NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR
DEPARTMENT OF MECHANICAL ENGINEERING
SOLID MECHANICS SESSIONAL (MES452)

INSTRUCTION SHEET

UNIVERSAL TESTING MACHINE

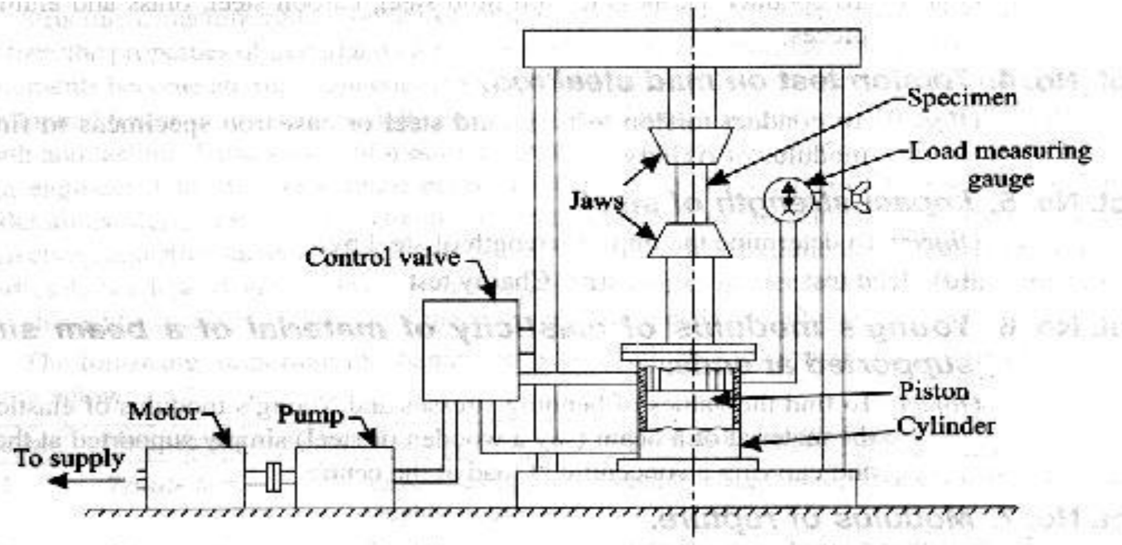
EXPERIMENT NO. – 01

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.

DIAGRAM:-



• Fig. 1. Tenstile testing machine.

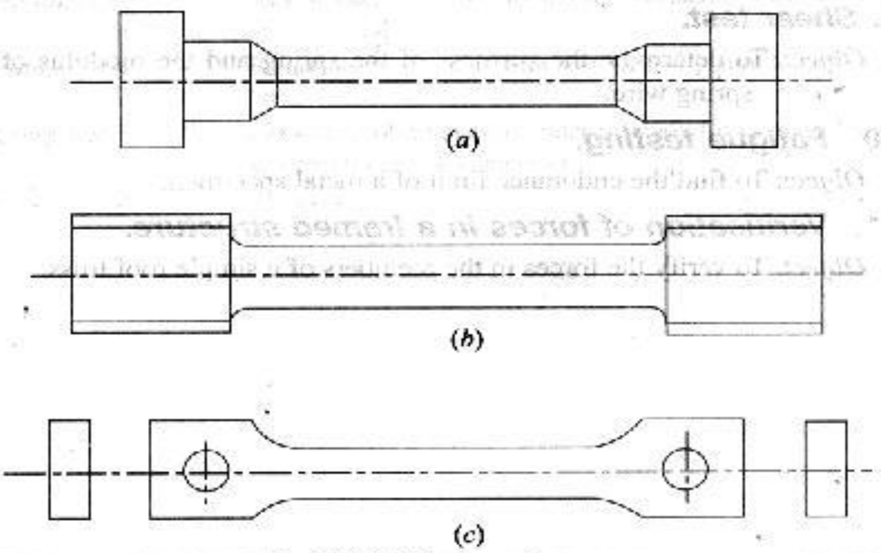


Fig. 2. Mild steel specimens.

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. 2 Tones; 10 Tones; 20 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 tension test.

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 supports are adjusted to required distance.

Stuffers at the back of the bending table at different positions. Then place the specimen on bending table & apply the load by bending attachment at the upper stationary head. Then perform the test in the same manner as described in tension test.

BRINELL HARDNESS TEST:-

Place the specimen on the lower table & lift it up slightly. Adjust the zero fixed value at the bottom side of the lower cross head. Increase the load slowly ultimate load value is obtained. Then release the load slowly with left control valve. Get the impression of a suitable value of five to ten millimeter on the specimen & measure the diameter of the impression correctly by microscope & calculate Brinell hardness.

SHEAR TEST:-

Place the shear test attachment on the lower table, this attachment consists of cutter. The specimen is inserted in roles of shear test attachment & lift the lower table so that the zero is adjusted, then apply the load such that the specimen breaks in two or three pieces. If the specimen breaks in two pieces then it will be in angle shear, & if it breaks in three pieces then it will be in double shear.

STUDY OF EXTENSOMETER:-

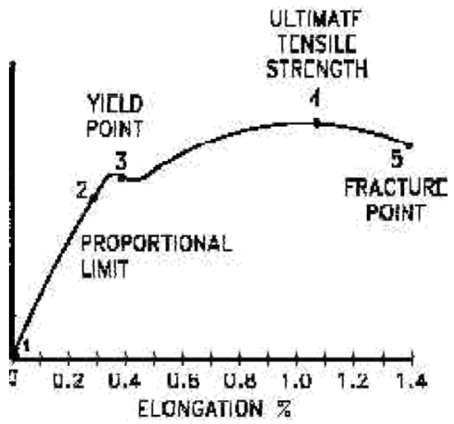
This instrument is an attachment to Universal / Tensile Testing Machines. This measures the elongation of a test place on load for the set gauge length. The least count of measurement being 0.01 mm, and maximum elongation measurement up to 3 mm. This elongation measurement helps in finding out the proof stress at the required percentage elongation.

WORKING OF THE INSTRUMENT:-The required gauge length (between 30 to 120) is set by adjusting the upper knife edges (3) A scale (2) is provided for this purpose. Hold the specimen in the upper and lower jaws of Tensile / Universal Testing Machine. Position the extensometer on the specimen. Position upper clamp (4) to press upper knife edges on the specimen. The extensometer will be now fixed to the specimen by spring pressure. Set zero on both the dial gauges by zero adjust screws (7). Start loading the specimen and take the reading of load on the machine at required elongation or the elongation at required load. Force setter accuracies mean of both the dial gauge (8) readings should be taken as elongation. It is very important to note & follow the practice of removing the extensometer from the specimen before the specimen breaks otherwise the instrument will be totally damaged. As a safety, while testing the instrument may be kept hanging from a fixed support by a slightly loose thread.

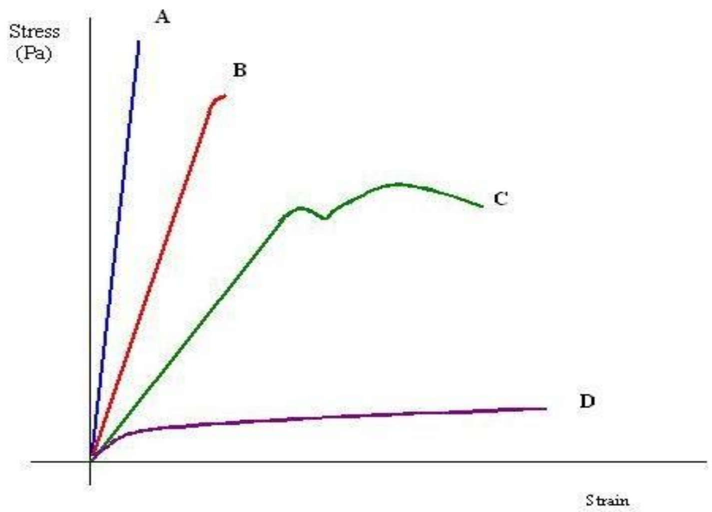
TECHNICAL DATA:-

- Measuring Range: 0 – 3 mm.
- Least Count: 0. 01 mm.
- Gauge Length adjustable from: 30 – 120 mm
- Specimen Size: 1 to 20mm Round or Flats up to 20 x 20 mm.

A) Stress-strain graph of Mild Steel



B) Stress-strain graphs of different materials.



- Curve **A** shows a **brittle** material. This material is also strong because there is little strain for a high stress. The fracture of a brittle material is sudden and catastrophic, with little or no plastic deformation. Brittle materials crackunder tension and the stress increases around the cracks. Cracks propagate less under compression.
- Curve **B**is a **strong** material which is not ductile. Steel wires stretch very little, and break suddenly. There can be a lot of elastic strain energy in a steel wire under tension and it will “whiplash” if it breaks. The ends are razor sharp and such a failure is very dangerous indeed.
- Curve **C** is a **ductile** material
- Curve **D** is a **plastic** material. Notice a very large strain for a small stress. The material will not go back to its original length.

EXPERIMENT NO. – 02

AIM: -To determine tensile test on a metal.

OBJECTIVE: - 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.

APPARATUS: -

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

DIAGRAM:-

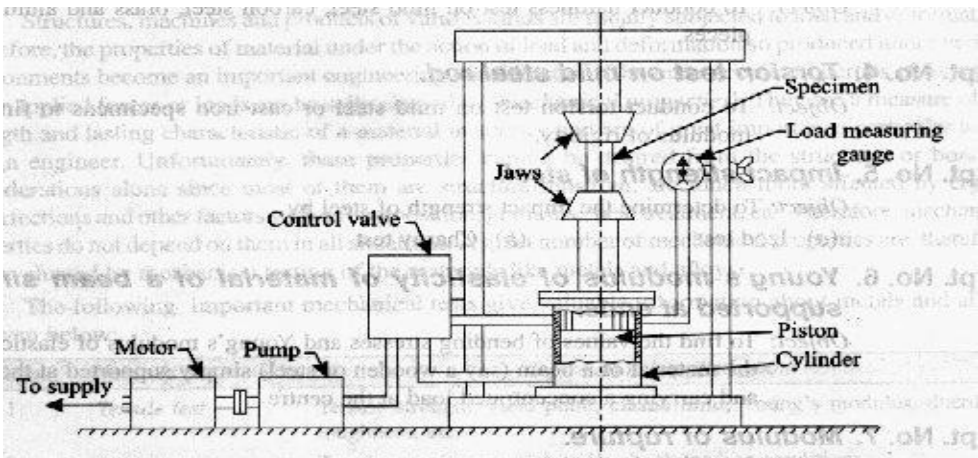


Fig. 1. Tenstile testing machine.

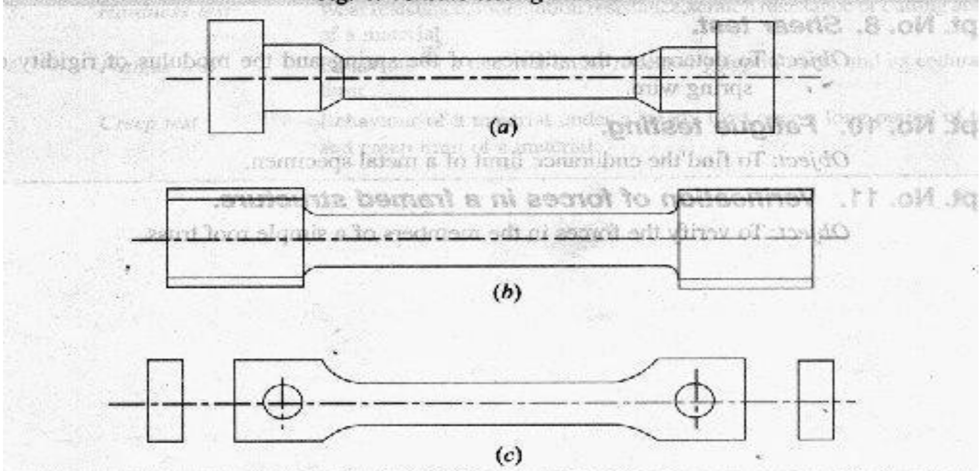


Fig. 2. Mild steel specimens.

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.

PROCEDURE:-

(i) 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. \

(ii) Insert the specimen into grips of the test machine and attach strain-measuring device to it.

(iii) Begin the load application and record load versus elongation data.

(iv) Take readings more frequently as yield point is approached.

(v) Measure elongation values with the help of dividers and a ruler.

(vi) Continue the test till Fracture occurs.

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

OBESERVATION:- A) Material:

Original dimensions	Final Dimensions:
• **Length = ------------** • **Diameter = ---------** • **Area = --------------**	• **Length = ------------------** ▪ **Diameter = -----------------** ▪ **Area = ------------------------**

OBESERVATION TABLE:-

S. No.	Load (N)	Original Gauge Length (mm)	Extension (mm)	Stress = Load / Area (N/mm^2)	Strain = Increase in length / original length
1					
2					
3					
4					
5					

To plot the stress strain curve and determine the following.

(i) **Limit of proportion** $= \dfrac{\text{Load at limit of proportionality}}{\text{Original area of cross-section}} \, {}^{N}\!/\!_{mm^2}$

(ii) **Elastic limit** $= \dfrac{\text{Load at elastic limit}}{\text{Original area of cross-section}} \, {}^{N}\!/\!_{mm^2}$

(iii) **Yield strength** $= \dfrac{\text{Yield Load}}{\text{Original area of cross-section}} \, {}^{N}\!/\!_{mm^2}$

(iv) **Ultimate strength** $= \dfrac{\text{Maximum tensile load}}{\text{Original area of cross-section}} \, {}^{N}\!/\!_{mm^2}$

(v) **Young's modulus** $E = \dfrac{\text{Stress below proportional limit}}{\text{Corresponding strain}} \, {}^{N}\!/\!_{mm^2}$

(vi) **Percentage elongation** $= \dfrac{\text{Final length (at fracture) - original length}}{\text{Original length}} \times 100 = \cdots\cdots\%$

(vii) **Percentage reduction in area** $= \dfrac{\text{Original area - area at fracture}}{\text{Original area}} \times 100 = \cdots\cdots\%$

RESULT:- i) Average Breaking Stress = ii) Ultimate Stress = iii) Average % Elongation =

PRECAUTION:-

(i) If the strain measuring device is an extensometer it should be removed before necking begins.

(ii) Measure deflection on scale accurately & carefully