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Basics of Manufacturing Processes of Composite Materials

Puneet Sahu[1], Amit Kumar Kundu[2], Purnesh Agrawal[3], Deepika Purohit[4], Prakash Gawali[5]

[1,3,4]Student, Dept. of Mechanical Engineering, Acropolis Institute of Technology & Research, Indore (M.P.) India

[2,5]Asst. Prof., Dept. of Mechanical Engineering, Acropolis Institute of Technology & Research, Indore (M.P.) India

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ABSTRACT

The advent of composite materials altered the functionality and usability of mechanical components in products and equipment.

Several of the traditional materials used in part design have been replaced by composite materials. Aside from their usual mechanical capabilities, composite materials can also benefit from many other important characteristics such as corrosion resistance, high strength, lightweight, design flexibility, durability, and many more.

The composite has a wide range of uses, from everyday items to industrial goods. This paper provides a broad overview of the uses, benefits, and drawbacks of composite materials.There are several manufacturing procedures used to create composite materials, and some natural composite fibres are compared.Nowadays, using composite materials in place of consumable ones is increasingly widespread.

I. INTRODUCTION

Engineers are constantly looking for structural materials with low density, low weight, high strength and stiffness, resistance to abrasion and impact, resistance to wear, low thermal expansion, and corrosion resistance at a cheaper cost. To create a composite material, two or more materials are combined to create the aforementioned properties.

Materials made of two or more constituent materials each having unique physical and chemical properties are called composite materials. These materials combine to form a new substance that has improved qualities that are not present in either of the component materials, such as strength, stiffness, and durability.

Two essential elements in composite materials—reinforcement and matrix—work in tandem to produce a new substance with improved qualities.

The ingredient that gives the composite material its strength and stiffness is referred to as reinforcement. Usually, the embedded object in the matrix material is a fibre or a particle. A wide range of materials, including carbon fibres, glass fibres, aramid fibres, and even natural fibres like hemp or bamboo, can be used to create reinforcements. Depending on the desired qualities of the composite material, such as strength, stiffness, and thermal properties, the reinforcement material is chosen.

The term "matrix" refers to the substance that envelops and holds the reinforcing material together. The material that fills the spaces between the reinforcement fibres or particles is commonly a polymer resin or a ceramic substance. By distributing loads and stresses among the fibres, the matrix material supports the reinforcement. The matrix material also shields the reinforcing material from harm caused by external elements like moisture, heat, and chemical exposure.

Overall, the combination of reinforcement and matrix elements enables the production of composite materials with specified features and tailoring to meet specific performance needs in a variety of applications.

The nature and characteristics of the reinforcing and matrix materials utilised heavily influence the characteristics of the composite material. For instance, glass fibre-reinforced polymer composites are known for their low cost and good impact resistance, while carbon fibre-reinforced polymer composites are known for their high strength and stiffness. The qualities of the composite can also be affected by the choice of matrix material because different types of resin

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offer varying degrees of stiffness, toughness, and resistance to environmental conditions.

The composite materials that are most frequently employed are fibre-reinforced composites, which are made of a matrix material (like resin) that has been reinforced with fibres (such as carbon or glass). Metal-matrix, ceramic-matrix, and polymer-matrix composites are some more varieties of composites.

Composite materials are widely employed in many industries, including aerospace, automotive, construction, sports equipment, and biomedical applications. Composite materials have many benefits, including a high strength-to-weight ratio, resistance to corrosion, and the capacity to be moulded into intricate designs.

In today's society, composite materials are used in a wide range of industries, including the aerospace and automotive sectors as well as those of construction, sports equipment, and biomedicine.

The potential of composite materials to offer improved qualities and performance compared to conventional materials is what gives them relevance in today's society. They make it possible to create goods that are robust, lightweight, and durable, all of which are crucial in numerous industries. By lowering weight and enhancing fuel efficiency, composite materials also have the potential to lessen the environmental effect of manufacturing and transportation. Overall, it is expected that the use of composite materials will increase as new applications are created and as consumer demand for eco-friendly and high-performing materials rises.

II. MANUFACTURING TECHNIQUE

Depending on the exact use and required features of the composite material, there are several manufacturing procedures used to create composite materials, each having its bets and drawbacks. Typical strategies include:

a. Hand lay-up: In this manual procedure, reinforcement materials are manually layered in a mould before being moistened with a resin matrix. While labour- and time-intensive, the procedure can be utilised to create intricate forms.

b. Spray-up: In this procedure, resin and chopped fibres are sprayed with a spray cannon onto a mould. Although this method gives a worse-grade surface finish than manual lay-up, it is quicker.

c. Resin transfer moulding (RTM): RTM is a closed-mould method in which resin is injected under pressure into a preform made of reinforcing components. High-fibre volume fraction pieces with excellent surface polish are produced with this method.

d. Filament winding: In this procedure, continuous fibres are wound in a preset pattern around a mandrel or mould before being impregnated with resin. High strength-to-weight components with consistent fibre orientation are created with this method.

e. Compression moulding: In this procedure, the resin is pumped at high pressure and heated into a mould containing a pre-cut reinforcement element. High-strength and stiffness items are created using this method.

f. Automatic fibre placement (AFP): In this highly automated procedure, carbon fibres are positioned by a robot on a mandrel or mould before being resin-impregnated. Complex forms with exact fibre orientation are created using this method.

g. 3D printing: Using a specialized printer, layers of matrix material and reinforcing fibres can be printed to create composite materials. Complex shapes and personalization are possible with this procedure, although it is currently constrained by the materials that may be employed.

The hand lay-up approach is used to manufacture the composite material. A manual procedure known as "hand lay-up" is used to create composite materials, usually for one-off or low-volume production runs. With this method, layers of reinforcement materials, such as carbon fibre or fibreglass, are manually stacked in a mould before being drenched in a liquid resin matrix. To ensure appropriate alignment and the removal of any air pockets, the layers are added one at a time, each one being carefully positioned and smoothed down by hand.

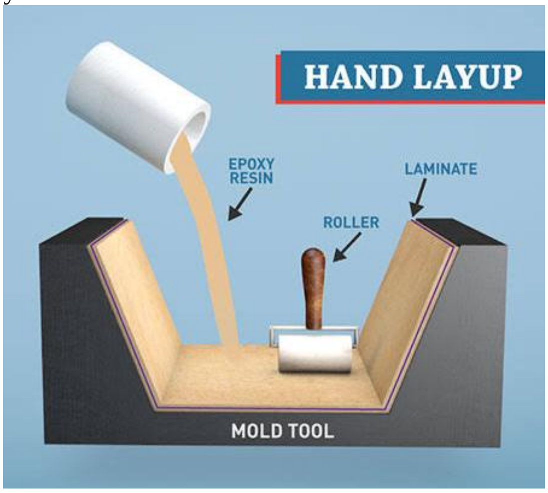

Figure 1. Hand Lay-Up Process

III. COMPARISON OF FIBRES

Coir fibre, glass fibre, bamboo fibre, and sisal fibre are some examples of fibres that are frequently used as reinforcement components in composite materials. Based on a few of these fibres' characteristics, the following comparison is made:

a. Tensile strength: Among the four fibres, glass has the highest tensile strength, followed by bamboo, sisal, and coir.

b. Glass fibre also has the highest flexural strength, which is followed by bamboo, sisal, and coir fibre.

c. Elastic modulus: Glass fibre is the stiffest fibre because it has the highest elastic modulus. After sisal and coir fibre, bamboo fibre has the second-highest elastic modulus.

d.Density: Coir fibre is a fantastic option for lightweight applications because it has the lowest density of the four fibres. The dense fibres are glass, bamboo, and sisal, in that order.

e. Price: Among the four fibres, coir is often the least expensive, followed by sisal, bamboo, and glass fibre.

f. Sustainability: Due to their natural and regenerative nature, coir and bamboo fibre are also regarded as sustainable materials. Sisal and glass fibres are less environmentally friendly because they are synthetic and take a lot of energy to generate.

Plant fibers	Tensile strength (MPa)	Young modulus (GPa)	Specific modulus (GPa)	Tenacity MN/m^2	Density (g/cm^3)	Moisture regain %
Cotton	400-700	6-10	4-6.5	-	1.55	8.5
Kapok	93.2	4	12.9	-	0.45	10.9
Bamboo	571	27	18	-	1.52	-
Flax	510-910	50-70	34-48	-	1.45	12
Hemp	300-760	30-60	20-41	-	1.43	12
Jute	200-460	20-55	14-39	440-553	1.34	12
Kenaf	300-1200	22-60	-	-	1.30	17
Ramie	915	23	15	-	1.55	8.5
Abaca	14	41	-	-	1.52	14
Banana	530	27-32	20-24	529-754	1.35	-
Pine apple	414	60-82	42-57	413-162	1.44	-
Sisal	100-800	9-22	6-15	568-640	1.45	11
Coir	100-200	6	5.2	131-175	1.15	13

Figure 2. Comparison of Different Fibres

IV. MATERIALS USED

The coirfibre is used to create composite materials for packaging based on comparisons and our specifications.Coir fibreis anatural fibre that is derived from coconut husk. It has good abrasion resistance and is a rough, stiff, and robust fibre. Mats, carpets, brushes, couch padding, and erosion control items are just a few examples of the many uses for coir fibres. Coir fibre’s primary attributes include being natural, renewable, strong, long-lasting, high moisture absorption, resilient, low thermal conductivity, low elasticity, and biodegradable. Natural coir fibre is a flexible material with several beneficial qualities that make it suited for a variety of uses. In many applications, it is a desirable replacement for synthetic fibres.

Figure 3. Coir Fibre

Epoxy, a two-part thermosetting polymer, is frequently used in many different products, such as composites, adhesives, and coatings. There are two parts to it: a resin and a hardener. When the two ingredients are combined, a chemical process occurs that allows the combination to harden and

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cure into a durable and long-lasting material.Epoxy is known for its strong bonds, great strength, and resistance to chemicals and corrosion. It can be used to bond a variety of substances, including composites, metals, and polymers. It is often used as a coating to shield surfaces from abrasion, corrosion, and degradation. Epoxy is frequently used in composite materials as a matrix material to surround and bind reinforcing fibres, such as carbon fibre or glass fibre.

Figure 4. Epoxy

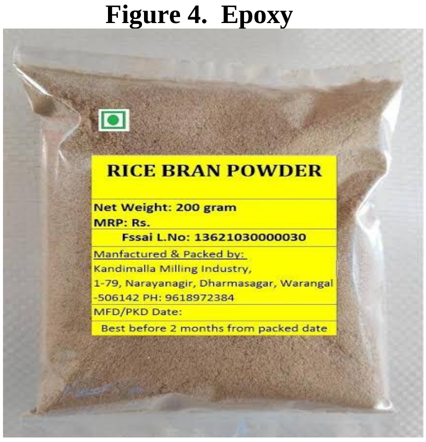

Figure 5. Rice Husk

The outer layer of rice grains, known as the rice husk, is taken off during milling. It is a common natural waste material found all over the world. Because of its low cost, high silica content, and low density, rice husk is an excellent material for use in composite composites. When combined with a polymer matrix, rice husk can be utilised as a filler material in composites to create a material with improved mechanical properties. Rice husk is a useful reinforcement material due to its silica concentration, which increases the composite's stiffness and strength. The composite material's weight can also be reduced due to the low density of rice husk.

V. CONCLUSION

The composite materials are provided many design possibilities, as well as matrix, fibre, and performance options. The process of design depends on your selections. At this point, composite materials are common in our lives. The performance and sustainability of composite materials are produced by choosing the appropriate raw materials and the appropriate manufacturing process. To meet end-user requirements, composite material structures can be constructed from multiple materials of different properties. For the development of new composite materials to replace traditional materials, numerous investigations have been conducted and are still being conducted.

REFERENCES

[1]. NPTEL Lectures by Prof. J. Ramkumar, IIT Kanpur.

[2]. Book of Mechanics of Composite Materials by Autar K. Kaw.

[3]. Shinde Rohit Anil, Jadhav Raviraj Mohan, Mali Sagar Vilas, Patil Shivtej Mohan, Mr. Amol A Patil. 2021. A research paper onepoxy-based composite material from natural fibre for the manufacturing of helmets. JETIR Volume 8, Issue 7, July 2021.

[4]. M. Venkatesulu, P. Kothakota. 2021. A review paper of composite materials: History, Types, Advantages, And Applications over traditional materials. IJRAME Volume 9, Issue 4, April 2021

[5]. Shishupal Singh, Ramendra Singh Niranjan, Ajeet Pratap Singh, Yastuti Rao Gautam, Mukesh Kumar Verma. 2021. Processing and Strength Analysis of composite material for packaging. IJRASET Volume 9, Issue 5, May 2021.

[6]. M P Todor, C Bulei, T Heput, I Kiss. 2018. Researches the development of new composite materials complete/ partially biodegradable using natural textile fibres of new vegetable origin and those recovered from textile waste. IOP Conf. Series: Materials Science and Engineering 294 (2018) 012001 dio: 1088/1757-899X/294/1/012021.