WORK SHOP

(CIVIL ENGINEERING DEPARTMENT)

EXPERIMENT-1

AIM: Demonstration on Tension test on mild steel, shear test on mild steel specimen and compression test on cast iron.

TENSION TEST ON MILD STEEL

AIM:

a) To study the behavior of standard mild steel specimen, under the action of a gradually increasing axial tensile load, tested up to failure, as per IS: 1608 - 1972.

b) To determine tensile strength, true and nominal breaking stress.

APPARATUS: Universal testing machine, Extensometer, Gripping device, Scale, Micrometer, Punch and Hammer.

SCOPE AND APPLICABILITY:

The tension test is done on a standard test piece by applying a gradually increasing uniaxial load (static load). This is also called static tension test. It is one among the most commonly made simple mechanical tests to evaluate the fundamental mechanical properties viz., elasticity, ductility and tensile strength. These properties are important parameters in the design of structural components which are expected to undergo static tensile force during the loading period. Tension test is also made use of to study the stress-strain characteristics of mild steel in tension which is of greater interest in mechanics of materials. It helps to understand the yielding and necking phenomenon and the cup and cone type of fracture.

IMPORTANT TERMS AND DEFINITIONS:

a) **Gauge Length**: It is the distance between two reference points on the prescribed part of the test piece on which deformations are measured during the test. As per BIS specification, the original gauge length before the test piece is strained is given by the following formula.

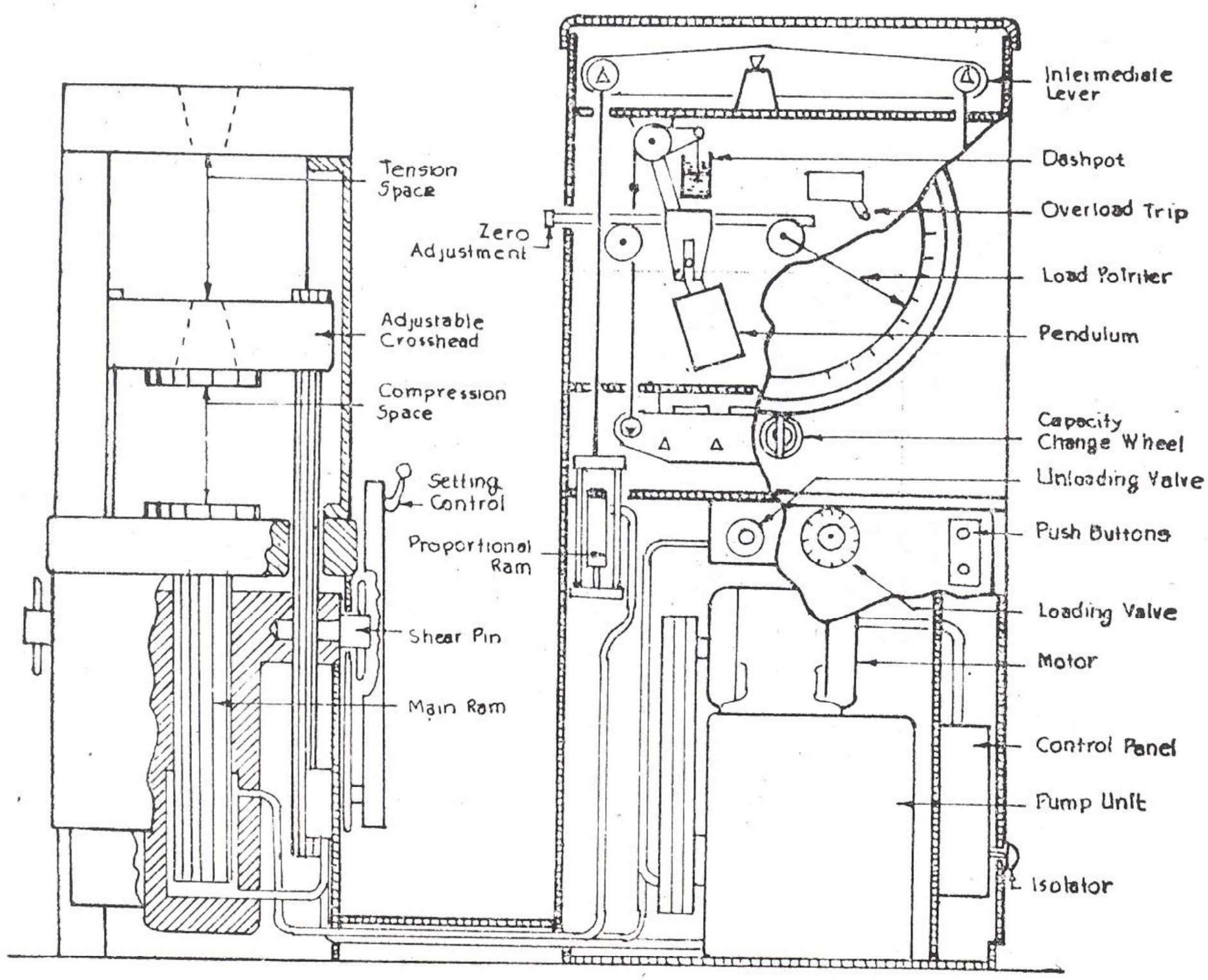
$$\mathrm{L}_0 = 5.65\sqrt{S_0}$$

$$= 5\, d_0 \text{ for circular section}$$

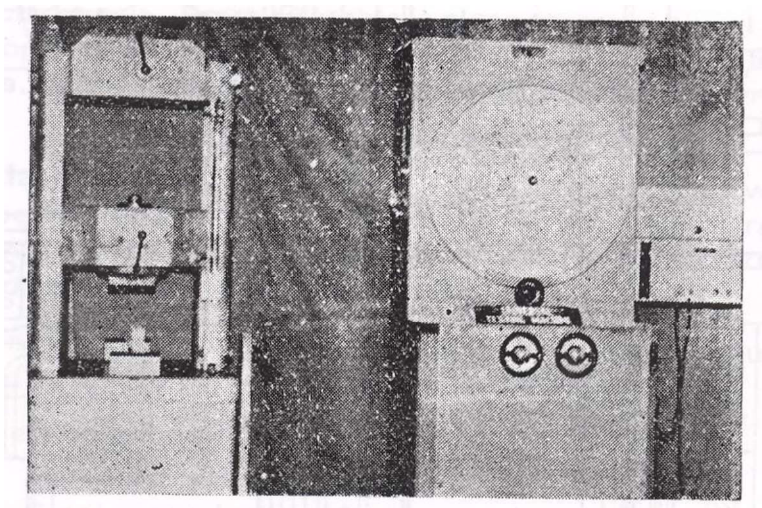
Where d_0 = Original diameter

S_0 = Original c/s area

L_0 = Original gauge length



UNIVERSAL TESTING MACHINE



UNIVERSAL TESTING MACHINE

b) **Tensile Strength:** The maximum load reached in the test divided by the original c/s area. This is also termed as maximum tensile stress or ultimate tensile stress for the material of the specimen.

c) **Breaking Stress**: Load at the time of breaking divided by the original c/s area is called nominal breaking stress.

   Load at the time of breaking divided by the final c/s area is called true breaking stress. True breaking stress is always more than the nominal breaking stress.

d) **Elastic limit:** Elasticity is the property by which a material regains its shape fully when the load is removed. Elastic limit is the stress limit below which a material behaves as perfectly elastic. Practically this is close to proportional limit (limit up to which stress is proportional to strain) so both are approximately considered as same. (Actually elastic limit comes after proportional limit in stress-strain graph.)

e) **Modulus of Elasticity**: It is the ratio of axial stress to axial strain within the elastic limit. It is the slope of the initial straight line portion of the stress-strain graph, where stress is taken along Y-axis. It is a measure of elasticity. It is also known as Young's Modulus, 'E'. Standard value of 'E' for mild steel is 2.1×10^5 N/mm^2

SPECIMEN:

Test should be conducted on a standard specimen as specified by IS: 1608-1972. As per BIS, c/s of the test piece may be circular, square or rectangular. Test on circular specimen is done in the laboratory. Diameter of the specimen may be in between 3.99 mm to 22 .56mm. Form of a typical circular test piece is shown in Fig 1-1

Extensometer:

The extensometer is used for measuring extension precisely. It has a least count of 0.0025mm. It has two clamping points 50mm apart and a graduated drum which can be rotated using a screw head. It also has a light arrangement which enables the user to know whether the predefined extension has taken place or not

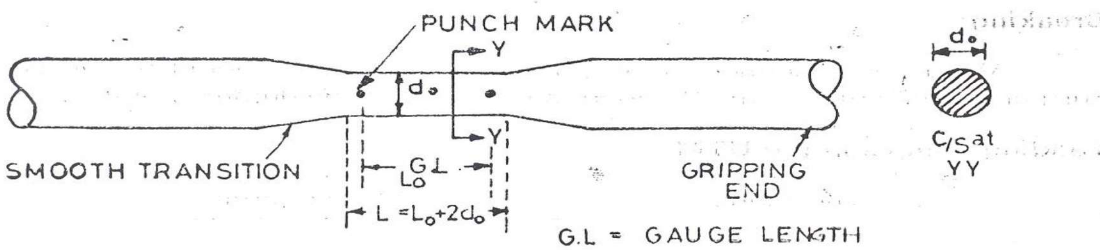


Fig. 1.

PROCEDURE:

1. Diameter of the given specimen is measured using screw gauge at three different places and average diameter d_0 is calculated.
2. Centre point of the specimen is located and half the gauge length is set on either side of it by punch marks.
3. The ends of the specimen are then gripped in the cross heads of the UTM using gripping jaws.
4. Load pointer of UTM again moves forward up to a maximum point, leaving the dummy needle at the maximum load value and it moves backward as the 'necking'[1]starts.Note down the maximum load in kg. (Pu)
5. Finally the specimen fails at a lower load than the maximum load. Note down this breaking load (P_b) in kg when the specimen breaks.
6. The failed specimen is then removed. Keep the two pieces together and measure the final gauge length (L_u). The final diameter at the neck is measured (d_u).
7. The failure pattern is then studied.

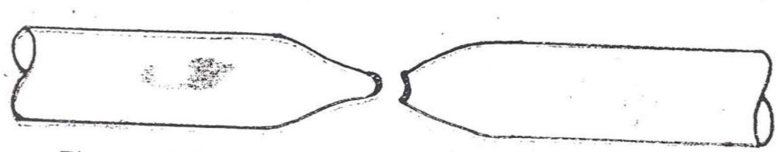


Fig. 1-4. CUP AND CONE TYPE OF FRACTURE

OBSERVATION

Diameter(mm)	d_1=	d_2=	d_3=
Average diameter	d_0=	mm	
Gauge length	L_0=	mm	
Maximum load	P_u=	kg	
Breaking load	P_b=	kg	
Final gauge length after fracture	L_u=	mm	
Diameter at neck	d_u=	mm	

CALCULATION:

Initial Area= A_O = $\pi d_o^2/4$= mm^2

Final Area = A_U = $\pi d_u^2/4$= mm^2

Ultimate stress σ_u = $P_u \times 9.81/A_0$

=

= N/mm^2

Nominal breaking stress σ_b = $P_b \times 9.81/A_0$

=

=

N/mm^2

True breaking stress σ_{bt} = $P_b \times 9.81/A_u$

SHEAR TEST ON MILD STEEL

AIM:

To determine the ultimate shear strength in single shear and double shear of mild steel rod.

APPARATUS:

(1) Compression Testing Machine (2) Shear Shackle

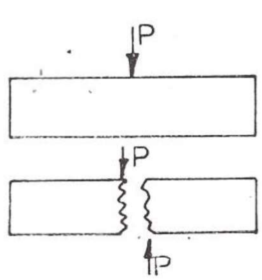
(3) Micrometer screw gauge.

THEORY:

Shear stress is caused by forces which act parallel to an area of cross section and tend to produce sliding of one portion past another portion. If there is only one cross section which resists the failure, the material is said to be in single shear and the average ultimate shear strength will be equal to the failure load divided by the area of cross section. If two areas resist the failure then the material is said to be in double shear and the average ultimate shear strength will be equal to the failure load divided by twice the area of cross section.

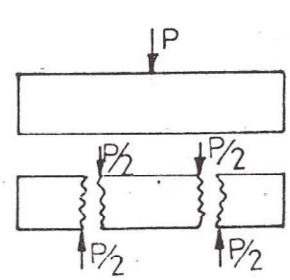
The procedure for shear test is standardized by IS:5242-1969 "Method of Test for Determining Shear Strength of Mild Steel".

A special shear attachment called Shear Shackle is used to hold the specimen. The specimen can be placed either one end supported or two ends supported in the shackle. One end supported specimens fail under single shear and both ends supported specimens fail under double shear.



SINGLE SHEAR
(shear strength= P/A)

Fig. 1



DOUBLE SHEAR
(shear strength = P/2A)

Fig. 2

SCOPE AND APPLICABILITY OF DIRECT SHEAR TEST:

The result obtained from the direct shear test, that is the ultimate shear strength is used to arrive at a safe shear stress of the material after adopting a suitable factor of safety. This value of safe shear stress is used in design of rivets, crankpins, etc.

The result of the test depends to a considerable degree on the hardness and sharpness of the edges of the support bearing the specimen. Care should be taken to minimize the bending stress across the plane along which the shearing load is applied. This test has further limitation of being useless for the determination of modulus of elasticity or modulus of rigidity owing to the impossibility of measuring strains.

PROCEDURE:

1) Note down the diameter of the specimen.
2) Place the specimen in the shear shackle with one end supported for single shear test
3) Place the shackle in the compression testing machine and load without any jerk till failure (load is to be applied in a uniform rate)
4) Note down the failure load P_u
5) Calculate the ultimate strength in shear.

OBSERVATIONS:

Initial diameter d_0 =…………………………………….mm

Load at failure P_u =…………………………………..kg

Area (Ao) = $\pi d_o^2/4$ = --- mm^2

Shear Strength = P_u / A_o = --------------------------------------- N/mm^2

COMPRESSION TEST ON CAST IRON

AIM:

To conduct compression test on a cast iron specimen and to determine the compressive strength

APPARATUS:

Compression testing machine, scale, calipers.

THEORY, SCOPE AND APPLICABILITY:

‘Compression test' usually refers to tests in which a standard specimen is subjected to a' gradually increasing (static) uniaxial compressive load until failure occurs.

Compression test is to be done with utmost care. Any lack of alignment of the specimen in a compression test causes increase in eccentricity of the load as load increases and lack of stability may cause collapse under a relatively lighter load. Length (height) of compression specimen is another important factor in this test. Since the specimen is expected to fail under pure compression, length (height) is to be limited to such a value that bending due to column action (buckling) should not take place. So shorter specimens are preferred for the test.

SPECIMEN:

Short or medium specimens are generally used. If the length of the specimen is increased considerably with respect to diameter bending action takes place. When the height is very less compared to diameter, the diagonal planes along which failure would take place intersect the base. So generally ratio of length to diameter of 2 to 3 is commonly employed.

DESCRIPTION OF COMPRESSION TESTING MACHINE:

It is of self contained type, consisting principally of one piece frame. The lower portion serving as an oil reservoir also supports the cylinder and ram which applies the load to the specimen through a platen attached to the top of the ram. The upper platen is spherically seated and is fitted to the adjusting screw which can be raised or lowered to accommodate varying heights of specimens within the range of the machine. The load applied to the specimen is indicated on pressure gauges. Hydraulic pressure is applied to the ram by means of hand operated or electrically operated pump attached to the main frame.

PROCEDURE

1) Measure diameter and height of the specimen accurately.
2) Place the specimen centrally in the compression testing machine.
3) Keep the specimen tight in position by screwing down the upper platen.
4) Set a dial gauge to note the deformation and note down the least count of the dial gauge. The dial gauge has a range of 0-50 mm (1 div=0.01mm). Set the dial gauge to zero and note down the initial reading
5) Start pumping. Then note down the dial gauge reading for fixed load intervals.
6) Remove the dial gauge before the specimen fails.
7) Note down the failure load.
8) Remove the specimen, measure final diameter and height. Also study the fracture (Note: 1)

OBSERVATIONS:

Initial diameter d_0 =…………………………………mm

Load at failure P_u =…………………………………kg

Area (Ao) = π $d_o^2/4$ = --- mm^2

Compressive Strength = P_u / A_o = --- N/mm^2

EXPERIMENT- 4
LEVELLING

AIM: To plot the profile of a ground using dumpy-level and leveling staff.

INTRODUCTION

Levelling is defined as the art of determining the relative heights or elevations of points or objects on the earth's surface. It deals with the measurements in the vertical plane.

Definition of terms used in leveling:

Datum:

It is the surface with respect to which elevations of different points are expressed. Mean sea level is adopted as datum.

Bench Mark:

It is a fixed reference point whose elevation with respect to datum is known. It is required for starting the levelling work and also for checking the accuracy at the end of the work.

Reduced Level:

It is the vertical distance of a given point above or below the datum. It is also known as elevation.

Line of collimation:

It is the line passing through the intersection of the horizontal and vertical cross hairs and the optical centre of the object glass and its continuation.

Height of instrument or height of plane of collimation: (H.I)

It is the elevation of plane of collimation (Le. plane of sight) when the instrument is leveled correctly.

Back Sight: (B.S.)

It is the staff reading taken on a point of known elevation or change point. It is the first staff reading to be taken after the level is set-up and levelled properly

Fore Sight: (F.S.)

It is the last staff reading taken before shifting the instrument so that R.L. of change point =H.I - Fore sight.

Intermediate Sight: (I.S.) It is the staff reading taken on a point other than F.S. and B.S. points, from the same set up of the instrument. R.L of point =H.I.- I.S.

Change Point:

When the staff readings are not visible from the same set-up of the instrument, we have to shift the instrument. The point which denotes this shifting is known as the change point or turning point. On this change point both F.S. and B.S. are to be taken, F.S is taken before shifting the instrument and B.S is taken after shifting the instrument to determine the new H.I.

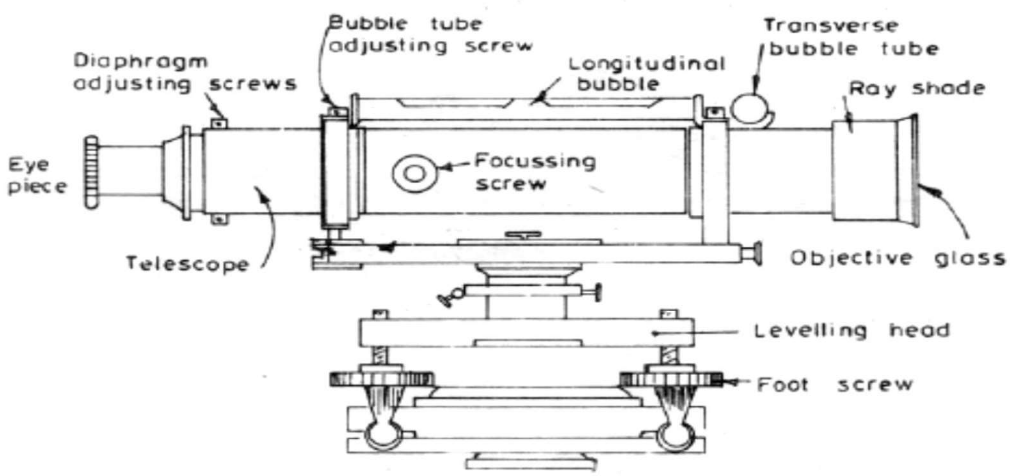
LEVEL INSTRUMENTS

The instruments commonly used in direct levelling are,

1) Level 2) Levelling staff

1) Level:

The purpose of a level is to provide a horizontal line of sight. The dumpy level is a commonly used level



DUMPY LEVEL

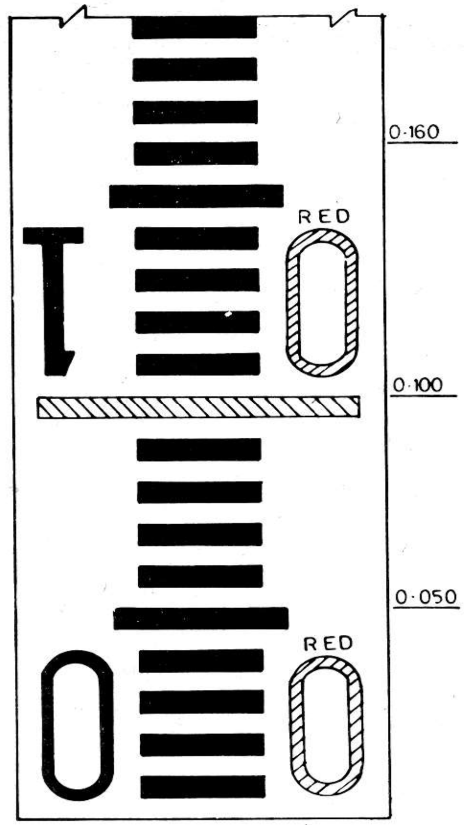
2) Levelling Staff: (rod)

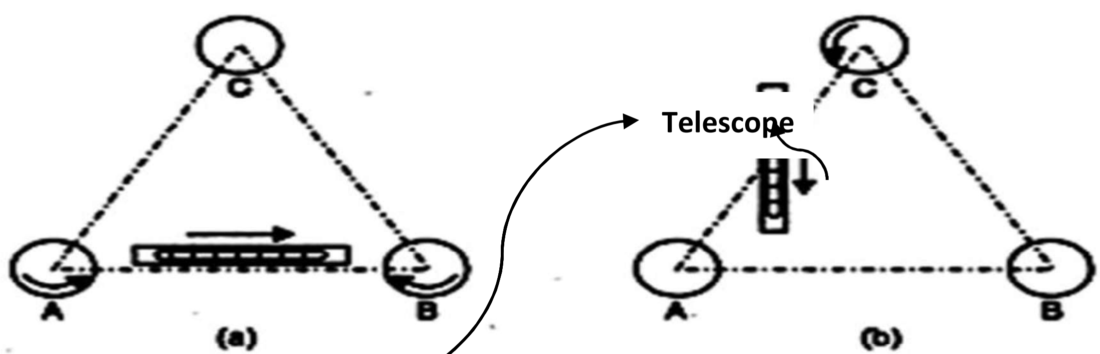
This is required to determine the vertical distance of the given point above or below the horizontal line of sight.

Levelling Staff: The purpose of levelling staff is to determine the amount by which the station is above or below the line of sight.

Folding Staff:

The folding type is of 4 m. length made up of well seasoned timber. It consists of two 2m wooden pieces with a joint in between. Each meter is divided in to 200 divisions, the thickness of the graduations being 5 mm. Each decimetre length IS figured with a corresponding numeral in black and marked to the left. Each meter numeral is in red and marked to the right. The graduations are inverted so that through the telescope they appear correct. When not in use, the staff can be folded about the hinge so that it becomes convenient to carry.





LEVELLING-UP WITH THREE FOOT SCREWS.

a) Elimination of parallax:

Parallax is the condition arising because of improper focusing where in the image formed by the objective is not lying in the plane of cross hairs. It can be eliminated using following steps.

(i) Focusing the eye-piece:

Turn the telescope towards sky or towards a clear white background such as paper sheet and move the eye-piece in or out until the cross-hairs are seen sharp and distinct.

(ii) Focusing the telescope:

Turn the telescope towards staff and turn the focusing screw until the image appears clear and sharp.

Procedure:

1) Let AB be the centre line.
2) Set up the level either to left or right of centre line. and temporary adjustment are done properly.
3) A back sight is taken on BM to determine H.
4) Having stretched the chain from A in line with AB, staff reading are taken at A and entered in intermediate column.
5) The staff held along the centre line at every 15m chain.
6) The last reading taken before shifting the instrument is termed as fore sight and entered in F.S column. All other readings taken after B.S and before F.S. are termed as Intermediate sights and are noted in I.S, column.

Plotting the Profile:

A horizontal line is first drawn as a datum and the chainages of staff points taken along section or centre lines are marked to convenient scale. Perpendicular line are then drawn at each plotted chainage and on these lines, the respective levels are set off. The elevation of the datum line should be so assumed that the lengths of ordinates would be between 40mm to 150mm. Suppose if the R.L's of the different points varies between 104m and 112m, the elevation (RL) of the datum line can be assumed as 100m.

Vertical scale used in plotting is exaggerated i.e., larger than horizontal; usually ten times.

Sl. No	B.S	I.S	F.S	H.I	R.L	Chainage in m (Centre)	Remarks
	ΣB.S		ΣF.S				

Arithmetical Check: ΣB.S - ΣF.S = Last RL – First RL