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To Study the Tensile properties of Carbon Steel using UTM

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Abstract: Material testing is done to measure the characteristics and behaviors of structural materials. As structural components fail due to fracture or excessive deformation, test results help in anticipating how much stress the structural materials can be expected to withstand. Results obtained through testing are used to specify the suitability of the material for various structural applications. Tensile Test, which is carried out in a Universal Testing Machine (UTM), is one such test, where the test specimen is subjected to controlled tension until failure. In this paper we study the Parameters obtained after Tensile Test include Yield stress, Ultimate tensile stress, and Nominal breaking stress, Actual breaking stress, percentage of elongation and Percentage of reduction area.

Keywords: Material testing, tensile stress, Carbon steel, UTM

INTRODUCTION

The subject of mechanical testing of materials is an important aspect of engineering practice. Today, more concern is being given to the interpretation of test results in terms of service performance, as well as giving reliable indications of the ability of the material to perform certain types of duty. Mechanical tests are also employed in investigational work in order to obtain data for use in design to ascertain whether the material meets the specifications for its intended use Carbon steels are widely used as a major structural material in several fields of engineering such as aerospace, building construction, automotive, and offshore structure. It is found that the stress-strain behavior of Carbon steels depends on the loading rate. Hence, the knowledge of the mechanical behavior of such steels at different strain rates is crucial in several fields of engineering to improve safety against crash, impact, and blast loads.

Description of the equipment/machine:

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. A Universal testing machine (UTM) is used to test the mechanical properties of a given test specimen by exerting tensile, compressive or transverse stresses.

Theoretical Background:

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 essentially 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 and rupture.

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Resources Required:

Sr. No.	Name of Resource	Suggested Broad Specification
1	Universal Testing Machine	**Universal Testing Machine:** Capacity 40 tones. Type: Mechanical type digital, Electrically operated Accessories: Tensile test attachment for flat and round specimen.
2	Vernier Caliper	Least Count of 0.02 mm and measuring range of 0.02 mm to 150 mm.
3	Carbon Steel Specimen	Perfect straight bar of Carbon steel of uniform 12.4 mm diameter. Gauge Length of rod shall be around 5 times of diameter. The length shall be sufficient enough to fix bar in the grips plus clear space between cross heads.
4	Punch & Hammer	Tip hardened punch to mark gauge length on the specimen.

Experimental Procedure:

1. By use of vernier caliper, the thickness and width of given specimen (Carbon steel) were measured. The gauge length of specimen was determined to be 62 mm.
2. A Ruler was used to measure and confirm the gauge length of each specimen
3. The software for acquiring and recording data was activated and the material corresponding to the specimen was selected in the software.
4. By zeroing the load cell, the Instron Load Frame could only be set to measure only the tensile load on each specimen inserted.
5. The jaws were adjusted to fit the size of specimen, this was followed by attaching the extensometer on the reduced section of gauge specimen.
6. To avoid slipping of specimen, the scroll wheel was used in preloading the machine.
7. After the specimen was removed, the extensometer were adjusted to zero values and the test commenced to measure strain of the specimen.
8. The data was recorded by the software on the spreadsheet.
9. By placing each sample in the universal testing machine, the tensile test was conducted and results were recorded in the computer. The data was latter retrieved for Calculation and plotting of the graphs.

Observations & Calculations:

Observation before test:

1. Diameter of bar-

a) d1= 12.4mm b) d2=12.4mm c) d3=12.4mm

2. Average diameter = d = 12.4mm
3. Gauge length = Lo = 5d = 5X12.4 = 62 mm

Observation during test:

1. Range of Loading = 0 to 400 KN
2. Load at Elastic limit = 40 KN
3. Load at upper yield point = 42 KN
4. Load at lower yield point = 37 KN
5. Ultimate load = 55 KN
6. Breaking Load = 47 KN

Observations after test:

1. Final gauge length = L = 69 mm
2. Reduced diameter = d_R = 8.5 mm

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Observation table for tension test:

Sr. No.	Load in KN (P)	Elongation(mm)	Stress ($\sigma = P/A$)	Strain (Extension / gauge length) (ε)
1	5	0	41.40	0.0000
2	10	0	82.81	0.0000
3	14	0.1	115.93	0.0016
4	17	0.2	140.78	0.0032
5	20	0.4	165.62	0.0065
6	23	0.7	190.46	0.0113
7	25	0.9	207.02	0.0145
8	30	1.1	248.43	0.0177
9	35	1.4	289.83	0.0226
10	40	1.7	331.24	0.0274
11	42	1.8	347.80	0.0290
12	45	2.2	372.64	0.0355
13	47	2.6	389.20	0.0419
14	50	2.9	414.04	0.0468
15	53	3.2	438.89	0.0516
16	55	4	455.45	0.0645
17	54	4.6	447.17	0.0742
18	51	5.5	422.33	0.0887
19	49	6.2	405.76	0.1000
20	47	7	389.20	0.1129

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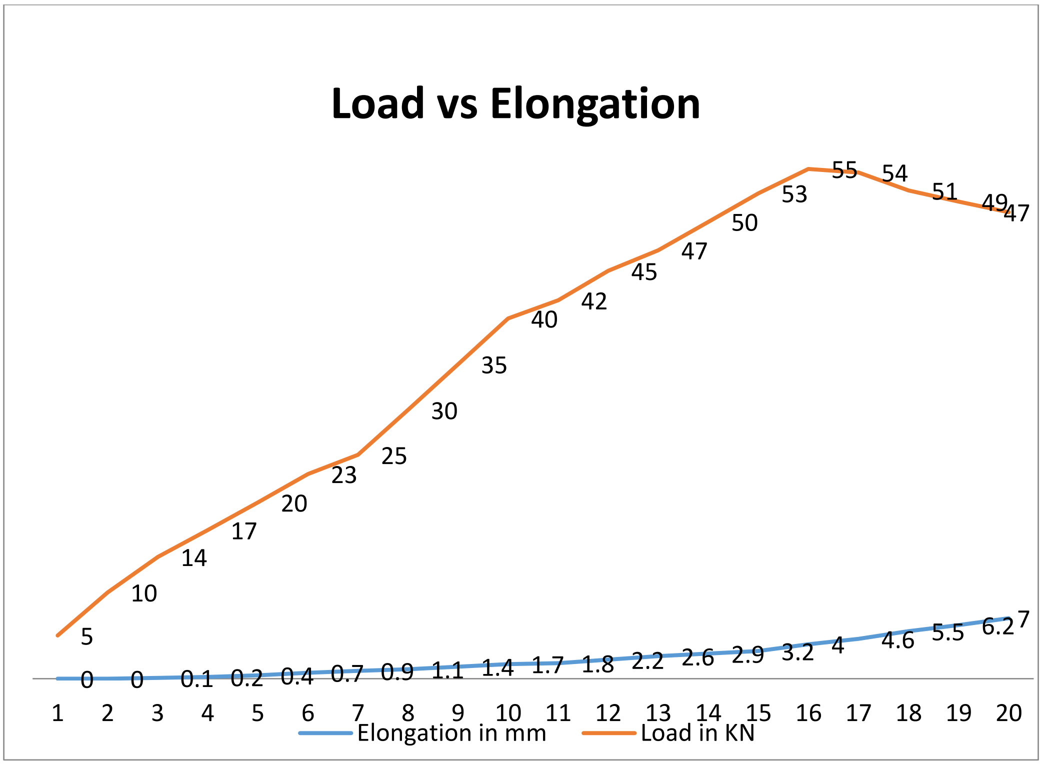
Graph:



CALCULATIONS

1. Cross sectional area = $A_0 = \pi d^2/4 = 120.76$ mm².
2. Reduced cross sectional area $= A = \pi d_R{}^2/4 = 56.74$ mm².
3. Yield stress = Yield load/Cross sectional area = 42000/120.76 = 347.79 N/mm².
4. Ultimate stress = ultimate load/ cross sectional area = 55000/120.76 = 455.44 N/mm².
5. Breaking stress = Breaking load / cross sectional area = 47000/120.76 = 389.20 N/mm².
6. % Elongation $= \left(\frac{L-L_0}{L_0}\right)\times 100 = \left(\frac{69-62}{62}\right)\times 100 = 11.29\%$
7. Reduction in area $= \left(\frac{A_0-A}{A_0}\right)\times 100 = \left(\frac{120.76-56.74}{120.76}\right)\times 100 = 53.01\%$
8. (Within elastic limit) Stress = $\sigma = 331.23$ N/mm².

CONCLUSION

Plain carbon steel is the most important group of engineering alloys and a large portion of the steel produced today is plain carbon steel. They account for the vast majority of steel applications depending on the processes and needs. Civilization and modern urbanization are greatly dependent on steel without a doubt.

A wide range of application as well as its abundance in nature has given it a dominance over other materials. Today it is used in every sector of our lives and been subjected to constant modification for able to be used in advanced applications in near future.

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