CIVIL ENGINEERING MATERIALS
COURSE CODE: CE-116
LECTURE # 1

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INTRODUCTION

Civil Engineering Materials include all those materials that are widely used in the **civil engineering** practice including reinforced concrete, asphalt, masonry, wood, structural steel, aluminium, and polymers etc.

- The quality of construction materials whether naturally available or manufactured must not below a specific standard level.
- Different agencies have developed there standards for testing the materials to ensure the required quality of materials.
- ASTM, AASHTO, ISO etc.

INTRODUCTION

Construction materials are primarily evaluated for the following Properties

- Physical properties
- Mechanical properties
- Chemical properties
- Electrical & Thermal properties

PHYSICAL PROPERTIES

- Density
- Magnetism
- Specific weight/Gravity
- Porosity & Voids ratio
- Water absorption
- Permeability
- Colour
- Melting Point
- Boiling Point
- Solubility
- Odour
- Viscosity

DENSITY

Mass per unit volume is called density

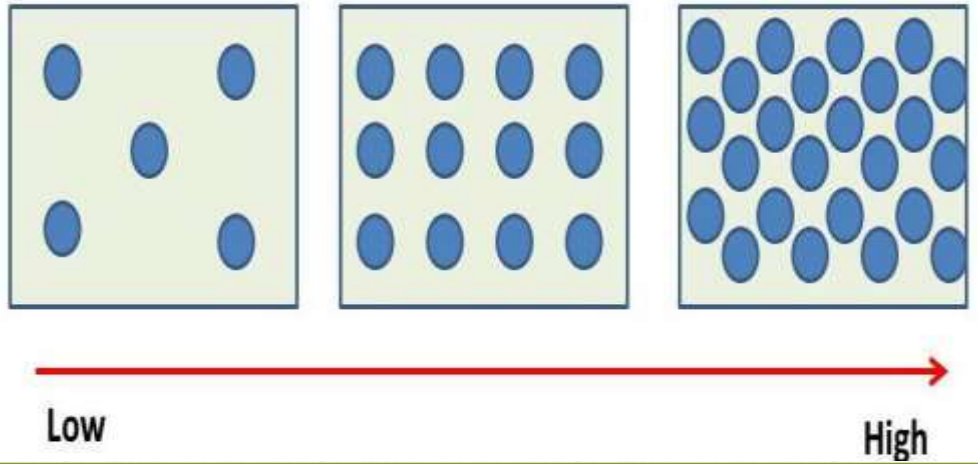
$$\rho = \frac{M}{V} \text{ g/ cm}^3$$

where M = mass (g)

V = volume (cm^3)

Density of some building materials is as follows:

Material	Density (g/cm^3)
Brick	2.5–2.8
Granite	2.6–2.9
Portland cement	2.9–3.1
Wood	1.5–1.6
Steel	7.8–7.9



SPECIFIC GRAVITY

The ratio of weight/mass of a given volume of solid to the weight/mass of an equal volume of water at 4°C

$$G_s = \frac{\gamma_s}{\gamma_w} = \frac{\rho_s}{\rho_w}$$

At 4° C γ_w = 1 g/ cc or 9.8 kN/ m^3

POROSITY

The ratio of volume of all the voids "Vv" to the total volume of the material mass "V" is known as the porosity

$n = \frac{Vv}{V}$ Porosity falls in the range of: $0 < n < 100$

Where **V = Vs + Vv** V = Total volume of soil mass

Vs = Volume of solid particles of soil

Vv = Volume of voids, which may be filled with air or water or both

VOID RATIO

Ratio of volume of voids of a material to volume of solids is called voids ratio.

The voids ratio is defined as: $e = \frac{Vv}{Vs}$

The relation between these quantities can be simply determined as follows:

$Vs = V - Vv = (1 - n)\, V$ $\qquad$ $n = \frac{Vv}{V}$

Hence $e = \frac{Vv}{Vs} = \frac{Vv}{(1-n)V} = \frac{n}{1-n}$

MECHANICAL PROPERTIES

- Strength
  - Compressive
  - Tensile
  - Bending
  - Impact
- Hardness
- Elasticity
- Plasticity
- Ductility
- Brittleness
- Stiffness
- Toughness

STRENGTH

- The ability of the material to resist failure under the action of stresses caused by loads, the most common being Compression, Tension and Bending strength.
- Materials such as stones and concrete have high compressive strength but a low tensile and bending strengths while materials like steel have good tensile but low bending strengths.
- A composite material of concrete and steel is used to resist both the effects of compression and tension within the same member/structure.

HARDNESS

- The ability of material to resist penetration by another harder body
- The material ability to resist scratching and denting

ELASTICITY

- The ability of a material to restore its initial form and dimensions after the load is removed.
- Within the limits of elasticity of solid bodies, the deformation is proportional to the stress. Ratio of unit stress to unit deformation is termed as modulus of elasticity (E).
- A large value of E represents a material with very small deformation.

PLASTICITY

- **Plasticity** is the ability of a solid material to undergo deformation, a non-reversible change of shape in response to applied forces.
- For example, a solid piece of **metal** being bent or pounded into a new shape displays **plasticity** as permanent changes occur within the material itself.

DUCTILITY

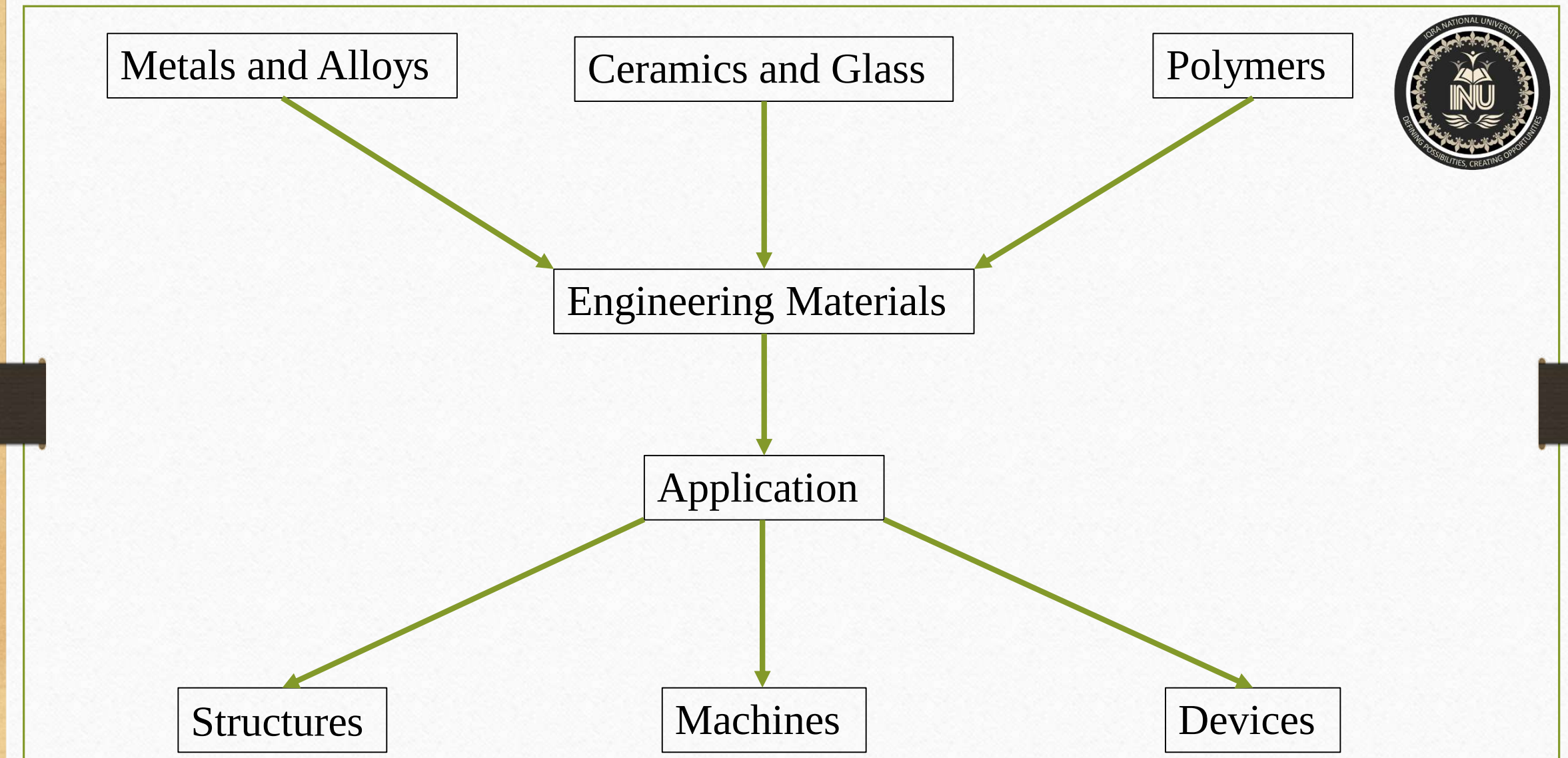
- The ability of a material to undergoes large deformation without sudden failure.
- Ductile materials posses good characteristics of Elasticity and Plasticity and give significant warning before failure under the action of loads
- Examples: Steel, Copper etc.

BRITTLENESS

- The inability of a material to undergoes large deformation with sudden failure.
- Brittle materials posses no or little Plasticity
- Examples: Glass, Stone, Brick, Concrete etc.

FLEXIBILITY

- The ability of a material to undergoes large deformation in response to an applied force.
- Such materials posses small value of modulus of elasticity (E)


Metals and Alloys
Ceramics and Glass
Polymers
Engineering Materials
Application
Structures
Machines
Devices

THANK YOU