Construction Materials For Food Science and Engineering

Construction Materials and Their Properties

Prof. Dr. S. M. Iqbal Hossain

Dept. of Food Science and Engineering

Materials for Food Science and Engineering

Material Science and Material Engineering

- **Material Science: Understanding of how materials behave like they do, and why they differ in properties was only possible with the atomistic understanding allowed by quantum mechanics, that first explained atoms and then solids starting in the 1930s. The combination of physics, chemistry, and the focus on the relationship between the properties of a material and its microstructure is the domain of Materials Science.**
- **Material Engineering: The development of this Material Science allowed designing materials and provided a knowledge base for the engineering applications of different materials which is domain of Materials Engineering.**

Construction / Engineering Material

Definition: Any material that has got application in engineering construction (building, machine, equipment, apparatus etc.) is termed as engineering material.

Example of Construction/Engineering Materials: Stone, Brick, Lime, Cement, Sand, Surki, Khoa, Iron, Steel, Timber, polymers, Paint, Soil, Rubber etc.

Note: Not Engineering Materials- Gold, Diamond etc.

Properties of Engineering Materials

- **Property:** A quality that defines a specific characteristic of a material is termed as a property. The properties of a material provide basic information about its behavior under various conditions. An engineer must know the properties of materials before considering it for a particular use in any engineering constructions.
- **Test for Evaluation of Properties:** Most properties of engineering materials need to be evaluated entirely by experiment. Experiment that is undertaken to determine the properties of materials is called tests. Test provides the numeric information about the specific property or quality of the materials that is used in design of a structure or machine.
- **Testing standardization**: The procedure of testing are standardized by some organization either nationally or internationally to compare the values of the properties with some assurance.

Example of Testing Organization: 1. BSI (British Standard Institute), 2. ASTM (American Society of Testing Materials, 3. AASHO (American Association of State Highway Official), 4. ACL (American Concert Institute), 5. BSTI (Bangladesh Standards and Testing Institution), 6. BIS (Bureau of Indian Standards),7. PSQCA (Pakistan Standard and Quality Control Authority)

Some Most Important Properties of Engineering Materials

1. Physical properties	Size, shape, density, porosity, structure, texture
2. Mechanical properties	Strength, elasticity, plasticity, stiffness, ductility, malleability, hardness, brittleness, resilience, creep
3. Chemical properties	Corrosion resistance, acidity, alkalinity, chemical composition
4. Thermal properties	Specific heat, Thermal expansion, conductivity
5. Magnetic properties	Permeability, cohesive force, hysteresis.
6. Electrical properties	Conductivity, dielectric permitivity, dielectric strength

Properties of Engineering Materials

1. Strength: It is the property of a material that represents its ability to resist the external applied force without breaking or yielding.

- **Compression strength**
- **Tensile strength**
- **Shear strength**

Stress: Stress in the intensity of internal forces developed when an external force is applied on an engineering material. It is denoted by

$$S = \frac{P}{A} \text{..} (1)$$

Where,

- S is the stress (psi)
- P is the external force applied (pound)
- A is the cross-sectional area of the surface on which the force P is applied (square inch).

Properties of Engineering Materials

(a) Compressive stress: This type of stress is induced in an engineering material when it is subjected to a compressive force.

$$\text{Compressive stress} = \frac{\text{Compressive load}}{\text{Area under Load}} \quad \text{.....} \quad \text{.....} \quad \text{....(2)}$$

(b) Tensile stress: This type of stress is induced in an engineering material when it is subjected to a tensile force.

$$\text{Tensile stress} = \frac{\text{Tensile load}}{\text{Area under tensile load}} \quad \text{.....} \quad \text{.....} \quad \text{....(3)}$$

Properties of Engineering Materials

(c) Shear stress: When a part of an engineering material tends to slide over another portion at a given section, the fibres at the section are said to be sheared.

$$\text{Shear stress} = \frac{\text{Shear load}}{\text{Area under shear}} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

2. Strain: When external force (load) is applied to a material not only a stress is induced in the fibres, but the size or the shape of the material is also changed. Strain is the geometrical deformation of a material due to application of an external force and it is denoted by the following expression:

$$e = \frac{X}{L} \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where, e is the strain (dimensionless), X is the extension or shortening of length and L is the original length.

Properties of Engineering Materials

3. **Stiffness:** It is the ability of a material to resist deformation under stress. The modulus of elasticity is the measure of stiffness.
4. **Elasticity**: It is a property of a material which allows it to return to its original shape and size after the load to which it is subjected is released. Steel is an example of elastic material.
5. **Plasticity** is the opposite property of elasticity. A perfectly plastic material does not return to its original shape and size when the load causing deformation is removed. Lead is an example of plastic material.
6. **Ductility:** It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percentage reduction in area. The ductile material commonly used in engineering practice are mild steel, copper, aluminium, nickel, zinc, tin and lead

Properties of Engineering Materials

7. **Malleability:** This property permits plastic deformation of a material when subjected to compression. Materials that can be hammered into thin sheets are malleable materials. Wrought iron is an example of malleable material.
8. **Brittleness:** The opposite property of malleability is the brittleness. Cast iron, glass are the example of brittle material.
9. **Toughness:** It is the property of a material to resist fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of energy that a unit volume of the material has absorbed after being stressed upto the point of fracture. This property is desirable in parts subjected to shock and impact loads.
10. **Fatique:** When a material is subjected to repeated stress, it fails at stress below the yield point stresses. Such type of failure of a material is known as fatique. The failure is caused by means of a progressive crack formation which are usually fine and microscopic size. This property is considered in designing shafts, connecting rodes, springs, Gears, etc.

Properties of Engineering Materials

11. **Hardness:** The term hardness, when used as a technological property of materials, is primarily associated with the surface. An appropriate definition of hardness is the resistance of a material to permanent deformation of its surface. This deformation may be in the form of scratching, mechanical wear or cutting.
12. **Resilience:** The resilience of a material is its ability to absorb energy in the elastic range. It is measured by the amount of energy absorbed per unit volume within the elastic limit. This property is essential for spring material.
13. **Creep:** When a part is subjected to a constant stress at high temperature for a long period of time, it will under go a slow and permanent deformation called *creep*. This property is considered in designing internal combustion engines, boilers and turbines.

Selection of Engineering Material

Importance: Selection of engineering material is very important as the quality and cost of the product depends on the materials used for the construction of machine or building.

Four Criteria for Selecting Engineering materials:

1. **Property:** Properties of the material in relation to intended use (e.g. strength, durability & workability).
2. **Economy:** The materials should be economic.
3. **Availability:** Locally available materials should be preferred.
4. **Ease of Handling and Fabrication:** Material should be such that it can be easily handled and fabricated.

Materials for Food Engineers

- **Iron and Steel**
- **Non-Ferrous Metals and Alloys-**
  - **Copper, Zinc, Tin, Aluminum etc.**
- **Sand, Brick, Lime, Cement, Concrete**
- **Wood or Timber**
- **Polymers- Plastic, Rubber**
- **Glass and Ceramics**
- **Protective coating materials**

Thanks