EXPERIMENT NO. 2(A)
COMPRESSION TEST OF WOODEN BLOCK

OBJECTIVES

1. To study the Universal Testing Machine
2. To observe the behavior of a block of wood under compressive loading parallel to grain
3. To draw the stress-strain diagram
4. To determine-
   i. Proportional Limit
   ii. Yield Strength
   iii. Ultimate Compressive Strength
   iv. Modulus of Elasticity
   v. Modulus of Resilience

THEORY

The compression test is commonly performed on a Universal Testing Machine in order to determine the mechanical properties of materials. The compression space is in the lower portion of the machine. Most ductile materials behave the same in tension and compression. However, there are some materials that are very weak in tension and extremely strong in compression such as concrete, wood. cast iron etc. That is why these materials are mostly tested in compression. The strength of wood is highly dependent on the loading direction. Wood is strongest in compression along the fibers and is weakest in the radial and tangential direction.

For elastic material according to Hook's law, stress is proportional to strain up to a certain limit, called proportional limit. The constant of proportionality is called modulus of Elasticity, E.

$$\sigma = P/A, \qquad \varepsilon = A/L, \qquad E = \sigma / \varepsilon \text{ (within proportional limit)}$$

Where σ is stress, ε is strain, and E is Modulus of Elasticity, P is applied load, A is the original area of cross-section and A is change in gauge length L due to load.

Definition of some important terms of the Stress-Strain Diagram:

Proportional limit: The point in the stress-strain diagram up to which the stress is proportional to strain is called the proportional limit.

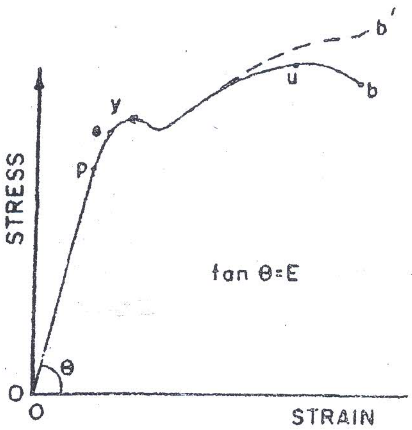
Yield Point: The point (y is the figure) in the stress-strain diagram at which strain increases without appreciable increase in stress and the material is said to be deformed plastically.

Ultimate Strength: The maximum stress (u in the figure) on the stress-strain diagram is called the ultimate strength or tensile strength.

Ultimate Compressive Strength: The maximum stress a material withstands when subjected to an applied load. At the point of maximum stress the material begins to yield and will fracture unless load is substantially reduced.

Modulus of Elasticity: Within the proportional limit stress is proportional to strain and this constant of proportionality is called modulus of elasticity. The modulus of elasticity, E has relatively large values for materials that are very stiff, such as structural metals. Steel has a modulus of approximately 200 GPa; for aluminum 70 GPa. More flexible materials have a lower modulus; a typical value for wood is 11 GPa.

Modulus of Resilience: The ability of a material to absorb energy within the proportional limit. The modulus of resilience is the strain energy density (strain energy per unit volume) requried to stress the material to its proportional limit. It can be derived from a material's stress-strain curve.



APPARATUS

1. Universal Testing Machine
2. Dial Gauge
3. Slide Calipers

SPECIMEN

Block of wood with square cross-section

PROCEDURE

1. Make sure that the universal testing machine is recently calibrated.
2. Measure the dimensions of the specimen by slide calipers.
3. Set the Universal Testing Machine Properly.
4. Fix the dial gauge by a magnetic holder and set the dial to read to zero.
5. Fix and apply load on the specimen.
6. Simultaneously record dial gauge reading and the corresponding load at regular intervals.
7. Take off the dial gauge when breaking starts.
8. Record the maximum and breaking load
9. Observe the plane of failure.

DATA AND CALCULATION

Date of Test:

Dimensions of Specimen:

Gauge Length =

Cross Sectional Area =

Dial Gauge Constant =

Table: Experimental data and calculation of the compression test of wooden block

Observation	Load (kg)	Dial Gauge Reading	Deformation (mm)	Stress (MPa)	Strain (mm/mm)	Remarks
	0					
	500					
	1000					
	1500					
	2000					
	2500					
	3000					
	3500					
	4000					
	4500					
	5000					
	5500					
	6000					
	6500					
	7000					
	7500					
	8000					
	8500					
	9000					
	9500					
	10000					

Find out the following:

1) Draw the Stress-Strain Diagram and estimate the following:

   i. Proportional Limit

   ii. Yield Strength

   iii. Ultimate Strength

   iv. Modulus of Elasticity

   V. Modulus of Resilience

2) Sketch the appearance of fracture.

QUESTIONS

1. Is accurate centering of a specimen on the testing machine important? Is so why?
2. State whether the plane of failure of your test specimen is horizontal, vertical or inclined. Why?
3. State whether the compressive strength is correct, if the ends of the specimen are not plane? Mention the reason for your answer.
4. What affect does the rate of loading have in this test?
5. What are the principal types of failure in wood under compression parallel to the grain? Draw figures.
6. Is there any relation between the strength and specific gravity of wood?
7. Mention the structural uses of timber

EXPERIMENT NO. 2(B)
IMPACT TEST

OBJECTIVES

1. To study the impact testing machine
2. To determine the energy absorbed in fracturing Mild steel, Brass and Cast Iron specimens
3. To observe the appearance of the fracture of the specimens

THEORY

The Impact test is done to measure the impact strength of materials. The impact strength indicates the amount of energy required to fracture the materials under dynamic or impact loading. The Impact testing machine which is used here is of the pendulum type. Mostly used types of the test are: I) Charpy and 2) Izod.

The test consists of measuring the energy absorbed in breaking a standard notched test piece by a single blow from a striker carried by a pendulum. The specimen is held in an anvil and is broken by hammer which falls from a fixed starting point. In this condition it has a definite potential energy equal to WH, where W is the weight of the pendulum and H is the height of the center of gravity above its lowest point. The pendulum achieves maximum kinetic energy at its lowest swing position, just before it hits the specimen. If the hammer is released from the starting position without setting the specimen, it will rise up to an angle θ_1. Again if the specimen is placed and then the specimen is released it will rise up to angle θ_2 after breaking the specimen. The impact strength or energy may be easily calculated if we get the difference between the height of drop before rupture and the height of rise after rupture of the test specimen.
before rupture and the height of rise after rupture of the test specimen.

By doing so, we get the absorbed energy $E = WH (\cos \theta_1 - \cos \theta_2)$-

Figure1: Schematic of the Charpy and Izod Impact Test

APPARATUS

1. Universal Impact Testing Machine
2. Slide Calipers

SPECIMEN

Notched Specimens-Mild Steel, Brass and Cast Iron

PROCEDURE

1. Measure the dimension of the specimen.
2. Set the pointer to read minimum on the graduated disc and note down the initial error.
3. Set the hammer block in the position "A" and the pointer on the scale at 0 and take the pointer reading.
4. Set the specimen on the anvil and then set the hammer to the initial position.
5. Release the hammer so that it strikes the specimen.
6. Take the pointer reading.
7. From the readings calculate the energy absorbed.

**** Be safe distance when the hammer swings.**

DATA AND CALCULATION

Date of Test:

Particulars of Specimen:

Depth of the notch:

Weight of the hammer, W:

Height of fall, H:

Free angle of rise θ degree

Type of specimen	Material	Cross section below the notch	Angle of rise θ_1	Angle of fall θ_2	Corrected energy absorbed (Nm)	Notch impact strength (Nm/mm^2)

QUESTIONS

1. Why is impact test important? Explain
2. What is the objective of using notched specimens in the test?
3. Suggest some ways for improvement of the experimental set-up
4. Explain the purpose of using standard specimens for the impact test.

EXPERIMENT NO. 3(A)
HELICAL SPRING TEST

OBJECTIVE

a. To find the stiffness of the spring.

b. To draw a curve by plotting load against deflection and find the stiffness and modulus of rigidity of the spring from the L-δ curve.

c. To compare theoretical and experimental stiffness and also modulus of rigidity.

d. To find the shear stress induced in the spring.

THEORY

Springs are machine/structure components which undergo significant deformation when loaded and their compliance enables them to store readily recoverable mechanical energy. A spring formed by winding wire into a helix along the surface of a cylinder is called helical spring.

If a helical spring of circular cross section is subjected to an axial load, any section of the spring will develop shear stresses and of these shear stresses the greater part is torsional stress.

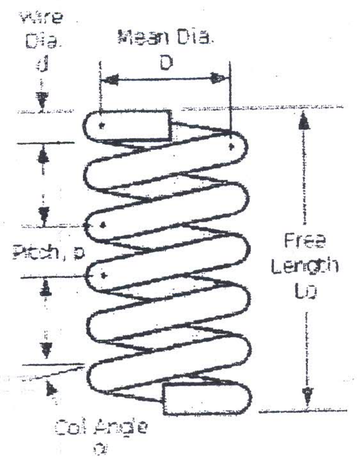


Fig: Helical Spring Geometry

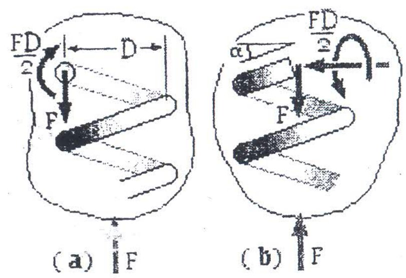


Fig: Free body of spring

Total shear stress is given by

$\tau_t = \tau_d + \tau_t = F/A + Tr/J = F/A(1+2R/r)$

Deflection of the helical spring is given by, $\delta = 8FD^3N_a / Gd^4$

Stiffness, $F/\delta = Gd^4 / 8D^3N_a$