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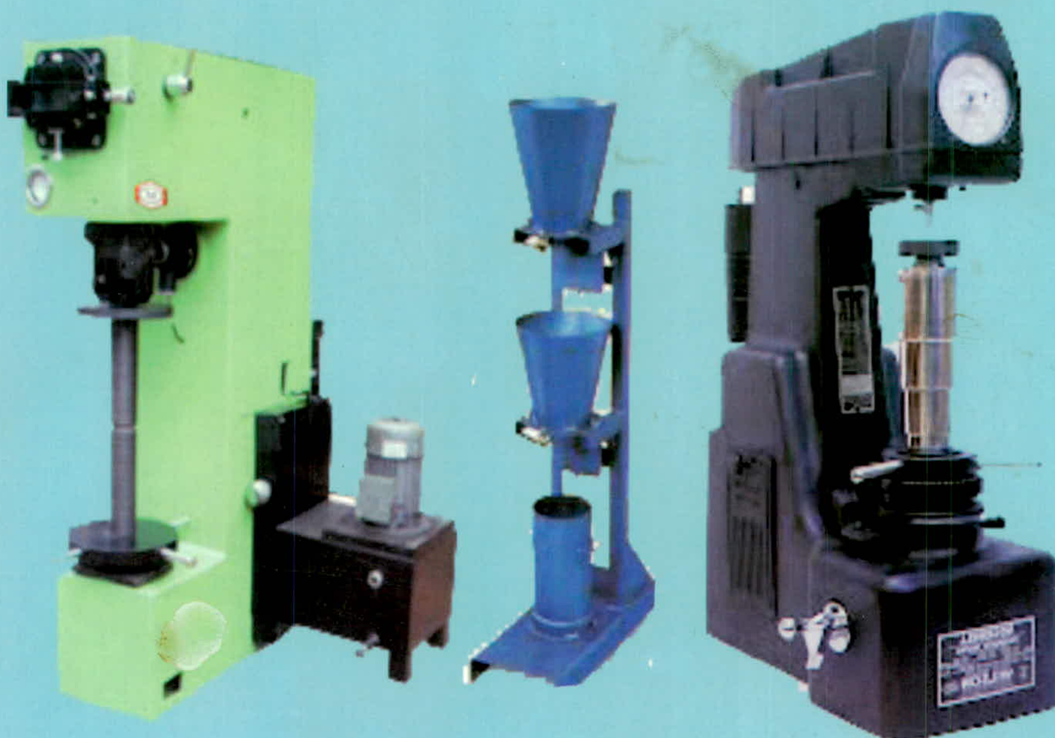
PRACTICAL MANUAL ON STRENGTH OF MATERIALS



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PREFACE

Practical manual on strength of material is written to provide a single source of information for agricultural engineering under graduate students and to provide them a solid base in engineering practical. The main purpose of teaching strength of material to agricultural engineering students is to equip them with understanding of scientific methods so that they may use this knowledge beneficially in their higher pursuits. The authors are highly thankful to all teachers and scientist for their kind co-operation towards speedy preparation of this practical manual. Authors are also indebted to all friends and colleagues, sources who have helped them at every stage for the preparation of this practical manual. Though every care has been taken to avoid any misprint, omission and error; yet the same might have left due to oversight. Authors will personally thank the person who brings to his notice shortcoming and the same will be taken care of for the future edition of the practical manual to make it more useful to the readers.

Raipur
February, 2013

Authors

CONTENT

PRACTICAL NO. 01

TITLE: To determine tensile test on a metal.

OBJECTIVES: To conduct a tensile test on a mild steel specimen and determine the following:

i) Limit of proportionality

ii) Elastic limit

iii) Yield strength

iv) Ultimate strength

v) Young's modulus of elasticity

vi) Percentage elongation

vii) Percentage reduction in area

MATERIAL AND EQUIPMENTS REQUIRED

i. Universal Testing Machine (UTM)
ii. Mild steel specimens
iii. Graph paper
iv. Scale
v. Vernier Caliper

THEORY

The tensile test is most applied one, of all mechanical tests. In this test ends of test piece are fixed into grips connected to a straining device and to a load measuring device. If the applied load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original from as soon as load is removed. However, if the load is too large, the material can be deformed permanently. The initial part of the tension curve which is recoverable immediately after unloading is termed. As elastic and the rest of the curve which represents the manner in which solid undergoes plastic deformation is termed plastic. The stress below which the deformations essentially entirely elastic is known as the yield strength of material. In some material the onset of plastic deformation is denoted by a sudden drop in load indicating both an upper and a lower yield point. However, some materials do not exhibit a sharp yield point. During plastic deformation, at larger extensions strain hardening cannot compensate for the decrease in section and thus the load passes through a maximum and then begins to decrease. This stage the "ultimate strength"' which is defined as the ratio of the load on the specimen to original cross-sectional area, reaches a maximum value. Further loading will eventually cause 'neck' formation and rupture.

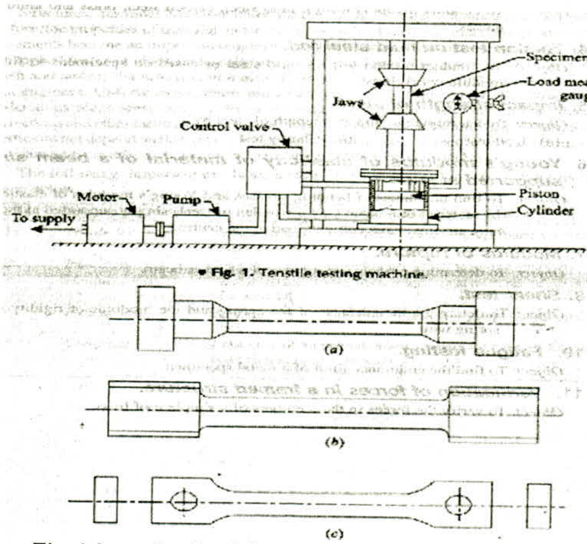


Fig.1 Longitudinal Cross Section of Specimen

PROCEDURE

1. Measure the original length and diameter of the specimen. The length may either be length of gauge section which is marked on the specimen with a preset punch or the total length of the specimen.
2. Insert the specimen into grips of the test machine and attach strain-measuring device to it.
3. Begin the load application and record load versus elongation data.
4. Take readings more frequently as yield point is approached.
5. Measure elongation values with the help of dividers and a ruler.
6. Continue the test till Fracture occurs.

7. By joining the two broken halves of the specimen together, measure the final length and diameter of specimen.

FORMULA USED

$$\text{Limit of proportion} = \frac{\text{Load at limit of proportionality}}{\text{Original area of cross-section}} = \ldots\ldots\ldots\ldots\text{N/mm}^2$$

$$\text{Elastic limit} = \frac{\text{Load at elastic limit}}{\text{Original area of cross-section}} = \ldots\ldots\ldots\ldots\ldots\ldots\text{N/mm}^2$$

$$\text{Yield strength} = \frac{\text{yield load}}{\text{Original area of cross-section}} = \ldots\ldots\ldots\text{N/mm}^2$$

$$\text{Ultimate strength} = \frac{\text{Maximum tensile load}}{\text{Original area of cross-section}} = \ldots\ldots\ldots\text{N/mm}^2$$

$$\text{Young's modulus} = \frac{\text{Stress below propornality limit}}{\text{Corresponding strain}} = \ldots\ldots\ldots\text{N/mm}^2$$

$$\text{Percentage elongation} = \frac{\text{Final length (at fracture)} - \text{original length}}{\text{original length}} = \ldots\ldots\ldots\%$$

$$\text{Percentage reduction in area} = \frac{\text{original area} - \text{area at fracture}}{\text{original area}} = \ldots.\%$$

OBSERVATIONS

A.Original dimensions of material (before testing)

Length = -----------

Diameter = ---------

Area = -------------

B. Final Dimensions of material (after testing)

Length = ----------------

Diameter = ----------------

Area = ----------------------

Observation table:-

S.N.	Load (N)	Original Gauge length	Extension (mm)	Load =Stress /Area (N/mm^2)	Strain=Increase in length/Original length
1.					
2.					
3.					
4.					
5.					

Results

Average Breaking Stress = ……………………

Ultimate Stress = ……………………

Average % Elongation =

PRECAUTIONS

1. If the strain measuring device is an extensometer it should be removed before necking begins.
2. Measure deflection on scale accurately & carefully.

PRACTICAL NO. 02

TITLE - To find the compressive strength of given specimen.

MATERIAL AND EQUIPMENT REQUIRED

- Universal testing machine,
- Compression pads and
- Specimen.

THEORY

This is the test to know strength of a material under compression. Generally compression test is carried out to know either simple compression characteristics of material or column action of structural members. It has been observed that for varying height of member, keeping cross-sectional and the load applied constant, there is an increased tendency towards bending of a member. Member under compression usually bends along minor axis, i.e, along least lateral dimension. According to column theory slenderness ratio has more functional value. If this ratio goes on increasing, axial compressive stress goes on decreasing and member buckles more and more. End conditions at the time of test have a pronounced effect on compressive strength of materials. Effective

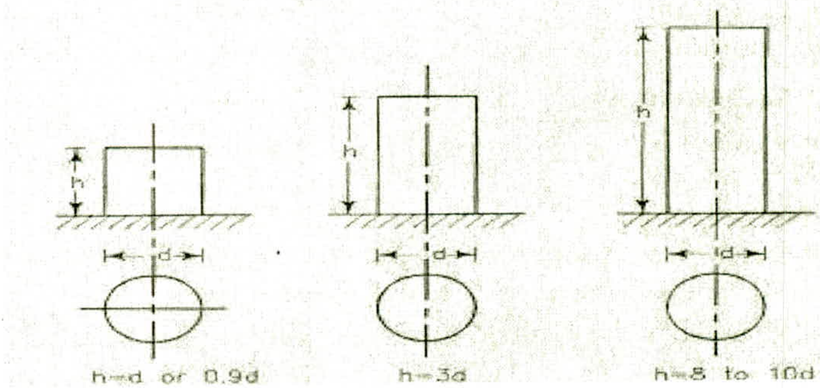


Fig.2. Types of specimen

length must be taken according to end conditions assumed, at the time of the test. As the ends of the member is made plain and fit between two jaws of the machine, fixed end is assumed for calculation of effective length. Effective length is taken as 0.5 L where L is actual length of a specimen.

PROCEDURE

1 Place the specimen in position between the compression pads.
2. Switch on the UTM
3. Bring the drag indicator in contact with the main indicator.
4. Select the suitable range of loads and space the corresponding weight in the pendulum and balance it if necessary with the help of small balancing weights
5. Operate (push) the button for driving the motor to drive the pump.
6. Gradually move the head control ever in left hand direction till the specimen fails.
7. Note down the load at which the specimen shears.
8. Stop the machine and remove the specimen.
9. Repeat the experiment with other specimens.

OBSERVATION

Cross sectional area of the specimen perpendicular to the load=A=......mm^2
Load taken by the specimen at the time of failure, W=. ......(N)
Strength of the pin against shearing (s) = [W/A] ....N/mm^2

RESULT

Compressive strength of the specimen ....N/mm^2

PRECAUTIONS

1. Place the specimen at center of compression pads,
2. Stop the UTM as soon as the specimen fails.
3. Cross sectional area of specimen for compression test should be kept large as compared to the specimen for tension test: to obtain the proper degree of stability.

PRACTICAL NO. 03

TITLE:- To perform bending test

MATERIAL AND EQUIPMENT REQUIRED

1. Universal testing machine
2. Beam of different cross sections and materials (say wood or steel)

THEORY

If a beam is simply supported at the ends and carries a concentrated load at the center, the beam bends concave upwards. The distance between the original position of the beam and its position after bending is different at different points (fig) along the length if the beam, being maximum at the center in this case. This difference is called 'deflection'.

In this type of loading the maximum amount of deflection is given by the relation,

$$\delta = \frac{Wl^3}{48\,EI}$$

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 = Moment of inertia of the beam, about the neutral axis, mm^4

δ= Deflection due to load.

Bending stress:

As per bending equation,

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

Where

M = bending moment, Nmm

I = moment of inertia, mm^4

σ_b = Bending stress, N/mm^2

y = distance of the fiber of the beam from the neutral axis, mm

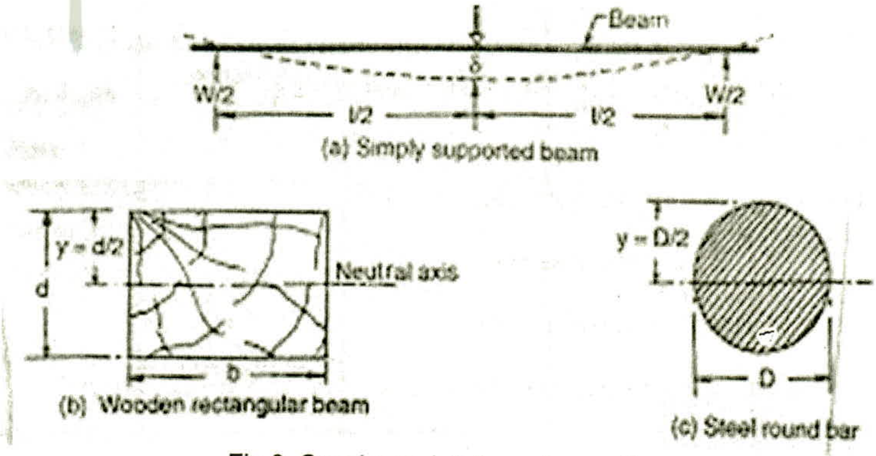


Fig.3. Specimen details and mounting

PROCEDURE

1 Adjust the supports alone the UTM bed so that they are symmetrically with respect to the length of the bed.
2. Place the beam on the knife edges on the blocks 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. Apply a load and again note the reading of the vernier scale.
5. Go on taking reading applying load in steps each time till you have minimum 6 readings.
6. Find the deflection (d) in each time by subtracting the initial reading of vernier scale.
7. Draw a graph between load (W) and deflection (d). On the graph choose any two convenient points and between these points find the corresponding values of W and d. putting these values in the relation.

$$\delta = \frac{Wl^3}{48\,EI}$$

Calculate the value of E.
8. Calculate the bending stresses for different loads using relation $M/I = \sigma_b/y$ given in the observation table.
9. Repeat the experiment for different beams.

OBSERVATION

Width of the beam=.........mm (for rectangular cross section)

Depth of the beam D=...mm (for circular cross section)

Moment of inertia of rectangular section= $bd^3/12$=.........mm^4

Moment of inertia of circular section =.........mm^4

Initial reading of the vernier= ....mm

(It should be subtracted from the reading taken after putting the load)

OBESERVATION TABLE

S. No	Load W(N)	Bending Moment $M = Wl/4$	Bending stress $\frac{M}{I} = \frac{\sigma_b}{y}$	Deflection $\delta(mm)$ $\delta = \frac{Wl^3}{48\,EI}$	Young's modulus of elasticity $E = \frac{Wl^3}{48\,\delta I}$ (N/mm^2)

RESULT:

a. Bending stress...........units

b. Young's modulus.........units

PRECAUTIONS

1 Make sure that the beam and load is placed at the proper position.

2. Cross section of the beam should be large.

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

PRACTICAL NO. 04

TITLE - To determined young's modulus of elasticity of a material in case of beam is simply supported (SSB) at both the ends.

MATERIAL AND EQUIPMENT REQUIRED

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

THEORY

If a beam is simply supported at the both the ends and carries a concentrated load at its centre, the beam bends concave from upwards. The distance between the original position of the beams and its position after bending at different points along the length of the beam, being maximum at the centre 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,

$$\delta_{SSB} = \frac{Wl^3}{48EI} \text{ .... (i)}$$

$$E_{SSB} = \frac{wl^3}{48\ \delta I} \text{------------- (ii)}$$

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 = Moment of Inertia of the beam, about the neutral axis, $mm.^4$

SSB= simply supported beam

BENDING STRESS

As per bending equation,

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

Where,

M = Bending moment, N-mm

I = Moment of inertia, mm^4

σ_b = Bending stress, N/mm^2, and

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

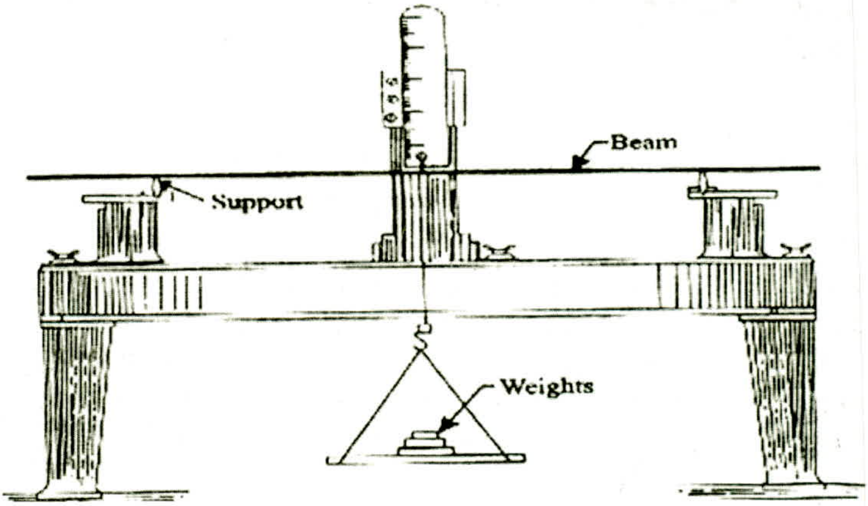


Fig.4.1:-Arrangement of beam with weights

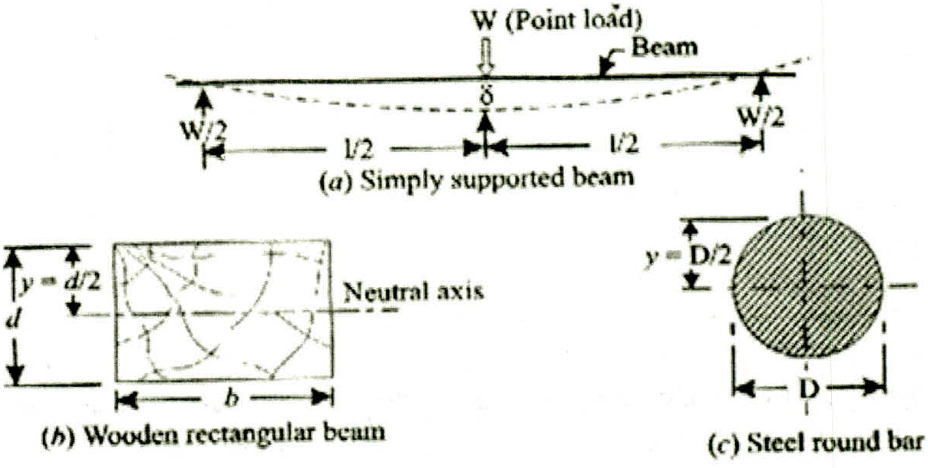


Fig.4.2.Different section of beam with typical cross section

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 centre 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

$$\delta = \frac{Wl^3}{48EI}$$

   Calculate the value of E
8. Calculate the bending stresses for different loads using relation

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

   As given in the observation table

OBESERVATION TABLE

S. No.	Load W (N)	Bending moment $M = Wl/4$	Bending Stress $\frac{M}{I} = \frac{\sigma_b}{y}$	Deflection, δ (mm) $\delta = \frac{Wl^3}{48\,EI}$	Young's Modulus of elasticity, $E = \frac{Wl^3}{48\,\delta I}$
1					
2					
3					
4					

RESULT

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

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

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.

PRACTICAL NO. 05

TITLE:- To study behavior of material under torsion

MATERIALS AND EQUIPMENTS REQUIRED

1. A torsion testing apparatus,
2. Standard specimen of mild steel or cast iron.
3. Twist meter for measuring angles of twist
4. A steel rule and calipers and micrometer.

THEORY

A torsion test is quite instrumental in determining the value of rigidity (ratio of shear stress to shear strain) of a metallic specimen. The value of modulus of rigidity can be found out through observations made during the experiment by using the torsion equation:

$$\frac{T}{I_p} = \frac{C\theta}{L}$$

Where,

T = Torque applied,

Ip = Polar moment of inertia,

C = Modulus of rigidity,

θ = Angle of twist (radians), and

L = Gauge length.

In the torque equipment refer fig. One end of the specimen is held by a fixed support and the other end to a pulley. The pulley provides the necessary torque to twist the rod by addition of weights (w). The twist meter attached to the rod gives the angle of twist.

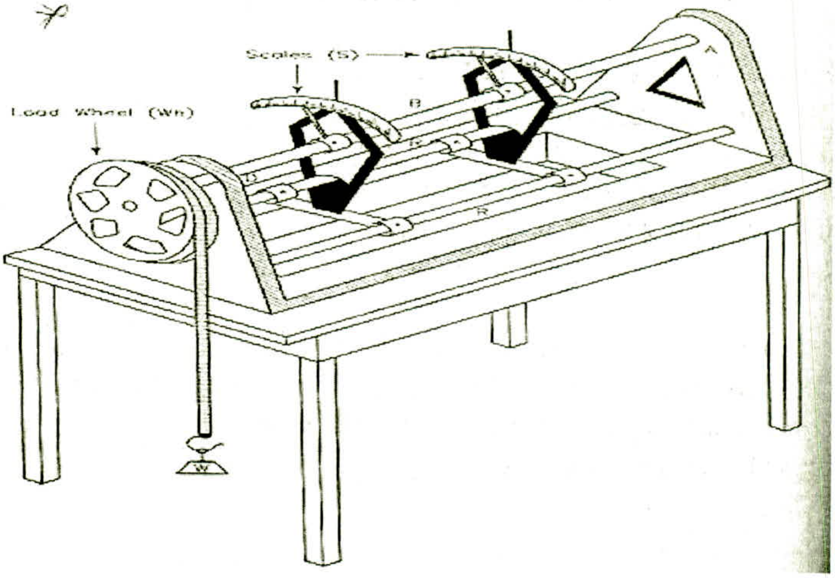


Fig.5.Torsion equipment assembly

PROCEDURE

1. Prepare the testing machine by fixing the two twist meters at some constant lengths from fixed support.
2. Measure the diameter of the pulley and the diameter of the rod.
3. Add weights in the hanger stepwise to get a notable angle of twist for T_1 and T_2
4. Using the above formula calculate C value.

RESULT

Modulus of rigidity of the shaft is ------------------------

PRACTICAL NO. 06

TITLE : To determine the stiffness of the spring and modulus of rigidity of the spring wire

MATERIALS AND EQUIPMENTS REQUIRED

i) Spring testing machine.

ii) A spring

iii) Vernier caliper, Scale.

iv) 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. The spring is usually made of either high carbon steel (0.7 to 1.0%) or medium carbon alloy steels. Phosphor bronze, brass, 18/8 stainless steel and Monel and other metal alloys are used for corrosion resistance spring. 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 idealize complex structural systems by suitable spring.

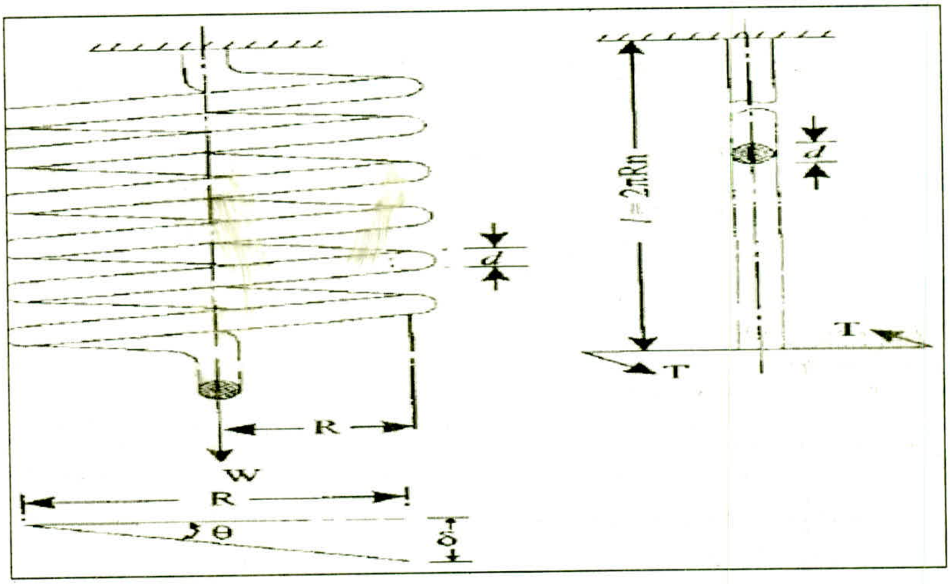


Fig.6. Typical section of spring

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.

OBESERVATION

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 =

Axial load on spring=

OBESERVATION TABLE

S.No.	Load, W (N)	Deflection, (δ) (mm)	Stiffness, K = W / δ (N / mm)

Mean k = ……

Modulus of rigidity

$$K = W/\delta = \frac{Cd^4}{64R^3n}$$

d = Diameter of spring wire

R = Mean radius of spring coil

n = No. of turns of coils

C = Modulus of rigidity of spring

W = Axial load on spring

δ = deflection of spring, as a result of axial load.

RESULT

The value of spring constant k of closely coiled helical spring is found to be------------ N / mm

PRECAUTIONS

1. The dimension of spring was measured accurately.
2. Deflection obtained in spring was measured accurately.

PRACTICAL NO. 07

TITLE : To determine the hardness of the given specimen using Rockwell hardness test.

MATERIALS AND EQUIPMENTS REQUIRED

Rockwell hardness testing machine.

Black diamond cone indenter,

Hard steel specimen.

THEORY

Rockwell test is an indentation test used for smaller specimens and harder materials. The test is subject of IS: 1586.In this test indenter is forced into the surface of a test piece in two operations, measuring the permanent increase in depth of an indentation from the depth increased from the depth reached under a datum load due to an additional load. Measurement of indentation is made after removing the additional load. Indenter used is the cone having an angle of 120 degrees made of black diamond.

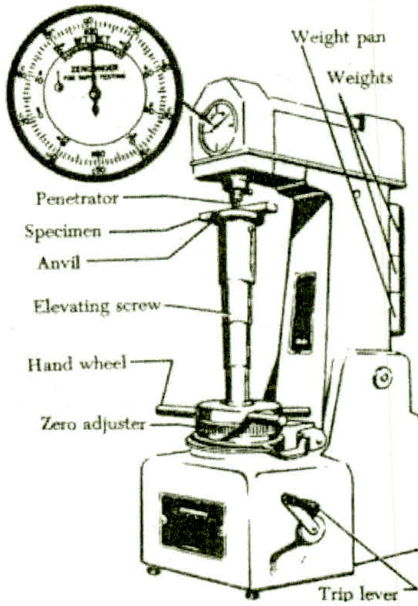


Fig.7. Rockwell hardness tester.

PROCEDURE

1. Examine hardness testing machine.
2. Place the specimen on platform of a machine. Using the elevating screw raise the platform and bring the specimen just in contact with the ball. Apply an initial load until the small pointer shows red mark.
3. Release the operating valve to apply additional load. Immediately after the additional load applied, bring back operating valve to its position.
4. Read the position of the pointer on the C scale, which gives the hardness number.

5. Repeat the procedure five times on the specimen selecting different points for indentation.

OBSERVATION

1. Take average of five values of indentation of each specimen.
2. Obtain the hardness number from the dial of a machine.
3. Compare Brinell and Rockwell hardness tests obtained.

RESULT:-

Rockwell hardness of given specimen is............

PRECAUTIONS

1. Thickness of the specimen should not be less than 8 times the depth of indentation to avoid the deformation to be extended to the opposite surface of a specimen.
2. Indentation should not be made nearer to the edge of a specimen to avoid unnecessary concentration of stresses. In such case distance from the edge to the center of indentation should be greater than 2.5 times diameter of indentation.
3. Rapid rate of applying load should be avoided. Load applied on the ball may rise a little because of its sudden action. Also rapidly applied load will restrict plastic flow of a material, which produces effect on size of indentation.

PRACTICAL NO. 08

TITLE : To determine the hardness of the given specimen using Brinell hardness test.

MATERIALS AND EQUIPMENTS REQUIRED

Brinell hardness tester, Aluminum specimen, Ball indenter.

THEORY

Hardness of a material is generally defined as Resistance to the permanent indentation under static and dynamic load. When a material is required to use under direct static or dynamic loads, only indentation hardness test will be useful to find out resistance to indentation. In Brinell hardness test, a steel ball of diameter (D) is forced under a load (F) on to a surface of test specimen. Mean diameter (d) of indentation is measured after the removal of the load (F).

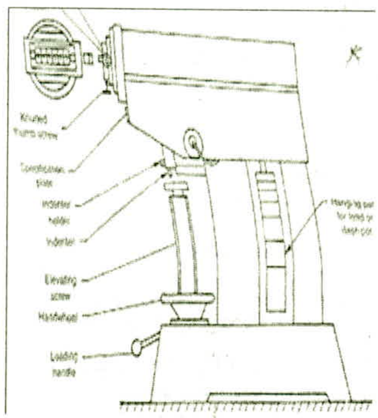


Fig.8. Brinell hardness tester

PROCEDURE

1. Load to be applied for hardness test should be selected according to the expected hardness of the material. However test load shall be kept equal to 30 times the square of the diameter of the ball (diameter in mm)

   $$F = 30\ D^2$$

   Where ball diameter, generally taken as 10 mm.

   For guidelines hardness range for standard loads given below.

Table: Hardness range for standard loads

Ball diameter	Load (kg)	Range of Brinell hardness
10	3000	96 to 600
	1500	48 to 300
	500	16 o 100

2. Apply the load for a minimum of 15 seconds to 30 seconds. [if ferrous metals are to be tested time applied will be 15 seconds and for softer metal 30 seconds.
3. Remove the load and measure the diameter of indentation nearest to 0.02 mm using microscope (projected image)
4. Calculate Brinell hardness number (HB). As per IS: 1500.
5. Brinell hardness number

$$BHN = \frac{2L}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

Where

D=diameter of ball indenter.

d = diameter of indentation.

L= applied load Hardness numbers normally obtained for different materials are given below (under 3000 kg and 10 mm diameter ball used)

Table:-Applied load Hardness numbers normally obtained for different materials

Ordinary steels medium carbon	100 to 500
Structural steel	130 to 160
Very hard steel	800 to 900

Note: Brinell test is not recommended for then materials having HB over 630. It is necessary to mention ball size and load with the hardness test when standard size of ball and load are not used. Because indentation done by different size of ball and load on different materials are not geometrically similar. Ball also undergoes deformation when load is applied. Material response to the load is not same all the time.

6. Brinell hardness numbers can be obtained from tables 1 to 5 given in IS: 1500, Knowing diameter of indentation, diameter of the ball and load applied.

OBSERVATION

1. Take average of five values of indentation of each specimen. Obtain the hardness number from equation.
2. Compare Brinell and Rockwell hardness tests obtained

RESULT

The Brinell hardness number of the specimen is

PRECAUTIONS

1. Thickness of the specimen should not be less than 8 times the depth of indentation to avoid the deformation to be extended to the opposite surface of a specimen.
2. Indentation should not be made nearer to the edge of a specimen to avoid unnecessary concentration of stresses. In such case distance from the edge to the center of indentation should be greater than 2.5 times diameter of indentation.
3. Rapid rate of applying load should be avoided. Load applied on the ball may rise a little because of its sudden action. Also rapidly applied load will restrict plastic flow of a material, which produces effect on size of indentation.
4. Surface of the specimen is well polished, free from oxide scale and any foreign material.

PRACTICAL NO:-09

TITLE : To determine the Impact toughness (strain energy) through Izod test.

MATERIALS AND EQUIPMENTS REQUIRED

1. Impact testing machine.(fig.9.1,9.2)
2. Specimen and v notch is shown in the fig9.3. Size of the specimen is 10mm X 10mm X 75mm

MOUNTING OF THE SPECIMEN

1 Specimen is clamped to act as vertical cantilever with the notch on tension side.

2 Direction of blow of hammer is shown in Fig 9.1. Direction of blow is shown in Fig. 9.2

THEORY

In an impact test a specially prepared notched specimen is fractured by a single blow from a heavy hammer and energy required being a measure of resistance to impact. Impact load is produced by a swinging of an impact weight W (hammer) from a height h. Release of the weight from the height h swings the weight through the arc of a circle, which strikes the specimen to fracture at the notch . Kinetic energy of the hammer at the time of impact is mv 2 /2, which is equal to the relative potential energy of the hammer before its release. (mgh),where m is the mass of the hammer and v = 2 *gh* is its tangential velocity at impact, g is gravitational acceleration (9.806 m/s 2) and h is the height through which hammer falls. Impact velocity will be 5.126 m/s or slightly less. Here it is interesting to note that height through which hammer drops determines the velocity and height and mass of a hammer combined determine the energy. Energy used can be measured from the scale given. The difference between potential energies is the fracture energy. In test machine this value indicated by the pointer on the scale. If the scale is calibrated in energy units, marks on the scale should be drawn keeping in view angle of fall () and angle of rise (. Height h1 and h2 equals, h1= R (1cosq) and h2= (1cosq). With the increase or decrease in values, gap between marks on scale showing energy also increase or decrease. This can be seen from the attached scale with any impact machine.

Energy used in fracturing the specimen can be obtained approximately as Wh1Wh2 This energy value called impact toughness or impact value, which will be measured, per unit area at the notch. Izod introduced Izod test in 1903. Test is as per the IS: 1598 Charpy introduced Charpy test in 1909. Test is as per the IS: 1499.

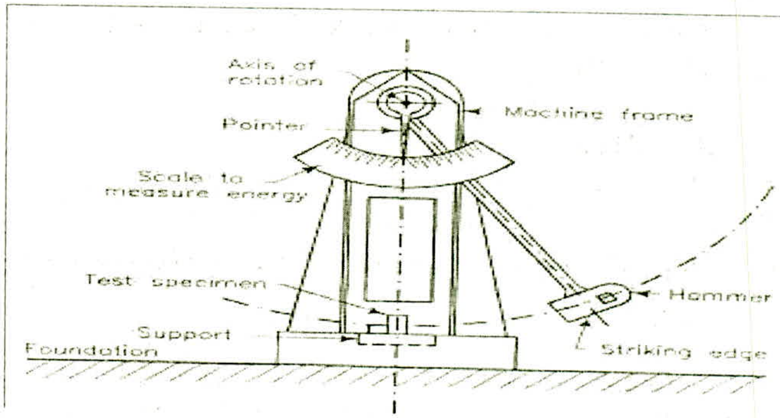


Fig.9.1 Izod Impact testing equipment

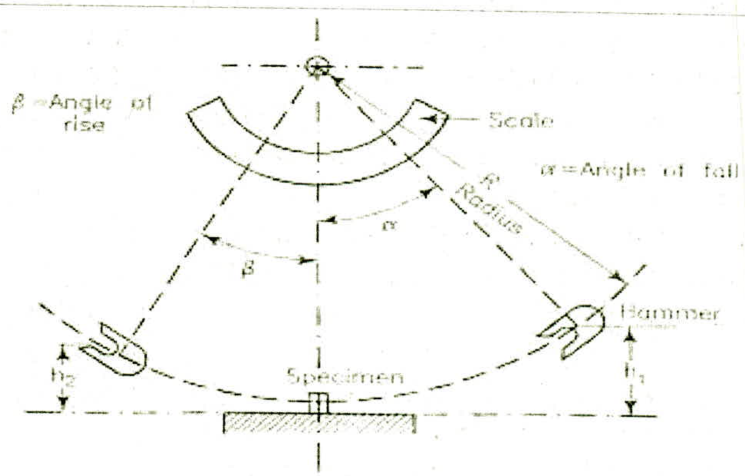


Fig.9.2.Schematic impact testing

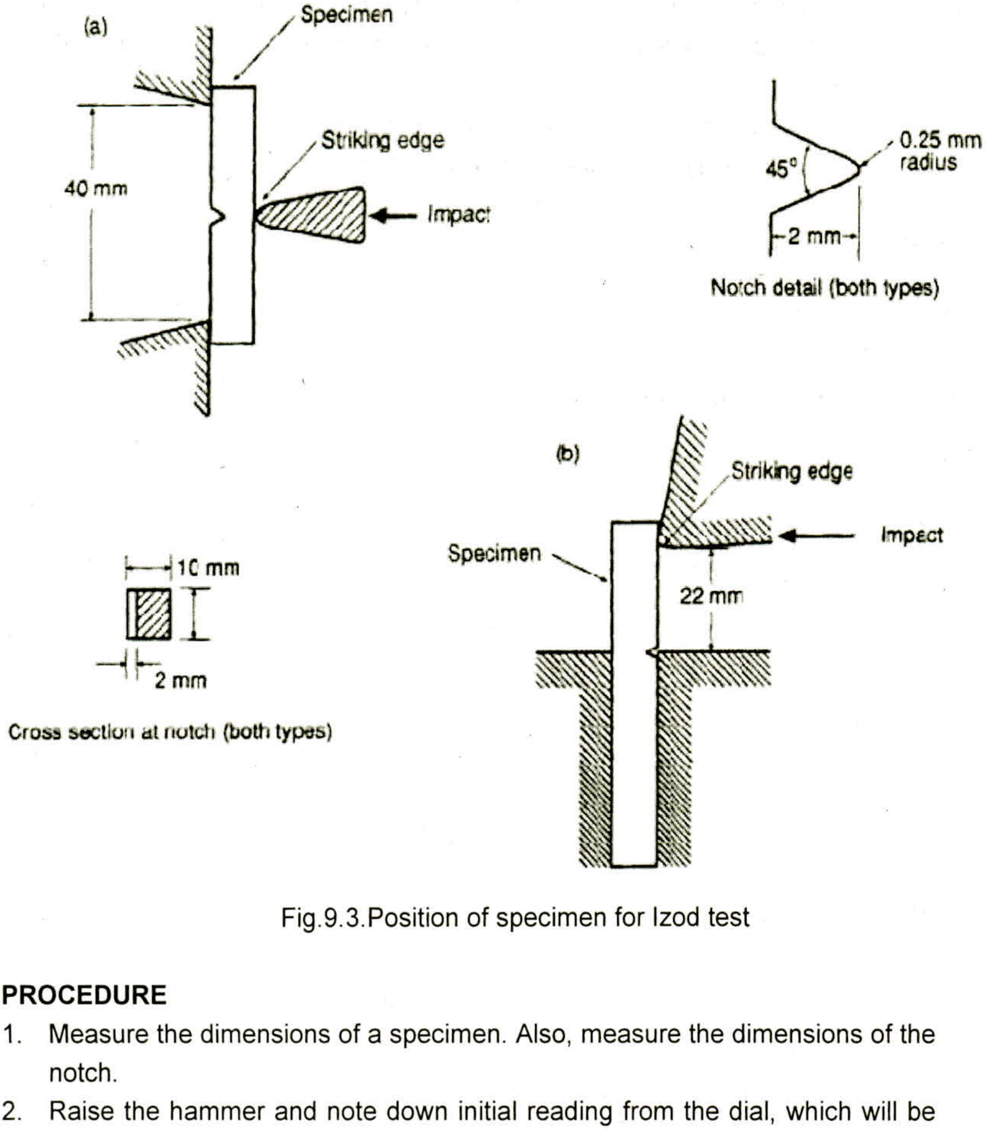


Fig.9.3.Position of specimen for Izod test

PROCEDURE

1. Measure the dimensions of a specimen. Also, measure the dimensions of the notch.
2. Raise the hammer and note down initial reading from the dial, which will be energy to be used to fracture the specimen.

3. Place the specimen for test and see that it is placed center with respect to hammer. Check the position of notch.
4. Release the hammer and note the final reading. Difference between the initial and final reading will give the actual energy required to fracture the specimen.
5. Repeat the test for specimens of other materials.
6. Compute the energy of rupture of each specimen.

OBSERVATION

Initial reading of dial -------------------- and final reading of the dial ----------------.

RESULT

Strain energy of given specimen is --------------------

PRACTICAL NO. 10

TITLE : To determine the Impact toughness (strain energy) through charpy test.

MATERIALS AND EQUIPMENTS REQUIRED

1. Impact testing machine. (Fig.10.1)
2. U notch is cut across the middle of one face as shown

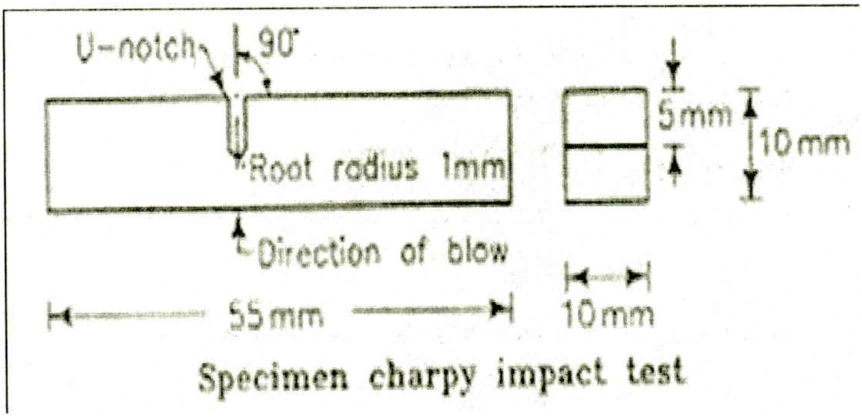


Fig.10.1.Charpy impact testing equipment

MOUNTING OF SPECIMEN

Specimen is tested as a beam supported at each end. Hammer is allowed to hit then specimen at the opposite face behind the notch.

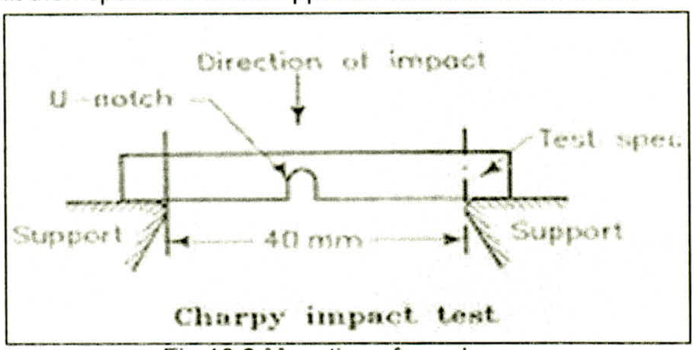


Fig.10.2.Mounting of specimen

PROCEDURE

1. Measure the dimensions of a specimen. Also, measure the dimensions of the notch.
2. Raise the hammer and note down initial reading from the dial, which will be energy to be used to fracture the specimen.
3. Place the specimen for test and see that it is placed center with respect to hammer. Check the position of notch.
4. Release the hammer and note the final reading. Difference between the initial and final reading will give the actual energy required to fracture the specimen.
5. Repeat the test for specimens of other materials.
6. Compute the energy of rupture of each specimen.

OBSERVATION

Initial and final reading of the dial --------------------- & ----------------------.

RESULT

Strain energy of given specimen is ------------------------

PRACTICAL NO. - 11

TITLE :- To measure the consistency of concrete by using slump cone and also find the workability.

MATERIALS AND EQUIPMENTS REQUIRED

Slump cone, tamping rod, metallic sheet, Scale for measurement.

THEORY

The concrete slump test is used for the measurement of a property of fresh concrete. The test is an empirical test that measures the workability of fresh concrete. More specifically, it measures consistency between batches. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test result is a measure of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

Types of Slump

The slumped concrete takes various shapes, and according to the profile of slumped concrete, the slump is termed as;

1. Collapse Slump
2. Shear Slump
3. True Slump

Collapse Slump

In a collapse slump the concrete collapses completely. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which slump test is not appropriate.

Shear Slump

In a shear slump the top portion of the concrete shears off and slips sideways.

OR

If one-half of the cone slides down an inclined plane, the slump is said to be a shear slump.

I. If a shear or collapse slump is achieved, a fresh sample should be taken and the test is repeated.

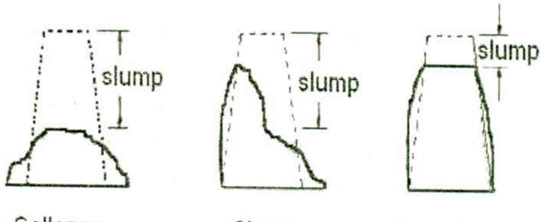
II. If the shear slump persists, as may the case with harsh mixes, this is an indication of lack of cohesion of the mix.

True Slump

In a true slump the concrete simply subsides, keeping more or less to shape

I. This is the only slump which is used in various tests.

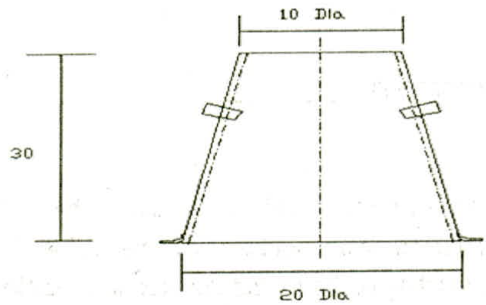
II. Mixes of stiff consistence have a Zero slump, so that in the rather dry range no variation can be detected between mixes of different workability.

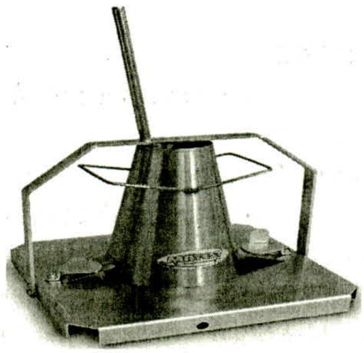


Types of slump

Table: Workability, Slump and Compacting Factor of concrete with 19 or 38 mm (3/4 or $1^1/_2$ in) maximum size of aggregate.

Degree of workability	Slump		Compacting Factor	Use for which concrete is suitable
	mm	in		
Very low	0-25	0-1	0.78	Very dry mixes; used in road making. Roads vibrated by power operated machines.
Low	25-50	1-2	0.85	Low workability mixes; used for foundations with light reinforcement. Roads vibrated by hand operated Machines.
Medium	50-100	2-4	0.92	Medium workability mixes manually compacted flat slabs using crushed aggregates. Normal reinforced concrete manually compacted and heavily reinforced sections with vibrations.
High	100-175	4-7	0.95	High workability concrete; for sections with congested reinforcement. Not normally suitable for vibration





PROCEDURES

1. The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.
2. The mould is placed on a smooth, horizontal rigid and non – absorbent surface.
3. The mould is then filled in four layers each approximately ¼ of the height of the mould.
4. Each layer is tamped 25 times rod taking care to distribute the strokes evenly over the cross section. After the top layer has been rodded, the concrete is struck off level with a trowel and tamping rod.
5. The mould is removed from the concrete immediately by raising it slowly and carefully in a vertical direction.
6. This allows the concrete to subside. This subside is referred as slump of concrete.
7. The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm is taken as slump of concrete.
8. The pattern of slump indicates the characteristics of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the

subsidence. Shear slump also indicates that the concrete is non-cohesive and shows the characteristic of segregation.

RESULT

The slump value of the concrete is ___________

PRECAUTIONS

In order to reduce the influence on slump of the variation in the surface friction, the inside of the mould and its base should be moistened at the beginning of every test, and prior to lifting of the mould the area immediately around the base of the cone should be cleaned from concrete which may have dropped accidentally.

PRACTICAL NO. 12

TITLE - To measure the workability of concrete by compaction factor test.

MATERIALS AND EQUIPMENTS REQUIRED

Compaction factor test apparatus

PROCEDURE:-

1. The sample of concrete to be tested is placed in the upper hopper up to the brim. The trap-door is opened so that the concrete falls into the lower hopper.
2. Then the trap-door of the lower hopper is opened and the concrete is allowed to fall in to the cylinder. In the case of a dry-mix, it is likely that the concrete may not fall on opening the trap-door
3. In such a case, a slight poking by a rod may be required to set the concrete in motion. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades.
4. The outside of the cylinder is wiped clean. The concrete is filled up exactly up to the top level of the cylinder.
5. It is weighed to the nearest 10 grams. This weight is known as " weight of partially compacted concrete"
6. The cylinder is emptied and then refilled with the concrete from the same sample in layers approximately 5cm deep. The layers are heavily rammed or preferably vibrated so as to obtain full compaction. The top surface of the fully compacted concrete is then carefully struck off level with the top of the cylinder and weighed to the nearest 10 gm. This weight is known as " weight of fully compacted concrete"

$$\text{The compaction factor} = \frac{\text{Weight of partially compacted concrete}}{\text{Weight of fully compacted concrete}}$$

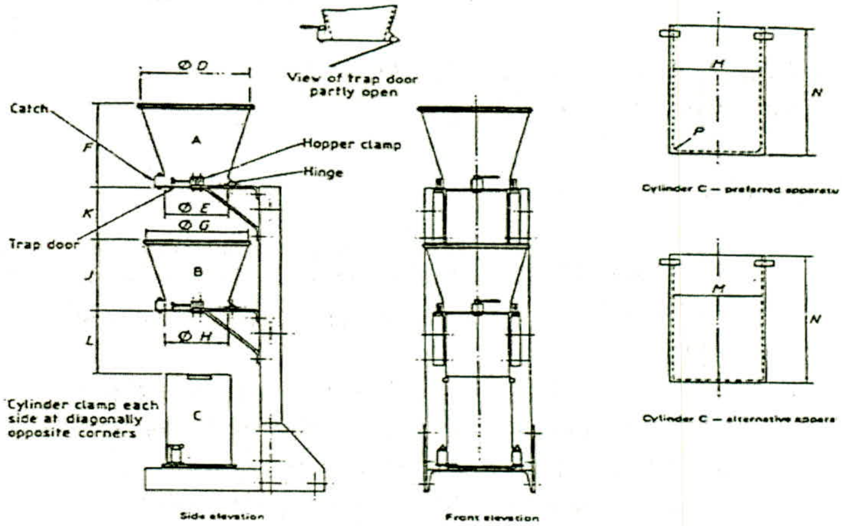


Fig.12. Compaction factor apparatus

OBSERVATION TABLE

Mass of cylinder W_1:

Sl. no	Water Cement ratio	Mass with partially compacted concrete (W2)	Mass with fully compacted concrete (W3)	Mass with Partially compacted concrete (W2 – W1)	Mass with fully compacted concrete (W3 – W1)	C.F= (W2-W1)/ (W3-W1)

RESULT:- The compaction factor of the given sample of concrete is_______________%

PRACTICAL NO:- 13

TITLE : To determine the cube strength of the concrete from given properties

MATERIALS AND EQUIPMENTS REQUIRED

Moulds for the test cubes, tamping rods or table vibrator.

PROCEDURE:-

1. Calculate the material required for preparing the concrete of given proportions
2. Mix them thoroughly in mechanical mixer until uniform colour of concrete is obtained
3. Pour concrete in the oiled with medium viscosity oil. Fill concrete is cube moulds in two layers each of approximately 75mm and ramming each layer with 35 blows evenly distributed over the surface of layer.
4. Fill the moulds in 2 layers each of approximately 50mm deep and ramming each layer heavily.
5. Struck off concrete flush with the top of the moulds.
6. Immediately after being made, they should be covered with wet mats.
7. Specimens are removed from the moulds after 24hrs and cured in water 28 days
8. After 24hrs of casting, cylinder specimens are capped by neat cement paste 35 percent water content on capping apparatus. After 24 hours the specimens are immersed into water for final curing.
9. Compression tests of cube and cylinder specimens are made as soon as practicable after removal from curing pit. Test-specimen during the period of their removal from the curing pit and till testing, are kept moist by a wet blanket covering and tested in a moist condition.
10. Place the specimen centrally on the location marks of the compression testing machine and load is applied continuously, uniformly and without shock.
11. Also note the type of failure and appearance cracks.

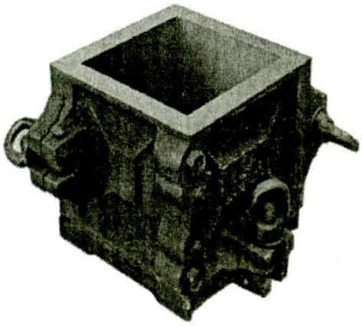


Fig.13.1.Cube mould (15 cm^3)

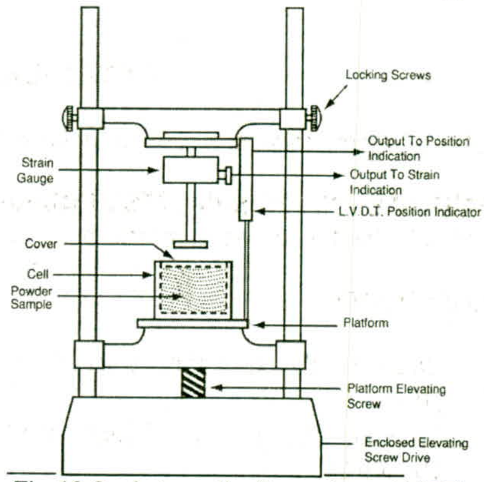


Fig.13.2. Automatic (based on LVDT) compression testing machine

OBSERVATION

Specimen	Trials			Mean Value N/mm^2
	1	2	3	
Load on cubes, KN				

RESULT

The compressive strength of cement concrete is ______________ N/mm^2

PRACTICAL NO:- 14

TITLE - To determine Bulk density and Voids

MATERIALS AND EQUIPMENTS REQUIRED

Measure, tamping rod, shovel or scoop.

PROCEDURE

1. The measure is filled to with thoroughly mixed aggregates to about one-third and tamped with 25 stroke of rounded end of tamping rod.
2. A further same quantity of aggregates is added with further tamping of 25 times and surplus aggregates is stuck off, using the temping rod as a straight edge. The net weight of the aggregate is determined and the bulk density is calculated.
3. The measure is then filled to over flowing by the means of shovel or scoop, the aggregate being discharged from the height not exceeding 50mm above the top of the measure.
4. The surface of the aggregate is then leveled with straight edge. The net weight of the aggregate in the measure is determined and the bulk density is calculated.
5. The percentage of voids are calculated as follows:

Percentage of voids=

$$\frac{Gs - \gamma}{Gs} x\, 100$$

Where,

Gs=specific gravity of aggregates.

γ =bulk density in kg/ litre.

RESULT

The percentage of voids is……………

The bulk density is………………