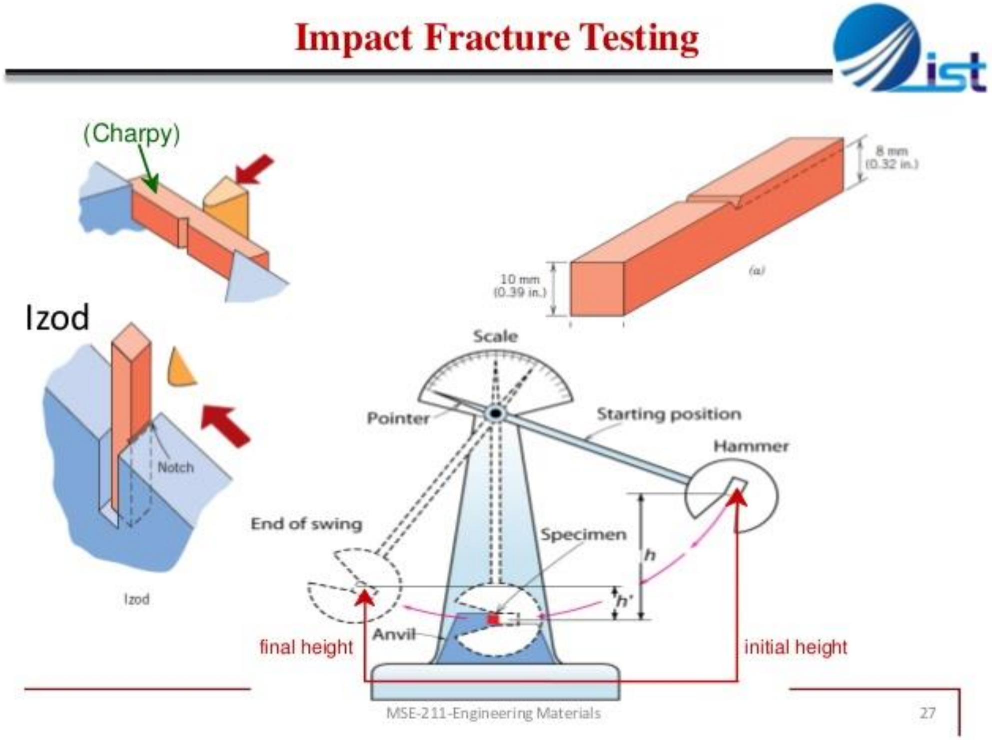
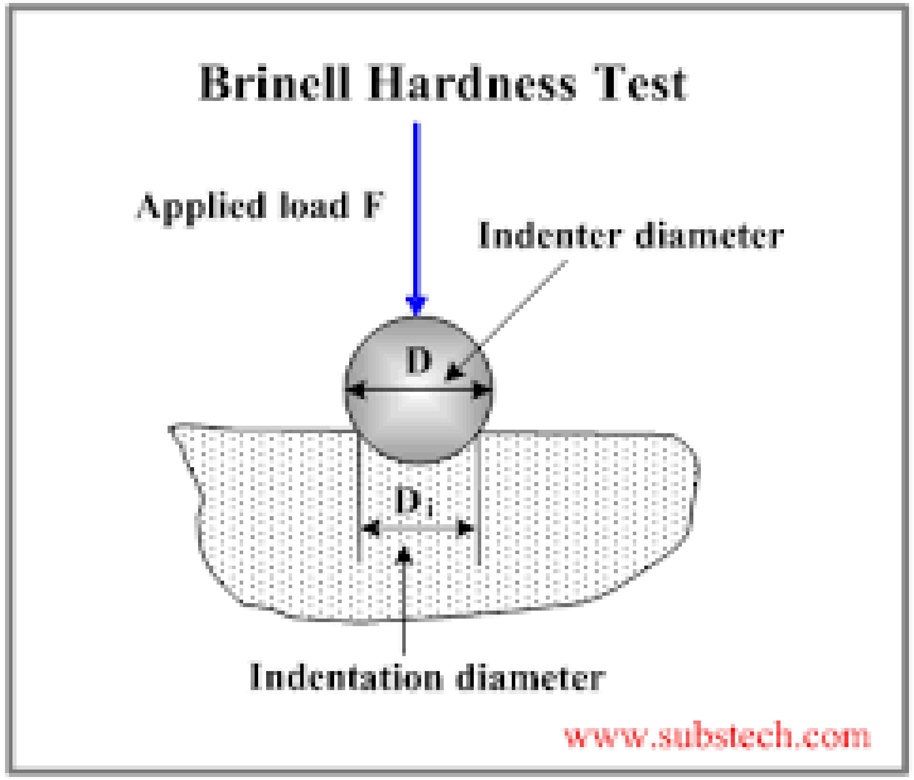
METHOD OF TESTING





Lecture-3

Why are metals tested ?

- Ensure quality
- Test properties
- Prevent failure in use
- Make informed choices in using materials

  Factor of Safety is the ratio comparing the actual stress on a material and the safe useable stress.

Two forms of testing

- **Mechanical tests** – the material may be physically tested to destruction. Will normally specify a value for properties such as strength, hardness, toughness, etc.

- **Non-destructive tests** (**NDT**) – samples or finished articles are tested before being used

STRESS

- stress – internal force in a material which tends to resist deformation when subjected to external forces

- intensity of a stress unit depends on the value of the force acting on a unit area of the material

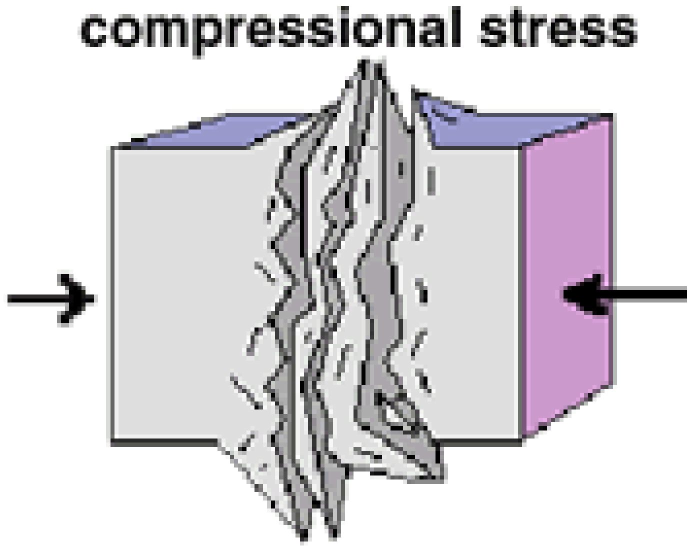
$$\text{stress} = \frac{\text{applied force}}{\text{c.s.a. of a material}}$$

Types of stresses

- Compressive stress
- Tensile stress
- Shear stress
- Torsion
- Bending

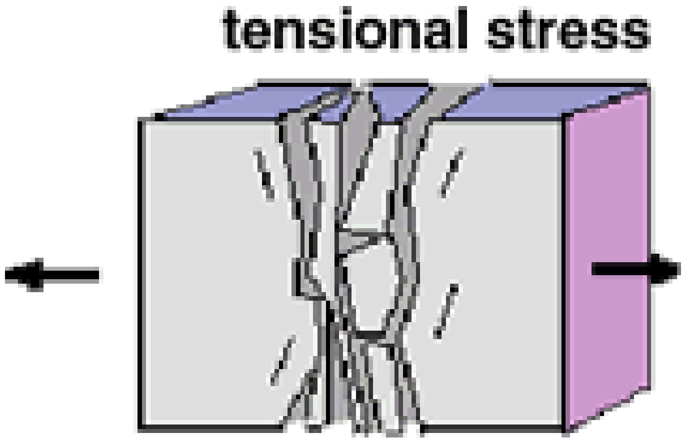
Compressive stress

- **Compressive stress** is the stress applied to materials resulting in their compaction (decrease of volume).
- Usually compressive stress is applied to columns, etc.



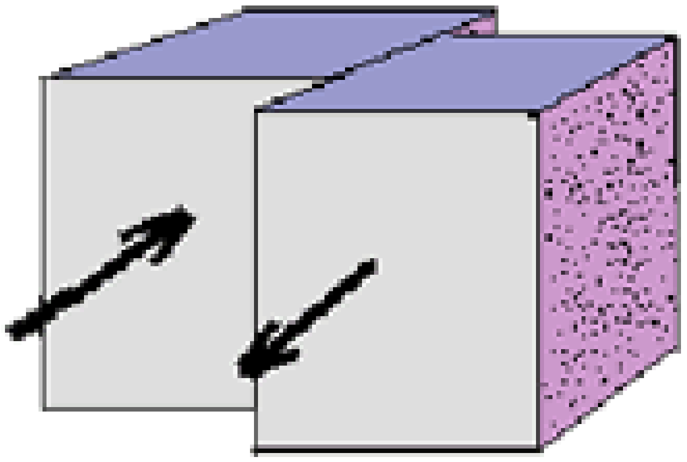
TENSILE STRESS

- **Tensile stress** is the stress state leading to expansion (volume and/or length of a material tends to increase). In the uniaxial manner of tension, tensile stress is induced by pulling forces across a bar, specimen, etc.



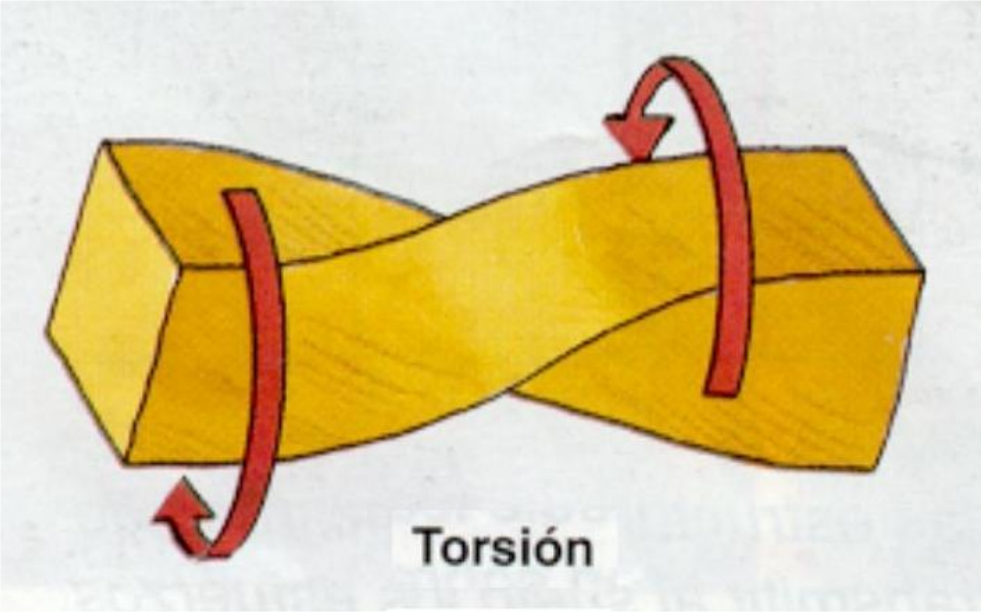
SHEAR STRESS

- **Shear stress** is a stress state where the shape of a material tends to change without particular volume change.



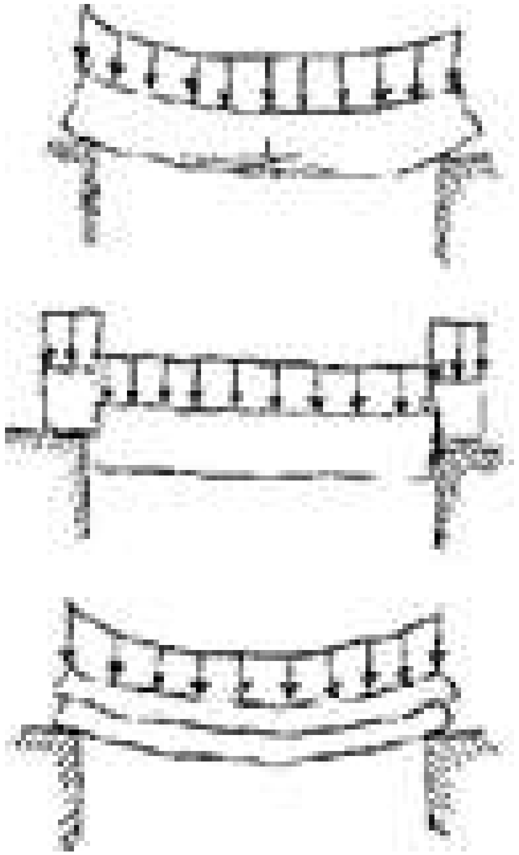
TORSION

- the stress which resists a force tending to twist the material (e.g. axle, screw, etc.)



Bending

- Bending occurs when the force applied tends to pull a horizontal bar out of its straight line.



Method of testing of Hardness test

Method of testing of Fatigue test

Method of testing of Tensile test

Method of testing of Impact test

TENSILE TEST

The following MATERIAL PROPERTIES can be evaluated / determined by TENSILE TESTING:

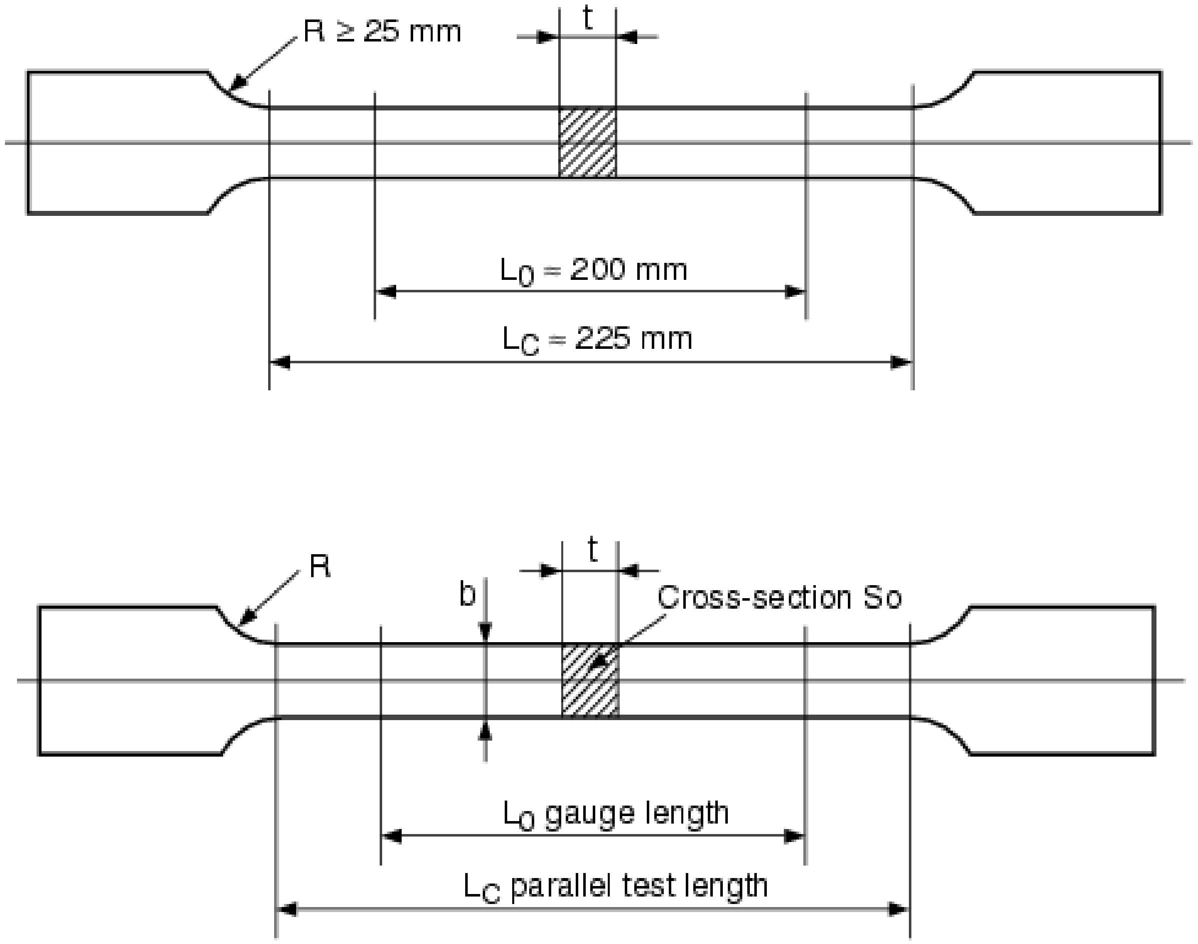
- STRENGTH
- DUCTILITY
- ELASTICITY
- STIFFNESS

TENSILE TEST

- STRENGTH - the greatest stress that the material can withstand prior to failure.
- DUCTILITY - a material property that allows it to undergo considerable plastic deformation under a load before failure.
- ELASTICITY - a material property that allows it to regain its original dimensions after removal of a deforming load.
- STIFFNESS - a material property that allows a material to withstand high stress without great strain.

TENSILE MACHINE & SPECIMEN.

SPECIMEN DIMENSIONS



TENSILE TESTING

- A machine which applies a tensile force (a force applied in opposite directions) to the specimen, and then measures that force and also the elongation:
- This machine usually uses a hydraulic cylinder to create the force. The applied force is determined by system pressure, which can be accurately measured.

PROCESS

The test process involves placing the test specimen in the testing machine and slowly extending it until it fractures. During this process, the elongation of the gauge section is recorded against the applied force. The data is manipulated so that it is not specific to the geometry of the test sample. The elongation measurement is used to calculate the *engineering strain* , ε, using the following equation:

$$\varepsilon = \frac{\Delta L}{L_0} = \frac{L - L_0}{L_0}$$

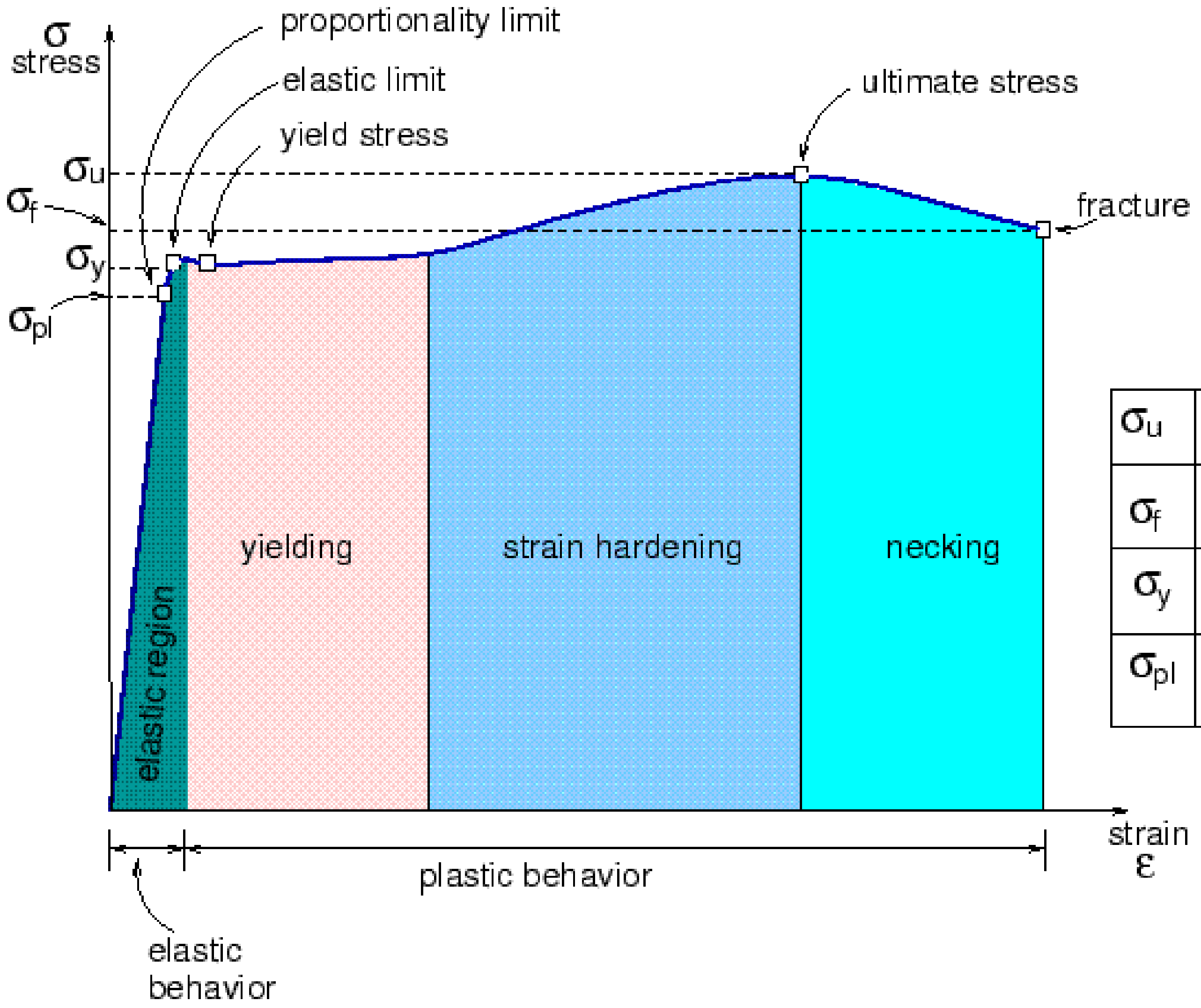
PROCESS

where ΔL is the change in gauge length, L_0 is the initial gauge length, and L is the final length. The force measurement is used to calculate the *engineering stress*, σ, using the following equation

$$\sigma = \frac{F_n}{A}$$

where F is the tensile force and A is the nominal cross-section of the specimen. The machine does these calculations as the force increases, so that the data points can be graphed into a *stress–strain curve*.

STRESS STRAIN DIAGRAM



σ_u	Ultimate stress
σ_f	Fracture stress
σ_y	Yield stress
σ_{pl}	Proportionality limit

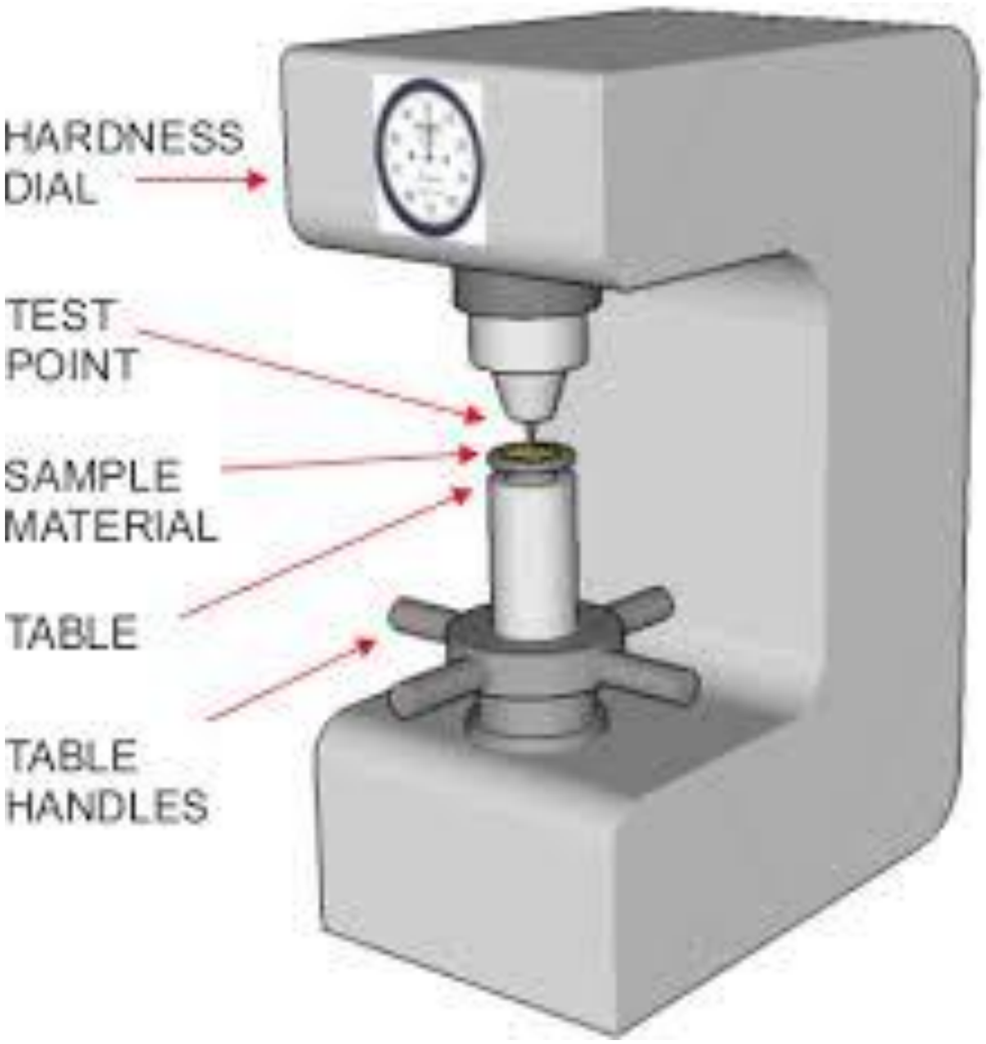
Modulus of elasticity

the modulus of elasticity (elastic modulus) of an object is defined as the slope of its stress-strain curve in the elastic deformation region

Yield point

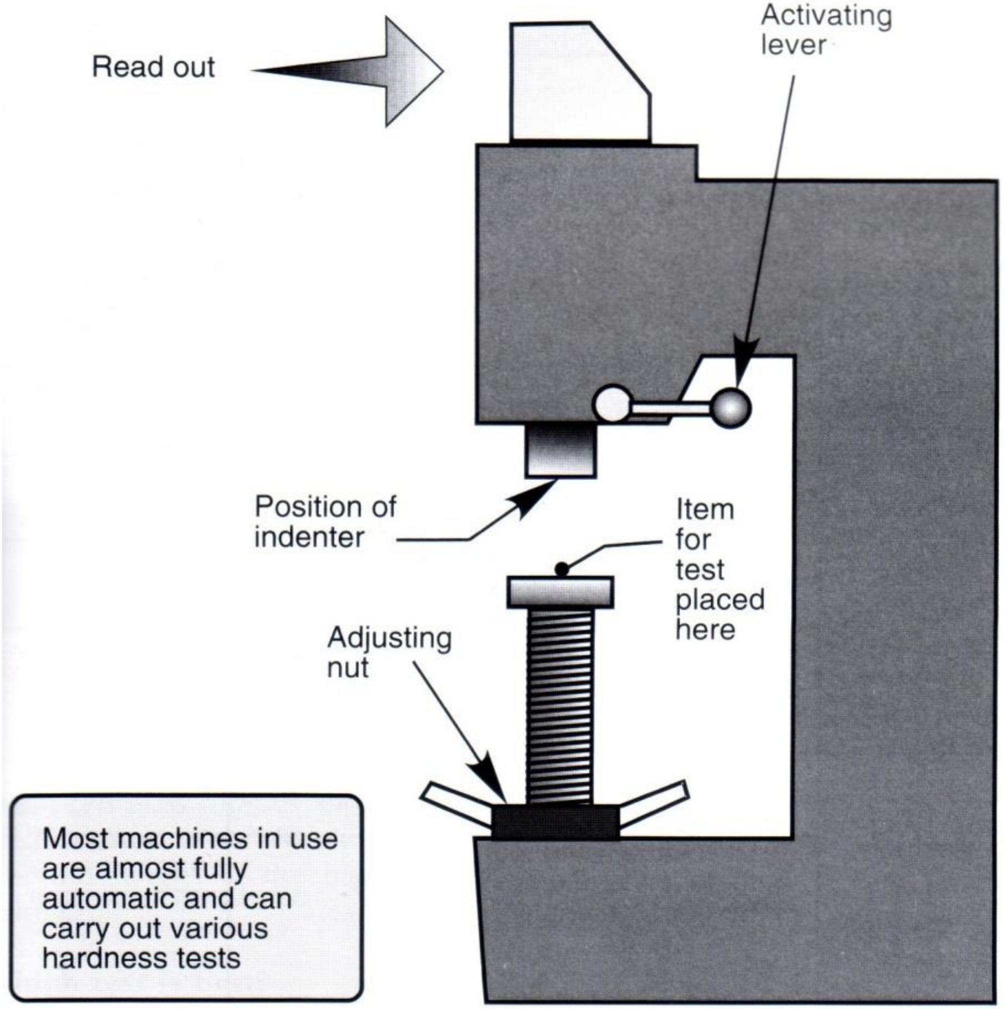
- the stress at which a material begins to deform plastically
- prior to the yield point the material will deform elastically and will return to its original shape when the applied stress is removed
- once the yield point is passed, some fraction of the deformation will be permanent and non-reversible

HARDNESS TEST APPRATUS



HARDNESS TESTING

- Hardness is the ability to withstand indentation or scratches



HARDNESS TESTING

- The indenter is pressed into the metal
- Softer materials leave a deeper indentation


O.M.A.G.
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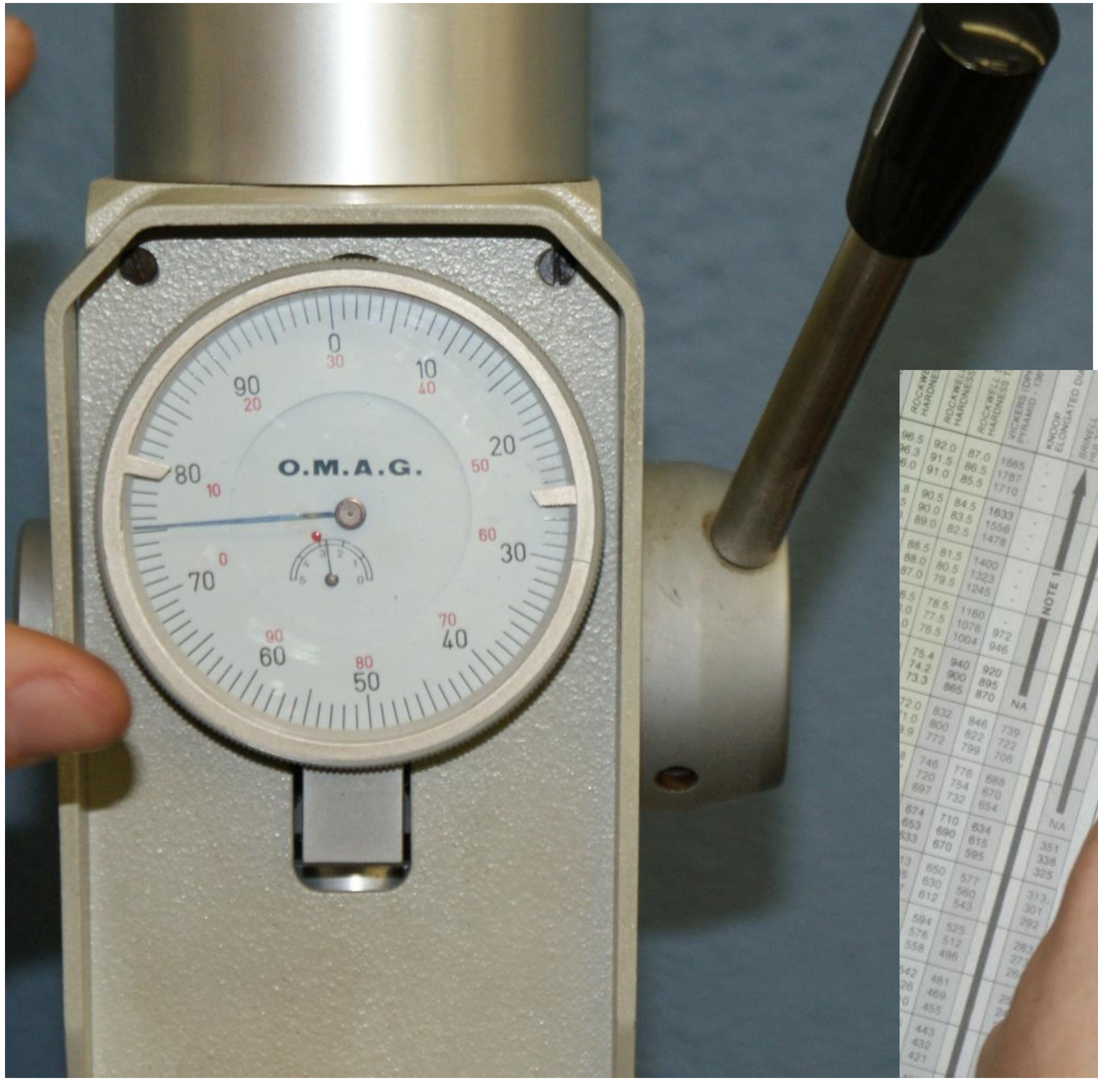
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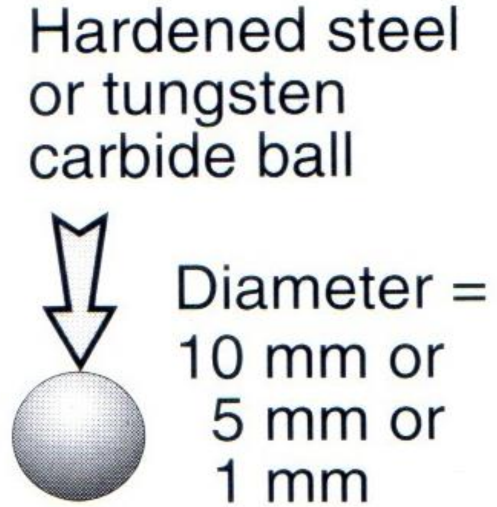
ROCKWELL HARDNESS TESTER
NOTE 1
NOTE 2

BRINELL HARDNESS TEST

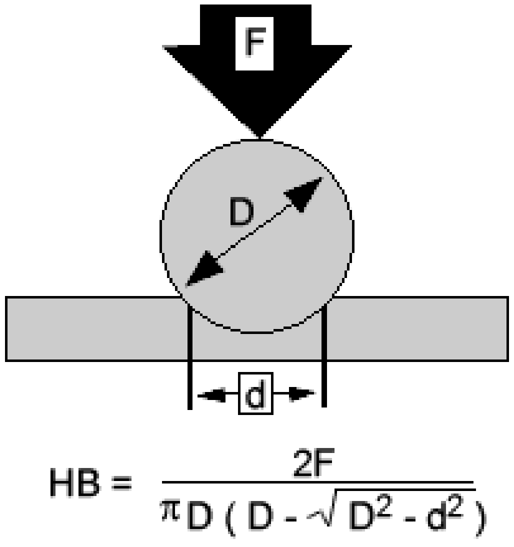
- Uses ball shaped indenter.
- Cannot be used for thin materials.
- Ball may deform on very hard materials
- Surface area of indentation is measured.



HARDNESS TESTING

$$\text{HBW} = 0.102 \frac{2F}{\pi D \left(D - \sqrt{D^2 - d^2}\right)}$$

F = applied force (N)
D = diameter of indenter (mm)
d = diameter of indentation (mm)



VICKERS HARDNESS TEST

- Uses square shaped pyramid indenter.
- Accurate results.
- Measures length of diagonal on indentation.
- Usually used on very hard materials