Basic Workshop

أساسيات الورش

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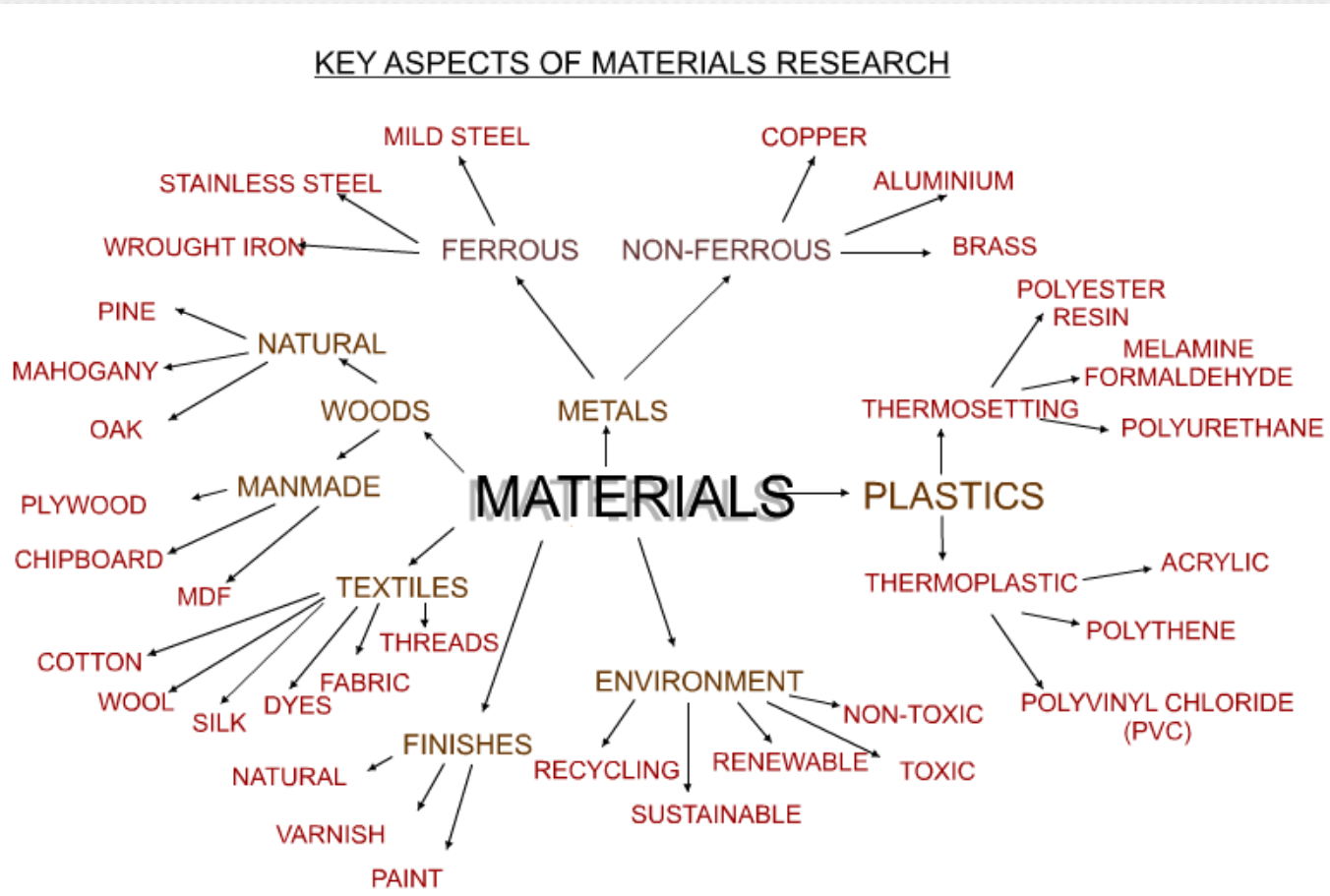
Classification of Engineering Materials

- There are thousands of materials available for use in engineering applications.
- Most materials fall into one of three classes that are based on the atomic bonding forces of a particular material.
- These three classifications are **metallic, ceramic and polymeric**. Additionally, different materials can be combined to create a **composite material**.
- Within each of these classifications, materials are often further organized into groups based on their chemical composition or certain physical or mechanical properties.
- **Composite materials** are often grouped by the types of materials combined or the way the materials are arranged together.

Classification of Engineering Materials



Classification of Engineering Materials

Metals

Polymer

Ceramics

Composites

Classification of Engineering Materials

Materials used in the design and manufacture of products

- **Plastics**
- **Wood**
- **Composites**
- **Ceramics**
- **Metals**
- **Fabrics**






Classification of Engineering Materials

(Plastics)

Plastics can be further classified as;

- Thermoplastic
- Thermoset
- Elastomer

Thermoplastics	Thermoset	Elastomers
Acrylics	Epoxy resins	Rubbers
Nylons	Phenolic	Silicones
Polyethylene	Polyesters	Polyurethanes

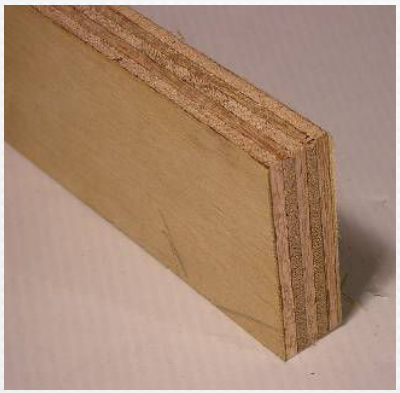
Classification of Engineering Materials

(Wood)

Wood can be further categorised as;

- Hardwood
- Softwood
- Manufactured board

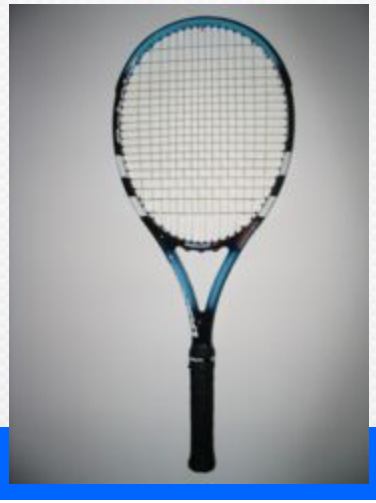
Hardwood	Softwood	Manufactured Board
Oak	Pine	Plywood
Ash	Cedar	Block board
Beech	Fir	MDF
Sycamore	Spruce	Melamine board

Classification of Engineering Materials

(Composites)

- A composite is a combination of two or more chemically distinct materials whose characteristics are superior to its constituents acting independently.
- Because of their high strength to weight ratio they are widely used in;
  - Aerospace industry
  - Offshore structures
  - Boats
  - Sporting goods

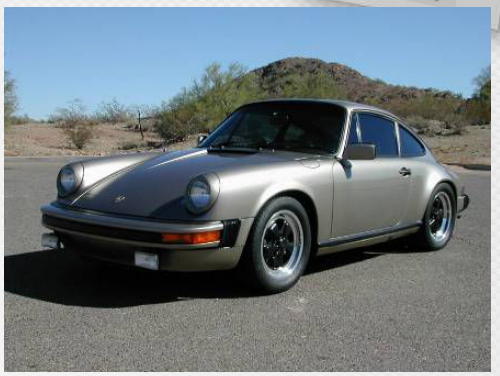


Classification of Engineering Materials

(Composites)

Examples of composites include;

- Reinforced Plastics
- Ceramic-matrix
- Metal-Matrix
- Laminates

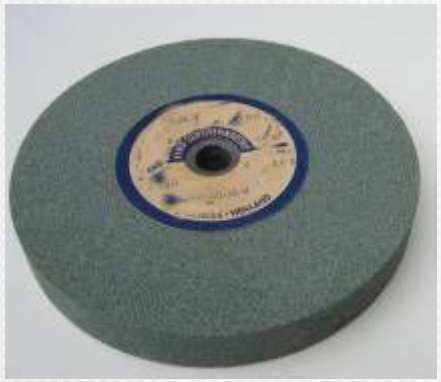


Classification of Engineering Materials

(Ceramics)

Ceramics are compounds of metallic and non-metallic elements, examples include;

- Oxides (alumina – insulation and abrasives, zirconia – dies for metal extrusion and abrasives)
- Carbides (tungsten-carbide tools)
- Nitrides (cubic boron nitride, 2nd in hardness to diamond)

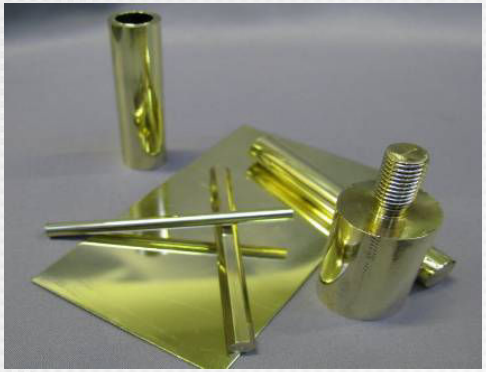


Classification of Engineering Materials

(Metals)

Metals can be further classified as Ferrous & Non-Ferrous, some examples include;

Ferrous	Non-Ferrous
Steels	Aluminium
Stainless Steels	Copper
High Speed Steels	Brass
Cast Irons	Titanium



Classification of Engineering Materials

Some *Ferrous* Metals And Properties

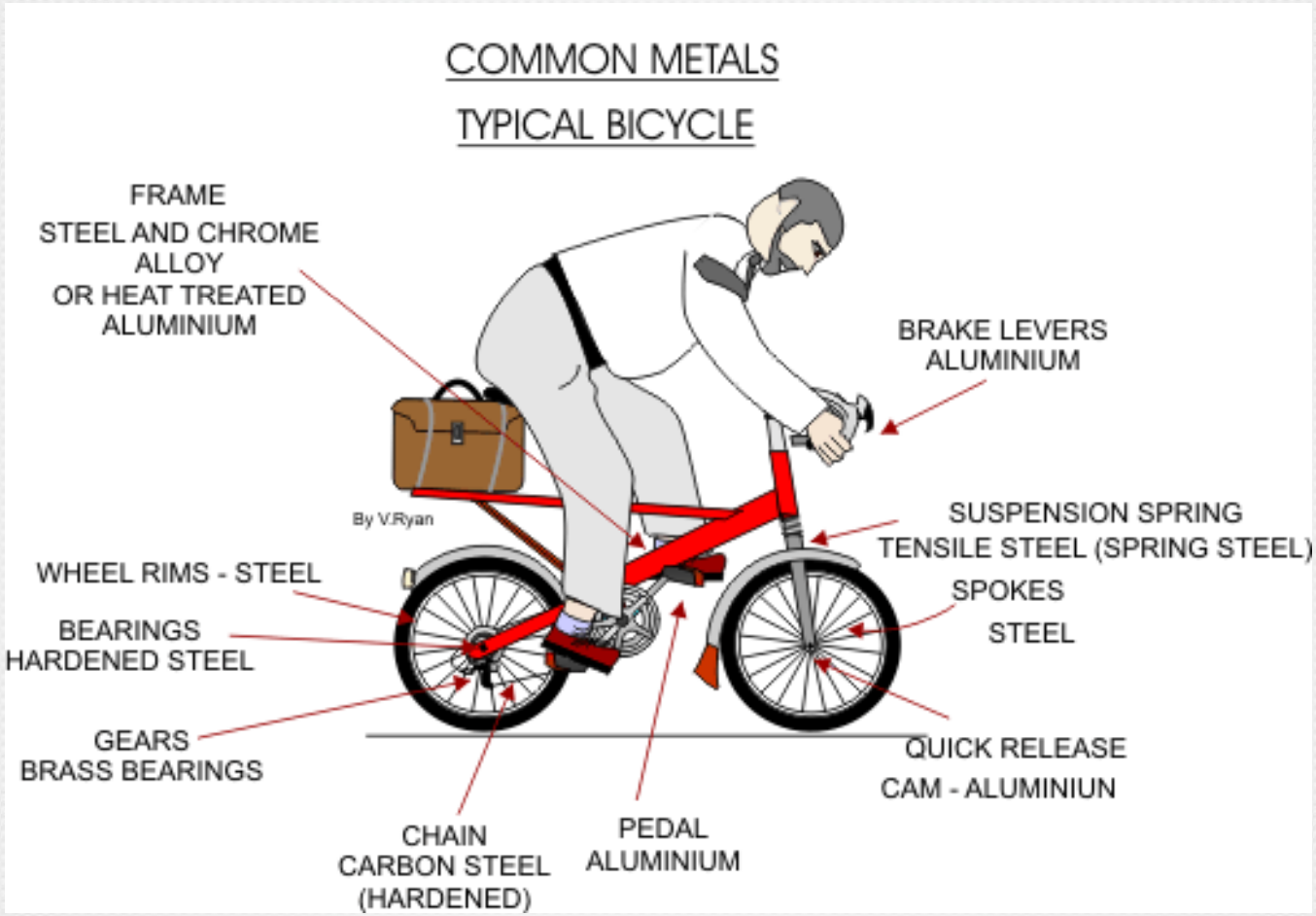
NAME	ALLOY OF	PROPERTIES	USES
Mild Steel	Carbon 0.1 - 0.3% Iron 99.9 - 99.7%	Tough. High tensile strength. Can be case hardened. Rusts very easily	Used in general metal products and engineering.
Carbon Steel	Carbon 0.6 - 1.4% Iron 99.4 - 98.6%	Tough. Can be hardened and tempered.	Cutting tools such as drills.
Stainless steel	Iron, nickel and chromium.	Tough, resistant to rust and stains	Cutlery, medical instruments.
Cast iron	Carbon 2 - 6% Iron 98 - 94%	Strong but brittle. Compressive strength very high	Castings, manhole covers, engines
Wrought iron	Almost 100% iron	Fibrous, tough, ductile, resistant to rusting.	Ornamental gates and railings.

Classification of Engineering Materials

Some *Non - Ferrous* Metals And Properties

NAME	ALLOY OF	PROPERTIES	USES
Aluminium	Al 95% Cu 4% Mn 1%	Ductile, soft, malleable, machines well. Very light.	Window frames, aircraft, kitchen ware.
Copper	Not an alloy	Ductile, can be beaten into shape. Conducts electricity and heat.	Electrical wiring, tubing, kettles, bowls, pipes.
Brass	Cu – Zn 65% - 35%	Hard. Casts and machines well. Surface tarnishes. Conducts electricity.	Parts for electrical fittings, ornaments
Lead	Not an alloy	Soft, heavy, ductile, loses its shape under pressure	Solders, pipes, batteries, roofing.

Classification of Engineering Materials

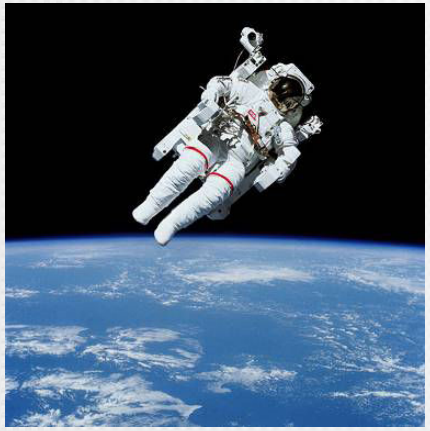


Classification of Engineering Materials (Fabrics)

Fabrics can be further classified as natural and synthetic

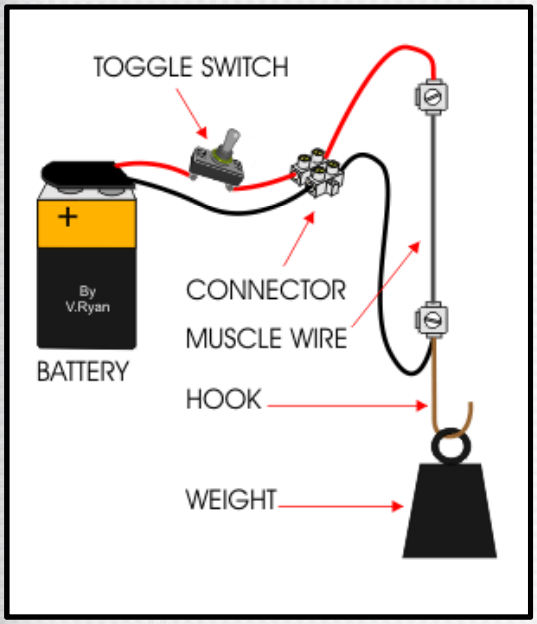
Natural	Synthetic
Cotton	Nylon
Canvas	Polyester

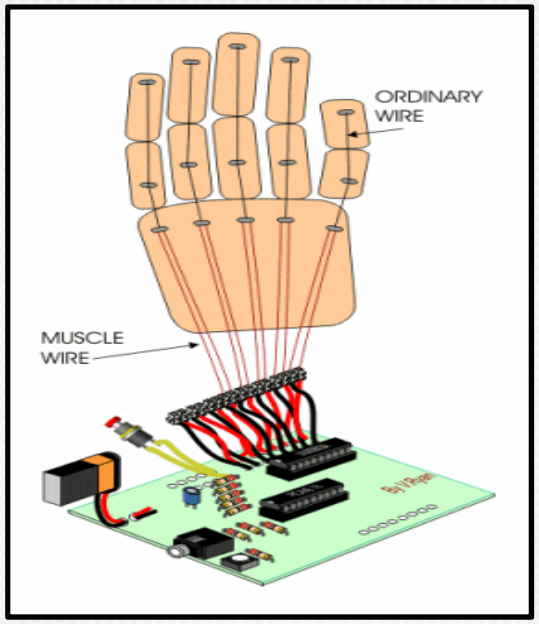
Materials used in space suits include aluminized Mylar, neoprene coated nylon, dacron, urethane coated nylon, tricot and spandex. The outer layer is a blend of Gortex, Kevlar and Nomex

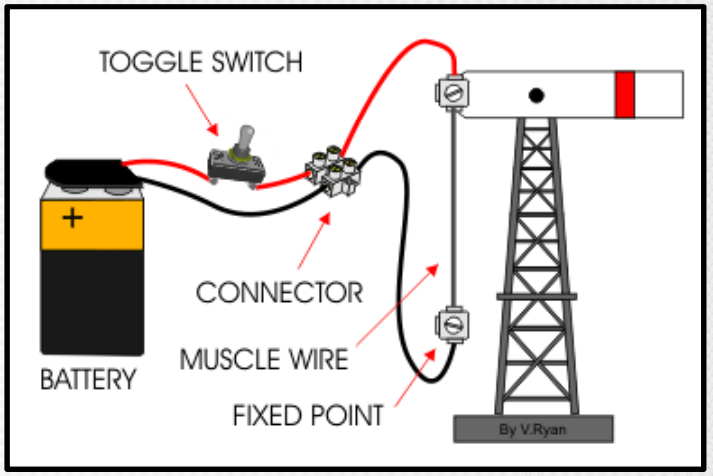


Classification of Engineering Materials

Smart Materials - Shape Memory Alloy







Mechanical Properties

INTRODUCTION

- Many materials, when in service, are subjected to forces or loads; examples include the aluminum alloy from which an airplane wing is constructed and the steel in an automobile axle.
- In such situations it is necessary to know the characteristics of the material and to design the member from which it is made such that any resulting deformation will not be excessive and fracture will not occur.
- The mechanical behavior of a material reflects the relationship between its response or deformation to an applied load or force.
- Important mechanical properties are strength, hardness, ductility, and stiffness.

Mechanical Properties

Properties of Materials
خواص المواد

Mechanical

- Strength
- Ductility
- Hardness
- Toughness
- Elasticity and Plasticity

Physical

- Density
- Melting point
- Conductivity
- Expansion
- ------

Chemical

Mechanical Properties

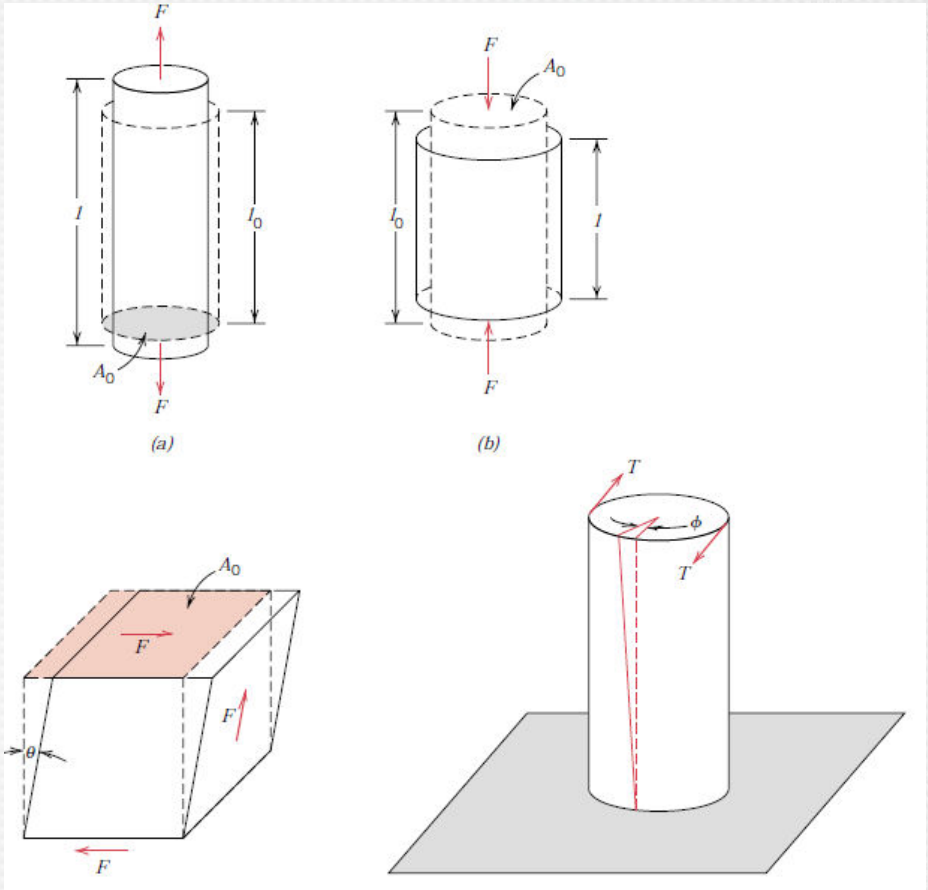
Stress and strain

Stress

$$R = \frac{P}{A_0}$$

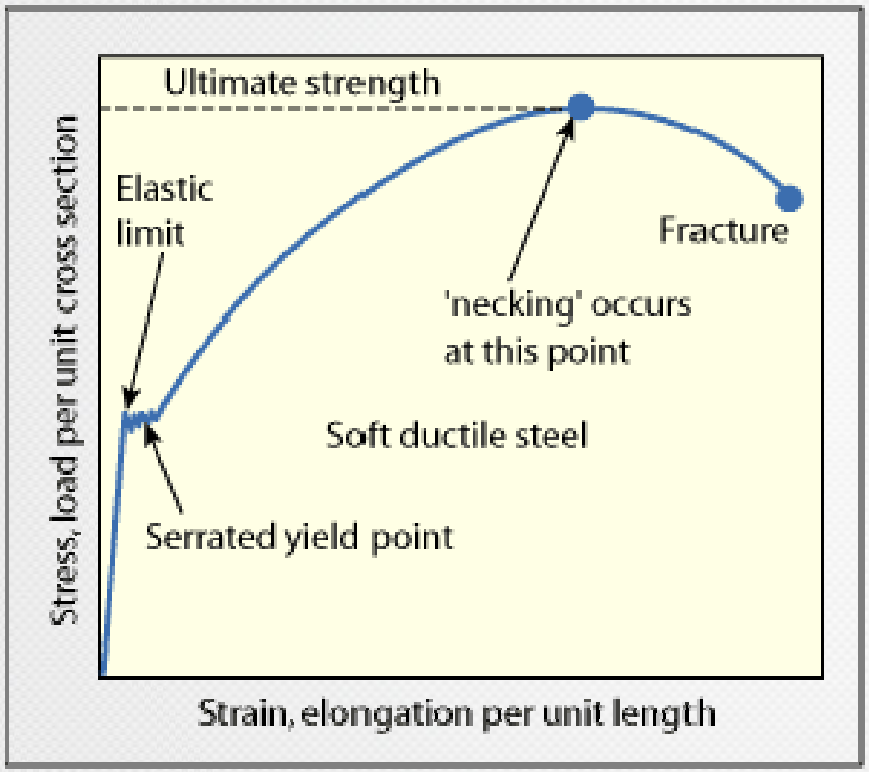
Strain

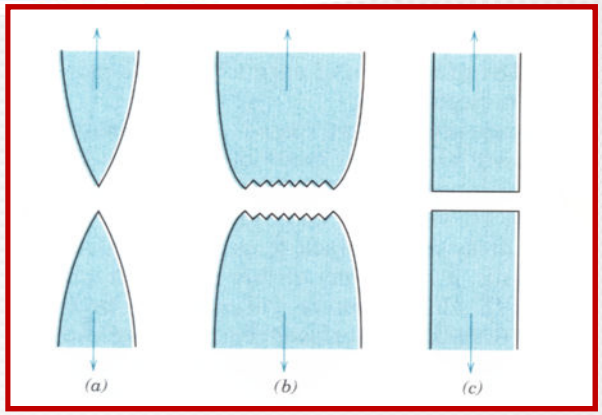
$$e = \frac{d}{L_0} = \frac{\Delta L}{L} = \frac{L - L_0}{L_0}$$

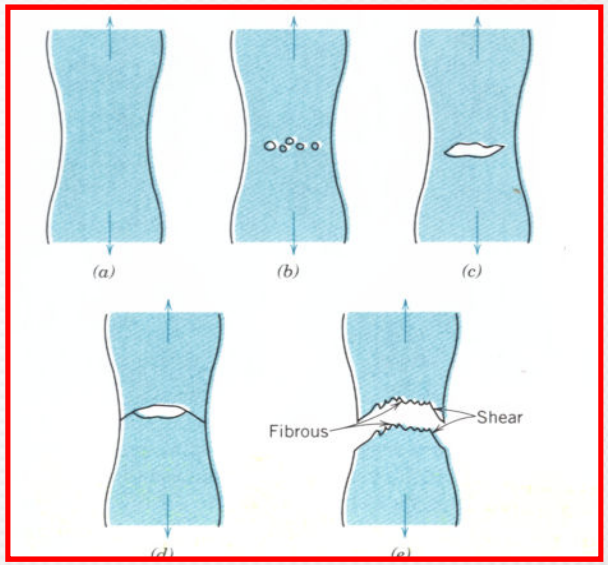


Mechanical Properties

Stress – Strain curve







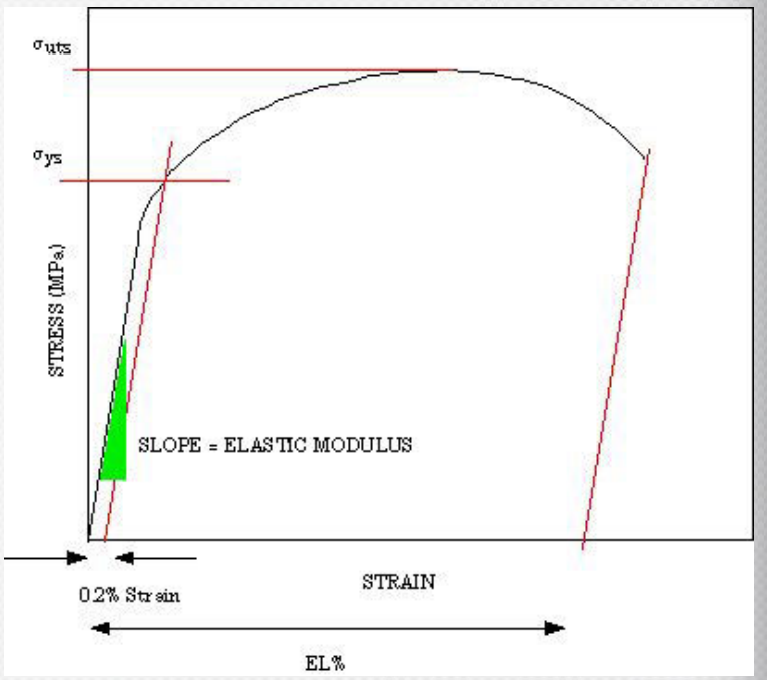
Mechanical Properties

Proportional limit
is the highest stress at which stress is directly proportional to strain. It is obtained by observing the deviation from the straight-line portion of the stress-strain curve

Elastic limit
is the greatest stress the material can withstand without any measurable permanent strain remaining on the complete release of load

Yield strength is the stress required to produce a small-specified amount of plastic deformation

Stress – Strain curve



Mechanical Properties

Hardness

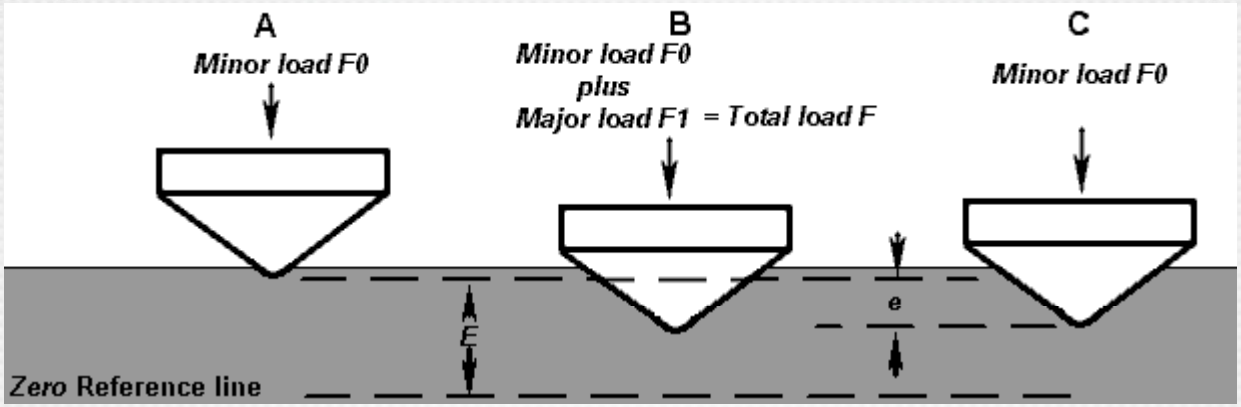
- Resistance of metal to plastic deformation, usually by indentation
- The ability to resist being permanently, deformed (bent, broken, or have its shape changed), when a load is applied.
- Hardness measurement can be defined as macro-, micro- or nano- scale according to the forces applied and displacements obtained

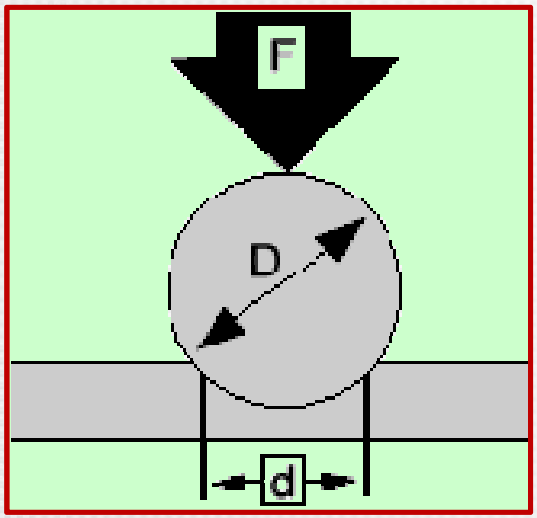
Hardness Measurement Methods

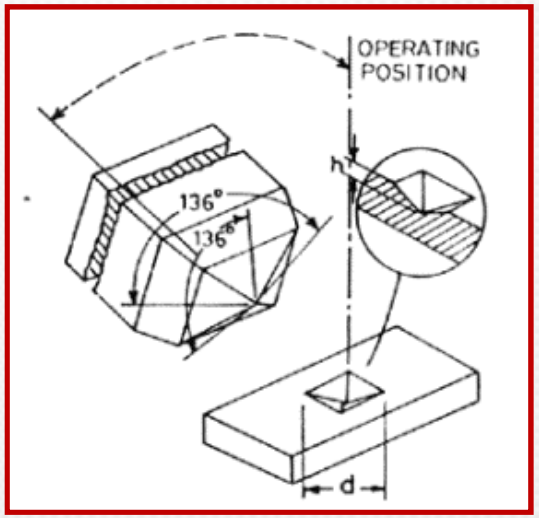
The most common hardness test methods used in today`s technology:

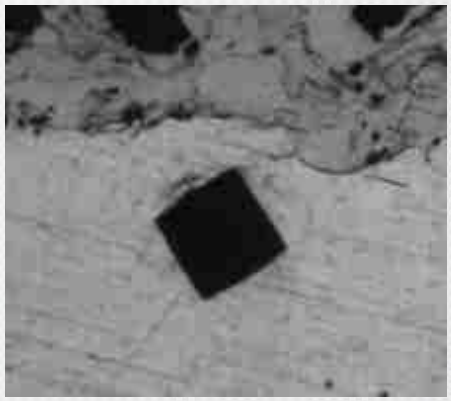
- Rockwell hardness test
- Brinell hardness
- Vickers

Mechanical Properties









Mechanical Properties

Toughness

It is a measure of the ability of a material to absorb energy up to fracture

The area beneath a stress / strain curve produced from a tensile test is a measure of the toughness of the test piece under slow loading conditions.