Lab Manual

Name of the Lab: MOS LAB

Name of the Faculty: A. ARUNA JYOTHI

Year/Sem : II/I

Academic Year: 2019-2020

Department of Mechanical Engineering

MALLA REDDY ENGINEERING COLLEGE (Autonomous)

(Approved by AICTE & Affiliated to JNTUH)

Maisammaguda, Dhulapally (Post via Kompally), Secunderabad-500 100

www.mrec.ac.in **E-mail: mrec.2002@gmail.com**

Malla Reddy Engineering College (Autonomous)
Department of Mechanical Engineering

(Established in 2002)

INSTITUTE VISION

Institute vision and mission

VISION

To be a premier center of professional education and research, offering quality programs in a socio-economic and ethical ambience.

MISSION

- To impart knowledge of advanced technologies using state-of-the-art infrastructural facilities.
- To inculcate innovation and best practices in education, training and research.
- To meet changing socio-economic needs in an ethical ambience.

Department Vision and Mission

VISION

To be phoenix centre producing proficient mechanical engineers with ignited minds, ethical values and innovation in advanced technologies.

MISSION

- To provide solid foundation in mechanical engineering principles.
- To improve the thought process of the students and make them innovative by exposing them to advanced technologies and research.
- To produce motivated and ethical graduates and postgraduates for continuous growth in career and serving the society.

Programme Educational Objectives

1. To develop the ability among students to synthesize data and technical concepts for application to product design in industry that need the global needs.
2. To provide students with sound foundation in the mathematical, scientific and engineering fundamental necessary to formulate, solve and analyses engineering problems and to prepare them to work as part of teams on multi disciplinary projects.
3. To promote student awareness of the lifelong learning and to create them with professional ethics and code of practice.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PROGRAMME OUTCOMES (POs) (for the regulations MR15-MR18)

PO 1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	Problem analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO 11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Understand the problem and apply design and analysis tools to find solution in the domains of Structural, thermal and Fluid Mechanics.
PSO2	Engage professionally in industries or as an entrepreneur by applying Manufacturing concepts.
PSO3	Systemize the Engineering and manufacturing practices using TQM concepts and Optimization techniques

Syllabus

2018-19 Onwards (MR-18)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	B.Tech. III Semester		
Code:80313	MECHANICS OF SOLIDS LAB	L	T	P
Credits: 1		-	-	2

Course Objectives:

Students will be able to experimentally learn the microstructure, compositions and various mechanical properties of the metals and alloys

List of Experiments

MECHANICS OF SOLIDS LABORATORY

1. Tensile test using UTM.
2. Bending test on a) simply supported beam b) cantilever beam.
3. Torsion test.
4. Hardness test on a) Brinell hardness tester b) Rockwell hardness tester.
5. Test on springs a) compression spring b) tension spring.
6. Impact test a) Izod b) Charpy.
7. Fatigue test.
8. Hoop stress and strain relationship for the Thin Cylinder.

TENSION TEST

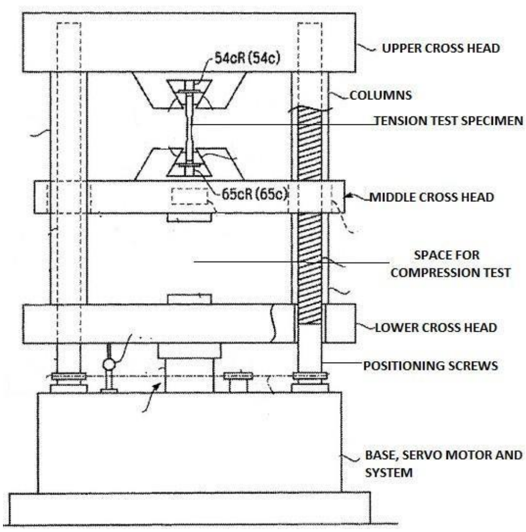
AIM: To determine ultimate tensile stress of a metal.
OBJECTIVE: To conduct a tensile test on a mild steel specimen and determine the following:

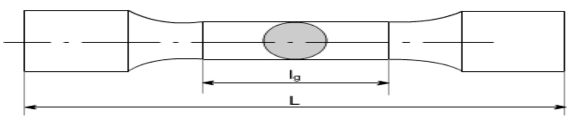
(i) Limit ofproportionality
(ii) Elastic limit
(iii) Yield strength
(iv) Ultimate strength
(v) Young‟s modulus ofelasticity
(vi) Percentage elongation
(vii) Percentage reduction inarea.

APPARATUS:

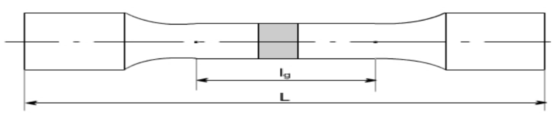
(i) Universal Testing Machine (UTM)
(ii) Mild steelspecimens
(iii) Graph paper
(iv) Scale
(v) Vernier Caliper

DIAGRAM:





[specimen with circular X-section]



[specimen with rectangular X-section]

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 essentJially 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 andrupture.

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.

DESCRIPTION OF UTM :

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 pecimen 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 tan 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 OFTESTING:-

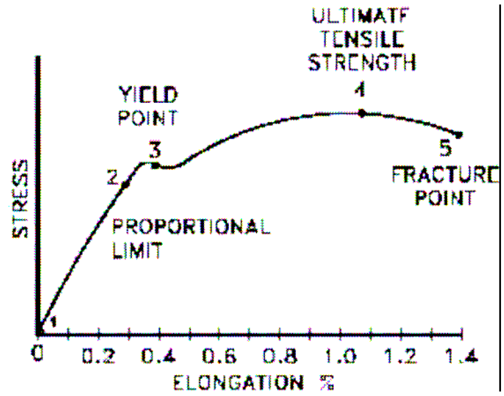
Initial Adjustment: - before testing adjust the pendulum with respect to capacity of the test i.e. 8 Tones; 10 Tones; 20 Tones; 40 Tones etc. For ex: - A specimen of 6 tones capacity gives more accurate result of 10 Tones capacity range instead of 20 Tones capacity range. These ranges of capacity are 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 tests.

EXTENSOMETER:-

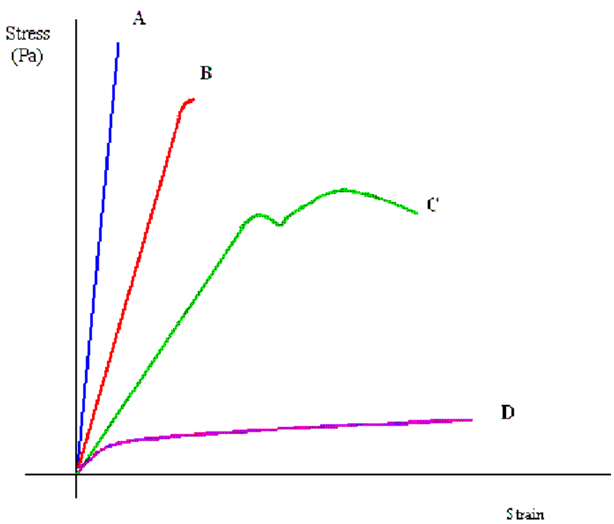
This instrument is an attachment to Universal / Tensile Testing Machines. This measures the elongation of a test place on load for the set gauge length. The least count of measurement being

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 30to 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.



A) Stress-strain graph of Mild Steel



C) 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 crack under 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.

OBESERVATIONS:

A) **Original dimensions**

Gauge Length = ------------

Diameter = ---------

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

B) **Final Dimensions:**

Gauge Length = -------------------

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

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

TABULATION:- (Cross check 'E' with reference table 1.0)

S.No.	Extension (mm)		Load,		Average Load	Young's Modulus E,
	Lef	Right	Lef	Right		
1						
2						
3						
4						
5						

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

ii) **Elastic limit** = $\frac{\text{load at elastic limit}}{\text{Original area of c/s}}$ N/mm^2

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

Ultimate strength = $\frac{\text{Maximum tensile load}}{\text{Original area of cross-section}}$

$$\text{Young's modulus}\quad E = \frac{Stress}{Strain} = \frac{F / A}{\Delta L / L}$$

$$\text{Percent elongation} = \frac{\text{final gage length} - \text{initial gage length}}{\text{initial gage length}}$$

$$= \frac{L_x - L_o}{L_o} = \text{inches per inch x 100}$$

Percent reduction of area (RA) =

$$\frac{\text{area of original cross section} - \text{minimum final area}}{\text{area of original cross section}}$$

$$= \frac{A_o - A_{min}}{A_o} = \frac{\text{decrease in area}}{\text{original area}} = \frac{\text{square inches or mm}}{\text{square inches or mm}} \text{ x 100}$$

PRECAUTIONS:-

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

GRAPH:

1. Stress Vs Strain

RESULT:-

i) Average Breaking Stress =

ii) Ultimate Stress =

iii) Average % Elongation =

iv) Modulus of Elasticity, E =

PRE LABQUESTIONS

2. Define Hook‟s law
3. Define elastic and plastic limit of a material.
4. Explain young‟s modulus?
5. Define gauge length.
6. Define mechanical properties of a materials.
7. Define proof stress.

POST LABQUESTIONS

1. What is the youngs modulus for steel, aluminium, brass.
2. What is ultimate tensile stress for steel, aluminium.
3. Identify upper & lower yield, proportional limit, fracture point on a σ-ϵ curve.

TORSION TEST

Aim: To conduct torsion test on mild steel or cast iron specimen to determine modulus of rigidity.

APPARATUS:

1. A torsion test machine along with angle of twist measuring attachment.
2. Standard specimen of mild steel or cast iron.
3. Steel rule.
4. Vernier caliper or a micrometer.

Torsion testingmachine:

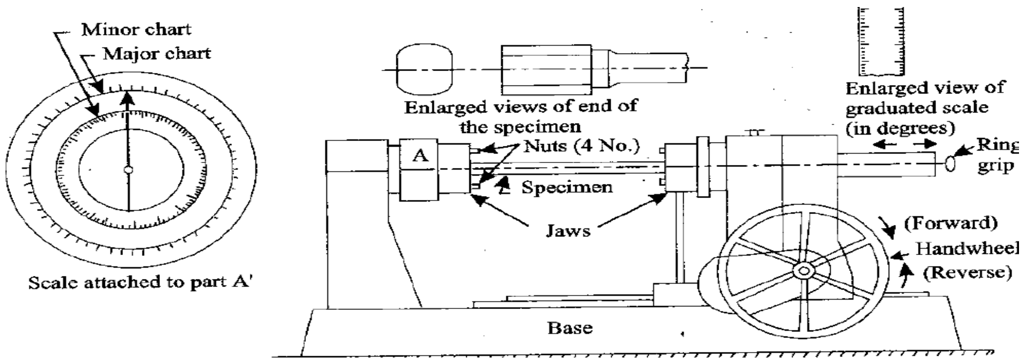
M/C SPECIFICATIONS:

Capacity: Torque Range: 0-10

Kg-m. Model: TTM-10..

SR.No: 2001/1012.

Mfd. By: Macro Testing Machines, Ichalkaranji, M.H, India.



THEORY:

For transmitting power through a rotating shaft it is necessary to apply a turning force. The force is applied tangentially and in the plane of transverse cross section. The torque or twisting moment may be calculated by multiplying two opposite turning moments. It is said to be in pure torsion and it will exhibit the tendency of shearing off at every cross section which is perpendicular to the longitudinal axis.

Torsion equation:

Torsion equation is given by below

$\mathbf{T/J = \tau/R = G\theta/L}$

$\mathbf{G = T L/J \theta}$ N/mm^2

T= maximum twisting torque (N mm)

J = polar moment of inertia

$(mm^4) = \pi d^4/32$ τ = shear

stress (N/mm^2)

G = modulus of

rigidity (N/mm^2) θ

= angle of twist in

radians

L= length of shaft under torsion (mm)

Assumptions made for getting torsion equation

1. The material of the shaft is uniform throughout.
2. The shaft, circular in section remain circular after loading.
3. Plane sections of shaft normal to its axis before loading remain plane after the torque have been applied.
4. The twist along the length of the shaft is uniform throughout.

5. The distance between any two normal-sections remains the same after the application of torque.

6. Maximum shear stress induced in the shaft due to application of torque does not exceed its elastic limit.

Procedure

1. 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.
2. Measure the diameter at about three places and take the average value.
3. Choose the appropriate range by capacity change lever
4. Set the maximum load pointer to zero.
5. Set the protractor to zero for convenience and clamp it by means of knurled screw.
6. Carry out straining by rotating the hand wheel in either direction.
7. Load the machine in suitable increments.
8. Then load out to failure as to cause equal increments of strain reading.
9. Plot a torque- twist (T- θ) graph.

6. Read off co-ordinates of a convenient point from the straight line portion of the torque twist (T- θ) graph and calculate the value of G by using relation.

OBESERVATIONS:-

Gauge length of the specimen, L = ………

Diameter of the specimen, d = ………

Polar moment of inertia, $J = \pi d^4/32$ = ...

TABULATION: (Cross check 'G' with reference table 1.0)

Sl. No.	Torque, Kg-cm	Torque, N - mm	Angle of twist		Modulus Rigidity	Average G, N/mm^2
			Degrees	Radians		

PRECAUTIONS:-

1) Measure the dimensions of the specimen carefully
2) Measure the Angle of twist accurately for the corresponding value of Torque.
3) The specimen should be properly to get between the jaws.
4) After breaking specimen stop to m/c.

GRAPH:

1. Torque Vs Angleof Twist

RESULT :-

Thus the torsion test on given mild steel specimen is done and the modulus of rigidity is -------------- N/mm^2

Pre Lab Questions

1. Define torque.
2. Give the expression for torque.
3. Define modulus of rigidity.
4. Give the values of G for different materials.

Post Lab Questions

1. What is angle of twist?
2. Define Polar moment of inertia?

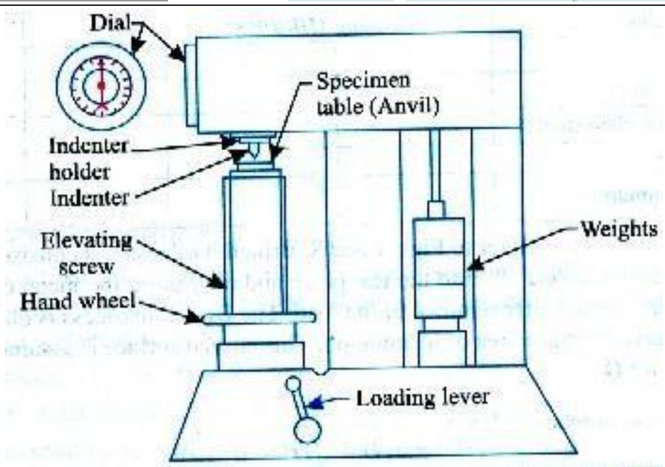
HARDNESS TEST

AIM: - To conduct hardness test on mild steel, carbon steel, brass and aluminum specimens.

APPARATUS:- Hardness tester, soft and hard mild steel specimens, brass, aluminum .

Diagram:

Nomenclature	Specifications
Loads	60,100,150,187.5, 250 (kgf)
Initial Load	10 (kgf)
Max. Test Height	230 (mm)
Depth of Throat	133 (mm)
Max. Depth of elevating screw below base	240 (mm)
Size of Base (approx)	171 x 423 (mm)
Machine Height	635 (mm)
Net.weight (Approx)	75 Kg



THEORY: The hardness of a material is resistance to penetration under a localized pressure or resistance to abrasion. Hardness tests provide an accurate, rapid and economical way of determining the resistance of materials to deformation. There are three general types of hardness measurements depending upon the manner in which the test is conducted:

a. Scratchhardnessmeasurement,

b. Reboundhardnessmeasurement

c. Indention hardness measurement.

In scratch hardness method the material are rated on their ability to scratch one another and it is usually used by mineralogists only. In rebound hardness measurement, a standard body is usually dropped on to the material surface and the hardness is measured in terms of the height of its rebound. The general means of judging the hardness is measuring the resistance of a material to indentation. The indenters usually a ball cone or pyramid of a material much harder than that being used. Hardened steel, sintered tungsten carbide or diamond indenters are generally used in indentation tests; a load is applied by pressing the indenter at right angles to the surface being tested. The hardness of the material depends on the resistance which it exerts during a small amount of yielding or plastic. The resistance depends on friction, elasticity, viscosity and the intensity and distribution of plastic strain produced by a given tool during indentation.

BRINELL'S HARDNESS

AIM :-

To determine the Brinell‟s hardness of the given test specimen.

APPARATUS:-

1. Brinell Hardness testing machine,
2. Specimen of mild steel / cast iron/ non ferrous metals
3. Brinell microscope.

THEORY:-

Hardness represents the resistance of material surface to abrasion, scratching and cutting, hardness after gives clear identification of strength. In all hardness testes, a define force is mechanically applied on the test piece for about 15 seconds. The indentor, which transmits the load to the test piece, varies in size and shape for different testes. Common indenters are made of hardened steel or diamond. In Brinell hardness testing, steel balls are

used as indentor. Diameter of the indentor and the applied force depend upon the thickness of the test specimen, because for accurate results, depth of indentation should be less than $1/8^{th}$ of the thickness of the test pieces. According to the thickness of the test piece increase, the diameter of the indentor and force are changed. A hardness test can be conducted on Brinell testing m/c, Rockwell hardness m/c or vicker 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. Its specification are as follows:

1. Ability to determine hardness upto 500 HB.
2. Diameter of ball (as indentor) used D = 2.5mm, 5mm, 10mm.
3. Maximum application load = 3000kgf.
4. Method of load application = Lever type
5. Capability of testing the lower hardness range = 1 HB on application of 0.5D2 load.

Indentation Hardness-A number related to the area or to the depth of the impression made by an indenter or fixed geometry under a known fixed load. This method consists of indenting the surface of the metal by a hardened steel ball of specified diameter D mm under a given load F kgf and measuring the average diameter d mm of the impression with the help of Brinell microscope fitted with a scale.

The Brinell hardness is defined, as the quotient of the applied force F divided by the spherical area of the impression.

HB = Load Applied (kgf.)/ Spherical surface area indentation (in mm.)

$$= 2F / \pi D (D - \sqrt{D^2 - d^2}) \text{ kg/mm}^2$$

PROOF:-

For any sphere of diameter "D" the surface area between any two parallel planes with distance "h" between them = ΠD x h

The spherical indentation in the Brinell hardness test is indicated by the portion A-C-B

A = Surface area of potion ACB of spheres = ΠD x CE

But CE = OC-OE

$= D/2 - \sqrt{(OA)^2 - (AE)}^2$

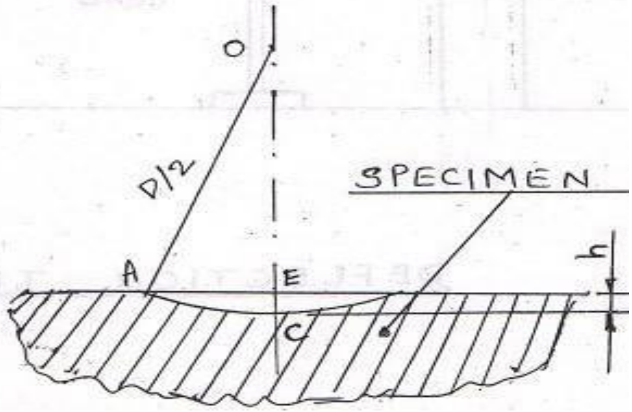
$= D/2 - \sqrt{(D/2)^2 - (d/2)^2}$

$= 1/2(D - \sqrt{(D^2 - d^2)}$

Area(A) = ΠD x CE

$= (\frac{\pi D}{2})(D - \sqrt{D^2 - d^2})$

Hardness =F/A= $2F / \pi D$ $(D - \sqrt{D^2 - d^2})$



PROCEDURE:

1. Select the proper size of the ball and load to suit the material under test.
2. Clean the test specimen to be free from any dirt and defects or blemishes.
3. Mount the test piece surface at right angles to the axis of the ball indenter plunger.
4. Turn the platform so that the ball is lifted up.
5. By shifting the lever applies the load and waits for some time.
6. Release the load by shifting the lever.
7. Take out the specimen and measure the diameter of indentation by means of the Brinell microscope.
8. Repeat the experiments at other positions of the test piece.
9. Calculate the value of HB.

OBSERVATIONS:

Test piece material =

Diameter of the ball, D =

Load section, P/D^2 =

Test load =

TABULATION: (Cross check with reference tables)

S. No.	Impression Diameter			Load Applied, Kg	Diameter of Ball, D mm	Average HB Kg/mm^2
	d_1	d_2	$(d_1+ d_2)/2$			
1						
2						
3						

PRECAUTIONS:-

- The surface of the test piece should be clean.
- The testing machine should be protected throughout the test from shock or vibration.
- The test should be carried out at room temperature.
- The distance of the center of indentation from the edge of test piece should be at least 2.5 times the diameter of the indentation and the distance between the centres of the two adjacent indentations should be at least 4 times the diameter of the indentation.
- The diameter of each indentation should be measured in two directions at right angles and themean value readings used the purpose of determining the hardness number.

RESULT:-

The Brinell hardness number of the specimen is --------

ROCKWELL HARDNESS TEST

AIM :

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

APPARATUS: -

1. Rockwell Hardness testingmachine,
2. 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 indentors 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 similar to Brinell hardness testing. It differs only in diameter and material of the indentor and the applied force. Although there are many scales having different combinations of load and size of indentor but commonly „C" scale is used and hardness is presented as HRC. Here the indentor 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 indentor at 60kgf. A hardness test can be conducted can be conducted on Brinell testing m/c, Rockwell hardness m/c or vicker testing m/c. The specimen may be a cylinder, cube, thick or thin metallic sheet. A Brinell-cum- Rocwell hardness testing m/c along with the specimen is shown in figure.

ASTM E 18 - 2000, Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.

ISO 6508-1 Metallic Materials - Rockwell hardness test (scales A, B, C, D, E, F, G, H, K, N,
T) - Part 1: Test method, 1999-09-01

ISO 6508-2 Metallic Materials - Rockwell hardness test (scales A, B, C, D, E, F, G, H, K, N,
T) - Part 2: Verification of testing machines, 1999-09-01

ISO 6508-3 Metallic Materials - Rockwell hardness test (scales A, B, C, D, E, F, G, H, K, N,

T) - Part 3: Calibration of reference blocks, 1999-09-01

Rockwell-cum-Brinell's hardness tester

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.

OBSERVATIONS:

Material of the specimen =

Thickness of test specimen =

Hardness scale used =

TABULATION: (Cross check with reference tables)

S. No.	Material	Rockwell Scale			Rockwell Number			Average
		Scale	Load	Indent	1	2	3	
1								
2								
3								
4								

PRECAUTIONS:

1. For testing cylindrical test specimens use V-type platform.
2. Calibrate the machine occasionally by using standard test blocks.
3. For thin metal prices place another sufficiently thick metal piece between the test specimen and the platform to avoid any damage, which may likely occur to the platform.
4. After applying major load wait for some time to allow the needle to come to rest. The waiting time may vary from 2 t0 8 seconds.
5. The surface of the test piece should be smooth and even and free from oxide scale and foreignmatter.
6. Test specimen should not be subjected to any heating of cold working.
7. The distance between the canters of two adjacent indentation should be at least 4 times the diameter of the indentation and the distance from the center of any indentation to the edge of the test piece should be at least 2.5 times the diameter of the indentation.

RESULT:-

Rockwell hardness of given specimen is --------

Viva Questions:

1. Define Hardness.
2. How the hardness will vary from hardened to unhardened steels.
3. What are the various methods of finding the hardness number of materials.

SPRING TEST

AIM: To determine the stiffness and modulus of rigidity of the spring wire.

APPARATUS: -

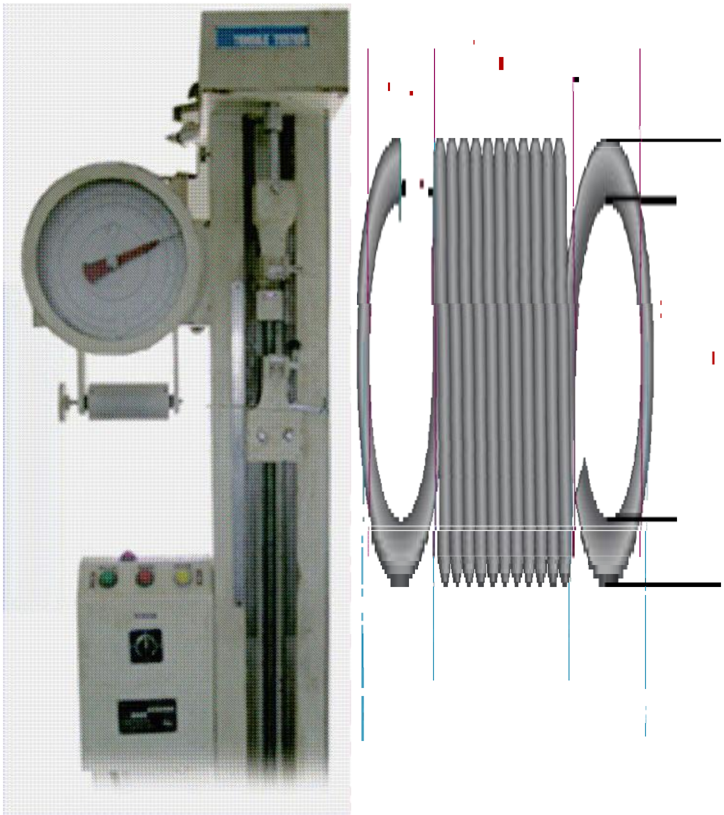
i) Spring testingmachine.

ii) A spring

iii) Vernier caliper, Scale.

iv) Micrometer.

DIAGRAM:-



M/C SPECIFICATIONS:

Capacity:

0-250 Kgf.

Model:

MX-250

SR.No:

2001/1001.

Mfd. By: Macro Testing Machines, Ichalkaranji, M.H, India.

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 idealise complex structural systems by suitable spring.

PROCEDURE:

1) Measure the outer diameter (D) and diameter of the spring coil (d) for the given compression spring.
2) Count the number of turns i.e. coils (n) in the given compression specimen.
3) Place the compression spring at the centre of the bottom beam of the spring testing machine.
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) Note down the initial reading from the scale in the machine.
6) Increase the load and take the corresponding axial deflection readings.
7) Find the actual deflection of the spring for each load by deducting the initial scale reading from the corresponding scale reading.
8) Calculate the modulus of rigidity for each load applied.
9) Plot a curve between load and deflection. The shape of the curve gives the stiffness of the spring.

FORMULA:

Modulus of rigidity, $G = \dfrac{64WR^3 n}{\delta d^4}$

Where,

i. W = Load in N

ii. R = Mean radius of the spring in mm (D –(d /2))/2

iii. d = Diameter of the spring coil in mm

iv. δ = Deflection of the spring in mm

v. D = Outer diameter of the spring in mm.

OBESERVATIONS:

10) Material of the spring specimen =
11) Least count of micrometer = ... mm
12) Diameter of the spring wire, d
    =..........mm (Mean of three readings)
13) Least count of Vernier Caliper = ... mm
14) Diameter of the spring coil, D =
    ……...mm (Mean of three readings)
15) Number of turns, n =
16) Initial scale reading = ... mm

TABULATION:

S.No.	Applied Load		Scale Reading, mm	Actual Deflection,	Modulus of Rigidity, GPa	Stiffness, N/mm
	Kg	N				
1						
2						
3						
4						
5						

GRAPH:

1. Load Vs Deflection

PRECAUTIONS:-

1) Dimensions should be measure accurately with the help of Vernier Calipers.
2) Deflection from the scale should be noted carefully and accurately.

RESULT:

The modulus of rigidity of the given spring = -------------------- GPa

The stiffness of the given spring = ------------------- N/mm^2

VIVA QUESTIONS:-

1. Define stiffness of a material.
2. Explain various types of springs.
3. How modulus of rigidity of a same material will vary with varying dimensions?

IMPACT TEST (CHARPY)

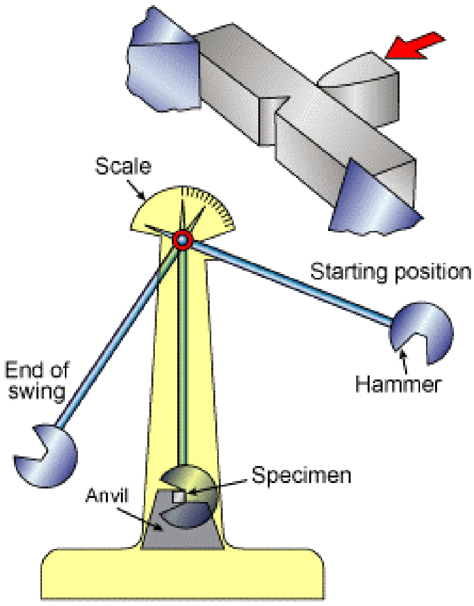
AIM: -To determined impact strength of steel**.**

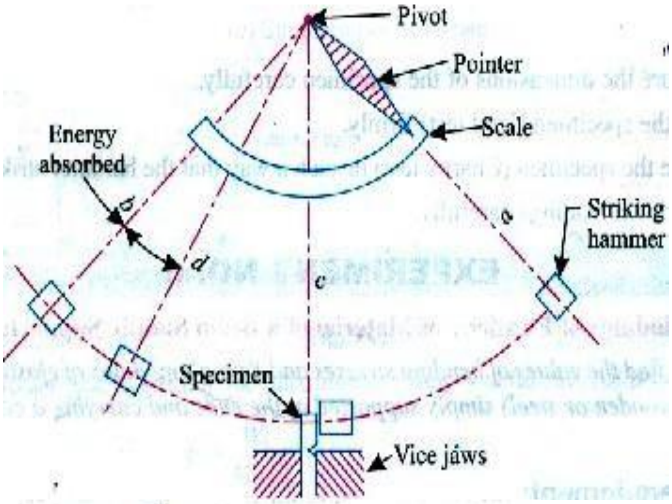
OBJECT: -To Determine the impact strength of steel by (Charpy test)

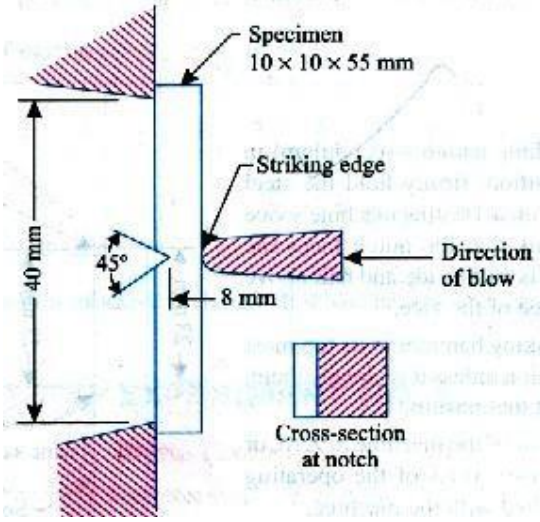
APPARATUS: -1. Impact testing machine

2. A steel specimen 10 mm x 10 mm X 55mm

DIAGRAM:-







THEORY:-

An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of unmatched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied loads while in service. Impact strengths are generally lower as compared to strengths achieved under slowly applied loads. Of all types of impact tests, the notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock loading. Values obtained from these tests are not of much utility to design problems directly and are highly arbitrary. Still it is important to note that it provides a good way of comparing toughness of various materials or toughness of the same material under different condition. This test can also be used to assess the ductile brittle transition temperature of the material occurring due to lowering of temperature.

PROCEDURE:-

(b) Charpy Test

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machines vice in such a way that the notch faces s the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.
5. The specimen is placed on supports or anvil so that the blow of hammer is opposite to the notch.

OBESERVATIONS:-

Charpy test

1. Impact value of - Mild Steel ------------ N-m
2. Impact value of - Brass ------------ N-m
3. Impact value of - Aluminum------------ N-m

RESULT:-

i. The energy absorbed for Mild Steel is found out to be (K) ------------ Joules.
ii. The energy absorbed for Brass is found out to be (K)-------------Joules.
iii. . The energy absorbed for Aluminum is found out to be (K) ------------- Joules

iv. Impact strength of the specimen, (K/A) = ------------------- J/mm^2

PRECAUTIONS:-

1. Measure the dimensions of the specimen carefully.
2. Locate the specimen (Charpy test) in such a way that the hammer, strikes it at the middle.
3. Note down readings carefully.

VIVA QUESTIONS:

1. Define toughness.
2. What is the difference between notched and unnotched specimens?

IMPACT TEST (IZOD TEST)

AIM: - To Determine the impact strength of steel by Izod impact test

APPARATUS: - 1.Impacttestingmachine

2. A steel specimen 75 mm X 10mm X 10mm

DIAGRAM:-

M/C SPECIFICATIONS:

Capacity: Energy range: i. Charpy: 0-300 J.

ii. Izod: 0-168 J.

Model:

ITM-300

SR.No:

2001/1016

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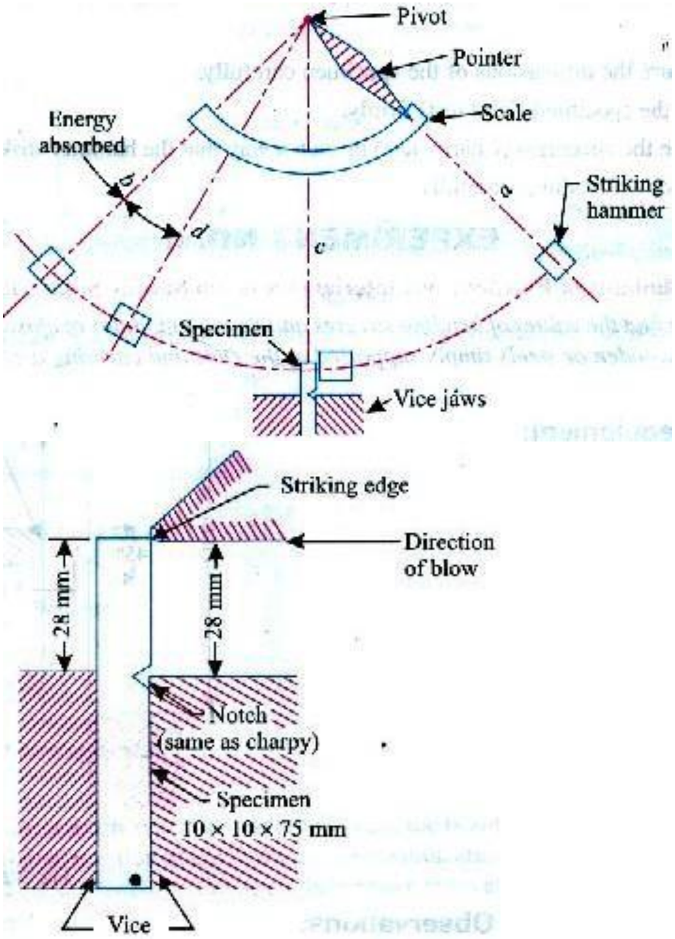
Mfd. By: Macro Testing Machines, Ichalkaranji, M.H, India.



THEORY:-

An impact test signifies toughness of material that is ability of material to absorb energy during plastic deformation. Static tension tests of unnotched specimens do not always reveal the susceptibility of a metal to brittle fracture. This important factor is determined by impact test. Toughness takes into account both the strength and ductility of the material. Several engineering materials have to withstand impact or suddenly applied loads while in service. Impact strengths are generally lower as compared to strengths achieved under slowly applied loads. Of all types of impact tests, the notch bar tests are most extensively used. Therefore, the impact test measures the energy necessary to fracture a standard notch bar by applying an impulse load. The test measures the notch toughness of material under shock loading. Values obtained from these tests are not of much utility to design problems directly and are highly arbitrary. Still it is important to note that it provides a good way of comparing toughness of various materials or toughness of the same material under different condition. This test can also be used to assess the ductile brittle transition temperature of the material occurring due to lowering of temperature.

PROCEDURE:-

(a) lzod test

1. With the striking hammer (pendulum) in safe test position, firmly hold the steel specimen in impact testing machine‟s vice in such a way that the notch face the hammer and is half inside and half above the top surface of the vice.
2. Bring the striking hammer to its top most striking position unless it is already there, and lock it at that position.
3. Bring indicator of the machine to zero, or follow the instructions of the operating manual supplied with the machine.
4. Release the hammer. It will fall due to gravity and break the specimen through its momentum, the total energy is not absorbed by the specimen. Then it continues to swing. At its topmost height after breaking the specimen, the indicator stops moving, while the pendulum falls back. Note the indicator at that topmost final position.
5. Again bring back the hammer to its idle position and back

OBESERVATIONS:-

Izod Test.

1. Impact value of - Mild Steel ------------ N-m
2. Impact value of - Brass ------------ N-m
3. Impact value of - Aluminum------------ N-m

PRECAUTIONS:-

1. Measure the dimensions of the specimen carefully.
2. Hold the specimen (lzod test) firmly.
3. Note down readings carefully.

RESULT:-

ii. The energy absorbed for Mild Steel is found out to be (K)-----------------Joules.

iii. The energy absorbed for Brass is found out to be (K)-------------------- Joules.

iv. The energy absorbed for Aluminium is found out to be (K) ------------------ Joules

v. Impact strength of the specimen, (K/A) = ------------------- J/mm^2

THICK/THIN WALL CYLINDER

AIM:

The experiment is conducted to

- Determine the **CIRCUMFERENTIAL AND LONGITUDINAL strain** at different Pressure condition.
- Also, Compare the Calculated Values with the obtained values

DESCRIPTION OF APPARATUS

The Apparatus consists of:

1. CYLINDER of thickness 2mm and 100mm diameter made of SS304 material. (t/D ratio of 1/50)
2. Drain valve and Pressure gauge fitting option is provided on the cylinder.
3. Cylinder is mounted between the studs with End plates for good aesthetic looks.
4. Gauging has being done on Longitudinal and Circumferential plane to measure the strain in their respective directions.
5. Pressure Gauge is provided to measure the pressure exerted on the system.
6. Hydraulic Hand pump is provided to create the required pressure in the cylinder.
7. Digital Strain Indicator is provided to measure the strains at different positions.
8. The whole setup is mounted on the table frame for easy and better operation.

PROCEDURE

1. Fill clean water in the Hydraulic Hand pump
2. Fix the connector of the pump to the pressure vessel or cylinder provided.
3. Provide necessary electrical connection (230V 1ph 5Amps with neutral and earthing) to the indicator provided.
4. Now on the Digital Multi-strain indicator set the display knob (right hand side of the display) to first position and set to zero using zero adjustment knob (below the display).
5. Similarly do the above step for second position.
6. Now, using the Hand pump provided load the vessel/cylinder.
7. Set the pressure by noting the value on the pressure gauge.
8. Note the strain readings at the Longitudinal and Circumferential positions from the indicator and display knob.
9. Repeat, steps 6 & 8 until loaded maximum.(25 kg/cm2)
10. Once completed release the drain so the pressure inside the cylinder reduces to zero.

CALCULATIONS

NOMENCLATURE USED

P = Pressure measured in kg/cm^2
D = Mean Diameter of the cylinder = 102mm
L = Length of the Cylinder = 500mm
σ_D = Circumferential or Hoop's Stress, MPa
σ_L = Longitudinal Stress, MPa
γ = Poisson's Ratio = 0.305 for SS304 material.
E = Young's Modulus, GPa
t = Thickness of the cylinder = 2mm

TABULATIONS:

Sl No.	Pressure on the cylinder		Micro Strain	
	Kg/cm^2	**MPa**	**Longitudinal**	**Circumference**

CALCULATIONS:

1. **HOOP'S STRESS OF CIRCUMFERENTIAL STRESS, σ_D**

$$\sigma_D = \frac{P\ D}{2t}\ MPa$$

2. **LOGITUDINAL STRESS, σ_L**

$$\sigma_L = \frac{P\ D}{4t}\ MPa$$

3. **CALCULATED STRAIN ALONG THE CIRCUMFERENCE,**

$$Calculated\ \varepsilon_D = \frac{(P\ D) * (2 - \gamma)}{(4\ t\ E)}\ \mu\varepsilon$$

4. **CALCULATED STRAIN ALONG THE LONGITUDE**

$$Calculated\ \varepsilon_L = \frac{(P\ D) * (1 - 2\gamma)}{(4\ t\ E)}\ \mu\varepsilon$$

TABULAR COLUMN

Sl No.	Pressure on the cylinder		Micro Strain			
	Kg/cm^2	MPa	Longitudinal		Circumference	
			Measured	Calcuated	Measured	Calculated

Sl No.	Pressure on the cylinder		Stress, MPa	
	Kg/cm^2	MPa	Longitudinal	Circumference

PRECAUTIONS

1) Clean the water tank regularly, say for every 15days.
2) Do not run the equipment if the voltage is below 180V.
3) Check all the electrical connections before running.
4) Before starting and after finishing the experiment the main control valve should be in close position.
7) Do not attempt to alter the equipment as this may cause damage to the whole system.

Result: