Properties of Materials
BTM 2413

CHAPTER 5:
THE ROLE OF MECHANICAL PROPERTIES IN ENGINEERING MATERIALS -II

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Introduction

- Aims
  - To introduce the mechanical properties and its testing methods
- Expected Outcomes
  - Explain the testing methods of mechanical properties
  - Know the manufacturing considerations of engineering materials….
- Other related Information
  - …..
- References

- Kenneth G Budinsky & Michael G Biddinsky, Engineering Materials: Properties and Selection, Ed 9, Prentice Hall

Tensile Testing

- Material Properties Obtained from Tensile Testing

Material properties	Indications
Modulus of elasticity	To measure relative stiffness of materials
Yield strength	
Ultimate tensile strength	
Ultimate tensile strength/ yield strength ratio Percent elongation	
Percent reduction in area	
General shape of the curve	

Tensile Testing

Resilience

- is defined as material's ability to absorb elastic energy
- Area under elastic region of stress-strain curve

$$\text{Resilience} = \frac{1}{2}\sigma_{el}{}^{2}\varepsilon_{el} = \frac{\sigma_{el}{}^{2}}{2E}$$

σ_{el} – stress at elastic limit

ε_{el} - strain at elastic limit

E – modulus of elasticity

If large energy absorption required → material should has HIGH elastic limit, LOW elastic modulus

Tensile esting

Toughness

- determined from stress-strain curve
- Is defined as ability of a material to absorb energy before fracture
- Area under plastic region of stress-strain curve

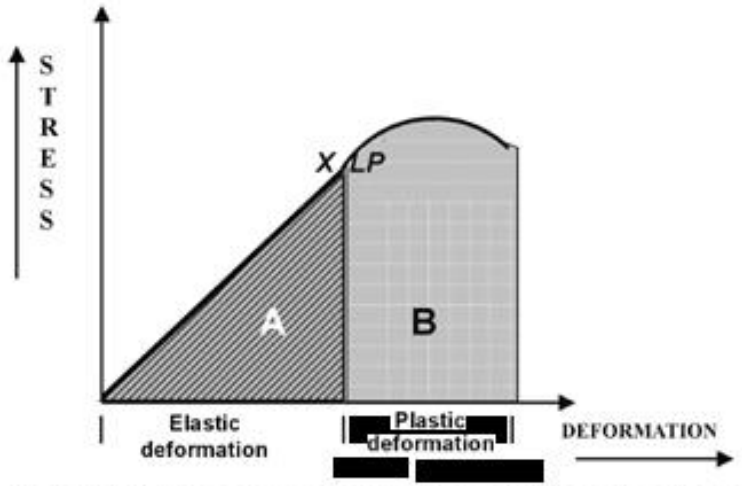


FIGURE 3- Areas indicating resilience (A) and toughness (A+B) of a material

Toughness

- Toughness in engineering materials is the energy required to fracture a given volume of material
- It relates to a material's ability to be battered without fracture
- Unit : joule
- Toughness is different with strength
- Toughness also can be measured by area under load-displacement curve
- Strength measured by stress
- Toughness usually measured by impact test
- Suitable for impact resistance

Shear Properties

- Shear load ; eg : bolts, rivets
- Shear test can be performed in a tensile machine using different grips
- Shear stress can be from force or torsion
- Shear strain refer to amount of twisting or angular displacement
- *Shear modulus, G*

$$\sigma_s = G\ \varepsilon_s$$

Hardness Test

There are many ways to measure hardness

- Brinell
- Rockwell
- Vickers
- Barcol Impresser
- Portable tester
- Microhardness

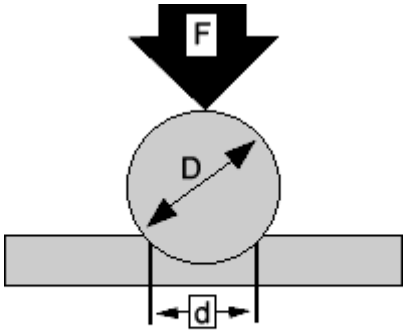
Hardness Test

Hardness is probably one of the most used selection factors. Most present days hardness tests consists of pushing a penetrator into the material and measuring the effects

Brinell hardness test uses 10 mm diameter ball, that is pushed into the surface and optical measuring device is used to measure the diameter of resulting indentation.

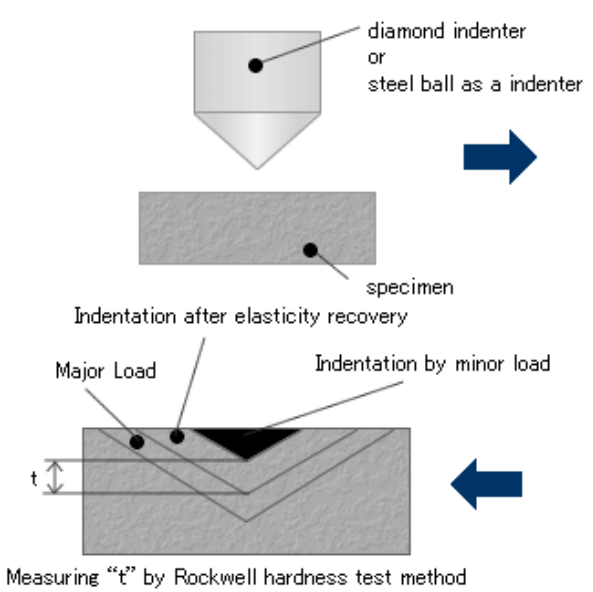
Rockwell hardness testers use different loads and penetrators and the depth of indentation is measured by machine and converted on a dial into hardness number

Hardness Tests

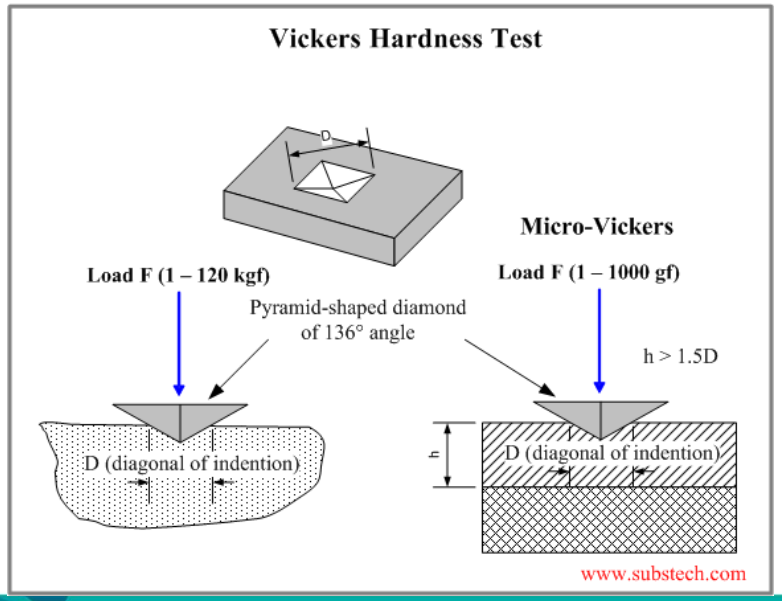


$$HB = \frac{2F}{\pi D \left(D - \sqrt{D^2 - d^2} \right)}$$

Degital Rockwell



Measuring "t" by Rockwell hardness test method



Impact Tests

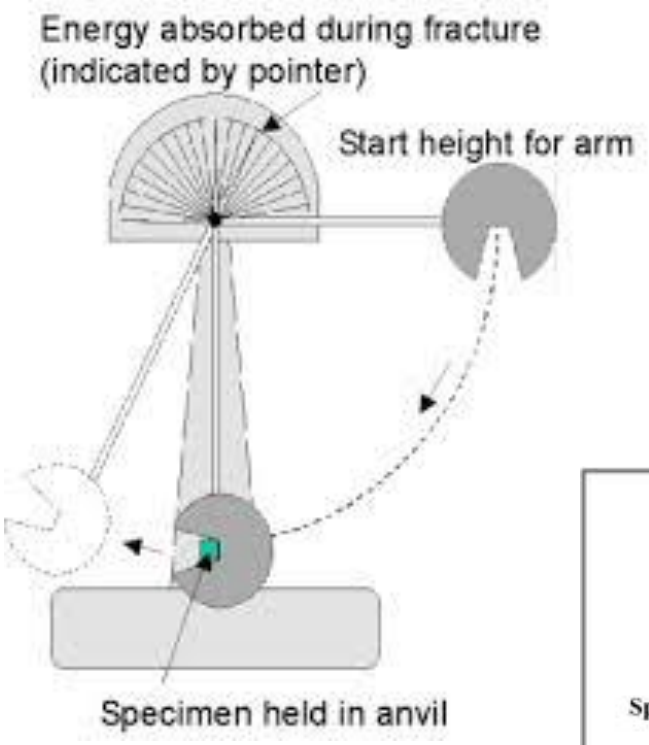
- To measure *impact strength*
- Ability to withstand shock/sudden loading
- Or can be defined as energy required to fracture a given volume of material
- Unit : Joule or Joule/m^3
- Common impact tests

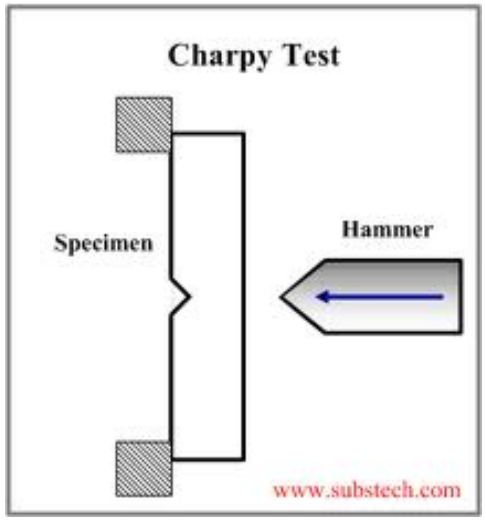
  i) Charpy

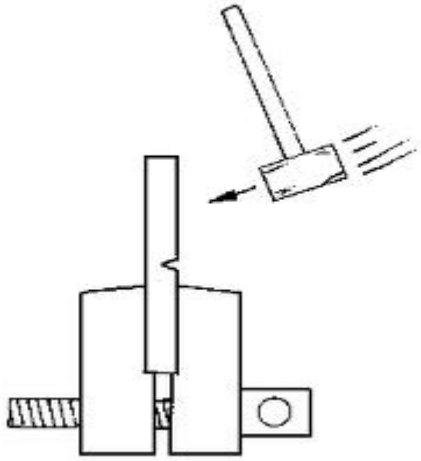
  ii) izod

  iii) impact

Impact Tests







Izod Test

Impact Test

- Drop Weight Test

Long Term Servicebility

- Ability to use for a long term period
- Exposed to various situation such as temperature, dynamic loads etc

Additional Mechanical properties used to measure this service ;

1. Endurance Limit
2. Creep
3. Stress Rupture
4. Facture Mechanics

Long Term Serviceability

Additional mechanical properties for long term serviceability are

1) Endurance Limit

- Also called fatigue strength
- Obtained by repeatedly loading a specimen at given stress level until it fails

2)Creep:

- This property is used to rate the resistance of material to plastic deformation under sustained load.
- Creep strength often is expressed to produce 0.1% strain in 1000 hrs.
- Creep can be an important selection factor with low melting temperature metals and polymers

Manufacturing Considerations

- Surface Finish: The surface characteristics of engineering materials often have a significant effect on serviceability
- Size and Shape Considerations