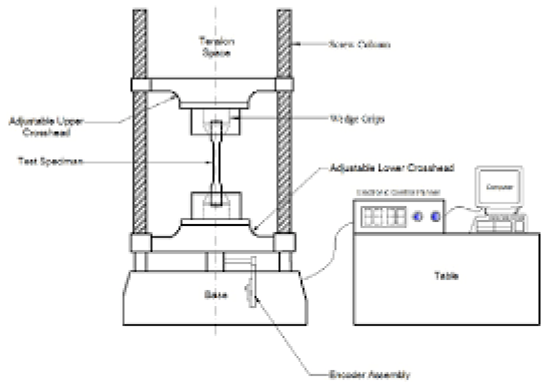
Bending Test

OBJECTIVE:-
To study the behaviour of mild steel rod subjected to gradual increasing equal loads at 1/3rd span and to determine its mechanical properties.

Apparatus used:- Universal Testing Machine, Dial Indicator, Scale & Vernier Calipers



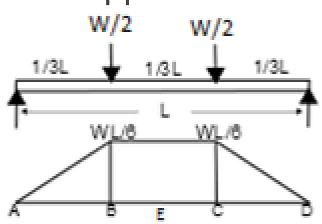
Theory:-
Bending strength is defined as a material's ability to resist deformation under load, it represents the highest stress experienced within the material at its moment of rupture. There are two types of bending tests. Three point bending test and four point bending test. In a three point bending test the area of uniform stress is quite small and concentrated under the centre loading point. In a four point bending test, the area of uniform stress exists between the inner span loading points (typically half the outer span length).

When a specimen is bent, it experiences a range of stresses across its depth. At the edge of the concave face the stress will be at its maximum compressive value. At the convex face of the specimen the stress will be at its maximum tensile value. Most materials fail under tensile stress before they fail under compressive stress, so the maximum tensile stress value that can be sustained before the specimen fails is its flexural strength. The flexural strength would be the same as the tensile strength if the material were homogeneous. Therefore the flexural properties of a specimen are the result of the combined effect of all three stresses as well as (though to a lesser extent) the geometry of the specimen and the rate the load applied. Bend testing provides insight into the modulus of elasticity and the bending strength of a material.

From bending equation,

$$M/I = \sigma/Y = f/R$$

Two point loads 'P/2' are applied at a distance of 1/3 L from the ends.



The moment due to two point loads P/2 at 1/3rd span is M= WL/6 and moment of inertia about the neutral axis is $I = \pi d^4/64$

Then the yield stress is

$$\sigma = \frac{\frac{WL}{6}}{\frac{\pi d^4}{64}} \times \frac{d}{2}$$

$$\sigma = \frac{WL}{6I} \times \frac{d}{2}$$

Then to determine the deflection at the centre of the span,

Deflection with respect to A is = moment of M/EI diagram between AE about A

$$\delta = \frac{1}{EI}\left(\left(\frac{1}{2} \times \frac{L}{3} \times \frac{WL}{6} \times \frac{2}{3} \times \frac{L}{3}\right) + \left(\frac{L}{6} \times \frac{WL}{6} \times \left(\frac{L}{3} + \frac{L}{12}\right)\right)\right)$$

$$\delta = \frac{23WL^3}{1296EI}$$

Then the deflection at B above E is =moment of M/EI diagram between BE about B

$$\delta = \frac{1}{EI}\left(\frac{L}{6} \times \frac{WL}{6} \times \left(\frac{L}{12}\right)\right)$$

$$\delta = \frac{WL^3}{432EI}$$

The deflection of B below A= $\delta = \frac{23WL^3}{1296EI} - \frac{WL^3}{432EI}$

Then the deflection under point load P/2 at B is $\delta = \frac{5WL^3}{324EI}$

Procedure:-

1. Measure the initial Diameter of the bending test sample in two perpendicular directions using vernier caliper, calculate the initial area and moment of inertia.
2. Measure the length of the specimen using scale keeping the span of the beam as L= 690mm based on the limitation of the experimental setup.
3. Based on the span of the beam being L= 690mm mark on the test sample mild steel rod by using a chalk at the mid span and one third loading points where a dial gauge is placed.
4. Insert the specimen between the special 2- point loading setup with roller supports which is being fixed on the lower crosshead of the universal testing machine. Adjust all the dial gauges to zero.
5. Start the loading process, note down the deflection using dial gauges under mid-span, one third span. Stop the experiment once the specimen has been yielded.
6. Once the yield limit is crossed, the specimen mild steel rod will have permanent bend or deformation as it has crossed the elastic limit.

- Diameter of the Specimen D (mm) = 24.3
- Span of the beam , L (mm) = 690

Observation:-

Diameter of the specimen,D (mm)	24.3
Span of the Beam, L(mm)	690
Slope of load deflection plot (N/mm)	617.05
Moment of Inertia about the neutral axis, I (mm^4)	
Stress at yield point (MPa)	

Result:-