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High Performance Composites

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Abstract:*Composite materials are used in a number of applications such as domestic, automotive, aerospace and renewable energy industries. To meet the specific requirements reinforcing members are added in to base polymer. The increasing public demand for safety and government regulation has stipulated the researchers to work on composite structure which are weight and has an efficient energy absorbing capability. The use of composites in engineering applications are enormous. A composite material is a combination of two materials with different physical and chemical properties. When they are combined they create a material which is specialized to do a certain job, for instance to become stronger, lighter or resistant to electricity. They can also improve strength and stiffness. The reason for their use over traditional materials is because they improve the properties of their base materials and are applicable in many situations.*

Key Words: composites, traditional materials, base materials

1. Introduction

A material which is composed of two or more materials at a microscopic scale and have chemically distinct phases. Heterogeneous at a microscopic scale but statically homogeneous at macroscopic scale. Constituent materials have significantly different properties.

Composites are multifunctional materials consisting of two or more chemically distinct constituents, on a macro-scale, having a distinct interface separating them. More than one discontinuous phases are embedded in a continuous phase to form a hybrid composite. The discontinuous phase is usually harder and stronger than the continuous phase and it is called the hybrid reinforcement and the continuous phase is termed the matrix.

1.1 Classification of Composites

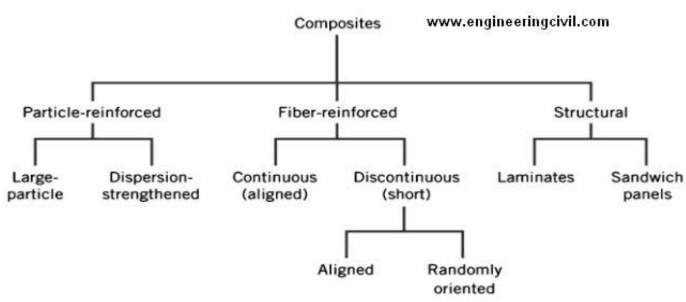


Figure 1.1 Classification of Composites

Composite material is a material composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different form those of any of the constituents.

2. Fibre Reinforce Composites

A fiber-reinforced composite (FRC) is a composite building material that consists of three components: (i) the fibers as the discontinuous or dispersed phase, (ii) the matrix as the continuous phase, and (iii) the fine interphase region, also known as the interface. This is a type of advanced composite group, which makes use of rice husk, rice hull, and plastic as ingredients. This technology involves a method of refining, blending, and compounding natural fibers from cellulosic waste streams to form a high-strength fiber composite material in a polymer matrix.

2.1 Structural composites

An engineered wood product designed for structural use, SCL is manufactured from wood strands or veneers bonded with adhesives and created using a layering technique where the outcome is a block known as a billet. Similar to conventional sawn lumber and timber, SCL products are used for common structural applications and include laminated veneer lumber (LVL), parallel strand lumber (PSL), laminated strand lumber (LSL) and oriented strand lumber (OSL). With its ability to be manufactured using small, fast-grow and underutilized trees, SCL represents an efficient use of wood resources as it helps to meet the challenge of increasing demand for quality structural lumber.

As part of the engineered wood products family, SCL has been successfully used in a variety of areas used as headers and beams, truss chords, I-Joist flanges, columns and studs.

3. Introduction of E-Glass Fibre

Glass fiber is a material consisting of numerous extremely fine fibers of glass. E-glass have good strength & electrical resistivity. It was later found to have excellent fibre forming capabilities and is now used almost exclusively as the reinforcing phase in the material commonly known as fibre glass.

3.1 Composition of E-Glass Fibre

E-Glass is a low alkali glass with a typical nominal composition of SiO_2 54wt%, Al_2O_3 14wt%, CaO+MgO 22wt%, B_2O_3 10wt% and Na_2O+K_2O less then 2wt%. Some other materials may also be present at impurity levels.

3.2 Properties of E-Glass fibre

- Low cost
- High strength
- High stiffness
- Non-flammable
- Resistant to heat
- Good chemical resistance
- Relatively insensitive to moisture
- Good electrical insulation
- Higher density compared to carbon fibres and organic fibres.
- Good electrical insulation
- Able to maintain strength properties over a wide range of conditions

3.3 Applications of E-Glass in Composite materials

The use of E-Glass as the reinforcement material in polymer matrix composites is extremely common. Optimal strength properties are gained when straight, continuous fibres are aligned parallel in a single direction.

To promote strength in other directions, laminate structures can be constructed, with continuous fibres aligned in other directions. Such structures are used in storage tanks and the like.

Random direction matts and woven fabrics are also commonly used for the production of composite panels, surfboards and other similar devices.

4. Introduction to Graphene

Graphene is a one-atom-thick layer of carbon atoms arranged in a hexagonal lattice. It is the building-block of Graphite (which is used, among other things, in pencil tips), but graphene is a remarkable substance on its own - with a multitude of astonishing properties which repeatedly earn it the title "wonder material".

Graphene is the thinnest material known to man at one atom thick, and also incredibly strong - about 200 times stronger than steel. On top of that, graphene is an excellent conductor of heat and electricity and has interesting light absorption abilities. It is truly a material that could change the world, with unlimited potential for integration in almost any industry.

Graphene is an extremely diverse material, and can be combined with other elements (including gases and metals) to produce different materials with various superior properties. Researchers all over the world continue to constantly investigate and patent graphene to learn its various properties and possible applications.

4.1 Properties of Graphene

Due to the strength of its 0.142 Nm-long carbon bonds, graphene is the strongest material ever discovered, with an ultimate tensile strength of 130,000,000,000 Pascals (or 130 gigapascals), compared to 400,000,000 for A36 structural steel, or 375,700,000 for Aramid (Kevlar). Not only is graphene extraordinarily strong, it is also very light at 0.77milligrams per square metre (for comparison purposes, 1 square metre of paper is roughly 1000 times heavier). It is often said that a single sheet of graphene (being only 1 atom thick), sufficient in size enough to cover a whole football field, would weigh under 1 single gram.

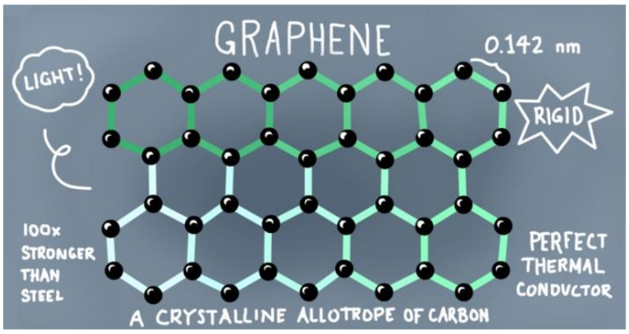


Figure 12 Structure of Graphene

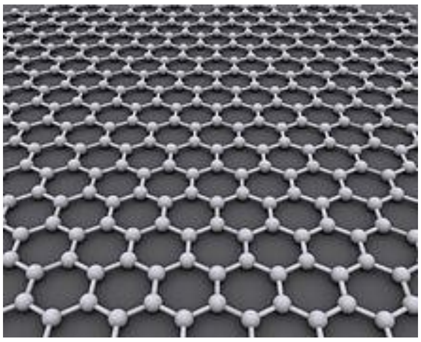


Figure 1.3 Graphene is an atomic-scale hexagonal lattice made of carbon atoms

4.2 Advantage of Graphene

- It is two hundred times stronger compare to steeland incredibly flexible.
- It is thinnest material possible and it is completely transparent which can transmit more than 90 % of the light.
- It can transfer electrons at much faster rate compare to silicon. It can pass at the speed of 1000 Kms/sec which is about 30 times fast compare to silicon.
- It can be used in flexible electronic newspaper, foldable televisions etc.
- It can be used in clothing which uses graphene based photo-voltaic cells as well as super conductors. Due to this tablets and mobile phones can be charged in minutes while in the pockets itself.
- It can be used for wide variety of applications such as flexible displays (OLEDs, LCDs), RAM, energy efficient transistors, energy storage devices, textile electrodes, copper nano wires, thermal management, spintronics etc.

4.3 Uses of graphene

Potential graphene applications include lightweight, thin, flexible, yet durable display screens, electric/photonics circuits, solar cells, and various medical, chemical and industrial processes enhanced or enabled by the use of new graphene materials.

- Graphene in Batteries
- Graphene Electrodes for Touch Screens
- Transparent conducting electrodes
- Hall effect sensors
- Spintronic
- Thermoelectric
- Contaminant removal
- Water filtration
- Thermal management

Graphene is a single layer of carbon atoms, arranged hexagonally, in a chicken-wire structure. Layers and layers of it make up the much more familiar graphite pencil lead.In graphite, the electrons associated with the carbon atoms interact with each other between the layers to stick the sheets together in a mass.

5. Introduction to Epoxy Resin

Epoxy resins are much more expensive than polyester resins because of the high cost of the precursor chemicals most notably epi chloro hydrin. However, the increased complexity of the 'epoxy' polymer chain and the potential for a greater degree of control of the cross linking process gives a much improved matrix in terms of strength and ductility. Most epoxies require the resin and hardener to be mixed in equal proportions and for full strength require heating to complete the curing process. This can be advantageous as the resin can be applied directly to the fibres and curing need only take place at the time of manufacture. And known as pre-preg or pre impregnated fibr

5.1 Properties of Epoxy

- High shear and peel strength
- Tough and resilient
- Good resistance to dynamic loading
- Bonds a wide variety of materials in common use
- Epoxy also has excellent resistance to chemical.

5..2 Advantages of Epoxy Resin

- Low shrink during cure
- Excellent moisture resistance
- Excellent chemical resistance
- Good electrical properties
- Increased mechanical and fatigue strength

5.3 Uses of Epoxy resins

- As the binder in cements and mortars
- Rigid foams
- Non-skid coatings
- Solidifying sandy surfaces in oil drilling
- Industrial coatings
- Potting and encapsulating media

5. Introduction to Hardner

A substance or mixture added to plastic composition to promote or control the curing action by taking part in it. Also, a substance added to control the degree of hardness of the cured film. In our project we are using Araldite AW106 Hardener HV 953

6. Fabrication of composite material

Compositions of composite material for preparation of sample for Testing are shown in table 1.1

Table 1.1

Specimen no	Epoxy Resin :Hardner Ratio	Graphene Weight (%)	E-Glass Fibre
1	10:6	9 %	3 layers
2	10:6	12 %	3 layers

6.1 Hand Lay-Up

The fibres are first put in place in the mould. The fibres can be in the form of woven, knitted, stitched or bonded fabrics. Then the resin is impregnated. The impregnation of resin is done by using rollers, brushes or a nip-roller type impregnator. The impregnation helps in forcing the resin inside the fabric. The laminates fabricated by this process are then cured under standard atmospheric conditions. The wet/hand lay-up process is depicted in Figure 1.15. The materials that can be used have, in general, no restrictions. One can use combination of resins like epoxy, polyester, vinylester, phenolic and any fibre material.

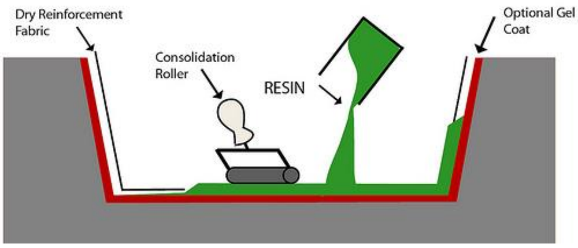


Figure 1.2 Hand layup Technique

6.2 Advantages of Hand Lay-Up Technique

- The process results in low cost tooling with the use of room-temperature cure resins.
- The process is simple to use.
- Any combination of fibres and matrix materials are used.
- Higher fibre contents and longer fibres as compared to other processes.

6.3 Disadvantages Hand Lay-Up Technique

- Since the process is worked by hands, there are safety and hazard considerations.
- The resin needs to be less viscous so that it can be easily worked by hands.
- The quality of the final product is highly skill dependent of the labours.
- Uniform distribution of resin inside the fabric is not possible. I
- leads to voids in the laminates.
- Possibility of diluting the contents.

The disadvantage of hand layup is overcome by compression molding Process. It is done by compression Molding machine apply 20 KN load on Mould

7.Testing – Mechanical Properties

7.1 Tensile Test

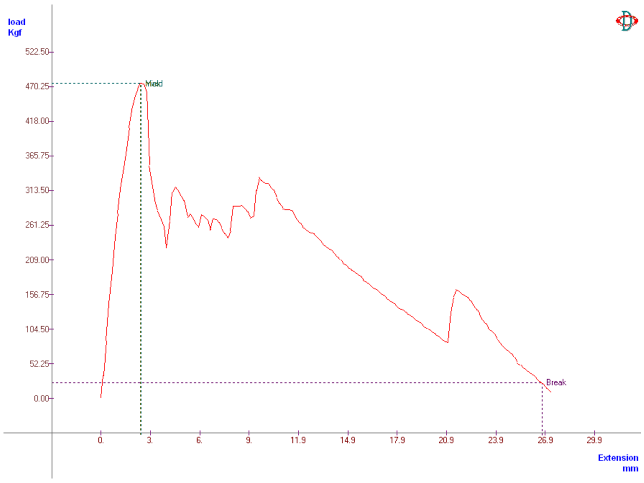
The ability to resist breaking under tensile stress is one of the most important and widely measured properties of materials used in structural applications. The force per unit area (MPa or psi) required to break a material in such a manner is the ultimate tensile strength or tensile strength at break. Tensile properties indicate how the material will react to forces being applied in tension. elasticity, elastic limit, elongation, proportional limit, and reduction in area, tensile strength, yield point, yield strength and other tensile properties.

Figure 1.3 Tensile Testing Machine

Specimen 1

Specimen	1 (9 % Graphene)		
Ref. Standard	ASTM D 648		
Grip Length	165 mm	Guage Length	125 mm
Sample Width	25 mm	Sample Thickness	3 mm

Graph View



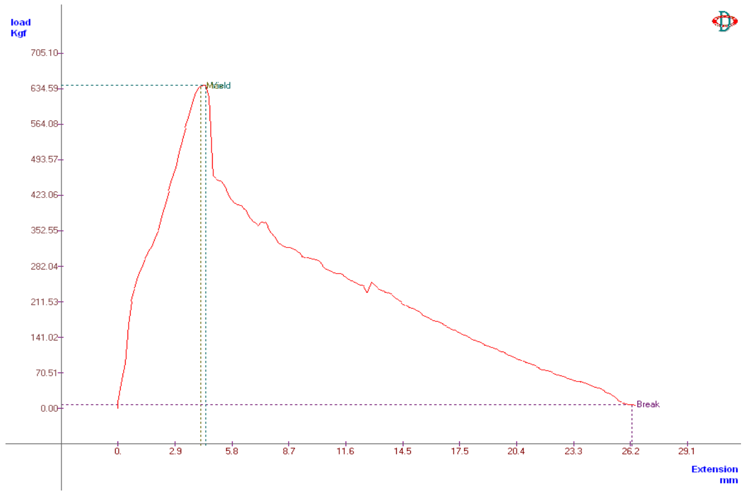
Results Obtained

Sr. No.	Results	Value	unit
1	Area	0.75	cm^2
2	Yield Force	475.00	Kg
3	Yield Elongation	2.43	mm
4	Break Force	24.0	Kg
5	Break Elongation	26.67	mm
6	Tensile Strength at Yield	633.33	Kg/cm^2
7	Tensile Strength at Break	32.00	Kg/cm^2
8	% Elongation	16.16	%

Specimen 2

Specimen code	2 (12 % Graphene)		
Ref. Standard	ASTM D 648		
Grip Length	165 mm	Guage Length	125 mm
Sample Width	25 mm	Sample Thickness	3 mm

Graph View



Results Obtained

Sr. No.	Results	Value	unit
1	Area	0.75	cm^2
2	Yield Force	641.00	Kg
3	Yield Elongation	4.49	mm
4	Break Force	8.0	Kg
5	Break Elongation	26.24	mm
6	Tensile Strength at Yield	854.67	Kg/cm^2
7	Tensile Strength at Break	10.67	Kg/cm^2
8	% Elongation	15.90	%

8. Conclusion

- The Mechanical properties of the composites are Improving, when graphene is added with matrix as Epoxy Resin during the prepare the composite.

- Tensile strength of 9 % Graphene Specimen is 633.33 kg/cm^2 and 12 % Graphene Specimen is 854.67 kg/cm^2 Here Tensile Strength of the 12 % of Graphene Specimen are improved by adding of 3% Extra graphene to the Composite.

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