

**LAB MANUAL**  
**MATERIAL SCIENCE ENGINEERING (ME-303)**

1. **Strength testing of a given mild steel specimen on UTM with full details and s-e plot on the machine.**

OBJECTIVE : To measure tensile and compressive strength of a mild steel specimen with the help of a Universal Testing Machine (UTM).

INSTRUMENT REQUIRED :

i)UTM

ii) MS specimen      iii) Vernier caliper

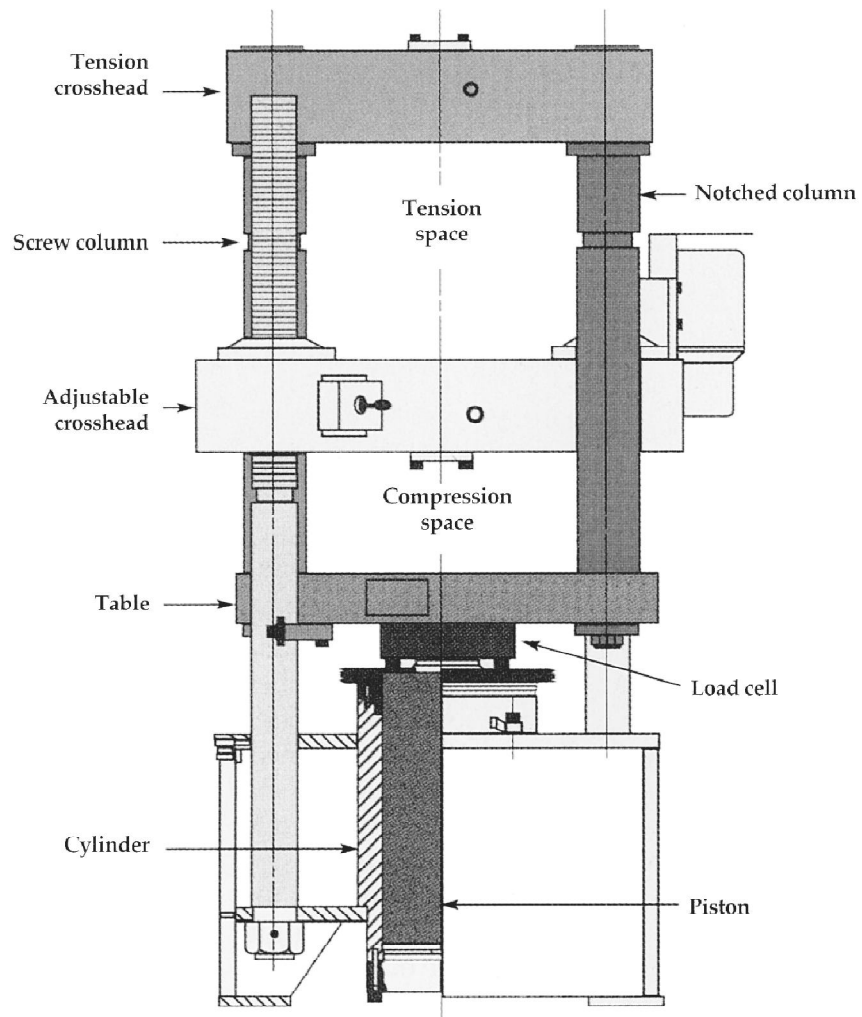


Fig1, UTM

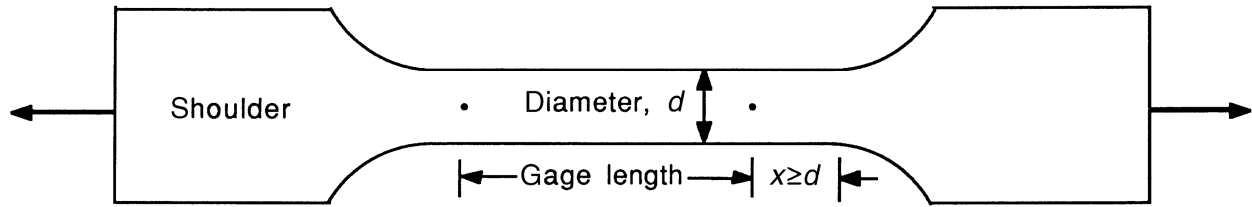


Fig2, Test specimen

RESULT :

Length of the test specimen =                      Diameter of test specimen =                      Area=

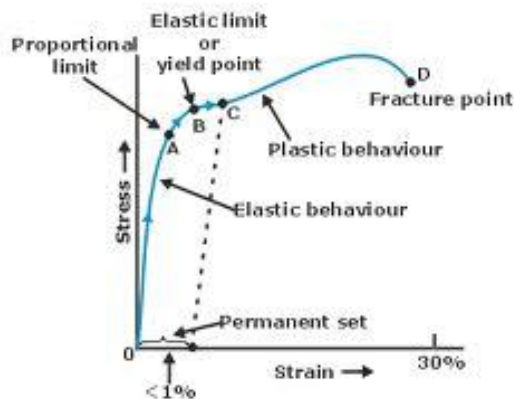
s. no.	Load (Kgf)	Stress(Kgf/sq. m)	Deformation in length (m)	Longitunal strain	Deformation in diameter (m)	Lateral strain

Young modulus = elastic stress/elastic strain

poison ratio = lateral strain/longitunal strain

=

=



A typical stress-strain curve for a ductile metal

Fig3, stress-strain curve for MS specimen

## 2. Impact testing on impact testing machine like Charpy, Izod or both:

OBJECTIVE: To measure impact strength, i.e. Total energy absorbed before fracture.

INSTRUMENTS REQUIRED:

- i) Impact testing Machine
- ii) MS specimen

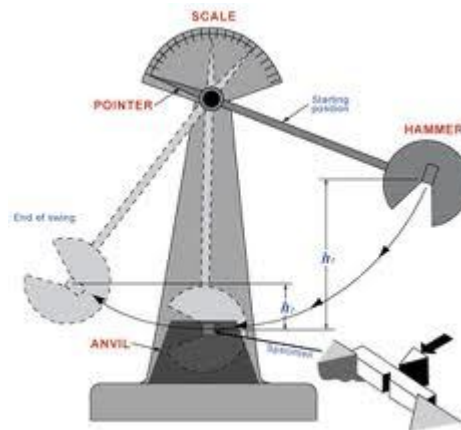


Fig1: impact testing machine

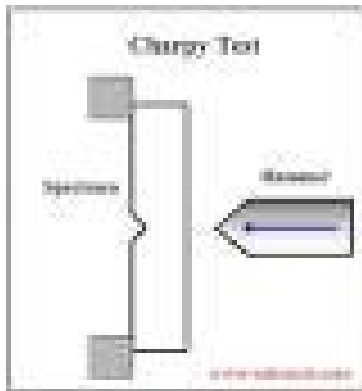


Fig2, Impact test specimen(Charpy test)

RESULT:

Initial reading =                                  error =                                  Final reading =

Energy absorbed before fracture (Impact strength) = Initial reading - Final reading

=.....Joule.

### 3. Fatigue testing on fatigue testing machine.

OBJECTIVE: To measure the fatigue strength (Endurance limit) i.e. minimum reversible cyclic load on the material by which a material breaks.

INSTRUMENTS REQUIRED:

- i) Fatigue testing machine
- ii) MS test specimen

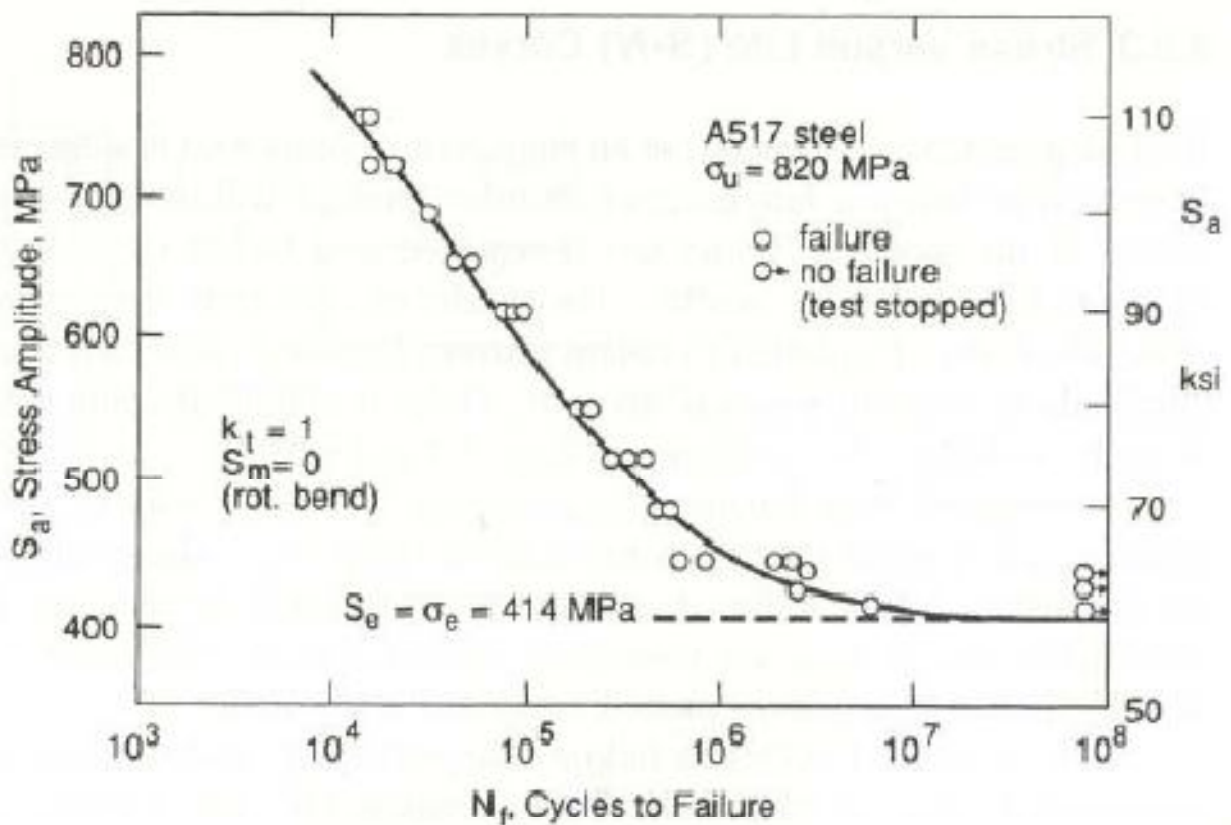


Figure 1: Stress-Life curve for ferrous material

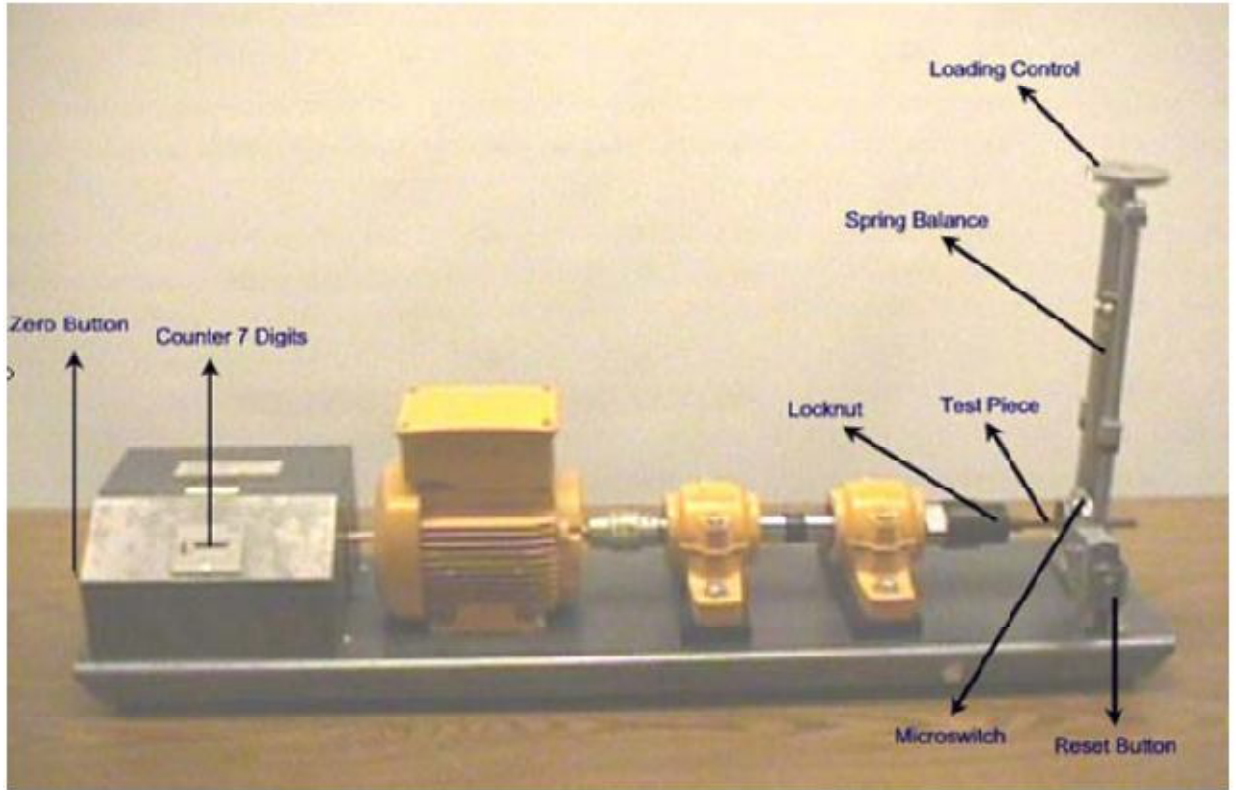


Figure2, Fatigue testing machine

RESULT:

Experiment no.	Load (Kg)	No. of cycles
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

.....kg is the load at which the no. of cycles are  $10^7$  (i.e. the material not breaks), is called the endurance limit or fatigue strength.

#### 4. Creep testing on creep testing machine:

OBJECTIVE: Creep is the property of the material by virtue of which it resists continuous deformation under a steady load. The aim of this experiment is to measure creep strength of the material.

INSTRUMENTS REQUIRED:

- i) Creep testing machine
- ii) Soldier wire as test specimen
- iii) Scale
- iv) Stop watch

RESULT:

Experiment no.	deformation (mm)	Time(hr.)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

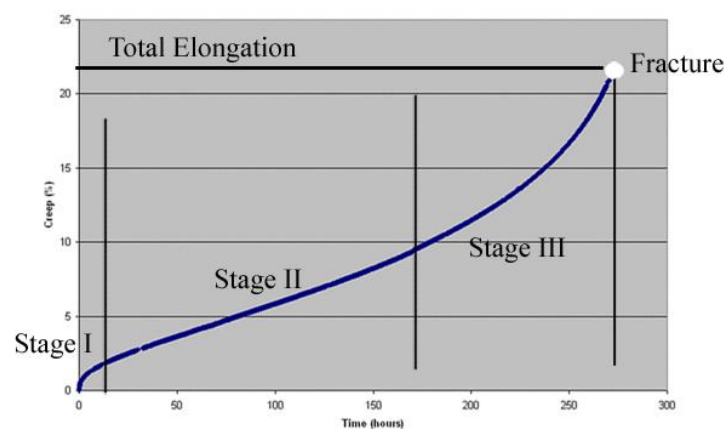


Fig1, Creep curve

Stage I: Very rapid deformation in very short time span, Stage II: Rate of deformation is changed a little at long time span, Stage III: again very rapid deformation take place in small time span comparing to stage II and finally material fails or creep fracture takes place at a certain point known as creep strength.

5. Torsion testing of a rod on torsion testing machine:

OBJECTIVRE: To measure the torsional strength of a solid cylindrical MS bar by using the following formula,

$$T / J = f_s / R = G \vartheta / L$$

T = Torque(N-m), J = polar moment of inertia =  $\pi D^4 / 64$  (m<sup>4</sup>), R = radius of the bar (m), G = Modulus of rigidity,  $\vartheta$  = angle of twist (rad), L = length of the bar (m), D = Diameter of bar = 2R

INSTRUMENT REQUIRED: i) Torsion testing machine  
ii) Vernier caliper

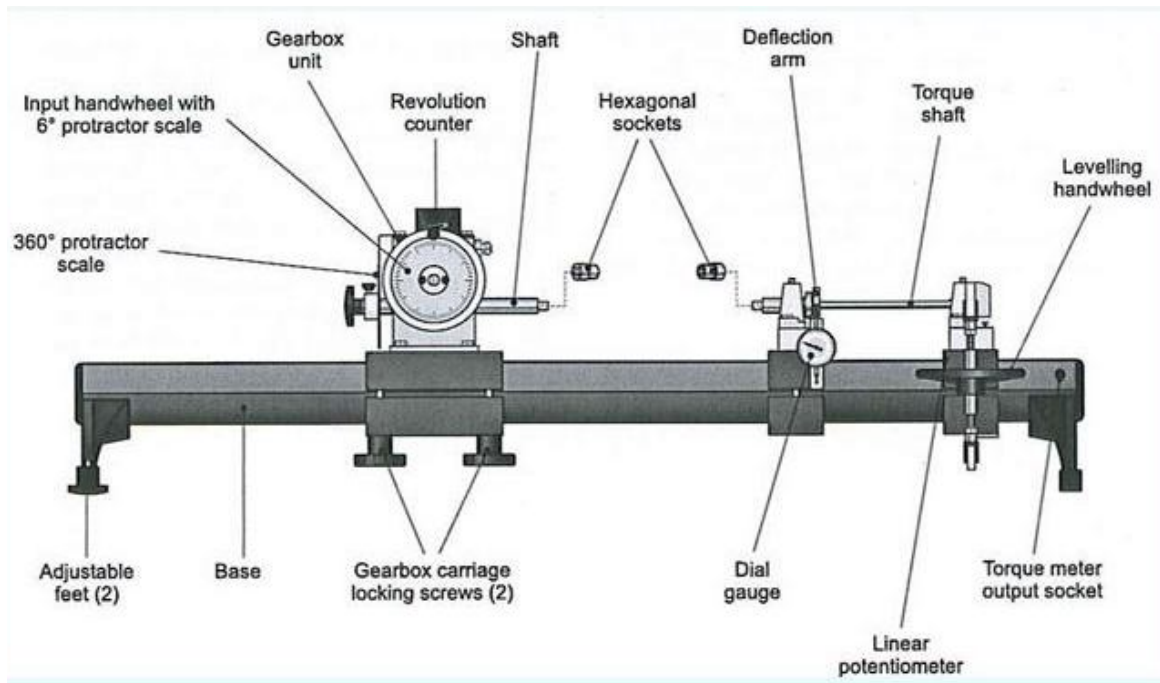


Fig1, Torsion testing machine

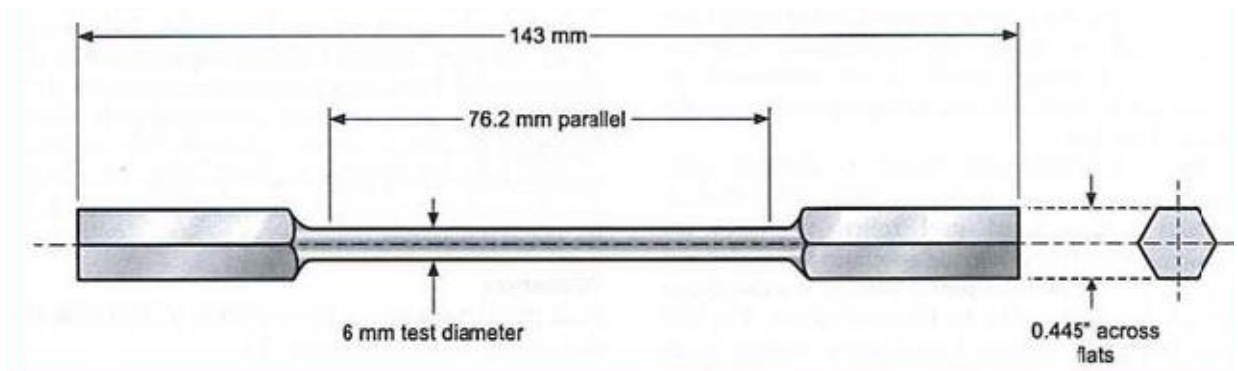


Fig2, Torsion test specimen

Tortional strength (T) = .....N-m.

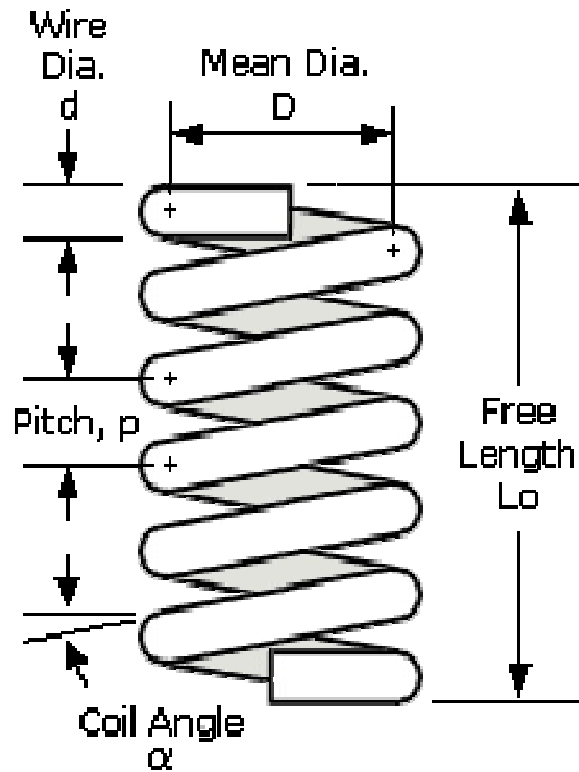


### 6. Spring index testing on spring testing machine:

OBJECTIVE: To measure the spring index i.e. load (tensile / compressive) required for unit deflection (elongation / compression) of a helical spring.

Spring index (k) = load applied on spring (W) / total deflection of spring ( $\Delta$ )

INSTRUMENT REQUIRED: i) spring index testing machine  
ii) Spring specimen



RESULT:

s. no.	Load applied (W) N	Deflection( $\Delta$ )mm	Spring index( $k = W / \Delta$ )N/mm	Average Spring index( $k = W / \Delta$ )N/mm

## 7. Hardness testing of given specimen using Rockwell testing

machines.

**OBJECTIVE:** Hardness is the property of the material by virtue of which it resists indentation or penetration or scratching. In this experiment we have to measure the Rockwell hardness (in 'C' scale) of a high carbon steel specimen.

### INSTRUMENT REQUIRED:

- i) Rockwell hardness testing machine
- ii) High carbon steel specimen
- iii) Conical diamond indentator / penetrator



### RESULT:

Minor load = 10 kgf

Major load = 150 kgf

s. no.	Rockwell hardness(RHC)	Average Rockwell hardness(RHC)
1		
2		
3		

## 8. Specimen preparation for micro structural examination-cutting, grinding, polishing, etching.

OBJECTIVE: Before observing the micro structure under Optical Microscope, specimen preparation is required. Specimen preparation is done by grinding the specimen in grinding machines using coarse grade grains and polishing machine using fine grade grains and velvet cloths. After this etching by Nital solution is done (Nital is a solution of alcohol and nitric acid commonly used for routine etching of metals. It is especially suitable for revealing the microstructure of carbon steels. The alcohol can be methanol, ethanol or methylated spirits.)



Fig1, polishing machine

Precaution: Polishing should be done with very carefully so that the surface should be very smooth and there should not be any scratches on the surface of the specimen.

## 9. Comparative study of microstructures of given specimens (Low carbon steel)

OBJECTIVE: To study and observe the different microstructure like ferrite, perlite, cementite, austenite, bainite and martensite of a given specimen (Mild steel) and knowing about their properties.

PERLITE: It is Mixture of Ferrite and cementite. Its ductility is more. This microstructure is required for the material used for wire drawing .

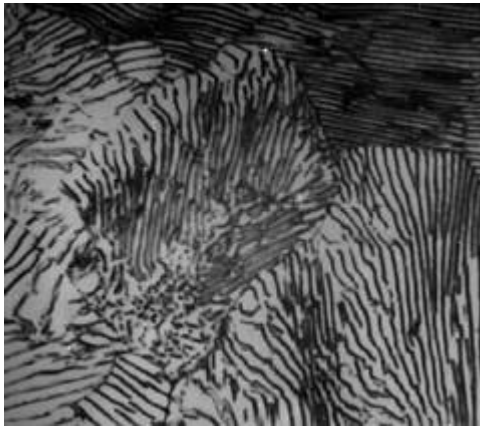


Fig1, perlite



Fig2, ferrite

FERRITE: This microstructure has more ductility property, used for wire drawing.

AUSTINITE: In heat treatment process before obtaining any desired microstructure, at first austenite must be formed by heating and after that we can obtain desired microstructure from austenite by proper cooling. Austenite microstructure is not available in room temperature.

MARTENSITE: It is the hardest microstructure, required to increase the hardness of the material.

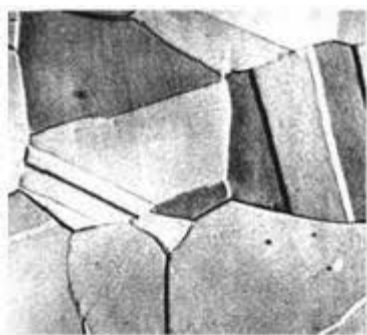


Fig3, **Microstructure of Austenite**

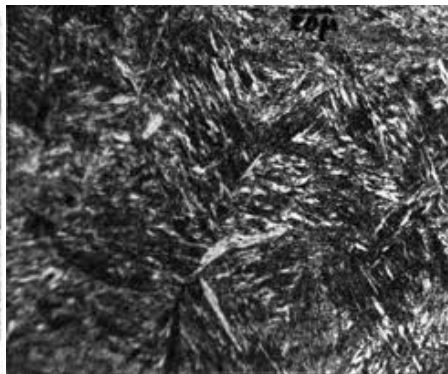


Fig4, Martensite

## 10. Heat treatment experiments such as normalizing, quenching etc. and comparison of hardness before and after

**OBJECTIVE:** Normalizing is done for increase the ductility and reduces the hardness of the steel. Normalizing is done by heating the steel (both for hypo and hyper eutectoid)  $30^{\circ}\text{C}$ - $40^{\circ}\text{C}$  above the upper critical temperature(see iron-carbon diagram) followed by air cooling(see TTT diagram). Microstructure obtained after Normalizing is fine pearlite.

Hardening is done for increase the hardness of the steel. Hardening is done by heating the steel (for hypo eutectoid)  $30^{\circ}\text{C}$ - $40^{\circ}\text{C}$  above the upper critical temperature and for hyper eutectoid steel  $30^{\circ}\text{C}$ - $40^{\circ}\text{C}$  above the lower critical temperature(see iron-carbon diagram) followed by water cooling(see TTT diagram). Microstructure obtained after Quenching is Martensite.



Fig1, Heat treatment furnace(muffle furnace)

**INSTRUMENT REQUIRED:**

- i) Heat treatment furnace
- ii) MS specimen
- iii) Rockwell hardness testing Machine

