Determination of Tensile Strength of a given specimen using UTM (25KN)

Experiment Findings · September 2023

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SESSIONAL REPORT

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Determination of Tensile Strength of a given specimen using UTM (25KN)

Remarks

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Objectives:

To conduct a tensile test on a mild steel specimen and determine the following properties of that specimen:

1. Elastic limit
2. Yield strength
3. Ultimate tensile strength (UTS)
4. Breaking stress
5. Young's Modulus of Elasticity

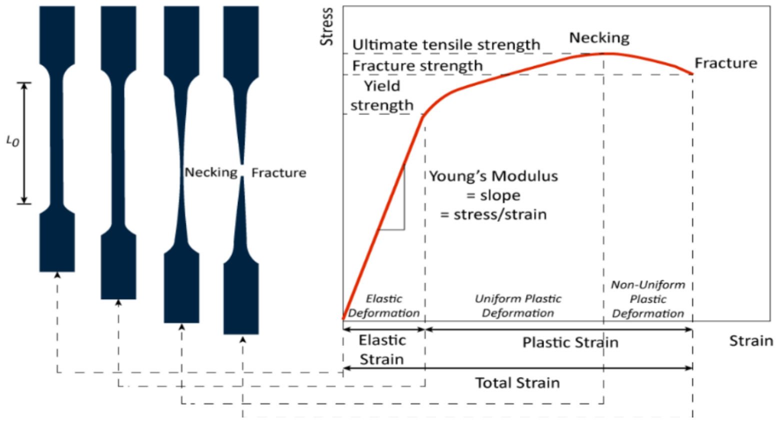
Apparatus:

1. Universal Testing Machine (UTM)
2. Mild steel specimen
3. Scale
4. Slide calipers
5. Marker

Theory

A tensile test, also known as a tension test, is a fundamental mechanical test used to evaluate the mechanical properties of materials, particularly their tensile strength, yield strength, and elongation.

In this test, the ends of the specimen are fixed into grips connected to a straining device and to a load device. If the load is small enough, the deformation of any solid body is entirely elastic. An elastically deformed solid will return to its original shape as soon as the 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 essentially entirely elastic is known as the yield strength of material. In some material the onset of the plastic deformation is denoted by the sudden drop in load indicating both an upper and lower yield point. However, some materials do not exhibit a sharp yield point. During plastic deformation at larger extensions, strain hardening can not compensate for the decrease in section and thus the load passes through a maximum and then begin to decrease. This stage is the "Ultimate Strength" which is defined as the ratio of the load on the specimen to original cross section area, reaches a maximum value. Further loading will eventually cause 'neck' formation and rupture.



(b)

Fig 1: (a) Universal Testing Machine

Fig 1: (b) Stress-Strain curve

A stress-strain diagram, also known as a stress-strain curve, is a graphical representation of how a material responds to an applied load or force. It illustrates the relationship between the stress (σ) applied to a material and the corresponding strain (ε) it undergoes as a result of that stress.

In the initial portion of the stress-strain curve, as stress is applied to the material, it deforms elastically, meaning it returns to its original shape once the load is removed. Within this region, the relationship between stress and strain is linear, following Hooke's law: $\sigma = E\,\varepsilon$

At a certain stress level, known as the yield point, the material begins to exhibit plastic deformation. After the yield point, as more stress is applied, the material continues to deform plastically. The stress-strain curve in this region is no longer linear, and the material's shape changes significantly.

The maximum stress that a material can withstand before it fails or fractures is known as the ultimate tensile strength (UTS). This point represents the peak of the stress-strain curve. Beyond the UTS, the material starts to weaken and eventually ruptures.

In some materials, particularly ductile ones like metals, there is a phenomenon called necking that occurs after the UTS. The cross-sectional area of the specimen reduces significantly at one localized region, causing a narrowing or neck to form. This necking is followed by a rapid decrease in stress. The stress-strain curve terminates at the fracture point, which is the point where the material completely fails or ruptures. The stress at this point is typically lower than the UTS due to the necking and weakening that may have occurred.

Procedure

1. The gauge length, width and thickness of the specimen was measured at first.
2. The specimen was inserted into the grips of the UTM.
3. After continuous loading the fracture occurred.

Experimental Results

i. **Observation:**

a. Initial gauge length of the specimen, l_l= 49.87 mm

b. Initial cross-sectional area of the specimen, A_l= 4.2 mm^2

c. Load at yield point, F_t= 386N

d. Ultimate load after specimen breaking, F=-378N

e. Elongation of the specimen, Δl = 2.52mm

ii. **Observation Table:**

Thickness (mm)	Width (mm)	Area (mm^2)	Load at yield point (N)	UTS (MPa)	Yield Strength (MPa)
0.27	**15.5**	**4.2**	**386**	**627**	**91.9**

iii. **Calculation:**

a. Elastic limit= $\frac{\text{Load at elastic limit}}{\text{Initial Area}} = \frac{386}{42} = 91.9\ MPa$

b. %percentage of elongation $= \frac{\Delta l}{l1} \text{x}100\%$

$$= \frac{2.52}{49.87} \text{x}100\%$$

$$= 5.05\%$$

c. Young's Modulus of elasticity = $\frac{\text{Stress}}{\text{Strain}}$

$$= \frac{52 - 25.2}{0.109 - 0.0575} = 520.388\ MPa$$

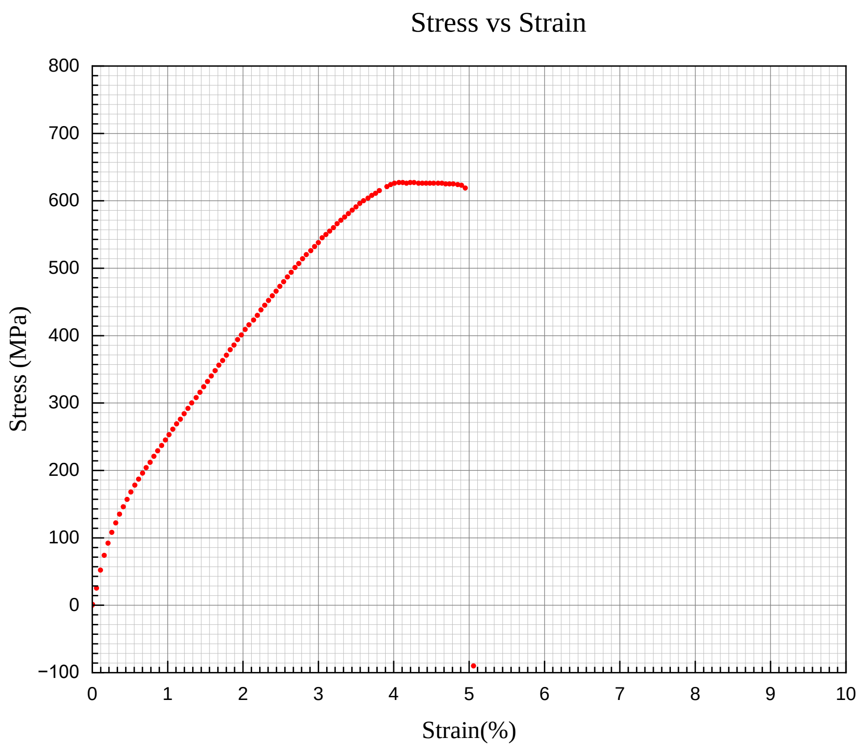


Fig 1: Stress vs Strain graph

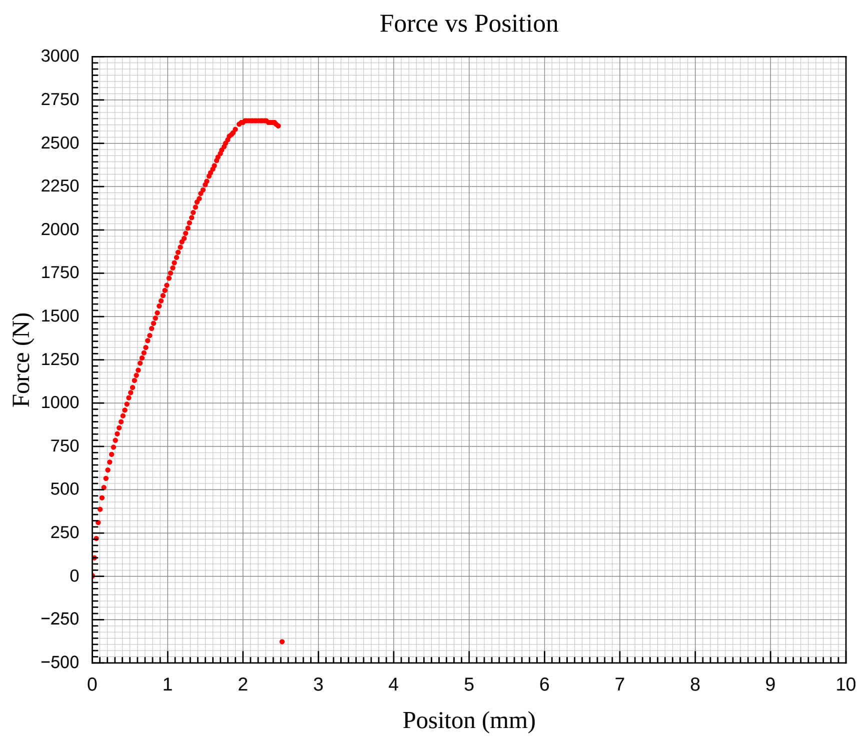


Fig 2: Force vs Position graph

Discussion

After this experiment we came to know about how we can perform tensile testing of different composite materials using Universal Testing Machine (UTM). We performed tensile test and calculated other properties from this experiment. For mild steel tensile test a computerized data was provided , by these data we have plotted the stress-strain curve and found UTS point. In this graph, we found detached curve after a certain value when the specimen got fractured.

Conclusion

Tensile testing using a UTM is a versatile and essential tool in materials science and engineering. It provides critical data that informs material selection, design, quality control, and research and development efforts, ultimately contributing to the safety and performance of a wide range of products and structures.

Reference

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