Engineering Materials

any material that is used for the construction , whether residential or industrial.

Engineering materials are divided into:-  
A – metallic materials   
used in the manufacture of construction and equipment, and are divided into:-  
 1 - ferrous metals: such as steel and iron types  
 2- Non-ferrous metals: such as copper, aluminum, Titanium , ect.

B-non –metallic materials  
 Divided into:-   
 1 - Building Materials: - such as stone ,bricks, cement, gypsum ect.   
 2 - Variety of materials: such as plastic, rubber, cork, glass and other.

C-Energy producing materials:- such as water, fuel, and materials of atomic energy.

The ground and its atmosphere and hydrosphere are the main source of raw materials from which engineering materials are extracted .

**Properties of engineering materials**

Are the features that characterize the different materials from each other, and appear as a special qualities of the material, can be recognized by either simple sense or by using equipment and instrument .

The properties of engineering materials to: --  
A - **Physical properties**: such as dimensions, shape, weight and other   
B - **Mechanical properties**: - such as elasticity , plasticity , strength, ect.  
C - **Chemical properties**: such as chemical composition, alkalinity, acidity, ect.  
D - **Thermal properties**: - thermal conductivity, thermal insulation, thermal expansion  
E - **Electric and magnetic properties**: such as, electrical conductivity and magnetic force  
H - **Properties of sound**: - such as sound conductivity and reflection of sound and absorption of sound

F- **Optical properties**: - such as color and light refraction and reflection of light

**Physical Properties**

**1. Bulk Density (ρb):** Bulk density is the **dry mass** per **unit volume** of a substance under **packing conditions**. It is denoted by:

**ρb** = 𝑀/ 𝑉𝑏 , (kg//m3) (3)

In this formula: **ρb** is the density (kg/m3);

***M*** is the mass under dry conditions (kg);

*Vb* is the volume under packing conditions (m3).



**Packing Conditions**: That means powdery or granular materials are packed.

**Bulk Density** Not equal to **( ≠ ) True Density**

**2. Apparent Density (ρa):** Apparent Density is the **dry mass** per **unit volume** of a substance under **natural conditions**. It is defined by:

**ρa** = M/ Va , (kg /m3) (2)

In this formula: **ρa** is the density (kg/m3);

***M*** is the mass under dry conditions (kg);

*Va* is the volume under natural conditions (m3).

**Natural Conditions**: That means the volume of a substance under these conditions refers to the solid volume and the volume of inner pores.



**3. Density (True Density) (ρ):** Density is the **dry mass** per **unit volume** of a substance under **absolute compact conditions**. It is defined by:

**ρ** = M/ V , (g/cm3) (1)

In this formula: **ρ** is the density (g/cm3);

***M*** is the mass under dry conditions (g);

*V* is the volume under absolute compact conditions (cm3).

**Absolute Compact Conditions**: That means the volume under these conditions refers to the solid volume without the volume of inner pores.

**Density index (ρ0) : is the percentage of the bulk density to the density .**

**ρ0= Bulk Density / Density**

**\*for almost all building materials( ρ0) is less than ( 1) because there are no absolutely dense body in nature .**

**Specific Gravity (GS) of solid particles of a material is the ratio of weight /mass of a given volume of solids to the weight /mass of an equal volume water at 4 ْC**

**G s= γS /****γW = ρS/ ρW**

**At 4 ْC γW= 1 g/cm3**   **or 9.8 KN/m3**

**Porosity ( n ) : is defined as a ratio of volume of voids , and the total volume**

**n (%) = VV / V x 100%**

**where :**

**VV is the voids volume ; Vis total volume of the specimens**

**Void ratio (e ) : is a ratio of volume of voids (VV ) to the volume of solids (VS) .**

**e( %): VV / VS x 100%**

**Following inter relationship exists between void ratio and porosity**

**N = e / e+1**