under tensile loading as per IS 1608.			
3.	Determine Young's Modulus of Elasticity of different materials beam simply supported at ends.			
4.	Calculate Impact Value/toughness of Mild Steel using IZOD Impact Test Apparatus as per IS 1757.			
5.	Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Charpy Impact test as per IS 1598.			
6.	Estimate Maximum Bending moment and shear force for simply supported and cantilever beam under point load and UDL using Combined Shear Force and Bending Moment apparatus.			
7.	Measure flexural rigidity (EI) for a given beam using.'Slope and Deflection' apparatus and compare it with theoretical value.			
8.	Measure principal stresses and strains in a beam made of aluminum and loaded as a cantilever and compare them with theoretical values using 'Principal stress and strain Apparatus'.			
9.	Investigate the effect of beam length and width on deflection of beam and compare it with theoretical value using 'Slope and Deflection' apparatus.			
10.	Measure the buckling load of three different. Slenderness ratio long columns of same lengths using. 'Behavior of column and struts' apparatus.			

EXPERIMENT-01

AIM-Perform Compression test on cast iron on Universal Testing Machine.

APPARATUS: -Cylindrical or cube shaped specimen of cast iron, vernier caliper, scale, dialgauge (or compress meter).

THEORY: - Several machine and structure components such as columns are subjected to compressive load in applications. These components are made of high compressive strength materials. Not all the materials arestrong in compression. Several materials, which are good in tension, are poor in compression. Contrary to this, many materials poor in tension but very strong in compression. Cast iron is one such example. That is why determine of ultimate compressive strength is essential before using a material. This strength is determined by this compression test. During the test, the specimen is compressed, and deformation versus the applied load is recorded. Compressive load tends to squeeze the specimen. Brittle materials are generallyweak in tension but strong in compression. Hence this test is normally performed on cast iron, cement concrete etc. But ductile materials like aluminium and mild steel which are strong in tension are also testedin compression.

In compression test the material experiences opposing forces that push inward upon the specimen from opposite sides or is otherwise compressed, squashed, crushed, or flattened. The test sample is generally placed in between two hard metal bearing blocks that distribute the applied load across the entire surface area of two opposite faces of the test sample and then the plates are pushed together by a universal testing machine causing the sample to flatten. A sample will get shortened in the direction of the applied forces and expands in the direction perpendicular to the force as shown in Fig I.

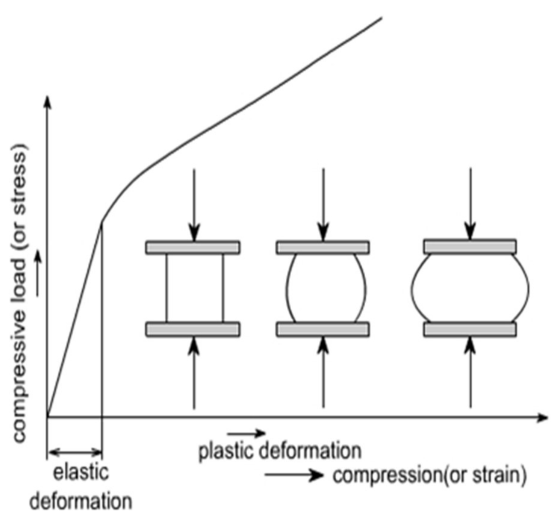
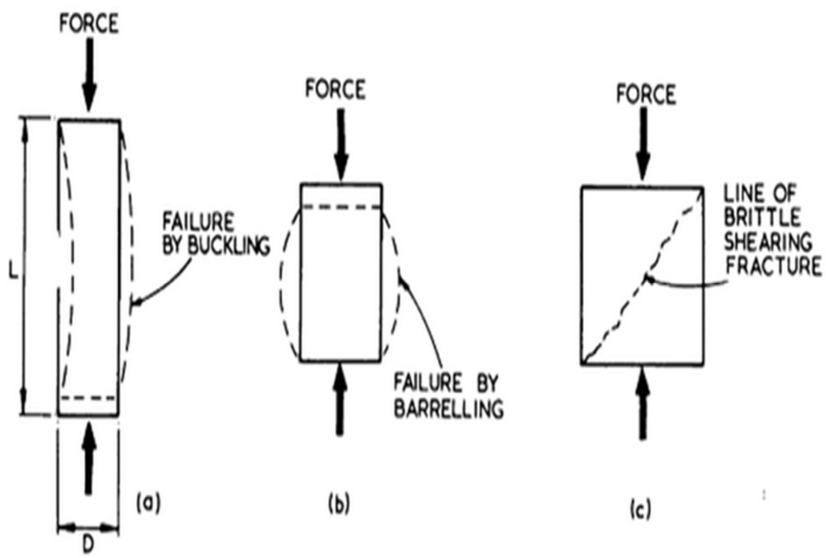


Fig I. Deformation of Sample under compressive load

Failure patterns: Ductile material will have proportional limit in compression very close to those in tension. The initial regions of their compression stress strain diagram are very similar to tension diagrams. When a mild steel specimen is compressed, it begins to bulge outward on the sides and become barrel shaped. With increasing load the specimen is flattened out, thus offering increased resistance to further shortening. Failure patterns are shown in Fig II A 2.2



RELEVANT T INDIAN STANDARD FOR COMPRESSION TEST:

IS 13780 (1993): Hard metals - Compression Test

PROCEDURE: -

1. Measure the diameter of the test sample using vernier caliper at three different points and calculate Moment of Inertia.

2. Measure the length of the test sample using vernier caliper.

3. The specimen is placed centrally between the two compressions plates, such that the center of moving head is vertically above the center of specimen.

4. Load is applied on the specimen by moving the movable head.

5. The load and corresponding deflections are measured at different intervals. The load interval may be as400 KN.

6. Load is applied until the specimen fails.

OBSERVATIONS: -

1. Average initial diameter of the specimen d = ————— mm.
2. Length of specimen l = ——————— mm.
3. Moment of Inertia about neutral axis I = π $d^4/64$ =_________________mm^4
4. Original c/s area A0 in mm^2 =---------------
5. Least Count =______________mm

Sr. no.	Load in (KN)	Dial reading in div.

RESULT: -

1) Proof stress = Proof load x 9.81 / A_0 =_______________N/mm^2

2) Compressive strength = Fracture Load / A_0 =_______________N/mm^2

3) Secant modulus = slope1 x (1/Least Count) x (L/ A_0) =______________GPa

4) Tangent Modulus = slope2 x (1/ Least Count) x (L/ A_0) =______________GPa

5) Modulus of Elasticity = slope3 x (1/ Least Count) x (L/ A_0) =______________GPa

CONCLUSION: -

The mechanical properties of mild Steel have been calculated.

Graph Paper:

Experiment-02

AIM-Plot Stress-Strain Curve for ductile materials like Mild Steel, Aluminum under tensile loading as per IS 1608.

APPARATUS REQUIRED:

1) Dogbane shape specimen (mild steel coupon)
2) Universal Testing Machine (UTM)
3) Measuring Scale

THEORY:

UTM (Universal Testing Machine): A machine designed to perform tensile, compressive, bend and shear test is called UTM. It mainly consists of two parts: -

- Loading unit and control unit. In addition to these two units, there are certain accessories like bending table, jaws for gripping recorders etc.
- Loading unit consists of two crossheads i.e., upper cross head and lower cross head and a table.

The initial slope is where stress is directly proportional to strain and the material behaves like this up to its elastic limit where it reaches its yield strength. Beyond this the material deforms permanently. The material then becomes strain hardened until you reach ultimate strength and necking starts to occur, and the material becomes weaker again until it breaks apart.

Yield stress is the stress at which the material deforms permanently, and ultimate stress is the stress at which material breaks. Hard steels and non-ferrous metals do not have defined yield limit, therefore a stress, corresponding to a definite deformation (0.1% or 0.2 %) is commonly used instead of yield limit. This stress is called proof stress or offset yield limit.

Yield strength: The stress at which elastic deformation changes to plastic deformation causing permanent deformation.

Tensile strength: Ultimate loads taken by the material before failure is known as failure load stress and corresponding to this is known as tensile strength. It is recommended by maximum stress strain curve and indicates when cracking will occur, its value does not depend on the size of the specimen.

Ultimate strength: The maximum stress that the material can withstand when subjected to tension on compression on shear is ultimate strength. It is the maximum stress in the stress-strain curve.

Breaking strength: The stress corresponding to the point of rupture on the stress-strain curve

Let the initial length of specimen = L1
Final length of specimen = L2

Change in length (ΔL) = L1 -L2

Percentage elongation= (L1 -L2) / L1 x 100

Yield strength= load at yield point / cross-sectional area

Ultimate strength = Ultimate load/ cross-sectional area in MPa

As per, Table 1, IS 432-1982
Thickness (mm) $\Phi < 20$ mm 20 mm< $\Phi < 50$ mm
Ultimate Tensile Stress (min) 410 N/mm2 410 N/mm2
Yield stress (min) 250 N/mm2 240 N/mm2
Percentage Elongation (Min) 23.0 23.0

PROCEDURE:

i) The sample of dog bones shape specimen was collected, and the gauge length was measured by using a measuring scale.

ii) The width and thickness of the specimen is to be measured by screw gauge (LC - 0.01mm) and the cross-section area was calculated.

iii) Then the dog bone shape specimen was gripped in the UTM, and the tensile force was applied to the specimen.

iv) The loads in kN were recorded from the recording device at ultimate point and at the yield point.

v) Then the stresses were calculated for the corresponding points.

vi) The ultimate stress (fu) and the yield stress (fy) were calculated.

vii) The stress vs strain curve is prepared.

OBSERVATIONS:

Width of the dog bone shape specimen (b) in mm

Thickness of the dog bone specimen (t) in mm

Hence, Cross-sectional area (A) =b x t in mm2

Ultimate Stress (fu)= Peak load/Area in N/mm2

Yield Stress (fy) = Ultimate stress x Factor of safety (0.67) in N/mm2

Initial Length (L_1) = 50 mm

Final Length (L_2) in mm

Percentage elongation= L2-L1 / L1 x 100

Check, whether Yield stress > 250 N/mm2 and Percentage elongation > 23%

Hence if above clause is satisfied, then mild steel is accepted for use.

<u>CONCLUSION:</u>

We have used mild steel coupon of dimensions (250 mm x10 mm x 12 mm) and found that the yield strength and the percentage of elongation are greater than the permissible values as per Table 1, IS 432-1982, therefore the mild steel coupon can be used for civil engineering purpose.

Thickness (mm)	**Φ < 20 mm**	**20 mm< Φ < 50 mm**
Ultimate Tensile Stress (min)	410 N/mm^2	410 N/mm^2
Yield stress (min)	250 N/mm^2	240 N/mm^2
Percentage Elongation (Min)	23.0	23.0

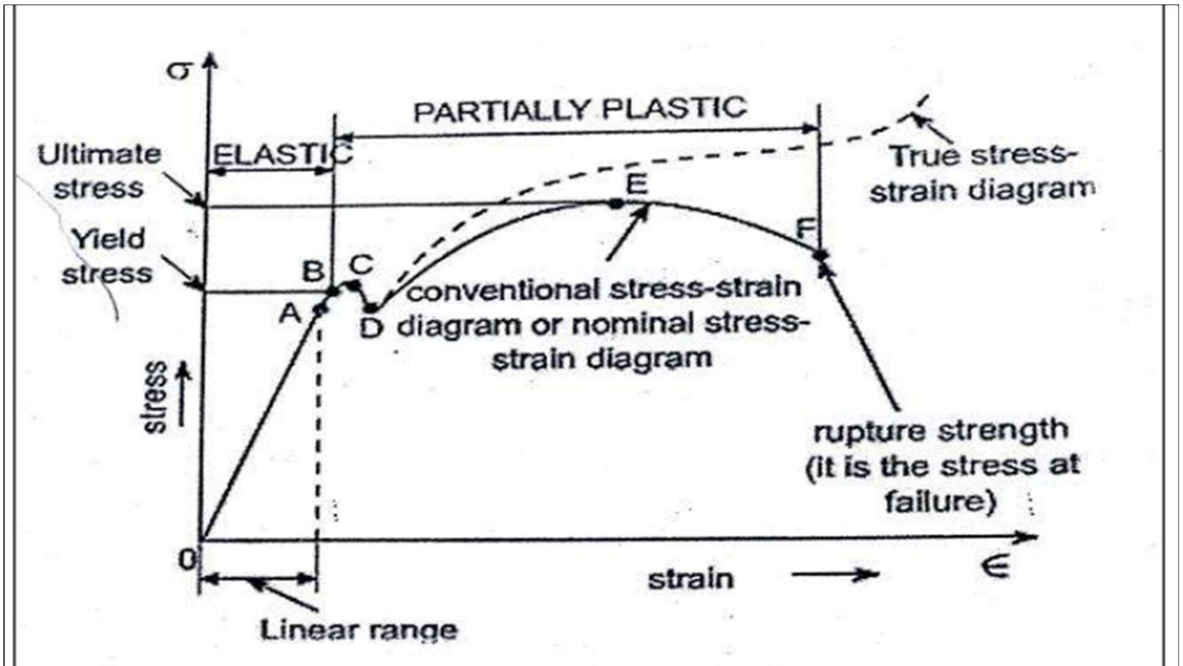


Figure: Typical stress-strain curve of mild steel

Experiment-03

AIM-Determine Young's Modulus of Elasticity of different materials beam simply supported at ends.

APPARATUS: -

Universal testing machine, Beam of wooden material

THEORY: -

If a beam is simply supported at the ends and carries a concentrated load at its center, the beam bends concave upwards. The distance between the original position of the beams and its position after bending at different points along the length of the beam be maximum at the center in this case. This difference is known as 'deflection' In this particular type of loading the maximum amount of deflection (δ) is given by the relation,

BENDING STRESS: -

From simple bending theory,

M = Bending moment in N-mm

I = Moment of inertia in mm4

σ =Bending stress in N/ mm2

y = Distance of the top fiber of the beam from the neutral axis

W = Load acting at the center in N

L = Length of the beam between the supports in mm

E = Young's modulus of material of the beam in N/mm2

I = Second moment of area (moment of Inertia) of the cross section

of the beam, about the neutral axis in mm4

PROCEDURE: -

1. Adjust cast- iron block along the bed so that they are symmetrical with respect to the length of the bed.

2. Place the beam on the knife edges on the block so as to project equally beyond each knife edge. See that the load is applied at the center of the beam.

3. Note the initial reading of vernier scale

4. Add a weight of 20N (say) and again note the reading of the vernier scale.

5. Go on taking readings adding 20N (say)each time till you have minimum six readings.

6. Find the deflection (δ) in each case by subtracting the initial reading of vernier scale.

7.Draw a graph between load (W) and deflection (δ). On the graph choose any two convenient points and between these points find the corresponding values of W and δ. Putting these values in the relation.

$M / I = \sigma / y = E / R$ ____(1)

$\delta = WL^3/48EI$ ------------(2)

Calculate the value of E

8. Calculate the bending stresses for different loads using relation

RESULT:

1. The Young's modulus for wooden beam is found to be ----- N/mm2

PRECAUTIONS:

1. Make sure that beam and load are placed in a proper position

2. The cross- section of the beam should be large

3. Note down the readings of the vernier scale carefully.

Experiment-04

AIM-Calculate Impact Value/toughness of Mild Steel using IZOD Impact Test Apparatus as per IS 1757.

THEORY: - In manufacturing locomotive wheels, coins, connecting rods etc. the components are subjected to impact (shock) loads. These loads are applied suddenly. The stress induced in these components are many times more than the stress produced by gradual loading. Therefore, impact tests are performed to assess shock absorbing capacity of materials subjected to suddenly applied loads. These capabilities are expressed as

(i) Rupture energy
(ii) Modulus of rupture
(iii) Notch impact strength

Two types of notch impact tests are commonly-

1. Charpy test

2. Izod test

In Izod test, the specimen is placed as 'cantilever beam'. The specimens have V-shaped notch of 45°. U-shaped notch is also common. The notch is located on tension side of specimen during impact loading. Depth of notch is generally taken as t/5 to t/3 where 't' is thickness of the specimen.

SPECIFICATION OF M/C AND SPECIMEN DETAILS:

Its specifications along-with their typical values are as follows:

- Impact capacity = 164 joule
- Least count of capacity (dial) scale = 2 joule
- Weight of striking hammer = 18.7 kg.
- Swing diameter of hammer = 1600 mm.
- Angle of hammer before striking = 90°
- Distance between supports = 40 mm.
- Striking velocity of hammer = 5.6m /sec.
- Specimen size = 75x10x10 mm.
- Type of notch = V-notch
- Angle of notch = 45°
- Depth of notch = 2 mm.

PROCEDURE: -

1. Lift the hammer to an appropriate knife edge position and notch the energy stored in the hammer. For the standard Izod test the energy stored should be 164j.

2. Locate the test specimen on the m/c supports.

3. Release the hammer. The hammer will break the piece and shoot up the other side of the specimen.

4. Note the residual energy indicated on the scale by the hammer.

5. Impact strength of the test specimen is the difference of the initial energy stored in hammer and the residual energy.

OBSERVATION: -

S.No.	Initial Energy (E1) in joule	Residual joule	Energy	(E2)	in	Absorb Energy (E1-E2)

CALCULATION: -

· Modulus of rupture = Rupture / Effective volume of specimen

· Notch impact strength = Absorb energy / Effective cross section area

PRECAUTIONS: -

1. The specimen should be prepared in proper dimensions.
2. Take reading more frequently.
3. Make the loose pointer in contact with the fixed pointer after setting the pendulum.
4. Do not stand in front of swinging hammer or releasing hammer.
5. Place the specimen proper position.

RESULTS: -

The impact strength of given specimen=……...joule/mm^2.

Experiment-05

AIM-Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Charpy Impact test as per IS 1598.

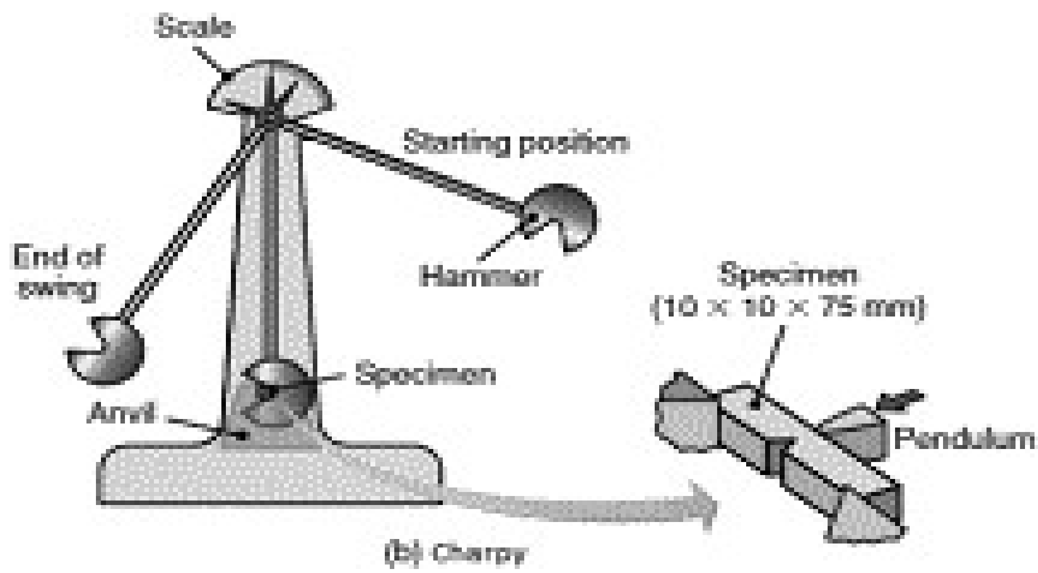
Minimum Theoretical Background:

Loads applied suddenly with an impact on a member induce higher stresses in the member. Static tension tests where load is applied gradually, do not always reveal the susceptibility of a metal to brittle fracture under such impact loading. This important factor is determined by impact test. Impact test signifies toughness of material that is ability of material to absorb energy during impact. Toughness takes into account both the strength and ductility of the material.

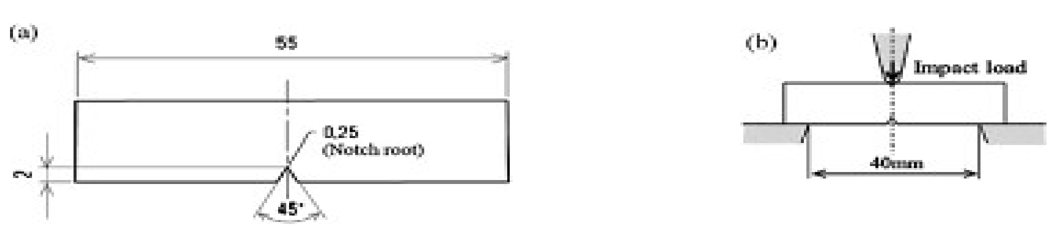
Two types of notch impact tests are commonly used - 1. Charpy test. 2. Izod test.

In Charpy test, the specimen is placed as 'horizontal simply supported beam'. The specimens have V-shaped notch of 45° at the centre of the length. The notch is located on tension side of specimen during impact loading.

Energy absorbed in Joules = Initial Energy in Joules - Final Energy in Joules



CHAPRY APPARATUS



S. No.	Name of Resource	Suggested Broad Specification	
1	CHAPRY Impact Test Apparatus:	Determine energy absorption capacity of Ductile and Brittle materials such as MS, Al, Br and Cu, by conducting Charpy Impact test as per IS 1757	
2	Charpy test specimen of Mild Steel, Aluminium, Brass and Copper	Square bar of size 10 mm as per details shown in sketch, with proper notch.	1 each

PROCEDURE:

Bring the striking hammer to its top most striking position so that the energy of the pendulum is 300 Joules and lock it at that position.

Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.

Without placing any specimen, release the hammer.

Hammer will push the pointer to show initial energy reading on the scale. Record this initial reading.

Bring the striking hammer back to its top most striking position and lock it at that position.

Bring indicator of the machine to zero.

Place the metal specimen in impact testing machine's vice in such a way that the notch is opposite to the hammer and is at the center of the span .

Release the hammer. It will fall due to gravity and break the specimen through its momentum, and will continue to swing.

Apply breaks to stop the swinging hammer.

Note down the final reading after impact.

Calculate energy absorbed by the specimen by using the given formula:

Repeat the procedure for specimens of different metals..

Compare energy absorption capacities of different metals.

OBSERVATION TABLE:

Sr. No.	Specimen (Metal)	Initial Energy Reading (J)	Initial Energy Reading (J)	Energy Absorbed by the specimen (J)	Mode of failure

PRECAUTIONS:

Avoid improper handling of instrument
Lock the hammer in position before placing the specimen.
Ensure that the broken pieces of specimen do not hurt students.
Read the values from Charpy scale only

Experiment-06

AIM-Estimate Maximum Bending moment and shear force for simply supported and cantilever beam under point load and UDL using Combined Shear Force and Bending Moment apparatus.

THEORY: -

BEAM: - It is a structural member on which the load act perpendicular to axis. It is that whenever a horizontal beam is loaded with vertical loads, sometimes it bends due to the action of the loads. The amounts by which a beam bends, depends upon the amount and types of loads, length of beam, elasticity of the beam and the type of beam. In general beams are classified as under:

1. Cantilever beam: - It is a beam whose one end is fixed to a rigid support and the other end is free to move.

2. Simply supported beam: - A beam supported or resting freely on the walls or columns at its both ends is known as simply supported beam.

3. Rigidly fixed or built-in beam: - A beam whose both the ends are rigidly fixed or built in walls is called a fixed beam.

4. Continuous beam: - A beam support on more than two supports is known as a continuous beam. It may be noted that a continuous beam may not be overhanging beam.

TYPES OF LOADING:

1. Concentrated or point load: - A load acting at a point on a beam is known as concentrated or a point load.

2. Uniformly distributed load: - A load, which is spread over a beam in such a manner that each unit length is loaded to a same extent.

3. **Uniformly varying load: -** A load, which is spread over a beam, in such a manner that its extent varies uniformly on each unit length.

SHEAR FORCE: - The shear force at the cross-section of a beam may be defined as the unbalanced vertical forces to the right or left of the section.

BENDING MOMENT: - The bending moment at the cross-section of a beam may be defined as the algebraic sum of the moment of forces, to the section.

IMPORTANT POINTS: -

1. If loading is uniformly distributed load, then shear force diagram will be a curve of first degree and B.M. diagram will be a curve of second degree.

2. If the loading is point load, then its corresponding S.F. diagram would be a curve of zero degree and the B.M. diagram would be a curve of first degree.

3. If the loading is uniformly varying load its S.F. diagram would be curve of second degree and BMD will be of third degree.

4. Bending moment is maximum where shear force is zero.

5. In case of simply supported beam the first step is to calculate the reactions at the support, then we proceed in usual manner.

6. In case of cantilever beam there is no need of finding reaction and start from the free end of the beam.

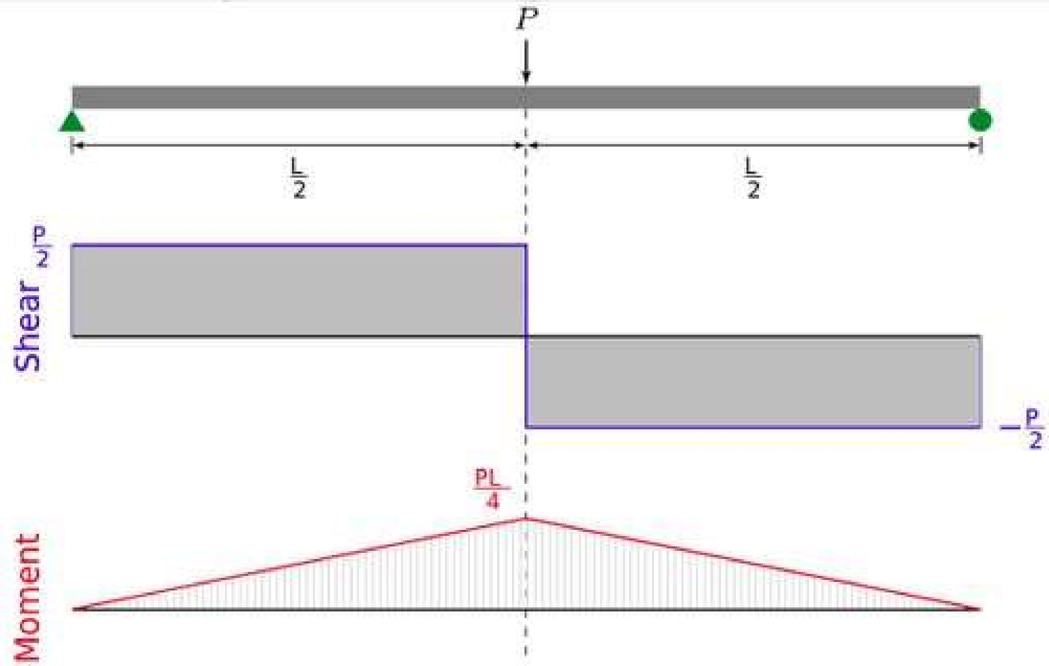
7. Point of flexural is where BM changes its sign.

8. B.M. at the support is zero for simply supported beam.

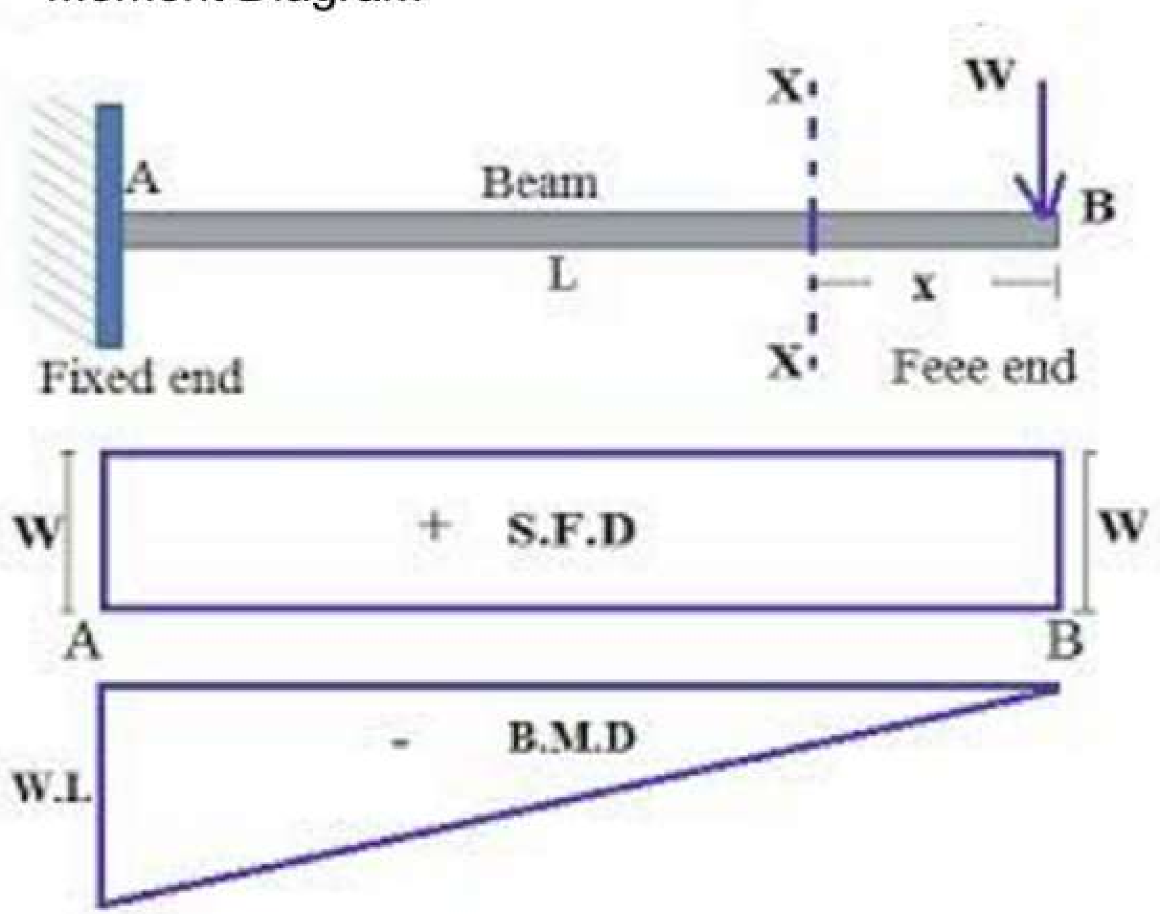
Example: - A simply supported beam Lm. long is subjected to P point loads, draw the S.F & B.M diagram for the beam.

RESULT: -

Two Point, simply supported Beam, Shear Force & Bending Moment Diagrams



Cantilever Beam, Shear Force and Bending Moment Diagram



Experiment-07

AIM-Measure flexural rigidity (EI) for a given beam using, 'Slope and Deflection' apparatus and compare it with theoretical value.

Apparatus: -

Elastic Properties of deflected beam, weight's, hanger, dial gauge, scale,and Vernier caliper.

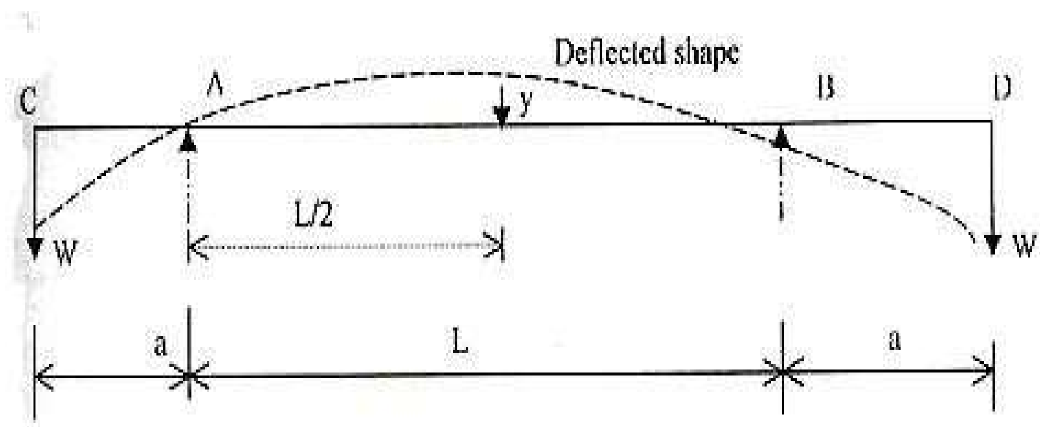
Formula: -

(1) Central upward deflection, $y = W.a.L^2 / 8y$.. (1)

(2) $EI = W.a.\ L^2 / 8y$..(2)

(3) Also, it is known that EI for beam = $E \times bd^3 /12$ ....(3)

Diagram: -



Theory: -

For the beam with two equal overhangs and subjected to two concentrated loads W each at free ends, maximum deflection y at the center is given by central upward deflection. Central upward deflection,

$$y = W.a.L^2 / 8EI$$

Where,

- a = length of overhang on each side
- W = load applied at the free ends

- L = main span
- E = modulus of elasticity of the material of the beam
- I = moment of inertia of cross section of the beam
- $EI = W.a.L^{2}/8y$
- It is known that.
- EI for beam = $E \times bd^{3} /12$
- Where, b = width of beam

  d = depth of beam

Procedure: -

i) Find b and d of the beam and calculate the theoretical value of EI by Eq. (3).

ii) Measure the main span and overhang span of the beam with a scale.

iii) By applying equal loads at the free end of the overhang beam, find the centraldeflection y.

iv) Repeat the above steps for different loads.

Calculation: -

1) Length of main span, L (cm) =
2) Length of overhang on each side, a (cm) =
3) Width of beam, b (cm) =
4) Depth of beam, d (cm) =
5) Modulus of elasticity, E (kg/cm2) = 2×10^{6}

Observation Table: -

Sr. No	Equal loads at the two ends (kg)	Dial gauge reading at the midspan of beam(cm)	EI from Eq. (3)	EI from Eq (2)
.				

Calculation: -

Average values of EI from observation = ……cm4

Average values of EI from calculation = …….cm^4

Result: -

Flexural rigidity (EI) is found theoretically and experimentally.

Precaution: -

1. Measure the center deflection y very accurately.
2. Ensure that the beam is devoid of initial curvature.
3. Loading should be within the elastic limit of the materials.

Experiment-08

AIM-Measure principal stresses and strains in a beam made of aluminum and loaded as a cantilever and compare them with theoretical values using 'Principal stress and strain Apparatus'.

Apparatus:

1.Cantilever beam, with Uniaxial, and Rosette Strain gauges

2.Wheatstone Bride and Strain Gauge Meter.

3.Cantilever flexure frame

4.No. B101 (2024-T6 high-strength aluminum alloy beam); 1/8 x 1 x 12.5 in. (3x25x320 mm)

5.Micrometer

6.Calipers

7.Scale

8.Weights and hanger

Theory:

Principal Stresses: These are the normal stresses acting on planes of zero shear stress. For a general state of stress there are three orthogonal principal stresses. The three principal directions for the principal stresses are orthogonal. The strains corresponding to principal stresses are called as principal strains.

It is customary to order the principal stresses such that $\sigma1 > \sigma2 > \sigma3$

Principal Planes: Principal planes are the planes of zero shear stress. These planes are perpendicular to the principal directions i.e., directions along which the 3 principal stresses act. The modulus of elasticity, or Young's modulus, is a material constant indicative of the material's stiffness. It is obtained from the stress versus strain plot of a specimen subjected to a uniaxial stress state (tension, compression, or bending).

Figure 1, for example, shows a typical "stress-strain" diagram for a metal under uniaxial stress.

For materials such as aluminum, strain is an essentially linear function of the stress up to the point at which the material yields. Figure 1 The modulus of elasticity, E, is defined as the slope of the linear portion of the diagram.

Where σ is the stress measured in psi (N/m2 or Pa).

In Equation above ε is the strain measured in in/in (m/m). Thus, the elastic modulus is measured in units of psi (Pa). A uniaxial stress state is obtained on the surface of a cantilever beam when it is loaded at its free end.

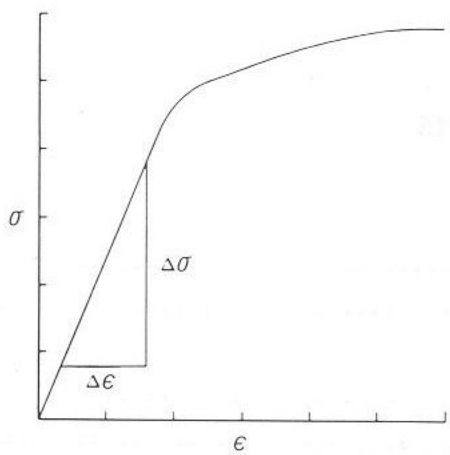
The loading condition, illustrated in Figure 2, places the beam in a combined shear and bending state but the shear stresses are zero on the upper and lower surfaces. The bending tresses are directed along the longitudinal axis of the beam; they maximize on the upper surface and decrease linearly through the thickness. When the beam has a rectangular cross-section, the magnitude of the tensile stress on the

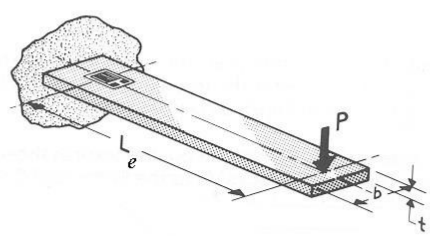
upper surface is equal to that of the compressive stress on the lower surface.

(1) $E = \Delta\sigma/\Delta\varepsilon$ (1)

(2) $\sigma = MC/I$ For cantilever beam $\sigma = (6PLe)/(bt2)$

Where,
b, and t are beam width and thickness.
Le is equivalent length of Beam.





Procedure: -

The surface strain at the section of interest will be measured by a strain gage bonded at that point. The load will be applied in increments, and the corresponding strains recorded. The stresses and strains will be plotted to produce a stress-strain diagram from which the modulus of elasticity is determined. Information should be entered on the attached work sheet. The steps to be followed are:

1. Measure and record the beam width (b), beam thickness (t), and effective length (Le).
2. Record the gage factor, Sg, indicated on the beam.
3. Using Equation (3), determine the load, P, to be applied for a stress, σ, of 15,000 psi to result at the strain gage. This is the maximum load that can be safely applied to the beam without exceeding the yield stress and is defined as Pmax (a few pounds).
4. With the gaged end of the beam near the support, center the beam in the flexure frame and firmly clamp the beam in place.
5. Referring to Figure below (and Handout), connect the lead wires from the strain gage to the posts on the sides of the “flexor” frame. Referring to Figures connect the appropriate gage leads from the Flexor cable to the S-, P+, and D-120 binding posts of the P-3500 strain indicator.

Note: The strain gage employed in this experiment is used in a "Full bridge" arrangement and Uniaxial Strains Only.

Useful Formula:

$$\upsilon = \left|\frac{\varepsilon_q}{\varepsilon_p}\right| = \_\_\_\_\_\_\_\_$$

$$\sigma_p = \frac{E}{(1-\upsilon^2)}(\varepsilon_p + \upsilon\varepsilon_q) = \_\_\_\_\_\_\_\_$$

$$\sigma_q = \frac{E}{(1-\upsilon^2)}(\varepsilon_q + \upsilon\varepsilon_p) = \_\_\_\_\_\_\_\_$$

A. Observed measurements:

Load (Kg)	Experimental			Corrected Experimental		
	ε_1 ($\mu\varepsilon$)	ε_2 ($\mu\varepsilon$)	ε_3 ($\mu\varepsilon$)	ε_1' ($\mu\varepsilon$)	ε_2' ($\mu\varepsilon$)	ε_3' ($\mu\varepsilon$)
0.5						
1.0						
1.5						
2.0						

B. Tabulation of loads, Strains & Stresses:

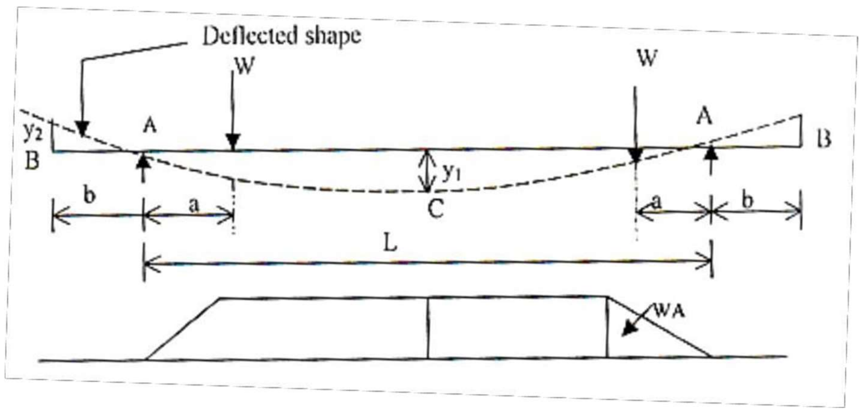
LOAD (gm)	STRAIN (ε) μ/μ	STRESS (psi) (INCREASING LOAD)	STRAIN (με) (DECREASING LOAD)	STRESS (psi) (DECREASING LOAD)

Experiment-09

AIM-Investigate the effect of beam length and width on deflection of beam and compare it with theoretical. value using 'Slope and Deflection' apparatus.

Apparatus: - Moment of area theorem apparatus.

Diagram: -



Theory: - According to moment area theorem

1. The change of slope of the tangents of the elastic curve between any two points of the deflected beam is equal to the area of M/EI diagram between these two points.
2. The deflection of any point relative to tangent at any other point is equal to the moment of the area of the M/EI diagram between the two points at which the deflection is required. Slope at

B= Y2 / b since the tangent at C is horizontal due to symmetry,

Slope at B= shaded area / EI

$= 1 / EI [Wa^2 / 2 + WA (L/2 - a)]=$……………

Displacement at B with respect to tangent at C = (y1 + y2) =

Moment of shaded area about B / EI= $1 / EI [Wa^2 / 2 (b+2/3a) + Wa (L/2 - a) (b+ a/2+L/2)]=$……….

Procedure: -

1. Measure a, b and L of the beam
2. Place the hangers at equal distance from the supports A and load them with equal loads.
3. Measure the deflection by dial gauges at the end B (y2) and at the center C (y1)
4. Repeat the above steps for different loads.

Observation Table: -

Length of main span, L (cm) =………………

Length of overhang on each side, a (cm) =…………

Modulus of elasticity, E (kg/cm^2) = 2×10^6

Sl. No.	Load at each Hanger (kg)	Central Deflection Y_1 (cm)	Deflection at Free end y_2 (cm)	Slope at B Y_2 / b	Deflection at C=Deflection at B (y_1)

Calculation: -

1. Calculate the slope at B as y_2 / b (measured value) ………………..
2. Compute slope and deflection at B theoretically from B.M.D. and comparewith experimental values.
3. Deflection at C = y_1(measured value) ……………………………………
4. Deflection at C = Average calculated value…………………………….

Result: -The slope and deflection obtained is close to the slope and deflection obtained byusing moment area method.

Precaution: -

1. Apply the concentration loads without jerks.
2. Measures the deflection only when the beam attains ion.
3. Measures the deflection very carefully and accurately.
4. Check the accuracy and least count of dial gauges used for measuring deflections.

EXPERIMENT-10

AIM-Measure the buckling load of three different slenderness ratio long columns of same lengths using. ‘Behavior of column and struts’ apparatus.

Apparatus:

a. Columns of various lengths made from different materials.

b. Column buckling machine.

c. Load equipment

d. Dial indicators

Theory:

There are usually two primary concerns when analyzing and designing structures:

(1) The ability of the structure to support a specified load without experiencing excessive stress.

(2) The ability of the structure to support a given load without undergoing unacceptable deformation.

In some cases, however, stability considerations are important especially when the potential exists for the structure to experience a sudden radical change in its configuration. These considerations are typically made when dealing with vertical prismatic members supporting axial loads. Such structures are called columns. A column will buckle when it is subjected to a load greater than the critical load denoted by Pcr. That is, instead of remaining straight, it will suddenly become sharply curved as illustrated in Figure 1. The critical load is given in terms of an effective length by:

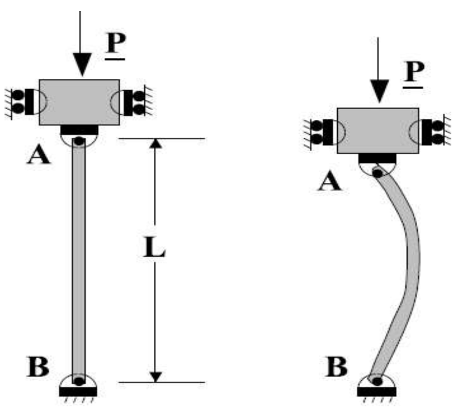
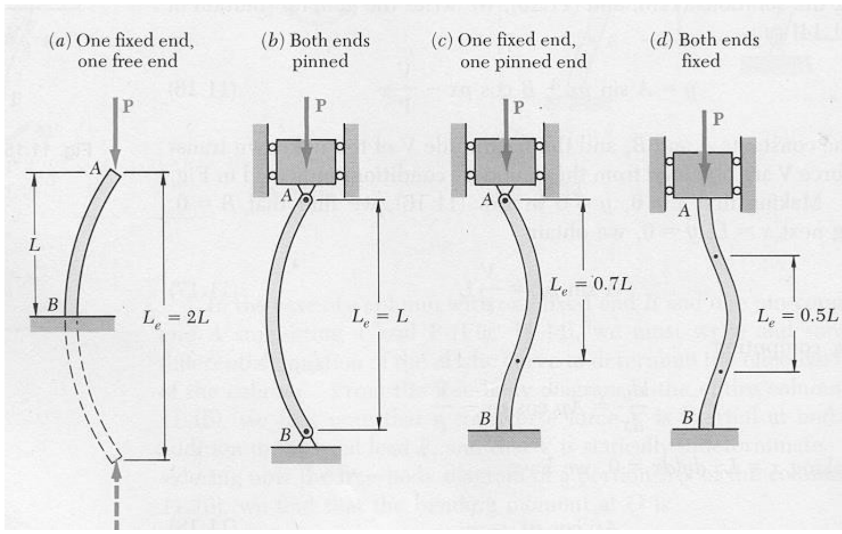


Figure 1. A column will buckle when a critical load is reached.

$$P_{cr} = \frac{\pi^2 E I}{L_e^2} \qquad \textbf{(4.3-1)}$$

Where,

E is the elastic modulus, I is the moment of inertia, and Le is the effective length.
The expression in Equation (4.3-1) is known as Euler's formula.
The effective length depends upon the constraints imposed on the ends of the column. Figure 2 shows how the effective lengthis related to the actual length of the column for various end conditions.



The critical load is computed by making I = Imin in Equation (4.3-1).

Thus, if buckling occurs, itwill take place in a plane perpendicular to the corresponding principal axis of inertia.
The radius of gyration, r, is often introduced into Euler's formula. This quantity is given by.

$$r = \sqrt{\frac{I_{\min}}{A}}$$

And

$$P_{cr} = \frac{\pi^2 E A}{(L_e/r)^2} .$$

Where A is the cross-sectional area of the column.
Substituting Equation (4.3-2) into (4.3-1),Finally:

$$\sigma_{cr} = \frac{P_{cr}}{A} = \frac{\pi^2 E}{(L_e/r)^2} .$$

In Above Equations,

the quantity (Le / r) is called the slenderness ratio of the column.
For long columns, with a large slenderness ratio, Euler's formula is adequate for design purposes.
However, for intermediate and short columns, where failure occurs essentially because of yield, empirical formulas are used to approximate test data. These empirical formulas are specified based on material tests conducted by engineers working in that field.

Procedure:-

The number of columns tested will be sizes from 10” to 20” using 10”, 12”,15”, 18”
Only one end condition, two different end conditions [see Figure 2, cases (b), (c),] would betested.

The most critical factor in this lab is to ensure that the columns are loaded in a perfectly horizontal and secured position. Any angular rotation (especially in the case when both ends are fixed) will result in erroneous results. Care should also be taken in adjusting the collar on the post for each column. It is important to stop the loading of the column as soon as the critical loadhas been reached to avoid permanent damage to the column.

For each column tested:

1. Measure and record the dimensions of the column on the worksheet.
2. Calculate the expected buckling load for the end conditions at hand. The steps for doing thisare outlined on the worksheet.
3. Orient the satin chrome blocks on the loading frame for the end conditions chosen. V-notchesshould face away from the mounting surface (towards the column) for pinned ends and towards the mounting surface (away from the column) for fixed ends.
4. With the end conditions selected, adjust the capstan nut.
5. The loading beam should then be adjusted to the desired column as follows:

The stop for the loading beam when the column starts to change mode of bucking.

After the column is in position, the dial indicator is installed in the brackets and fastened to the center post. The indicator bracket should be moved up or down the post so that the indicator point contacts the column at its midpoint.

The indicator may then be zeroed by loosening the black plastic knob that holds the indicator on the frame and then moving it gently toward the column until the needle on the small scale is zero. The large scale is zeroed by rotating the outside bezel until the large needle is on zero. One revolution on the large scale is 0.100 in. (2.54mm) and is equal to 1 on the small scale. Each graduation of the large scale is 0.001 in. (0.025 mm). Extreme care should be exercised in handling the dial indicator.