

EXPERIMENT NO.1

AIM:- To study the Rockwell Hardness testing machine and perform the Rockwell hardness test.

APPARATUS:- Rockwell Hardness testing machine, specimen of mild steel or other material.

THEORY:- Hardness represents the resistance of material surface to abrasion, scratching and cutting, hardness after gives clear indication of strength. In all hardness tests, a define force is mechanically applied on the piece, varies in size and shape for different tests. Common indenters are made of hardened steel or diamond.

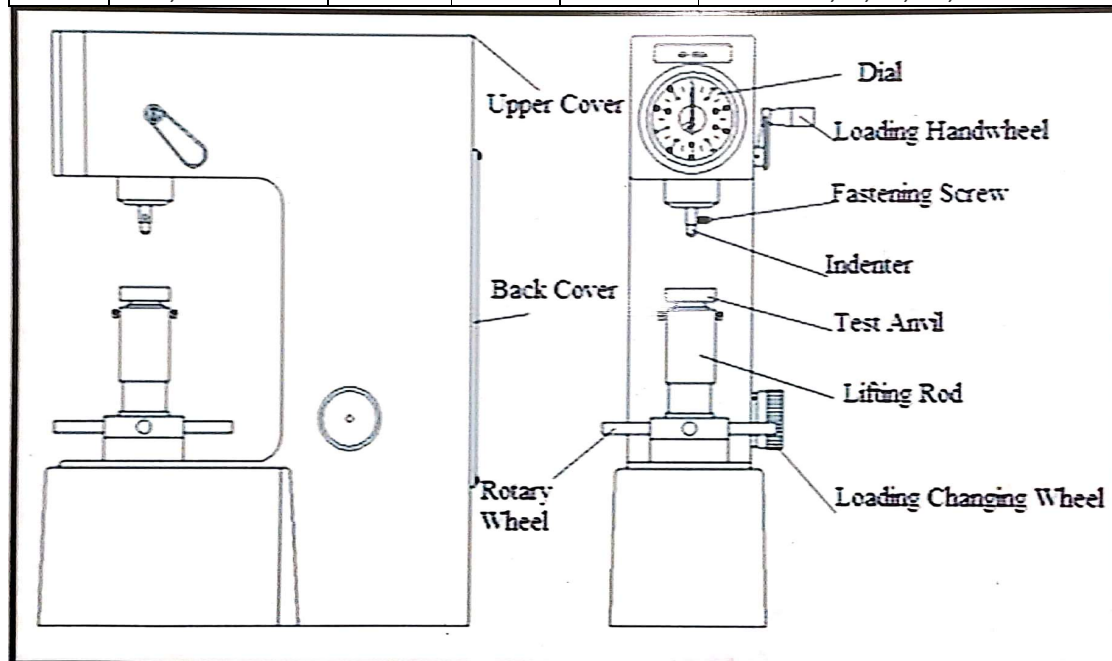
Rockwell hardness tester presents direct reading of hardness number on a dial provided with the m/c. principally this testing is like Brinell hardness testing. It differs only in diameter and material of the indenter and the applied force. Although there are many scales having different combinations of load and size of indenter but commonly 'C' scale is used, and hardness is presented as HRC. Here the indenter has a diamond cone at the tip and applied force is of 150 kgf. Soft materials are often tested in 'B' scale with a 1.6mm dia. Steel indenter at 60kgf.

SPECIFICATION OF HARDNESS TESTING M/C AND INDENTERS:-

A hardness test can be conducted can be conducted on Brinell testing m/c, Rockwell hardness m/c or Vickers testing m/c. the specimen may be a cylinder, cube, thick or thin metallic sheet. A Brinell-cum-Rockwell hardness testing m/c along with the specimen is shown in figure.

Various scales in Rockwell hardness test are given below:-

Scale	Type of indenter (Dimension)	Initial load (kgf)	Major load (kgf)	Pointer Position on dial	Kind of material
A	Cone, 120°	10	50	0	Much harder such as carburized steel, cemented carbides
B	Ball, 1.58mm	10	90	30	Soft steels, copper, aluminium, brass, grey cast iron.
C	Cone, 120°	10	140	0	Hard steels, Ti, W, Va, etc



PROCEDURE:-

1. Insert ball of dia. 'D' in ball holder of the m/c.
2. Make the specimen surface clean by removing dust, dirt, oil and grease etc.
3. Make contact between the specimen surface and the ball by rotating the jack adjusting wheel.
4. Push the required button for loading.
5. Pull the load release lever wait for minimum 15 second. The load will automatically apply gradually.
6. Remove the specimen from support table and locate the indentation so made.
7. Repeat the entire operation, 3-times.

OBSERVATION AND CALCULATION : –

Following observation are recorded are from a test on steel specimen using a hardened steel ball as indenter.

· Test piece material = MILD STEEL

- $HRA = 100 - (t/0.002)$
- $HRB = 130 - (t/0.002)$
- $HRC = 100 - (t/0.002)$

TABULATION:- (MATERIAL NAME= MILD STEEL, SCALE NAME=C)

SL NO	INDENTOR TYPE	INITIAL LOAD (IN KGF)	MAJOR LOAD (IN KGF)	HARDNESS READING (IN HRC)	AVERAGE HARDNESS READING (IN HRC)
1	CONE,120°	10	100	85	88
2	CONE,120°	10	100	88	
3	CONE,120°	10	100	91	

PRECAUTIONS:-

- The specimen should be clean properly
- Take reading more carefully.

CONCLUSION:- Hence, we have successfully determined the hardness value using Rockwell Hardness Testing machine.

EXPERIMENT NO.2

AIM OF THE EXPERIMENT:-

Determination of toughness of material by using impact testing machine. (Izod test).

APPARATUS REQUIRED:-

Sl.no	Name of the apparatus	Specification	Quantity
01	Impact testing machine		01
02	A mild steel specimen	(75x10x10)mm For Izod	01

THEORY:-

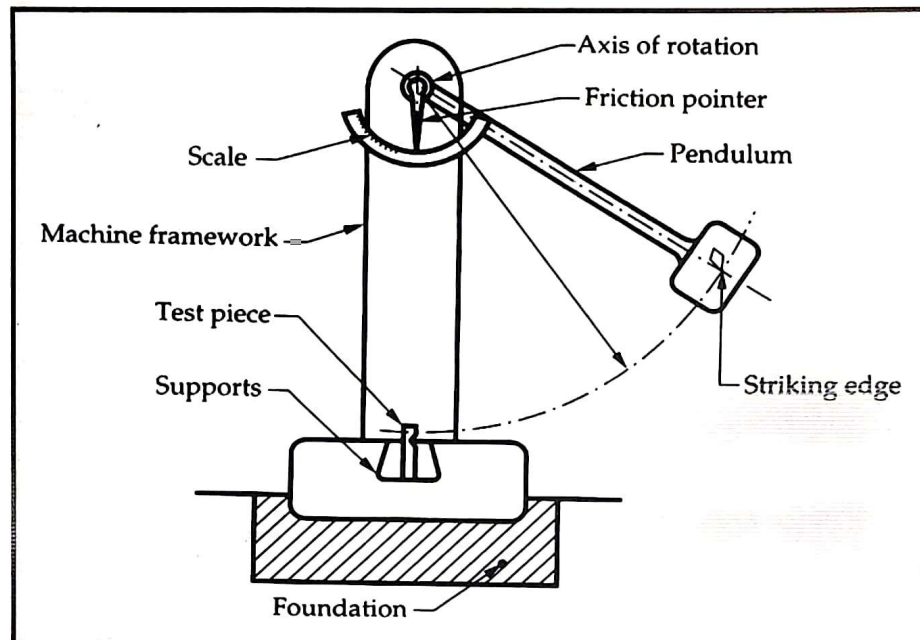
- An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation.
- This important factor is determined by impact test. Toughness considers both the strength and ductility of the material.
- Several engineering materials must withstand impact or suddenly applied load while in service.
- Strengths are generally lower as compared to strengths achieved under slowly applied load.
- Of all types of impact test, the notched bar tests are more extensively used. Therefore the impact test measures the energy necessary to fracture a standard notch bar by applying an impact load.
- The test measures the notch toughness of material under shock loading.

PROCEDURE:-

- Select the test mode i.e Izod or Charpy, depending up on the test to be conducted and fix the pendulum holding pipe at the respective angle i.e for Izod at 84 degree and secure it tight with the bolts provided.
- The striker for Izod and Charpy test are different and depending up on the test to be conducted fix the correct striker on the pendulum hammer end.
- Fix the specimen on the anvil in the position corresponding to the test mode i.e Izod or Charpy.
- Release the pendulum by operating the lever for the pendulum to strikes the specimen fitted on the anvil.
- Note the readings indicated by the pointer on the dial, which is the Izod or Charpy value.
- The diagrams of Izod and Charpy strikers and their positioning on the anvil is enclosed for easy identification and fitment.

OBSERVATION:-

- Energy absorbed by Izod test= 32 JOULE



CONCLUSION:-

From the above experiment we determine the toughness of material by using impact testing machine.

EXPERIMENT NO.3

AIM OF THE EXPERIMENT:-

Determination of torsional rigidity of the shaft by using torsion testing machine.

APPARATUS REQUIRED:-

SL.NO	NAME OF THE APPARATUS	SPECIFICATION	QUANTITY
01	Torsion testing machine		01
02	Mild steel specimen	D=16 mm L=150 mm	01
03	Steel rule	Least count=0.5mm	01
04	Vernier calliper	Least count=0.02mm	01

THEORY:-

- A torsion test is a quite instrumental in determining the value of modulus of rigidity (ratio of shear stress to shear strain) of a metallic specimen.
- The modulus of rigidity can be found out through observations, made during the experiment by using the torsion equation.
- Torque is defined as the product of twisting force to the distance between the point of application of the force and the axis of the shaft.
- The torsion equation is- $T/J = C\theta/L$.

So, $C = TL / J\theta$

Where,

T=Torque applied.

J=Polar moment of inertia = $\pi/32 \times D^4$

D= Diameter of specimen.

C=Modulus of rigidity.

θ =Angle of twist.

L=Gauge length of the specimen in mm.

PROCEDURE:-

- 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.
- Measure the diameter of the specimen at about three places and take the average values.
- Choose the appropriate range by capacity change lever.
- Set the maximum load pointer to zero.
- Set the protractor to zero for convenience.
- Carry out straining by rotating the hand lever in either direction.
- Load the machine in suitable increments, observing and recording strain gauge.

OBSERVATION TABLE:-

SL.N O	TORQUE APPLIED in (Kg-cm)	TORQUE APPLIED in (N-mm)	ANGLE (θ) (in degree)	ANGLE (θ) (in radian)	Modulus of Rigidity(i n N/mm ²)	Mean Modulus of Rigidity(i n N/mm ²)
1	30	2943	20	0.3490	196.596	151.23
2	31	3041.1	25	0.4363	162.613	
3	33	3237.3	30	0.5235	144.170	
4	31	3041.1	40	0.6981	101.560	

CALCULATION:- (Formula Used)

Polar moment of inertia (J) = $(\pi/32) \times D^4 = 6433.981 \text{ mm}^4$

Angle of twist(in radians) = $\theta \times (\pi/180) = \dots\dots\dots \text{ rad}$

Torque(in N-mm) = Torque(in kgf-cm) $\times 9.81 \times 10 = \dots\dots\dots \text{N-mm}$

Modulus of rigidity(C) = $TL / J\theta = \dots\dots\dots \text{N/mm}^2$

CONCLUSION:-

From the above experiment we have successfully determine the modulus of rigidity of mild steel specimen by using torsion testing machine.

EXPERIMENT NO.4

AIM OF THE EXPERIMENT:-

Determination of Salient points(Young's Modulus, Yield Point, Fracture point from stress –strain curve using Universal Testing Machine(UTM).

APPARATUS REQUIRED:-

SL.NO	NAME OF THE APPARATUS	SPECIFICATION	QUANTITY
01	Universal testing machine	200KN	01
02	Mild steel specimen	L=..... D=.....	01
03	Vernier calliper	Least count=0.02mm	01
04	Steel rule	L=300mm	01

THEORY:-

- The result obtained by the tensile test are widely used in design of material for structures and others purposes.
- In this test the specimen pulled out at a constant rate by gradually increasing the axial pole till the rupture takes place.
- The tensile test for a ductile material is generally carried out with the help of UTM.
- The machine has two units , one is controlling unit and another is release valve.
- Control unit is used for controlling the load applied and release valve is used for releasing the hydraulic pressure.
 - The tensile test of a material is generally performed to determine –
 - Proportional limit
 - Elastic limit
 - Yield point
 - Ultimate point
 - Fracture point or breaking point

PROPERTIONAL LIMIT:-

We see from the above diagram that from point 'o' to 'A' is a straight line which represents that the stress is proportional to strain. Beyond point 'A',The curve isslightly deviated from the straight line. It is then obeys the hook's law hold up to 'A' and is known as proportional limit.

ELASTIC LIMIT:-

It may be noted that even if the load is increased beyond point 'A' up to point 'B' the material will regain its shape and size after the release of load up to point B is known as elastic limit.

YIELD POINT:-

If the material is stretched beyond point 'B' the elastic stress will be reached i.e on the removal of the load ,the material will not be able recover its original shape and size .The point 'C' and 'D' are called upper yield and lower yield point respectively .The stress corresponding to yield point is known as yield stress.

ULTIMATE POINT:-

After the lower Yield point, the specimen regains some strength and higher value of stress are required for higher strain. The stress goes on increasing till point 'E' is

reached. At 'E' the stress which attains its maximum values is known as ultimate tensile stress.

BREAKING POINT:-

After the specimen has reached to the ultimate stress the neck is formed which decreases the cross-sectional area of the specimen. The stress is therefore reduced until the specimen breaks itself at point 'F'. The stress corresponding to point 'F' is known as breaking stress.

MATHEMATICAL FORMULA USED:-

Stress(σ) = load(P)/cross sectional area(A) (Its unit is N/m²)

Strain(ϵ) = change in length(Δl)/original length(l) (It is unit less)

Young's modulus(E)=stress(σ)/strain(ϵ) (Its unit is N/m²)

CALCULATION:- (formula used)

Area of specimen= $(\pi/4) \times d^2 = (\pi/4) \times (15)^2 = 176.6 \text{ mm}^2$

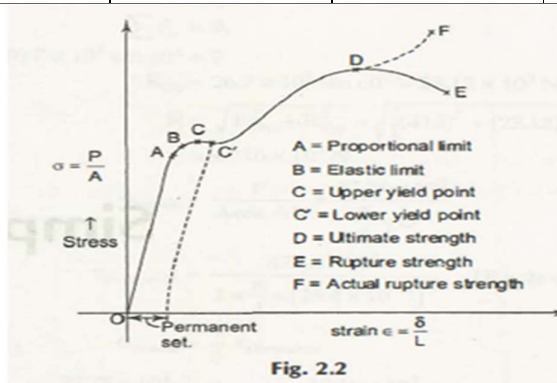
Stress= $P/A = (116 \times 10^3)/176.6 = 656.8 \text{ N/mm}^2$

Strain= $\Delta l/l = 15\text{mm}/75\text{mm} = 0.2$

Young's modulus=stress/strain= $656.8/0.2 = 3284 \text{ N/m}^2$

OBSERVATION TABLE:-

Sl no.	Load applied(P)	Change in length(Δl)	stress(P/A)	strain($\Delta l/l$)	Young's modulus(σ/ϵ)
1	$116 \times 10^3 \text{ N}$	15 mm	$(116 \times 10^3)/176.6$ $= 656.8 \text{ N/mm}^2$	$15\text{mm}/75\text{mm}$ $= 0.2$	$656.8/0.2$ $= 3284 \text{ N/m}^2$



Conditions for $\epsilon = \frac{\delta}{L}$ to be constant.

STRESS STRAIN CURVE

CONCLUSION:-

From the above experiment we have successfully determine the young's modulus of mild steel specimen by using universal testing machine.

EXPERIMENT NO.5

AIM OF THE EXPERIMENT:

To determine the shear resistance (ultimate shear load and shear strength) of a MS bar under a single shear condition.

APPARATUS REQUIRED:

Universal Testing Machine (UTM) or a shear test rig with a suitable shear fixture (supports and punch).

THEORY:

In a single-shear test the specimen is loaded so that fracture occurs along one plane. The shear stress at failure (average shear strength) is calculated as:

$$\tau_u = \frac{P_f}{A_s}$$

where

- τ_u = ultimate shear strength (N/mm² or MPa),
- P_f = load at failure (N),
- A_s = cross-sectional area at the shear plane (mm²).

For a circular bar, $A_s = \frac{\pi d^2}{4}$.

For a rectangular bar, $A_s = b \times t$ (width $\times$ thickness).

PROCEDURE:

- 1) Measure specimen diameter at the shear plane accurately.
- 2) Mount specimen in shear fixture so that a single shear plane is enforced. Using UTM, use single-shear fixture.
- 3) Apply load gradually at a constant displacement/strain rate until specimen fails. Record maximum load P_f .
- 4) Note type of fracture (ductile cup-shear, slant, etc.) and take photos if required.
- 5) Calculate τ_u using the formula above.

CALCULATION:

Specimen: circular MS bar, measured diameter $d = 10.00$ mm.

Load at failure measured $P_f = 20\,000$ N.

Area at shear plane:

$$A_s = \frac{\pi d^2}{4} = \frac{\pi (10)^2}{4} = 78.54 \text{ mm}^2$$

Ultimate shear strength:

$$\tau_u = \frac{P_f}{A_s} = \frac{20\,000}{78.54} = 254.6 \text{ N/mm}^2 = 254.6 \text{ MPa}$$

So the material's average shear strength = **254.6 MPa** and its shear resistance (ultimate load) was 20 kN.

CONCLUSION:

Hence we have successfully done the single shear test of MS bar and found shear resistance.