ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 1, January 2019

Experimental analysis on behaviour of mild steel in tension upto rupture

T.Prabahar[1]

Lecturer, Department of Mechanical Engineering (R&A/C), Valivalam Desikar Polytechnic College (Government Aided), Nagapattinam, Tamilnadu, India.[1]

Abstract: Mechanical testing shows an important role in finding the fundamental properties of engineering materials and in managing the quality of materials for use in design and construction. If a material is used as a part of an engineering structure, it is important to know that the material is strong and rigid enough to overcome the loads that it will experience in service. As a result, engineers have developed a number of experimental techniques for mechanical testing of engineering materials. Tension, compression, bending or torsion loading is the techniques used for mechanical testing. The most common type of test used to measure the mechanical properties of a material is the tension test. Tension test is widely used to provide basic information on the strength of materials and is an acceptance test for the specification of materials. The major parameters that describe the stress-strain diagram obtained during the tension test are the tensile strength, yield strength or yield point, elastic limit, ultimate stress, breaking stress percentage elongation and the reduction in area. In this paper, it is decided to do a tension test on mild steel using universal testing machine.

Keywords: Tension test, mild Steel, stress-strain diagram, elastic limit, universal testing machine.

I. Introduction

Generally engineering materials are elastic in nature. Hence a material is subjected to external force, it undergoes some changes in dimensions i.e. deformation. But the material undergoes some deformation, it will offer a resistance against deformation. It is directly proportional to deformation. When the material has offered full resistance to the external force, the equilibrium condition exists and thereby the deformation stops. The deformation is called strain and the resistance offered by the material against the deformation is called stress.

II. SIMPLE STRESSES AND STRAIN

Consider a bar of uniform cross sectional area A and length l is subjected to an axial pull P as shown in figure 1.

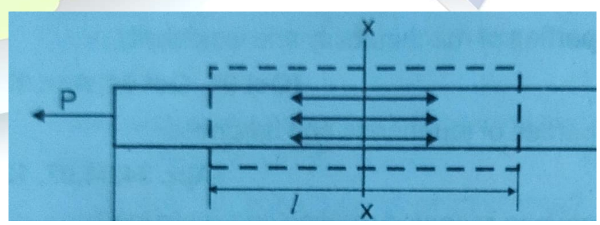

Figure 1 Stress and Strain

Consider a section xx which is normal to the axis of bar. Due to the action of external pulls, the length increases from l to $(l + \delta l)$ and its lateral dimensions i.e. diameter will decreases. The internal resistance is setup in section xx to avoid separation. This internal resistance must be equal

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 1, January 2019

to external load if it is to be equilibrium. i.e. to avoid separation. This resistance per unit area is called stress.

Stress p = Internal Resistance / Cross sectional Area
= P / A
The unit of load P is in Newton and denoted by N
The Unit of area A is in mm².
The unit of stress p is N/mm².
The deformation per unit length is known as strain, which is denoted by e.
Strain e = Change in length / Original length
= $\delta l / l$

III. CLASSIFICATION OF FORCE SYSTEM

Depending upon the type of load, it is generally classified as 1. Tensile force 2. Compressive force 3. Shear force 4. Bending force 5. Torsional force.

IV. BEHAVIOR OF MATERIALS IN TENSION UPTO RUPTURE

The tension test is one of the most commonly used tests for evaluating materials. In its simplest form, the tension test is carried out by holding opposite ends of a test item within the load frame of a test machine. A tensile force is applied by the machine, which results in the gradual elongation and eventual fracture of the test item. During this process, force-extension data are monitored and recorded. When properly conducted, the tension test provides force extension data that can quantitate several important mechanical properties of a material. .

V. STRESS-STRAIN DIAGRAM

To study the behaviour of materials in tension, the standard specimens are tested in a universal testing machine (U.T.M) up to rupture.

The stress strain diagram for a mild steel specimen is shown in fig 2.2.5. The tensile load is gradually applied and elongation of the specimen is noted using strain gauge or extensometer. Stress and strain at different loads are calculated and it is plotted in the graph.

1. Proportional limit

From the stress-strain diagram, it is clear that OA is a straight line, which represents that the stress is proportional to strain. Beyond the point A, the curve slightly deviates from straight line. Hence Hook's law holds good upto the point A. It is known as proportional limit.

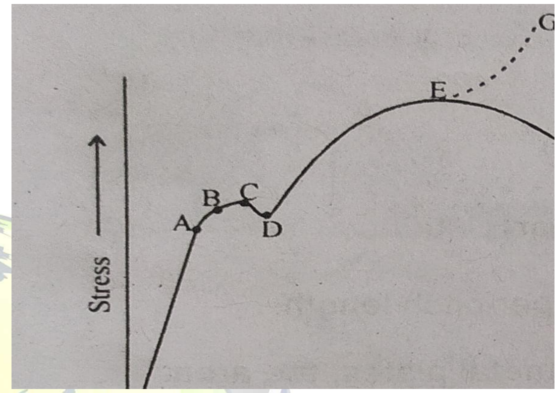

Figure 2 Stress-Strain Diagram

2. Elastic limit

When the load is increased beyond point between A to B, the material will regain its original shape, when the load is removed. It means that the material has elastic properties upto the point B. This point B is known as elastic limit.

3. Yield point

If the material is stressed beyond the point B, it becomes plastic i.e., the material will not be able to recover its original shape and size, when the load is removed. Beyond the point B, the strain increases at a faster rate with any increase in the stress until the point C is reached. At this point, the material yields before the addition of load and there is an appreciable strain without any increase in stress. In case of mild steel, it will be seen that small load drops to D. immediately after yielding commences. Hence there are two yield points C and D. The point C and D are called upper and lower yield point respectively. The stress corresponding to the point is known as yield point stress.

4. Ultimate stress

At D, the specimen regains some strength and higher value of stresses is required for higher strains, than those between A and D. If the load is applied beyond the point D, the gradual increase in strain is followed with the uniform reduction of its cross sectional area. Stretching of specimen between D and E, the work done on the specimen is largely transformed into heat and the specimen becomes

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 1, January 2019

hot. At E, the stress, which attains the maximum value, is known as ultimate stress.

5. Breaking stress

After the specimen has reached the ultimate stress, a neck is formed which decreases the cross sectional area of specimen and stress or load required to break away the specimen is less than the ultimate stress. Therefore the stress is reduced until the specimen breaks away at point F. The stress corresponding to point F is known as breaking stress.

The formation of neck at E reduces area of cross section and the specimen suddenly fails at F. Breaking stress seems to be lower than ultimate stress. The original area of cross-section of specimen is taken for calculating the stress and we have the curve EF. If the actual cross-sectional area (reduced area due to necking) is taken for calculating the stress, the true stress-strain curve would be EG as shown by dotted line.

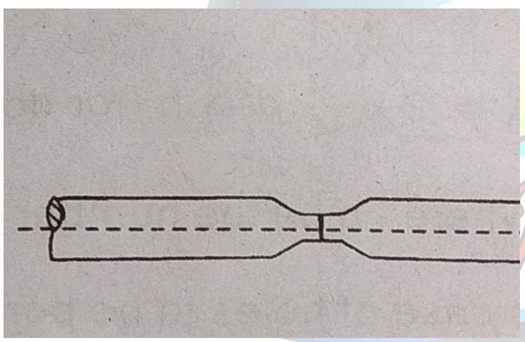

Figure 3. Reduced Area due to necking

6. Percentage reduction in area

It is the ratio of reduction in area of cross section at the neck to the original cross-sectional area.

Let A be the original cross-sectional area of bar in mm²
a be the cross-sectional area at neck in mm²

Therefore percentage reduction in area = (A-a / A) x 100

7. Percentage elongation

It is the ratio of increase in gauge length after fracture to the original length of specimen

Let l and l_1 are the original length and the final length of specimen respectively in mm

Therefore % elongation = (l_1 – l / l) x 100

The following observations were obtained on a mild steel specimen having an initial gauge length of 50 mm and initial diameter of 16 mm. Load at yield point = 60KN , Maximum or ultimate load = 88KN Load at fracture = 64KN, Diameter of neck = 9.2mm, Distance between the gauge points after fracture = 68.8mm.

To find
1. Yield stress,
2. Ultimate stress,
3. Nominal stress at fracture,
4. Percentage elongation,
5. Percentage reduction in area.

Solution:
Original area of cross section Area A = π/4 x d^2 = π/4 x 16^2 = 201.6 mm²

Area of neck a = π/4 x d^2 = π/4 x 9.2^2 = 66.476 mm²

1. Yield Stress = Load at yield point / Original area of cross section
   = 60000 / 201.06
   = 298.4 N/mm²
2. Ultimate tensile stress = Maximum load / Original area of cross-section
   = 88000 / 201.06
   = 437.7 N/mm²
3. Nominal stress at fracture = Load at fracture / Original area of cross section
   = 64000 / 201.06
   = 318.3 N/mm²
4. Percentage elongation = (l_1 – l / l) x 100
   = (68.8 – 50 / 50) x 100 = 37.6%
5. Percentage reduction in area = (A-a /A) x 100
   = (201.06-66.476/201.06)x100 = 66.94%

VI. CONCLUSION

In tensile tests on mild steel, the material initially exhibits a linear elastic behaviour, following Hooke's Law, where stress is proportional to strain. After reaching the yield point, plastic deformation occurs, and the material undergoes necking, a localized reduction in cross-section,

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 6, Issue 1, January 2019

before ultimately fracturing. The stress-strain curve reveals distinct phases: elastic, yielding, and fracture.

In conclusion, the tensile test on mild steel demonstrates its characteristic behaviour under tension. The material exhibits a linear elastic phase, followed by plastic deformation and necking, ultimately leading to fracture. The stress-strain curve provides a visual representation of these different phases and allows for the determination of important material properties.

REFERENCES

[1] Eduardo E. Cabezas, Diego J. Celentano, *Experimental and numerical analysis of the tensile test using sheet specimens*, Elsevier Science Publishers, Finite Elements in Analysis and Design, Vol 40 (2004) p.555–575

[2] M. Prakash, S. Shekhar, A.P. Moon, K. Mondal, *Effect of machining configuration on the corrosion of mild steel*, Elsevier Science Publishers, J. of Materials Processing Technology, Vol. 219 (2015), p.70–83.

[3] George E. Dieter, *Mechanical Behavior Under Tensile and Compressive Loads,* Mechanical Metallurgy, 3rd ed., McGraw-Hill, New York, 1986, p 275–295

[4] D. Lewis, *Tensile Testing of Ceramics and Ceramic-Matrix Composites*, Tensile Testing, P. Han, Ed, ASM International, 1992, p 147–182

[5] O.O. Joseph, F.I. Alo, *An Assessment of the Microstructure and Mechanical Properties of 0.26% Low Carbon Steel under Different Cooling Media: Analysis by one-way ANOVA,* ISSN 2224-6096 (Paper) ISSN 2225-0581,Vol.4, No.7, 2014

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 1, Issue 4, December 2014

