Date: / / Page no:

Q.1:- Properties of Material

① Physical Properties:-

- Density:- mass per unit volume.
- Melting Point:- Temperature at which a material changes from solid to liquid.
- Thermal Conductivity:- Ability to conduct ~~electricity~~. Heat.
- Electrical Conductivity:- Ability to Conduct electricity.

② Mechanical Properties:-

① Strength:- Ability of a material to resist external forces without breaking.

② Stiffness:- Ability to resist deformation under applied load.

③ Elasticity:- Ability to regain original shape after removal of load.

④ Plasticity:- Ability to retain deformation after the removal of load.

⑤ Ductility:- Ability to be drawn into thin wires.

(6) Brittleness:- Property of breaking without significant deformation.

(7) Malleability:- Ability to be hammered or rolled ~~into~~ thin sheets

(8) Toughness:- Ability to absorb energy before fracture.

(9) Resilience:- Ability to absorb energy and return to original shape after unloading.

(10) Hardness:- Resistance to scratching, wear, and ~~pent~~ penetration.

(11) Machinability:- Ease with which a material can be cut or machined.

(12) formability:- Ability to undergo plastic deformation without failure.

(13) Weldability:- Ability to be welded into a strong joint.

(14) Creep:- Slow deformation under constant stress at high temperature over time.

(15) fatigue:- failure of a material due to repeated or cyclic loading.

Date: / / Page no:

③ Chemical Properties:-

- Corrosion Resistance:- Ability to withstand ~~deform~~ deterioration due to reaction with environment.

- Oxidation Resistance:- Ability to resist degradation due to reaction with oxygen.

④ Thermal Properties:-

- Heat Capacity:- Ability to absorb heat.

- Thermal Expansion:- Increase in size with temperature.

Q.2:- Composition of steel and cast Iron.

- Cast Iron:- Contains 2.1% to 4% carbon, along with silicon (1-3%), manganese, phosphorus, and sulfur in small amounts.

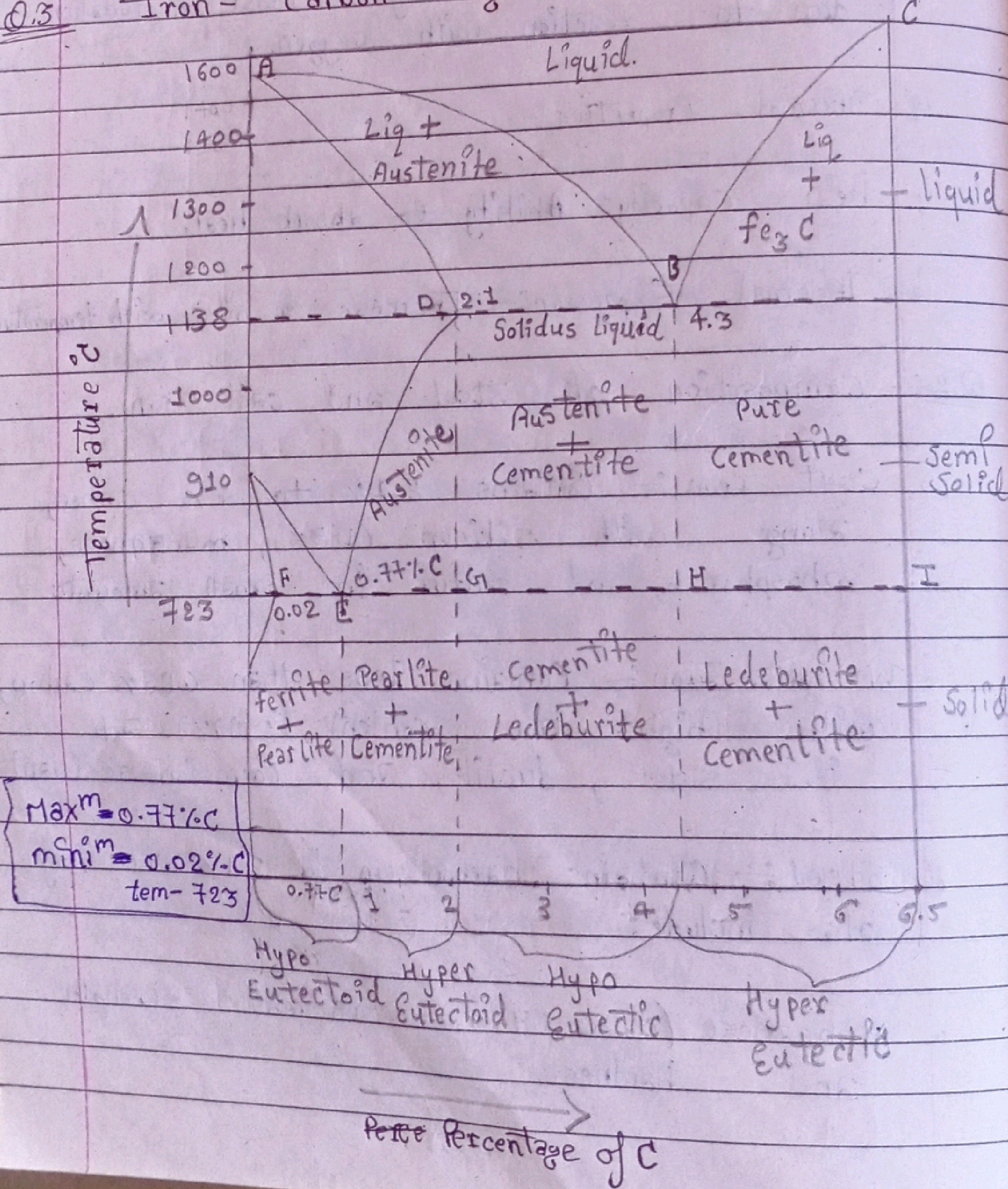
- Wrought Iron:- Contains less than 0.08% carbon, with high iron content (~99%). It is soft, ductile, and Corrosion-resistant.

- Steel:- Contains carbon up to 2.1%. It may also include:

- Manganese (0.30-1.70%):- Increase strength and hardness.

- Silicon (0.10 - 0.35%):- Removes oxygen during steel making.
- Sulfur and Phosphorus (अवांछनीय) (undesirable):- Affect ductility and toughness.

__Q.3__ Iron - Carbon Diagram



(1)
(2)
(3)

Date: / / Page no:

Atomic Structure :-

BCC – Body centre Cube
FCC – face centre cube

0 – 910°C — α - Iron BCC
910°C – 1400°C – γ - Iron FCC
1400°C – 1600°C – δ - iron BCC

① Eutectoid Reaction

Austenite $\xrightarrow[723°C]{0.77\%}$ ferrite + Pearlite

② Eutectile Reaction

Liquid $\xrightarrow[1138°C]{4.3\%C}$ Austenite + cementite

③ Peritectic Reaction

Liquid + δ. iron $\xrightarrow{1493°C}$ Austenite.

Blast → Pig iron → Cupola furnance → Wrought Iron

Purest form of fe – wrought Iron. 99.2 to 99.9% fe

ferrite Magnet 0.77% Carbon + fe

0 to 2.14 → steel

2.14 to 6.67 → Cast Iron

for ductile material
for mild steel
Tensile Test

Q.4:- Stress – strain diagram.

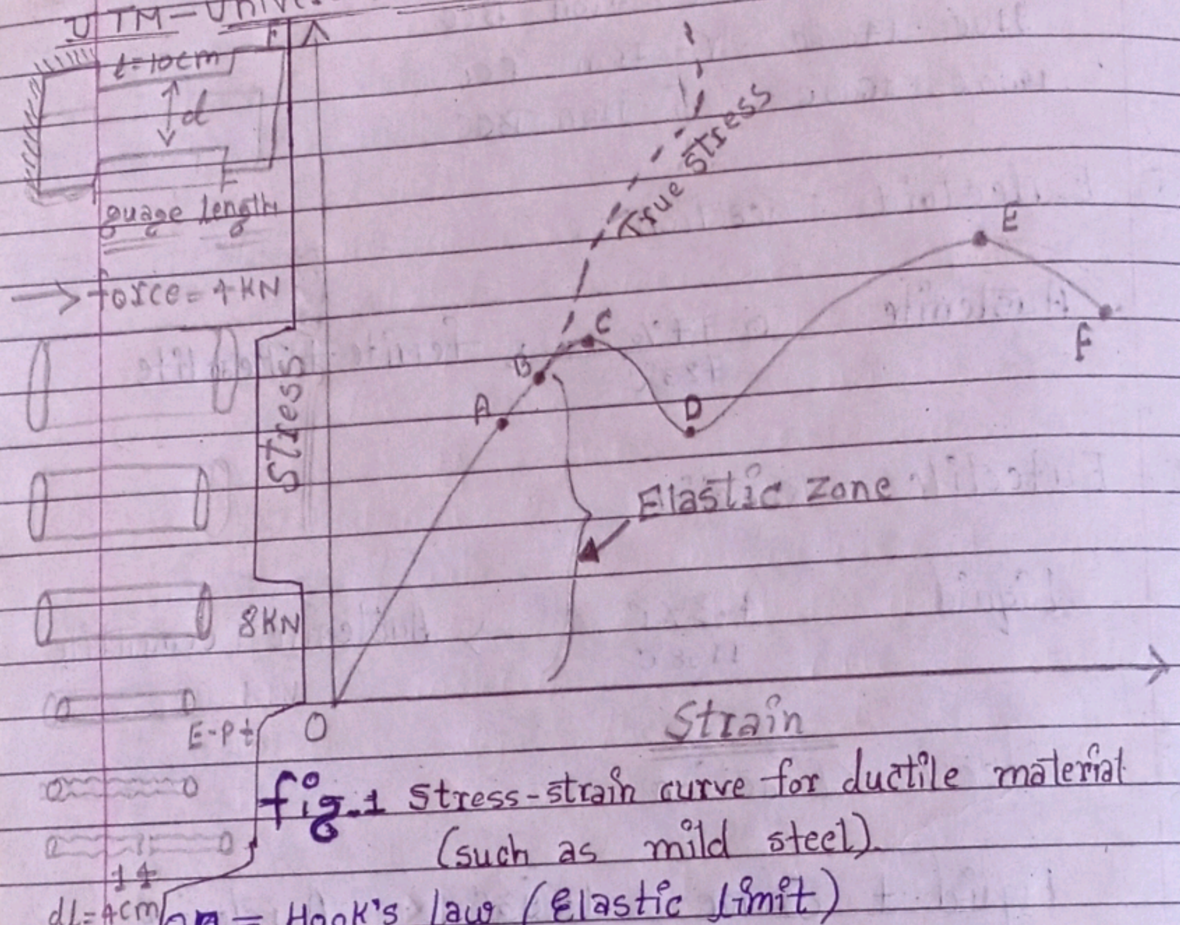


fig.1 stress-strain curve for ductile material (such as mild steel).

OA = Hook's law (Elastic limit)
OAB = Elastic Zone
C — Upper yield point
D — lower yield point
E — Ultimate point or Ultimate Strength
F — fracture point

Ultimate strength denoted by σ_{ut}

$\sigma_{ut} = 80 N/m^2$

factor of safety (F.O.S = 2)

Stress:- stress is the force applied to a material per unit area. It is denoted by (σ)

$$\sigma = \frac{f}{A} = \frac{\text{Internal Resistive force}}{\text{Cross-section Area}}$$

$$\text{Unit} = N/m^2$$

strain:- Strain is the resulting deformation or change in shape of the material. It is denoted by (ε)

$$\varepsilon = \frac{dl}{l} = \frac{\text{change in length (deformation)}}{\text{original length}}$$

Hook's law:-

It state that, the stress is directly proportional to strain up to Elastic limit

$$\sigma \propto \varepsilon$$

$$\sigma = E\varepsilon$$ where ~~is~~ E is Modulus of Elasticity. (Young's modulus).

$$\frac{f}{A} = E\frac{dl}{l}$$

Date: / / Page no.

Q.5 Hardness test

There are no. of method used for determining the hardness of material. The most Common used method is Brinell test, Rockwell test, and vickers test. In all of these method. an indenter is Pressed against Smooth and polished surface of the material. By applying specific load. The indenter Penetrates into the surface of the material. The mark produced by such Penetration is Called indentation. The dimension of the indentation, along with the magnitude of applied load, are used to calculate the hardness of the material. The value of hardness obtain by these test is denoted by a numbers.

Brinell Hardness Test

→ Most fundamental method

→ Indenter is a hard spherical ball, made of tungsten carbide

→ Dia of ball 10mm, These ball is pressed on plane and polished surface of the material.

→ Magnitude of applied load 3000 Kgf for steel & Cast Iron

1000 Kgf for Copper & Alloy

250 Kgf for soft material (aluminium)

→ The diameter of the indentation is measured by

$$BHN = \frac{2P}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

Limit

→ Not

→ Not

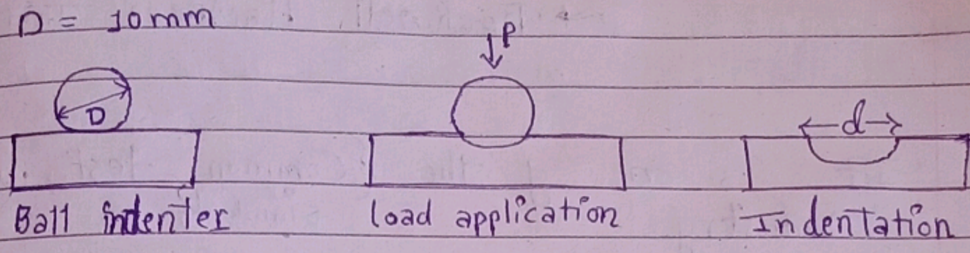
→ Dept

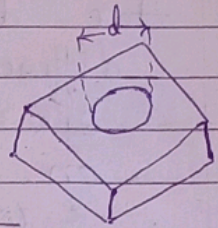
10

→ Due

BHN – Brinell Hardness number

Date: / / Page no:





Limitation of Brinell Hardness Test :-

→ Not use for the material Having above 450 BHN
→ Not use for the object having small depth
→ Depth of the object should be more than 10 times of the depth of indentation
→ Due to the indentation on the Product So the tested Product may not be further usable

→ Rockwell Hardness Test ←

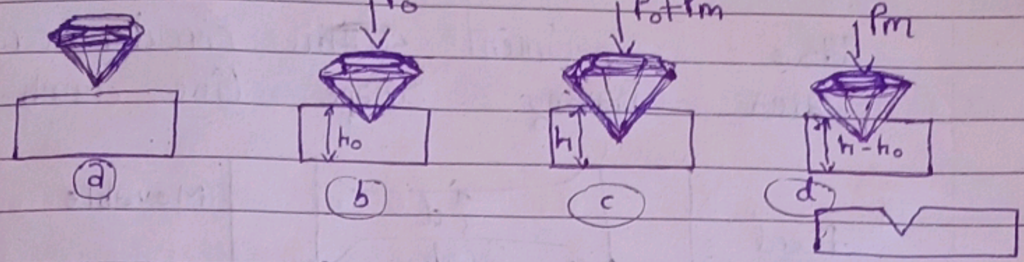
It is one of the {Common or Standard} test use in industry.
for different type of application there are different standard in this test They are identified as A, B, C and d on. In this test (A and C) the indenter is a diamond Cone, Know as Brale. The apex angle of the Cone is 120°. In Rockwell B test the indenter is a hardered steel ball having diametre of 1.5875 mm

Rockwell Hardness number are denoted by R_A, R_B, R_C.
The load is applied in two step.
Minor load P_0 → 10 kgf for A, B, C case
Major load P_m → 50 kgf for scale A
90 kgf for scale B
140 kgf for scale C

* The minor load caused a small impression in the specimen which is mostly elastic in nature. The major load enlarges the indentation by plastic deformation.
* The vertical travel of the indenter, after the application of minor load is h_0 and it is h after both the minor and major load have been applied.

The travel of 0.002mm of brale is considered as one unit

$$e = \frac{h - h_o}{0.002} \qquad R_A = R_C = 100 - e$$
$$R_B = 130 - e$$



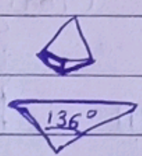
(a) Diamond Cone indenter (b) Indenter Position when minor load (c) with minor & major load (d) Indenter Position when the major load is removed

⇝ Vickers Hardness Test ⇜

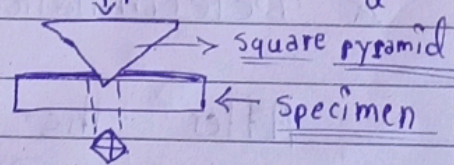
- → Indenter is a Square pyramid
- → Diamond Pyramid Hardness or DPH
- → The angle b/w the opposite lateral face of Pyramid 136° very small thickness. for small thickness the load applied is also small

5, 10, 20, 30, 100 or 120 Kgf

$$DPH = \frac{2P \sin(\alpha/2)}{d^2} = \cancel{1.854}\ 1.8544 \frac{P}{d^2}$$

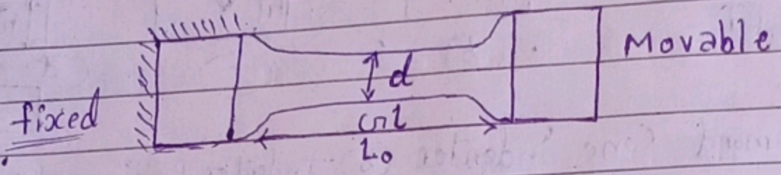


(a) Squard Pyramid Indenter



Q.6 Tensile Test :- The object of tensile test is to obtain the ultimate tensile strength, yield strength, percentage elongation and percentage reduction in cross sectional area

Use specimen with circular cross section area having shape like dumb-bell



Load is increased gradually. The load measured and displayed continuously ~~using~~ on a dial gauge or digital display. The elongation is also measured continuously using extensometer, mechanical arrangement with graph paper. The stress can be determine by using the data

* Load at yield point and area gives yield strength.
* load at ultimate point and gives ultimate strength

★ Determination of % elongation :-

After the specimen break the two piece are put together tightly and elongated gauge length is measured

Q.7 :-

$$\% \text{ elongation} = \frac{\text{change in length}}{\text{original length}} \times 100$$

L_0 = guage length

* Ductile material % elongation more than 15 %.
* Brittle material show less than 5 % elongation.

Q.7 Types of stress.

Stress :- when an external load is applied to an object, its molecule generate an internal resistive force, which appose the externally applied load. This resistive per unit area called stress.

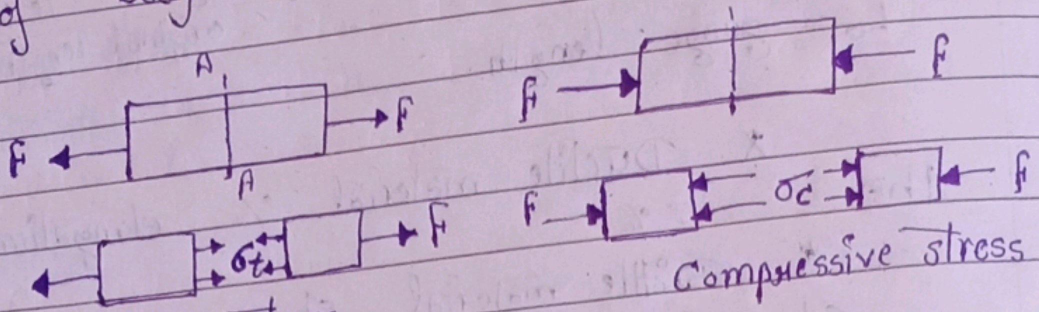
$$\text{stress} = \frac{\text{force}}{\text{area}} = N/m^2$$

Types :- Stress can be classify according to the type and nature of external applied force.

(1) Normal stress — (a) Tensile, (b) Compressive
(2) Tangential stress — shear stress — Direct shear, Torsional shear

Normal Stress :- (Tensile and Compressive)
when the external applied load is Perpendicular to the area on which stress is consider is called Normal stress.
when the applied load increase the length ob object it is tensile stress.

when the applied load decrease the length of body it is called Compressive stress



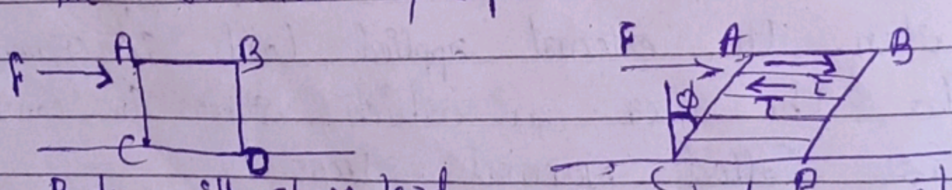
Tensile stress

Compressive stress

Tangential stress :- (Direct and Tansional shear)
Consider a rectangular body ABCD fixed at its lower surface CD. A force F act along its top surface AB. Considered the ABCD is manufacture of No. of layers when the ~~extem~~ external force F is applied on a body. It causes the different layer to slide relative to each other. each layer applied to slide relative to each other. Each layer to slide relative to each other. Each layer applied equal and opposite force above and below layer. This stress is called shear stress.

$$\tau = F/a$$

Where a is the area of the layer in the direction perpendicular to the paper.



Body with shear load Concept of shear stress

The shear strain is defined as the angular deformation of the face AC. It is equal to angle ϕ.

Q.8:- Alloy of steel and their applications.

Alloy steel is made by adding elements like chromium, nickel, vanadium, manganese, etc., to carbon steel to improve its properties such as strength, hardness, toughness, corrosion resistance, and wear resistance.

(1) Nickel steel:-
- Composition:- Steel + 2-5% Nickel
- Properties:- High toughness, strength, and corrosion resistance
- Applications:- Aircraft parts, turbines, gears, pressure vessels.

(2) Chromium steel:-
- Composition:- steel + 0.5-2% Chromium.
- Properties:- Hardness, wear resistance, corrosion resistance
- Applications:- Cutlery, Surgical tools, ball bearings.

(3) Nickel- Chromium Steel:-
- Composition:- steel + Nickel + Chromium
- Properties:- High strength, toughness, heat resistance
- Applications:- shafts, gears, axles, engine parts.

(4) Manganese Steel:-
- Composition:- Steel + 11-14% Manganese
- Properties:- Very hard, impact- resistant
- Applications:- Railway tracks, rock crushers, armor plates.

Date: / / Page no:

(5) Tungsten steel (Tool steel)

- Composition :- steel + 2-18% Tungsten
- Properties :- High hardness at high temperatures
- Applications :- Cutting tools, drills, dies

(6) Vanadium steel

- Composition :- steel + vanadium
- Properties :- High fatigue strength, shock resistance
- Applications :- crankshafts, gears, springs.

(7) Molybdenum steel

- Composition :- Steel + 0.25-8% Molybdenum
- Properties :- High temperature strength and Corrosion resistance.
- Applications :- High-speed tools, aircraft parts, boilers.