BASIC CIVIL ENGINEERING WORKSHOP

NAME :

H.T.NO :

YEAR/ SEMESTER :

Department of Civil Engineering

VEMU INSTITUTE OF TECHNOLOGY:: P.KOTHAKOTA

NEAR PAKALA, CHITTOOR- 517112

Approved by AICTE, New Delhi & Affiliated to JNTUA, Anantapur

INDEX

CANTILEVER BEAM

AIM: -To determined young's modulus of elasticity of material of cantilever beam

OBJECT:-To find the values of bending stresses and young's modulus of elasticity of the material of a cantilever beam and carrying a concentrated load at the end.

APPARATERS:

1. Deflection of beam apparatus
2. Pan
3. Weights
4. Beam of different cross-sections and material (say wooden and Steel beams)

THEORY:

The beam which has one end is fixed and another end is free is called cantilever beam. For the cantilever beam the bending moment is zero at free end and maximum at fixed end. When the cantilever beam is subjected to a load at free end the beam will bend in convexity downwards. The deflection at free end is maximum and at fixed end is zero.

When the cantilever beam is subjected to a load at free end then the maximum bending moment is given by

`M= WL

Where W =Load acting on the beam

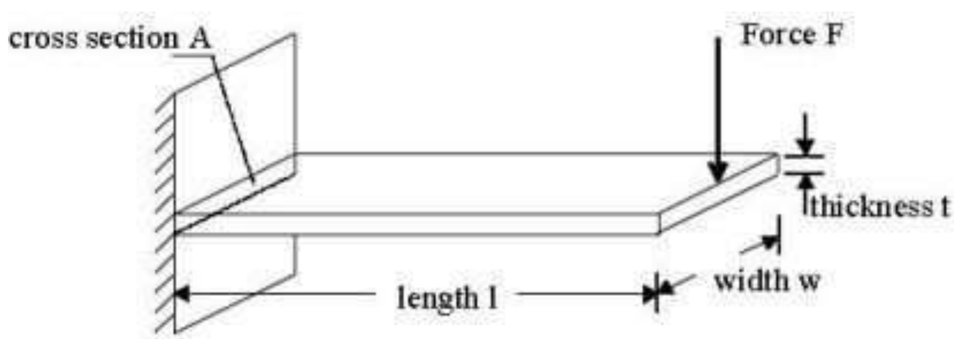
L= length of the beam

When the cantilever beam is subjected to a load at free end then the deflection is given by

$$ð = \frac{WL^3}{3EI}$$

<u>for diameter or depth of beam (d)</u>

S.NO	M.S.R.	V.C.R.	M.S.R+(V.C.R.X L.C.)
			Average=



From above equation

$$E = \frac{WL^3}{3\delta I}$$

Where

W =Load acting at the free end , N

L =Length of the beam mm

E =Young's modulus of material of the beam, N/mm^2

I =Second moment of area of the cross- section (i.e, moment of Inertia) of the beam, about the neutral axis, mm^4

$I = \frac{bd^3}{12}$ for rectangular beam

where

b= width of beam and d= depth of the beam

$I = \frac{\pi d^4}{64}$ for cirucular section

Where

d= diameter of the beam

BENDING STRESS:

When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

$$\frac{E}{R} = \frac{M}{I} = \frac{f}{y}$$

Where

OBESERVATION TABLE :-

SI.NO	LOADS ON BEAM	δ1	δ2	δ	Young's modulus $E = \frac{WL^3}{3\delta I}$	Bending moment M=WL	Bending stress $f = \frac{M}{I} y$
1							
2							
3							
4							
5							
6							

δ1= deflection in increasing order

δ2= deflection in decreasing order

E =Young's modulus of material of the beam, N/mm^2

R= radius of curvature

M=bending moment= WL Nmm

I =Second moment of area of the cross- section,mm^4

f= bending stress, N/mm^2

y=distance from N.A. ,mm

PROCEDURE:

1. place the cantilever beam, Take dimension i.e., Length, Width, Thickness of the specimen
2. check the flatness of given beam with the help of dial gauge
3. Place the dial gauge under the beam where the deflection is to be measured.
4. place the hanger at the end point of the beam
5. now place the weights in span in increasing order at free end
6. calculate the deflections in dial gauge for different weights
7. repeat the experiment with various loads of the beams
8. calculate deflections in decreasing order also
9. using the equation calculate the bending stress

PRECAUTIONS:

1. Make sure that beam and load are placed a proper position.
2. The cross- section of the beam should be large.
3. Note down the readings of the vernier scale carefully

RESULT:

1. The young's modulus for steel beam is found to be ----- N/mm^2

SIMPLY SUPPORTED BEAM

AIM: -To determined young's modulus of elasticity of material of beam simply supported at ends.

OBJECT:-To find the values of bending stresses and young's modulus of elasticity of the material of a beam simply supported at the ends and carrying a concentrated load at the centre.

APPARATERS:

1. Deflection of beam apparatus
2. Pan
3. Weights
4. Beam of different cross-sections and material (say wooden and Steel beams)

THEORY:-

If the beam is supports at the two ends, the beam is known simply supported beam. When a beam is subjected to load the beam goes under deformation. The difference between the elastic curve to original position of the beam is called deflection. When a simply supported beam subjected to point load at the midpoint, the beam bends concave upwards.

The deflection at mid point is given by

$$ð = \frac{WL^3}{48EI}$$

From above equation

$$E = \frac{WL^3}{48\delta I}$$

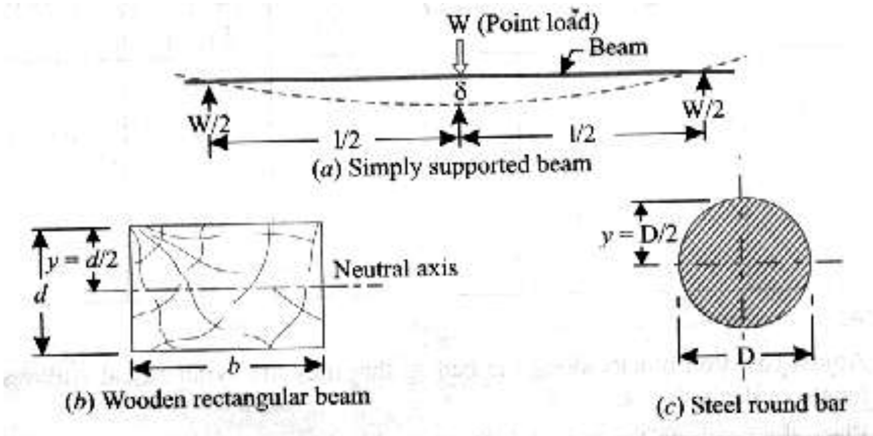


Fig. 14

<u>for diameter or depth of beam (d)</u>

S.NO	M.S.R.	V.C.R.	M.S.R+(V.C.R.X L.C.)
			Average=

Where

W =Load acting at the center, N

L =Length of the beam between the supports mm

E =Young's modulus of material of the beam, N/mm^2

I =Second moment of area of the cross- section (i.e, moment of Inertia) of the beam, about the neutral axis, mm^4

$$I = \frac{bd^3}{12}$$ for rectangular beam

where

b= width of beam and d= depth of the beam

$$I = \frac{nd^4}{64}$$ for cirucular section

Where

d= diameter of the beam

BENDING STRESS:

When the stress produced to due to bending moment, the stress is known as bending stress. The bending stress can be obtained by bending equation

$$\frac{E}{R} = \frac{M}{I} = \frac{f}{y}$$

Where E =Young's modulus of material of the beam, N/mm^2

R= radius of curvature

M=bending moment=$\frac{ML}{4}$,Nmm

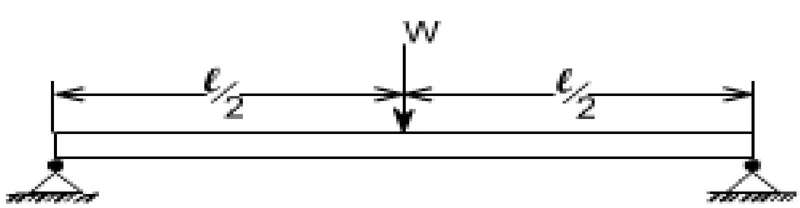
I =Second moment of area of the cross- section,mm^4

OBESERVATION TABLE :-

SI.NO	LOADS ON BEAM	δ1	δ2	Δ	Young's modulus $E = \frac{WL^3}{48\delta I}$	Bending moment $M=\frac{ML}{4}$	Bending stress $f = \frac{M}{I} y$
1							
2							
3							
4							
5							
6							

δ1= deflection in increasing order

δ2= deflection in decreasing order



f= bending stress, N/mm^2

y=distance from N.A. ,mm

For simply supported beam bending moment is zero at supports and maximum at mid point when the load is symmetrical

PROCEDURE:

1. place the simply supported beam, Take dimension i.e., Length, Width, Thickness of the specimen
2. check the flatness of given beam with the help of dial gauge
3. Place the dial gauge under the beam where the deflection is to be measured.
4. place the hanger at the midpoints of the beam
5. now place the weights in span in increasing order at mid point
6. calculate the deflections in dial gauge for different weights
7. repeat the experiment with various loads of the beams
8. calculate deflections in decreasing order also
9. using the equation calculate the bending stress

PRECAUTIONS:

1. Make sure that beam and load are placed a proper position.
2. The cross- section of the beam should be large.
3. Note down the readings of the vernier scale carefully

RESULT:

2. The young's modulus for steel beam is found to be ----- $N/mm^{2.}$

   (OR)

3. The young's modulus for wooden beam is found to be ----- N/mm

USE OF ELECTRICAL RESISTANCE STAIN GAUGES

AIM:

To determine the Strain of the cantilever beam subjected to Point load at the free end and to plot the characteristic curves.

APPARATUS:

1. Cantilever Beam Strain gauge Trainer Kit
2. Weights and Millimeter

FORMULA USED:

Strain, $S = \frac{6PL}{BET^2}$

Where,

P=Load applied in Kg.

L = Effective length of the beam in cm.

B = Width of the beam in cm.

T = thickness of the beam in cm.

E = young's modulus = $2x10^5 N/mm^{2.}$

S = Micro strain

THEORY:

When the material is subjected to any external load, there will be small change in the Mechanical properties like thickness of the material or change in the length

OBSERVATION:

Si.no	Weight (gms)	Actual readings (using formula) micro strains	Display readings		Error(%)
			While loading micro strains	While un loading micro strains	
1	100				
2	200				
3	300				
4	400				
5	500				
6	600				
7	700				
8	800				
9	900				
10	1000				

$$\% \text{ ERROR} = \frac{\text{Actual reading - display reading}}{\text{Maximum weight}} \times 100$$

Depending upon the nature of load applied to the material. The change in mechanical properties will remain till the load is released. The change in the property is called Strain (or) material gets strained.

Strain $S = \partial L/L$

Since the change in length is very small, it is difficult to measure ∂L, so the strain is measured in micro strain. Since it is difficult to measure the length, Resistance strain gauge are used to measure strain in the material directly. Strain gauges are bonded directly on the material using special adhesive s. As the material get strained due to load applied the resistance of the strain gauge changes proportional to the load applied. This change in resistance is used to convert mechanical property into electrical signal which can be easily measured and stored for analysis.

The change in the resistance of the strain gauge depends on the sensitivity of the strain gauge which is expressed in terms of a gauge factor, Sg

$$S_g = \frac{\Delta R}{R}$$

The output $\Delta R/R$ of a strain gauge is usually converted into voltage signal with a Wheatstone bridge. If a single gauge is used in one arm of Wheatstone bridge and equal but fixed resistors is used in the other arm, the output voltage is

$E = {}^{Ei}$ $_{Rg}$ o $\frac{}{4\Delta Rg}$ $E_O = \frac{1}{4EiSg\Delta}$

The input voltage is controlled by the gauge size and the initial resistance of the gauge. As a result, the output voltage E_o usually ranges between 1 to 10 ΔV / micro units of strain.

PROCEDURE:

1. The instrument is switched on (i.e.,). The display glows to indicate the instrument is ON.
2. The Instrument is allowed to be in ON position for 10 minutes for initial worm-up.
3. From the selector switch, FULL or HALF bridge configuration is selected.

2. The potentiometer is adjusted for ZERO till the displays reads ' 000’
3. 1 Kg load is applied on the pan of the cantilever the CAL Potentiometer is adjusted till the display reads 377 micro strains. When the weights are removed the display should come to ZERO, in case of any variation, ZERO Potentiometer is adjusted again and the procedure is repeated again. Now the instrument is calibrated to read micro strains.
4. Then the loads are applied on the pan in steps of 100 gm up to 1kg. When the cantilever is strained, instrument displays exact micro strain.
5. The readings are noted down in the tabular column. Percentages error in readings, hysteresis and accuracy of the instrument can be calculated by comparing with the theoretical results.

RESULT:

Thus the strain of the cantilever beam subjected to free end loading, is obtained in micro strains and the characteristics curves – Load Vs Strain, Output Voltage Vs Strain and Actual Vs Display readings are plotted.

COMPRESSIVE STRENGTH OF BRICK

AIM:

To determine the compressive strength of brick

OBJECT: - The specimen brick is immersed in water for 24 hours. The frog of

The Compressive Strength

APPARATUS:

Bricks, Oven Venire Caliper, Scale.

FORMULA: -

$$\text{Compressive Strength} = \frac{\text{Max. Load at failure}}{\text{Loaded Area of brick}}$$

THEORY: -

Bricks are used in construction of either load bearing walls or in portion walls incase of frame structure. In bad bearing walls total weight from slab and upper floor comes directly through brick and then it is transversed to the foundation. In case the bricks are

loaded with compressive nature of force on other hand in case of frame structure bricks are used only for construction of portion walls, layers comes directly on the lower layers or wall. In this case bricks are loaded with compressive nature of force. Hence for safely measures before using the bricks in actual practice they have to be tested in laboratory for their compressive strength.

PROCEDURE: -

OBSERVATION TABLE:

S.NO	LXBXH cm^3	Area LXB Cm^2	Load (p)	Compressive strength(P/A)

Average Compressive strength=……….

CALCULATION:- -

$$\text{Compressive Strength} = \frac{\text{Max. Load at failure}}{\text{Loaded Area of brick}}$$

1. Select some brick with uniform shape and size.
2. Measure its all dimensions. (LXBXH)
3. Now fill the frog of the brick with fine sand. And
4. Place the brick on the lower platform of compression testing machine and lower the spindle till the upper motion of ramis offered by a specimen the oil pressure start incrising the pointer start returning to zero leaving the drug pointer that is maximum reading which can be noted down.

PRECAUTION: -

1) Measure the dimensions of Brick accurately.
2) Specimen should be placed as for as possible in the of lower plate.
3) The range of the gauge fitted on the machine should not be more than double the breaking load of specimen for reliable results.

RESULT: -

The average compressive strength of new brick sample is found to be...............Kg/sq.cm.

FOR DIAMETER (d):

S.NO	M.S.R.	V.C.R.	M.S.R+(V.C.R.X L.C.)
			Average=

TORSION TEST

AIM:- Torsion test on mild steel rod

OBJECTIVE:

To conduct torsion test on mild steel or cast iron specimens to find out modulus of rigidity

APPARATUS:-

1. A torsion testing machine
2. Vernier Caliper
3. mild steel specimen

THEORY:- when two equal opposite torques applied on a shaft, the shaft is said to be in pure torsion. When the shaft is subjected to torsion, shear stresses and shear strains are produced in the material. A torsion test is quite instrumental in determining the value of modulus of rigidity of a metallic specimen. The value of modulus of rigidity can be found out by using torsion equation

$$\frac{G8}{L} = \frac{T}{J} = \frac{q}{r}$$

Where,

T= Torque applied

J = Polar moment of inertia

G = Modulus of rigidity

θ = Angle of twist (radians)

L = Length of rod

OBESERVATION

a. Gauge length of the specimen, l = ………
b. Diameter of the specimen, d = ………

c. Polar moment of inertia,

$$J = \frac{Gd^4}{32}$$

SI.NO	1	2	3	4	5	6	7	8	9	10
Torque(T)										
Angle of twist (θ) in degrees										
Modulus of rigidity (G) N/mm^2										

q = shear stress

R = radius of rod

PROCEDURE:-

1. Select the driving dogs to suit the size of the specimen and clamp it in the Machine by adjusting the length of the specimen by means of a sliding spindle
2. Measure the diameter at about three places and take the average value
3. Choose the appropriate range by capacity change lever
4. Set the maximum load pointer to zero
5. Set the protector to zero for convenience and clamp it by means of knurled Screw
6. Carry out straining by rotating the hand wheel in either direction
7. Load the machine in suitable increments
8. Then load out to failure as to cause equal increments of strain reading
9. Plot a torque- twist (T- θ) graph
10. Read off co-ordinates of a convenient point from the straight line portion

Straight line portion of the torque twist (T- θ) graph and calculate the value of 'G' by using relation

$$G = \frac{TL}{J\theta}$$

PRECAUTIONS:-

2) Measure the dimensions of the specimen carefully
3) Measure the Angle of twist accurately for the corresponding value of Torque
4) Maintain the distance from torsion machine when it is working
5) The cross section and the along the shaft is same

RESULT:-

Modulus of rigidity of mild steel rod is -------------- N/mm^2

SPRING TEST

AIM:

To determine the stiffness and rigidity modulus of the given spring by conducting impression test.

APPARATUS:

1. Closely coiled helical spring
2. Spring testing machine.
3. vernier caliper.
4. Micrometer

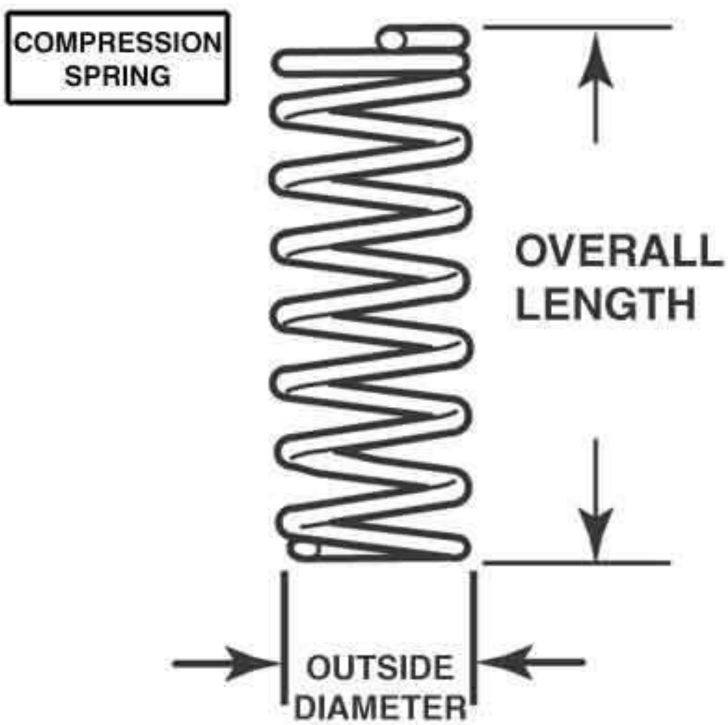
THEORY:

Springs are elastic member which distort under load and regain their original shape when load is removed. They are used in railway carriages, motor cars, scooters, motorcycles, rickshaws, governors etc. According to their uses the springs perform the following Functions:

1. To absorb shock or impact loading as in carriage springs
2. To store energy as in clock springs.
3. To apply forces to and to control motions as in brakes and clutches.
4. To measure forces as in spring balances.
5. To change the variations characteristic of a member as in flexible mounting of motors.

For spring wire diameter (d) :

S.NO	**M.S.R.**	**V.C.R.**	**M.S.R+(V.C.R.X L.C.)**
			Average=



Several types of spring are available for different application. Springs may classified as helical springs, leaf springs and flat spring depending upon their shape. They are fabricated of high shear strength materials such as high carbon alloy steels spring form elements of not only mechanical system but also structural system. In several cases it is essential to idealise complex structural systems by suitable spring.

PROCEDURE:

1) Measure the diameter of the wire of the spring by using the micrometer.
2) Measure the diameter of spring coils by using the vernier caliper
3) Count the number of turns.
4) Insert the spring in the spring testing machine and load the spring by a suitable weight and note the corresponding axial deflection in tension or compression.
5) Increase the load and take the corresponding axial deflection readings.
6) Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring.

OBSERVATIONS:

Least count of micrometer = ……mm

Diameter of the spring wire, d =………mm

(Mean of three readings)

Least count of vernier caliper = ……mm

Diameter of the spring coil, D = ……mm

(Mean of three readings)

Mean coil diameter, Dm = D - d……mm

Number of turns, n =

Mean radius of the spring = $\frac{D-d}{2}$…….m

TABULAR COLUMN:

S.NO	LOAD	DEFLECTION ð	K=W/ ð	MODULUS OF RIGIDITY

DESCRIPTION:

The compression test is similar to the tensile test and all the mechanical properties determined in the tensile test can be determined. When an axial compressive load ‘W’ is applied on a spring, every section of spring wire is subjected to a twisting moment W X R, Where ‘R’ is the mean radius of the coil. If’ ð’ is the deflection of spring due to compressive load then, the stiffness of the spring,

K = w/ ð

For a closely coiled helical spring.

$$\delta = \frac{64wR^3n}{Gd^4}$$

where,

δ = Deflection of the spring

W= Load applied

R = Mean radius of the coil

G = modulus of Rigidity

D= Diameter of the wire of the coil

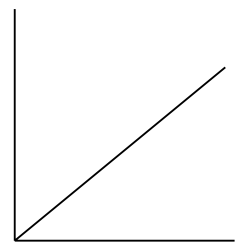
N= No. of terns of the spring.

From the above expression for a given spring, ‘G’ can be determined by measuring under a particular load ‘W

GRAPH:

A graph between Load Vs deflection is drawn. From the graph at a particular value of W the corresponding value of (δ)is noted. By using this values of **G** is calculated.

Load(w)



Deflection (δ)

RESULT:

Stiffness of the spring K =....................N/mm

Modulus of rigidity, G = ... N/mm^2

STUDY OF UNIVERSAL TESTING MACHINE

AIM: -

Study of Universal Testing Machine (U.T.M.)

OBJECT: -

To Study the various component parts of the Universal Testing Machine (U.T.M.) & test procedures of various practical's to be performed

APPARATUS:

Universal Testing Machine with all attachment i.e. shears test attachment, bending attachment, tension grips, compression test attachment etc

THEORY : - The Universal Testing Machine consists of two units.

1) Loading unit,
2) Control panel.

LOADING UNIT:-

It consists of main hydraulic cylinder with robust base inside. The piston which moves up and down. The chain driven by electric motor which is fitted on left hand side. The screw column maintained in the base can be rotated using above arrangement of chain. Each column passes through the main nut which is fitted in the lower cross head.

The lower table connected to main piston through a ball & the ball seat is joined to ensure axial loading. There is a connection between lower table and upper head assembly that moves up and down with main piston. The measurement of this assembly is carried out by number of bearings which slides over the columns.

The test specimen each fixed in the job is known as 'Jack Job'. To fix up the specimen tightly, the movement of jack job is achieved helically by handle.

CONTROL PANEL:-

It consists of oil tank having a hydraulic oil level sight glass for checking the oil level. The pump is displacement type piston pump having free plungers those ensure for continuation of high pressure. The pump is fixed to the tank from bottom. The suction & delivery valve are fitted to the pump near tank Electric motor driven the pump is mounted on four studs which is fitted on the right side of the tank. There is an arrangement for loosing or tightening of the valve. The four valves on control panel control the oil stroke in the hydraulic system. The loading system works as described below.

The return valve is close, oil delivered by the pump through the flow control valves to the cylinder & the piston goes up. Pressure starts developing & either the specimen breaks or the load having maximum value is controlled with the base dynameters consisting in a cylinder in which the piston reciprocates. The switches have upper and lower push at the control panel for the downward & upward movement of the movable head. The on & off switch provided on the control panel & the pilot lamp shows the transmission of main supply.

METHOD OF TESTING:-

Initial Adjustment:

before testing adjust the pendulum with respect to capacity of the test i.e. 8 Tones; 10 Tones; 20 Tones; 40 Tones etc

For ex: **-** A specimen of 6 tones capacity gives more accurate result of 10 Tones capacity range instead of 20 Tones capacity range. These ranges of capacity are adjusted on the dial with the help of range selector knob. The control weights of the pendulum are adjusted correctly. The ink should be inserted in pen holder of recording paper around the drum & the testing process is started depending upon the types of test as mentioned below.

TENSION TEST:-

Select the proper job and complete upper and lower check adjustment. Apply some Greece to the tapered surface of specimen or groove. Then operate the upper cross head grip operation handle & grip the upper end of test specimen fully in to the groove. Keep the lower left valve in fully close position. Open the right valve & close it after lower table is slightly lifted. Adjust the lower points to zero with the help of adjusting knob. This is necessary to remove the dead weight of the lower table. Then lock the jobs in this position by operating job working handle. Then open the left control valve. The printer on dial gauge at which the specimen breaks slightly return back & corresponding load is known as breaking load & maximum load is known as the ultimate load.

COMPRESSION TEST:-

Fix upper and lower pressure plates to the upper stationary head & lower table respectively. Place the specimen on the lower plate in order to grip. Then adjust zero by lifting the lower table. Then perform the test in the same manner as described in tensio

FLEXURAL OR BENDING TEST:-

Keep the bending table on the lower table in such a way that the central position of the bending table is fixed in the central location value of the lower table. The bending suppor