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LIST OF FIGURES

1. INTRODUCTION

1.1 The aim of the experiment

The aim of the experiment was to determine the mechanical properties of mild steel under tensile loading. The mechanical properties which were determined were young's modulus, yield strength, ultimate strength, percentage elongation after fracture, percentage reduction of area, nominal stress-strain diagram and true stress-strain diagram

1.2 Theory of experiment

Uniaxial tensile test is known as a basic and universal engineering test to achieve material parameters such as ultimate strength, yield strength, % elongation, % area of reduction and Young's modulus. These important parameters obtained from the standard tensile testing are useful for the selection of engineering materials for any applications required.

The tensile testing is carried out by applying longitudinal or axial load at a specific extension rate to a standard tensile specimen with known dimensions (gauge length and cross sectional area perpendicular to the load direction) till failure. The applied tensile load and extension are recorded during the test for the calculation of stress and strain. A range of universal standards provided by Professional societies such as American Society of Testing and Materials (ASTM), British standard, JIS standard and DIN standard provides testing are selected based on preferential uses. Each standard may contain a variety of test standards suitable for different materials, dimensions and fabrication history. For instance, ASTM E8: is a standard test method for tension testing of metallic materials and ASTM B557 is standard test methods of tension testing wronght and cast aluminium and magnesium alloy products.

A standard specimen is prepared in a round or a square section along the gauge length , depending on the standard used. Both ends of the specimens should have sufficient length and a surface condition such that they are firmly gripped during testing. The initial gauge length L_o is standardized (in several countries) and varies with the diameter (D_o) or the cross-sectional area (A_o) of the specimen. This is because if the gauge length is too long, the % elongation might be underestimated in this case. Any heat treatments should be applied on to the specimen prior to machining to produce the final specimen readily for testing. This has been done to prevent surface oxide scales that might act as stress concentration which might subsequently affect the final tensile properties due to premature failure. There might be some exceptions, for examples, surface hardening or surface coating on the materials. These processes should be employed after specimen machining in order to obtain the tensile properties results which include the actual specimen surface conditions.

2. EXPERIMENTAL METHODS

2.1 Machine and devices used in impact test

a) **Universal tensile testing machine**

The testing machine is a hydraulically operated with 400kN maximum, a machine allows also the performance of compression and bending test. Then load is measured by the load cell and displayed on a dial and a digital display. The displacement of the lower head is transmitted by the cord to the recording drum which is rotated cord slung around it.By that a pen fixed at that point draws a graph in a circumferential direction of the drum which is equivalent to the graph of force against elongation of the length of the specimen

Figure 1.

b) **Extensometer**

The mechanical device is a martens-- Kennedy's extensometer which has two bars with knives at the upper and lower, the upper knives are fixed, the lower ones can rotate. the rotation of the lower knives is magnified by the attached levers. The extensometer is clamped on the specimen in the tensile test in order to get the readings of the strain of the specimen at different loads

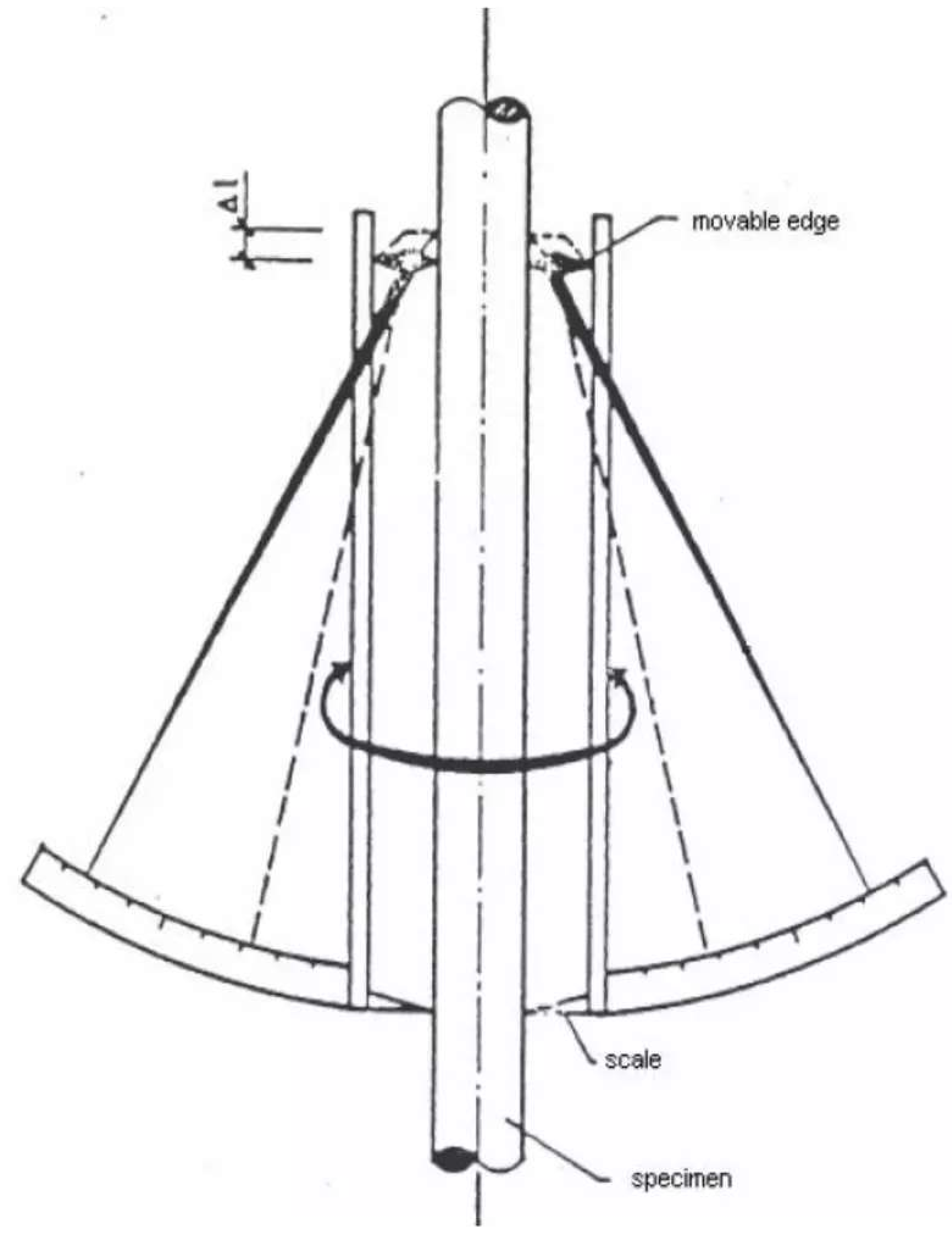


Figure 2.

c) **Vernier caliper**

Is a precision instrument that can be used to measure internal and external distances extremely accurately. Its Vernier scale has an accuracy of 0.01mm. It's uses for measuring diameters and length of the specimen in the experiment.

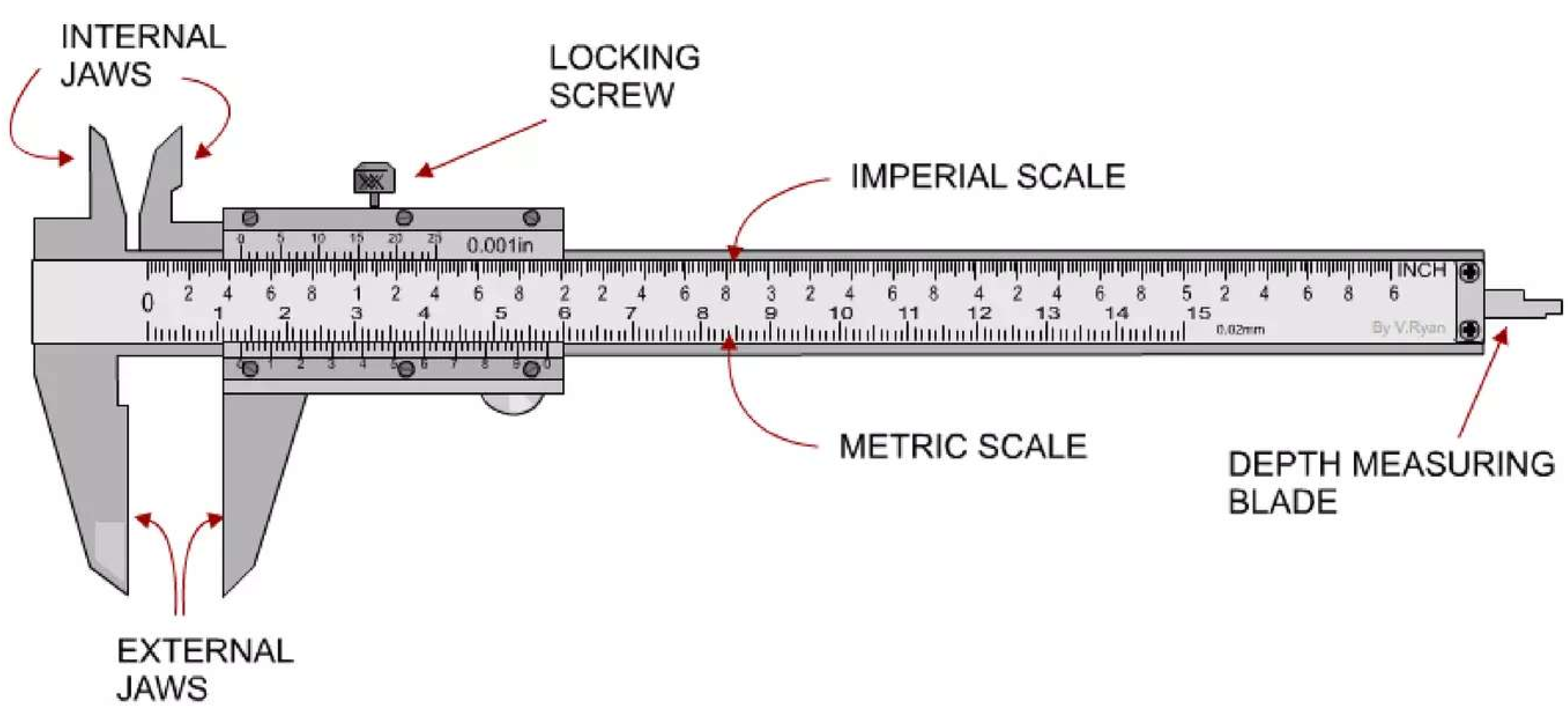


Figure 3.

d) **Harmer and punch**
Used for marking the initial length of specimen

1.2 specimen

Circular mild steel specimen with d=15.7mm and L=78.5mm

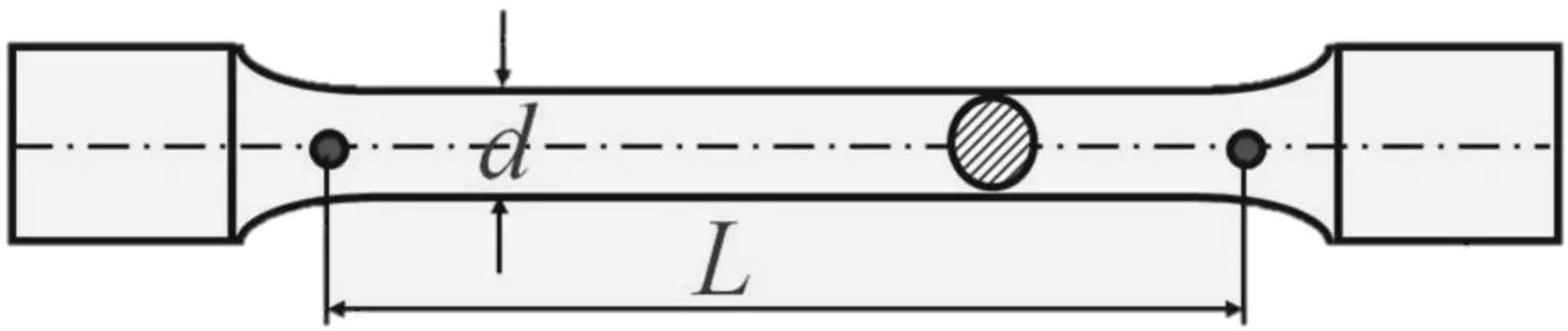


Figure 4.

3. EXPERIMENTAL PROCEDURE

a) Preparation of the material was done by measuring the initial diameter d_0 at the already prepared test position which was found to be 15.7mm.Calculating the reference length, that is $Lo=5d_o= 5x16=78.5mm$ and marking this length on a test position by using hammer and punch.

b) The specimen was mounted on the Universal Testing Machine and firmly clamped on a vices attached on the upper (fixed) Crosshead and bottom (Movable) Crosshead whereby up movement of the bottom crosshead provided clamping space while its down movement provided pulling space during stretching.

c) The extensometer was attached to the specimen.

d) The machine was set to read up to a Maximum Force of 140kN. according to the size and type of material.

e) A graph paper was stamped on a roller at the drawing pointer and marked a reading scale of 1cm: 10KN.

Figure 5.

f) The machine was started with initial setting of 0kN, followed by 30KN, 50KN, 70KN, 80KN, 90KN, 100KN,110KN,120KN,130KN At every Maximum Force set, the readings of Strain ‘e’ was recorded from both Right side and Left side reading of the Extensometer

g) At 110KN setting, the specimen showed sudden extension. Also the drawing Pointer’s trace abruptly diverged from the normal constant change slope curve to a constant Force curve to indicate the yield effect.

h) At 110KN setting, and without any more setting, the Specimen developed a Neck whereas, Force abruptly increased to 140KN and then sudden fracture occurred to the specimen. **Precaution to the specimen since when fracture leads to acidentary jump off hence my cause body damage**

i) The final dimensions of a Specimen were measured and recorded. However, the fractured portion appeared to be of conical Cup shape confirming the material tested was ductile. As shown in the table of results.

4. RESULTS AND DISCUSSION

4.1Table of Results

Loads(KN)	Strain readings(mm)		Average strain reading	Average X 0.2%	Diameter (mm)	Nominal stress (N/mm^2)	Nominal Strain $x10^{-3}$ (before yield)	True stress (N/mm^2)	True strain (mm) 10^{-3}
	LR	RR							
0	0	0	0	0	15.7	0	0	0	0
30	0.3	0.4	0.35	0.07	15.7	155.0	0.892	155.1	0.892
50	0.4	0.5	0.45	0.09	15.7	258.3	1.150	258.6	1.150
70	0.6	0.7	0.65	0.13	15.7	361.6	1.660	362.2	1.660
80	0.9	0.8	0.85	0.17	15.7	413.2	2.170	414.1	2.170
90	1.0	0.9	0.95	0.19	15.7	464.9	2.420	466.2	2.420
100	1.2	1.0	1.1	0.22	15.7	516.5	2.800	517.9	2.179
			AFTER	**YIELDING**					
110					15.5	568.2	0.026	583.0	0.026
120					14.8	619.8	0.125	697.5	0.118
130					14.2	671.5	0.222	820.9	0.201
140					13.4	723.1	0.373	992.7	0.317

Table 1.

4.1.1 Results taken from the specimen

a) Initial diameter (d_o) of specimen was **15.7**mm

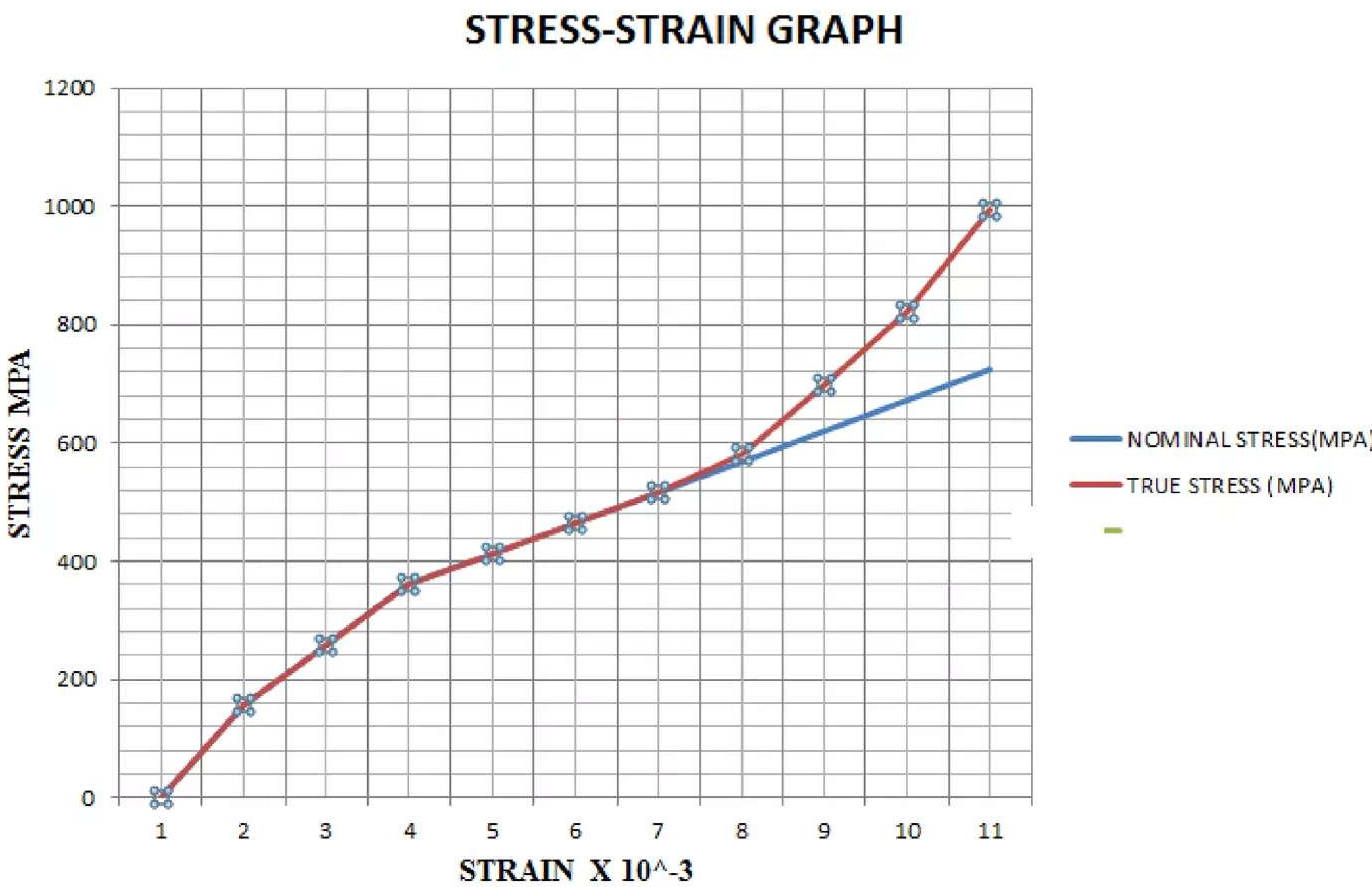
b) Initial gauge length (L_o) of specimen was **78.5**mm

c) Diameter at fracture (d_f) of the specimen was **9**mm

d) Length at fracture (L_u) of the specimen was **101**mm

4.1.2 Graph

The graph of engineering stress against engineering strain and the graph of true stress against true strain was plotted together



4.1.3 Results taken from the graph

a) Young modulus

This was obtained by taking the slope on the engineering stress against engineering strain on the point A (0.001, 175) and point B (0.0014, 250)

$$slope = \frac{change\ in\ engineering\ stress(N/mm^2)}{change\ in\ engineering\ strain}$$

$$slope = \frac{(450 - 90)N/mm^2}{0.0028 - 0.0011}$$

= 211,176Mpa =**211Gpa**

b) Ultimate strength

The ultimate strength is point on the engineering stress-strain curve with the maximum value of stress which is shown on the graph as last point. The ultimate strength is **723.1MPa**

c) Yield stress

The yield stress is **568.2MPa**

4.14 Results from calculations

a) Initial area (S_o) of specimen

$S_0 = \pi d_0^2/4 \quad = \pi x 15.7^2 /4$, $S_o =$ **$193.6mm^2$**

b) Area at fracture (S_u)

$S_u = \pi d_f^2/4 = \pi x 9^2/4$, $S_u =$ **$63.62mm^2$**

c) Percentage elongation (A)

$A = (Lu - Lo)/Lo$ x100, = (101- 78.5) x100/78.5 = **28.66%**

d) Percentage reduction of area (Z)

$Z = (S_0 – S_u)/S_o$ x 100 , = (193.6 – 63.62)x100/193.6 =**67.12%**

4.2 Discussion

From an experiment t, the young modulus of mild steel test is at least equal to actual young's modulus. This shows that the specimen is pure steel and some errors were avoided during experiment.

4.3 Sources of error

- Zero error of the machine
- Parallax error when reading the value s
- Human error in data analysis

5. CONCLUSION

The results of the experiment shows that the specimen undergoes ductile fracture because there was a reduction of area at the fractured point and the fracture appeared cup and cone, which concludes that mild steel is a ductile material, also in order to obtain better results, the experiment should be done carefully and use well calibrated instruments to avoid errors.