MATERIAL TESTING LABORATARY MANUAL

CIVIL ENGINEERING

SUB CODE-414

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Instructions.1.
Write observations, tables, diagrams, Specimen calculations in the blank left side of the journal and others to the right.

ROCKWELL HARDNESS TEST

Experiment No.1
DATE :

AIM

To determine the hardness 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 developed by the Wilson instrument co U.S.A in 1920.
This 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.

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.

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. Obtain the hardness number from the dial of a machine.
2. Compare Brinell and Rockwell hardness tests obtained.

Sl no	material	Diameter of the indenter	Scale reading	Average scale reading	Rock well hardness number

RESULT

Rock well hardness :

BRINELL HARDNESS TEST.

Experiment No.2
Date :

AIM

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

SPECIMEN AND SPECIMEN

Brinell hardness tester
Aluminum specimen
Ball indenter.

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.

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).

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.

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
Ball diameter Load (kg) Range of Brinell hardness
10 3000
1500
500
96 to 600
48 to 300
16 to 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
where D is the diameter of ball indenter and d is the diameter of indentation.
Hardness numbers normally obtained for different materials are given below (under 3000 kg and 10 mm diameter ball used)
Ordinary steels medium
carbon
Structural steel
Very hard steel
100 to 500
130 to 160
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.

Sl no	material	Diameter of the indenter	Scale reading	Average scale reading	Rock well hardness number

RESULT

The Brinell hardness number of the specimen is

IMPACT TEST

Experiment No.3
Date :

AIM

To determine the Impact toughness (strain energy) through Izod test and Charpy test

THEORY

In a 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 (fig..
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 (1cos
q) and h2= (1cos
q).
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.
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a. **Izod test**

SPECIMEN AND EQUIPMENT

1. Impact testing machine.
2. Specimen and v notch is shown in the fig.4. Size of the specimen is 10mm X 10mm X 75mm

Mounting of the specimen:
Specimen is clamped to act as vertical cantilever with the notch on tension side.

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.

Izode test

Material of the specimen =

Length of the specimen =

Breadth of the specimen =

Depth of the specimen =

Initial izode scale reading =

Final izode scale reading =

Impact strength = final izode scale reading – initial izode scale reading

RESULT

Strain energy of given specimen is

Charpy test

Specimen and equipment:

1. Impact testing machine.
2. U notch is cut across the middle of one face

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.

Charpy impact test

Initial energy (j)	Initial reading	Final reading	Energy absorbed (initial – final)

Calculation

Energy absorbed by the specimen =

Volume of the specimen (L x B x D) =

Toughness of the specimen = $\frac{\text{Energy absorbed by the specimen}}{\text{Volume of the specimen}}$

= j/mm^3

RESULT

Strain energy of given specimen is

TENSION TEST

Experiment No.4
Date :

AIM:

To determine the tensile strength of specimen

SPECIMEN AND EQUIPMENTS

Universal testing machine
Specimen Of different ferrous and non ferrous materials

THEORY

The tensile test is most applied one, of all mechanical tests. In this test ends of a test piece are fixed into grips connected to a straining device and to a loadmeasuring 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 position 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 rest of the curve, which represents the manner in which solid undergoes plastic deformation is termed plastic. the stress below which the deformation is essentially entirely elastic is known as the yield strength of material. In some materials (like mild steel) the onset of plastic deformation is denoted by a sudden drop in load indicating both an upper and 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 trough a maximum and then begins to decrease. As this stage the' Ultimate strength ', which is defined as the ratio of the specimen to original cross –sectional area, reaches a maximum value. Further loading will eventually cause 'neck' formation and rupture.

Usually a tension test is conducted at room temperature and the tensile

load is applied slowly. During this test either round or flat specimens (fig.7) may be
used. The round specimens may have smooth, shouldered or threaded ends. The load on the specimen is applied mechanically or hydraulically depending on the type of testing machine.

PROCEDURE

1. Measure the dimensions of a specimen
Diameter=d= ,
Total length of a specimen,
Cross sectional area = Ao= ,
Mark gage length (Lo) at three different portions on the specimen, covering effective length of a specimen.(this is required so that necked portion will remain between any two points of gage length on the specimen.)
2. Grip the specimen in the fixed head of a machine. (Portion of the specimen has to be gripped as shown in the fig.7.
3. Fix the extensometer within the gauge length marked on the specimen. Adjust the dial of extensometer at zero.
4. Adjust the dial of a machine to zero, to read load applied.
5. Select suitable increments of loads to be applied so that corresponding elongation can be measured from dial gauge.
6. Keep speed of machine uniform. Record yield point, maximum load point, point of breaking of specimen.
7. Remove the specimen from machine and study the fracture observes type of fracture.
8. Measure dimensions of tested specimen. Fit the broken parts together and measure reduced diameter and final gage length.

OBSERVATIONS

Specimen prepared from M.S bar/CI/Al
1. Diameter = d = mm

2. Gage length (lo)= 5Xd= mm
3. Original cross sectional area of the specimen
= Ao = mm
2
4. Final gage length obtained= Lo’=

5. Final diameter obtained = mm

Calculation

Material of the specimen =

Length of the specimen =

Diameter of the specimen =

Ultimate load=

Ultimate strength of the specimen = $\frac{\text{Ultimate load}}{\text{2xarea}}$

RESULTS

1. calculate stress and strain for every interval of applied load.

COMPRESSION TEST

Experiment No. 5
Date :

AIM

To find the compressive strength of given specimen.

MATERIAL AND EQUIPMENT

Universal testing machine,
Compression pads,
Given 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 crosssectional 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 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

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

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.

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

Calculation

Length of the brick =l

Breadth of the brick =b

Depth of the brick = d

specimen	length	breadth	depth	load	area	Stress N/mm^2

RESULT

Compressive strength of the specimen ………N/mm

WATER ABSORPTION TEST ON BRICK

Experiment No. 6
Date :

AIM

To determine the percentage of absorption on a clay brick

APPARATUS REQUIRED

Clay brick

Container

Water

Weighing balance

PROCEDURE

Determine the measurement of clay brick

Take the dry weight of the specimen

Put the brick in to the water containing container

After 24 hours take the specimen and take the wet weight

CALCULATION

W1 = Dry weight

W2 = wet weight

Absorption in percentage = $\frac{w1 - w2 \quad x}{W2}$ 100

RESULT

absorption in percentage =

SPRING TEST

Experiment No. 7
Date :

AIM

to determine the modulus of rigidity ,youngs modulus and stiffness of the given spring

APPARATUS AND SPECIMEN

Spring testing machine

Spring specimen

Ruler

PROCEDURE

1. Measure the outer diameter and diameter of the spring coil
2. Count the nimber of turns (n)
3. Fit the specimen on the testing nmachine
4. Adjust the top of the machine so that the other end of the specimen can be fitted to the bottom hook
5. Note down the initial reading
6. Apply the initial load and note down the corresponding scale reading .increase the load up to maximum of 180kg and note down the corresponding scale reading.
7. Find the actual deflection of the spring for each load by deduction the initial scale reading from the corresponding scale reading.
8. Calculate the module of rigidity for each load applied by using the following formula:
9. Calculate the Young's modulus by using the formula
10. Determine the stiffness for each load applied by using the formula
11. Find the value of modulus of rigidity and spring constant
12. A graph is plotted on load(P) against deflection(D)

13. Determine the rigidity modulus and Young's modulus and stiffness (k) from graph

Calculation

Stiffness = p/ D

P = load

D = deflection

Modulas of rigidity = $\frac{64PR^3 n}{d^4 D}$

R = mean radius of the spring

n = no.of turns

d = diameter of spring

D = deflection of the spring

E = 2n (1 + μ)

μ = poisson s ratio

Calculation

Sl no	Applied load in N	Scale reading mm	Actual deflection in mm	Modulus of rigidity in N/mm^2	Stiffness in N /mm

RESULT

1. The modulus of rigidity of the given spring = N/mm^2
2. The Young's modulus of the given spring= N/mm^2
3. The stiffness of the given spring = N/mm

Graphically

1. The modulus of rigidity of the given spring = N/mm^2
2. The Young's modulus of the given spring = N/mm^2
3. The stiffness of the given spring = N/mm