Composite Materials

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Composite materials have changed the world of materials revealing materials which are different from common heterogeneous materials. A composite material is a structural material that consists of two or more combined constituents which are combined at macroscopic level and are not soluble in each other. It should be understood that the aforesaid composite material is not the by-product of any chemical reaction between two or more of its constituents. One of its constituents is called the reinforcing phase and the other one, in which the reinforcing phase material is embedded, is called the matrix. The reinforcing phase material may be in the form of fibers, particles, or flakes (e.g. Glass fibers). The matrix phase materials are generally continuous (e.g. Epoxy resin). The matrix phase is light but weak. The reinforcing phase is strong and hard and may not be light in weight.

For example, in concrete reinforced with steel the matrix phase is concrete and the reinforcing phase is steel. In graphite/epoxy composites the graphite fibers are the reinforcing phase and the epoxy resin is the matrix phase.

A material shall be considered as a composite material if it satisfies the following conditions:

1. It is manufactured i.e., excluding naturally available composites.
2. It consists of two or more physically and/or chemically distinct, suitably arranged or distributed phases with an interface separating them.
3. It has characteristics that are not the replica of any of the components taken individually.

I. We need Composites to Enhanced desired properties of Materials;

These desired properties are:

- Strength
- Stiffness
- Toughness
- Corrosion resistance

•Wear resistance

• Reduced weight

• Fatigue life

• Thermal/Electrical insulation and conductivity

• Acoustic insulation

• Energy dissipation

• Attractiveness, cost,

•Tailorable properties

II. Functions of a reinforcement:

1. Contribute desired properties

2. Load carrying

3. Transfer the strength to matrix

IV. **Functions of a matrix:**

1. Holds the fibers together

2. Protects the fibers from environment

3. Protects the fibers from abrasion (with each other)

4. Helps to maintain the distribution of fibers

5. Distributes the loads evenly between fibers

6. Enhances some of the properties of the resulting material and structural component (that fiber alone is not able to impart). These properties are such as: transverse strength of a lamina and Impact resistance

7. Provides better finish to final product

V. **Classification of Composites**

<u>Based on the form of reinforcement:</u>

• **Fiber -** a filament with L/D very high (of the order 1000)

• **Particle –** non fibrous with no long dimension

• **Whiskers –** nearly perfect single crystal fiber (Short, discontinuous, polygonal cross-section)

VI. Properties of Fibrous Composites

Parameters affecting the properties of fibrous composites:

1. Length of the fiber
2. Orientation of the fiber (with respect to the loading direction)
3. Shape of the fiber
4. Distribution of the fibers in matrix material
5. Properties of the fibers
6. Properties of the matrix material
7. Proportion of fiber and matrix material

VII. Factors Affecting Fabrication Processes

1. User requirements
2. Performance requirements
3. Total production volume
4. Production rate
5. Cost of production
6. Size of the production
7. Surface finish of the final product
8. Geometry of the product
9. Material