MECHANICAL TESTING OF E-GLASS EPOXY RESINWITH FILLER (CALCIUM CARBONATE) COMPOSITE

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ABSTRACT :
The unique and diverse characteristics of composite materials have increased in many folds. From feather weight rods to high performance aircraft parts, the use fiber reinforced materials have become a compelling asset due to their high strength to weight ratio and high strength to stiffness ratio combined with easy manufacturing methods. The present endeavor is one such attempt to study the mechanical properties of Eglass Epoxy resin with filler (CACO3) composite. Epoxy matrix and chopped mat E-glass fiber is used to reinforce with polymer matrix by hand layup process.The glass fiber reinforced composites are prepared as 00 fiber orientation with all calcium carbonate as filler material.The specimens,after preparation, are tested for various mechanical properties.The properties studied in this case are Tensile Strength,Impact strength, flexural strength. The results have then been tabulated and studied to understand variation in the properties with and without filler material of the composite. Experimental procedure is carried out as per ASTM D638M (tensile), ASTM D790 (flexural), ASTM D256 (Impact).

KEYWORDS**:** Epoxy resin, Eglass, Calcium Carbonate, Composites

I.INTRODUCTION

Historically, technical developments have centered around two main areas, firstly the development of more powerful and efficient energy sources and secondly to obtain maximum possible motive power from the available energy. The second development is heavily dependent on the properties of engineering materials. In aircraft and aerospace industries, a union of opposites i.e., lightweight in combination with high stiffness is demanded. In pressure vessels technology, high strength and corrosion resistance are both prerequisites for efficient operation. Whenever a designer faces such situations composite materials provide an efficient solution to such problems. The flexibility that can be achieved with composite materials is immense. Merely by changing the composition, variety of properties can be altered thus making the composites versatile and reliable substitutes for the conventional structural materials.

DEFINITION:

A composite material is a combination of at least two chemically distinct materials with a distinct interface separating the components.
The two phases that make up a composite are:

(i) MATRIX
(ii) REINFORCEMENT

the matrix is the less strong phase being strengthened by the stronger reinforcing phase. reinforcements can have various geometries like particles, fibers, flakes etc. The reinforcement basically enhances the flexural strength.

MATRIX

Many materials when they are in a fibrous form exhibit very good strength property but to achieve these properties a suitable matrix should bond the fibers. The matrix isolates the fibers from one another in order to prevent abrasion and formation of new surface flaws and acts as a bridge to hold the fibers in place. A good matrix should possess ability to deform easily under applied load, transfer the load onto the fibers and evenly distributive stress concentration.

REINFORCEMENT

The role of the reinforcement in a composite material is fundamentally one of increasing the mechanical properties of the neat resin system. All of the different fibers used in composites have different properties and so affect the properties of the composite in different ways. For most of the applications, the fibers need to be arranged into some form of sheet, known as a fabric, to make handling possible. Different ways for assembling fibers into sheets and the variety of fiber orientations possible to achieve different characteristics

INTERFACE

It has characteristics that are not depicted by any of the component in isolation. The interface is a bounding surface or zone where a discontinuity occurs, whether physical, mechanical, chemical etc. The matrix material must “wet” the fiber. Coupling agents are frequently used to improve wettability. Well “wetted” fibers increase the interface surfaces area. To obtain desirable properties in a composite, the applied load should be effectively transferred from the matrix to the fibers via the interface. This means that the interface must be large and exhibit strong adhesion between fibers and matrix. Failure atthe interface (called de-bonding) may or may not be desirable.

CLASSIFICATION

Most composite materials developed thus far have been fabricated to improve mechanical properties such as strength, stiffness, toughness, and high temperature performance. It is natural to study together the composites that have a common strengthening mechanism. The strengthening mechanism strongly depends on the geometry of the reinforcement. Therefore, it is quite convenient toclassify composite materials on the basis of the geometry of a representative unit of reinforcement. Figure 1.1 represents a commonly accepted classification scheme for composite materials.

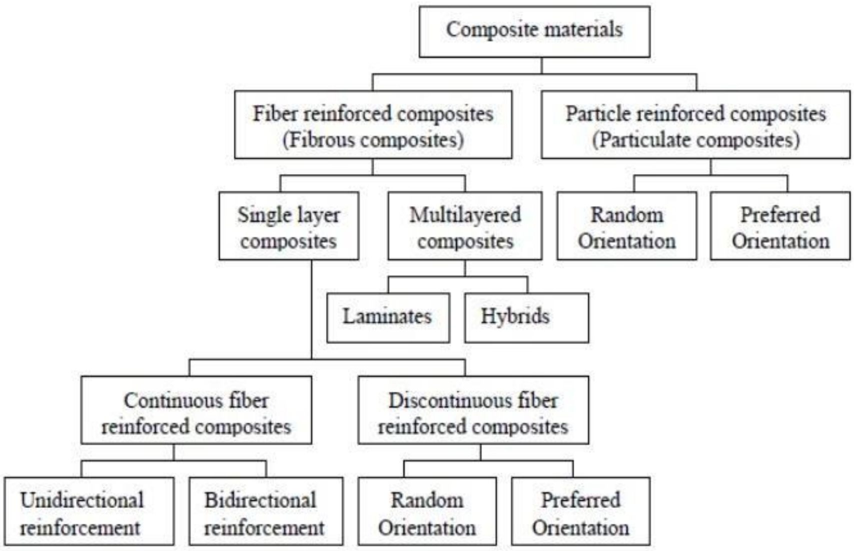


Figure1.1 Classification of composite materials

II. LITERATURE SURVEY

Jayaramudu, Agwuncha, Ray, Sadiku, and Rajulu et[1] studied with natural Polyalthiacerasoide woven fabrics mixing with epoxy composite. The woven fabrics extracted from bark of the tree to make hybrid composites. The hand lay-up technique was used to fabrication of hybrid composite at room temperature. The surface modification of woven fibre was done by the process of alkali treatment. The microstructure and morphology studied was completed using Fourier transforms infrared spectroscopic (FTIR) and scanning electron microscopic methods respectively. The FTIR analyses represent the least value of hemi-cellulose and lignin contents of alkali treated woven fabric. The hybrid composite suggested for various applications in building and construction industries as panels for partitioning, flooring, storage tanks and table taps, etc.

Barnasree, Kumar, and Bhowmik et.[2] were studied wood dust particle reinforced in epoxy based composite for analysis of mechanical behavior. The sundy wood dust particle used as reinforcement and LY 556 epoxy for resin. The six different percentage of filler particle used in study. Tensile and flexural test were carried out using UTM and sample size based on ASTM Standard. The different design parameters like as filler content and speed for loading with tensile and flexural strength using GRA were optimized.Optimizationby GRA has the advantage of selecting best and worst options. GRG shows that test run number 13 is the best suited and test run number 3 is the least important. Epoxy composite with 10 fillercontents (wt%) at corresponding speed of 1 mm/min shows best performance and on the other hand with 0 filler content (wt%) at the speed of 3 mm/min shows theworst performance.

Motaung and Anandjiwala et. Studied.[3] of behavior of sugar cane bagasse particle reinforced composite like as, thermal degradation and kinetics of the untreated, alkali treated and sulphuric acid treated sugar cane bagasse (SB). It had been estimated by non- isothermal thermogravimetric investigation under nitrogen atmosphere The alkali treated fabricated samples represent the maximum values of thermal degradation. FTIR and XRD established different functionalization with fibre surface and improved crystallinity. The NaOH treated sample exposed the maximum thermal stability with acid treated samples presented the lowest.

III. METHODOLOGY & BLOCK DIAGRAM

Fabrication process

Dough moulding compound(DMC)

1. Sheet moulding compound(SMC)
2. Filament winding
3. Injection moulding
4. Hand lay up technic
5. Fpr continuous paneling process
6. Frp foam structure
7. Vaccum bag moulding
8. Pressure bag moulding

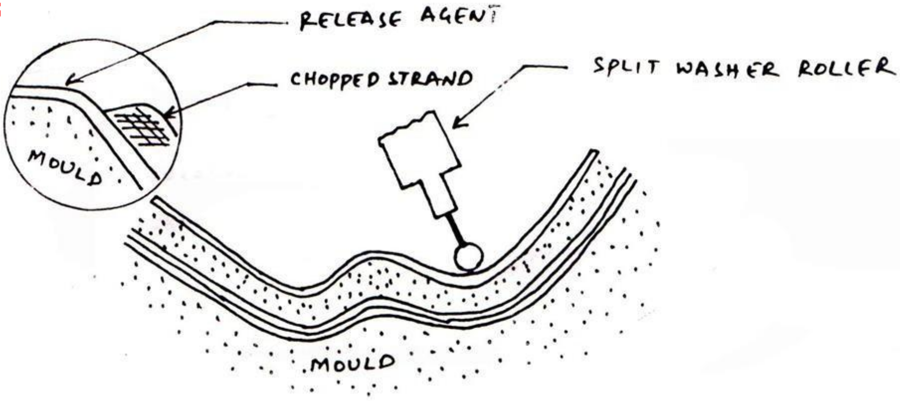
HAND LAY UP TECHNIQUE

➢ When the operator deposits resin and reinforcements in a mould by hand or hand tools, he is said to be making a hand lay-up molding.The different layers of reinforcement thoroughly wetted with resin are placed one over the other to build up the desired thickness. Hand lay-up may be chosen as the fabrication technique when.

➢ Only one side of the product needs smooth finish

➢ Only slight variations in thickness are permissible.

➢ Only when labor charges are not prohibitively high.The number of mouldings required is



HAND LAYUP TECHNIQUE

- The mould employed to obtain the molding may be made from materials like plastics, wood, clay, plaster or plywood depending on the availability. To prevent the sticking of the plastic to the mould-releasing agent like cellulose acetate, polyvinyl alcohol or candle wax is applied.

VI.EXPERIMENTALWORK

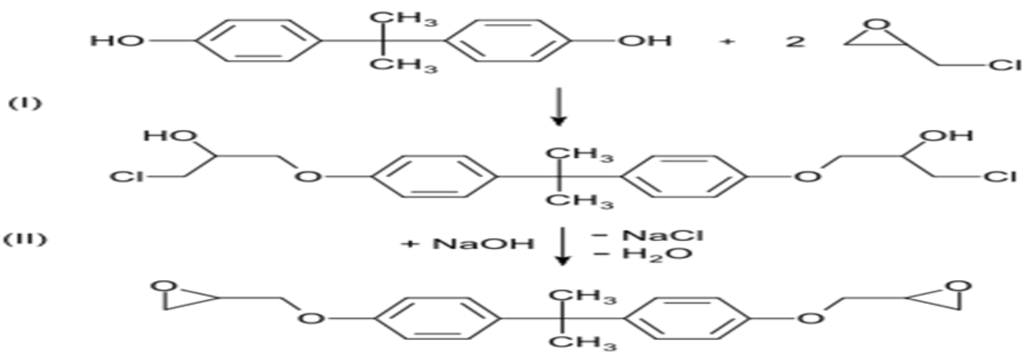
This chapter describes the details of processing of composites and the experimental procedures followed for their mechanical characterization. The raw materials used in this workare

(i) Epoxy Resin
(ii) Eglass Fiber
(iii) Calcium carbonate
(iv) Hardener

EPOXY RESIN:

Epoxies are the most common matrix material for high performance composites and adhesives.They have an excellent combination of strength, adhesion, lowshrinkage, processing.Theseresinscomeinviscousliquidform, and have low molecular weight.Commonly epoxy resins are produced through a reaction between epichlorohydrin and bisphenol-A

STRUCTURE OF EPOXY:



Epoxies differ from polyester resins in that they are cured by a 'hardener' rather than a catalyst. The hardener, often an amine, is used to cure the epoxy by an 'addition reaction' where both materials take place in the chemical reaction. The chemistry of this reaction means that there are usually two epoxy sites binding to each amine site. This forms a complex three-dimensional molecular structure.

Since the amine molecules 'co-react' with the epoxy molecules in a fixed ratio, it is essential that the correct mix ratio is obtained between resin and hardener to ensure that a complete reaction takes place. If amine and epoxy are not mixed in the correct ratios, unreacted resin or hardener will remain within the matrix which will affect the final properties after cure. To assist with the accurate mixing of the resin and hardener, manufacturers usually formulate the components to give a simple mix ratio which is easily achieved by measuring out by weight or volume.

E-GLASS FIBER:

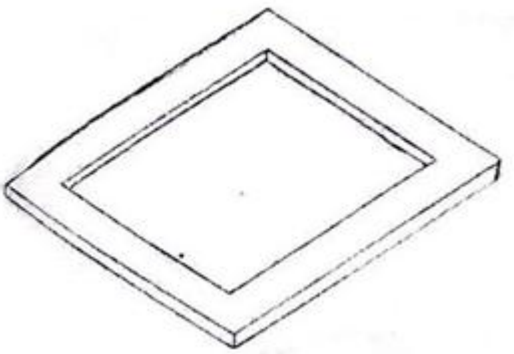
EGLASS FIBER

Instead of being formed into yarn, the continuous or long-staple strand may be chopped into short lengths. The strand is mounted on a set of bobbins, called a creel, and pulled through a machine which chops it into short pieces. The chopped fiber is formed into mats to which a binder is added. After curing in an oven, the mat is rolled up. Various weights and thicknesses give products for shingles, built-up roofing, or decorative mats that forms glass marbles of about 0.62 inch (1.6 cm) in diameter. These marbles allow the glass to be inspected visually for impurities. In both the direct melt and marble melt process, the glass or glass marbles are fed through electrically heated bushings (also called spinnerets). The bushing is made of platinum or metal alloy, with anywhere from 200 to 3,000 very fine orifices. The molten glass passes through the orifices and comes out as fine filaments.

The fiberglass industry faces some major challenges over the rest of the 1990s and beyond. The number of producers of fiberglass insulation has increased due to American subsidiaries of foreign companies and improvements in productivity by U.S. manufacturers. This has resulted in excess capacity, which the current and perhaps future market cannot accommodate. In addition to excess capacity, other insulation materials will compete. Rock wool has become widely used because of recent process and product improvements. Foam insulation is another alternative to fiberglass in residential walls and commercial roofs. Another competing material is cellulose, which is used in attic insulation. Because of the low demand for insulation due to a soft housing market, consumers are demanding lower prices. This demand is also a result of the continued trend in consolidation of retailers and contractors. In response, the fiberglass insulation industry will have to continue to cut costs in two major areas: energy and environment. More efficient furnaces will have to be used that do not rely on only one source of energy.

Due to their low cost, high tensile strength, high impact resistance and good chemical resistance glass fibers are used extensively in commercial applications, however their properties cannot match those of carbon fibers.

GLASS MOULD TO PREPARE COMPOSITE MATERIAL



GLASS MOULD TO PREPARE COMPOSITE MATERIAL

4.4. PREPARATION OF COMPOSITE SPECIMENS:

Preparation of EGLASS EPOXY WITH (10%) FILLER

1. Fabrication of the composites is done at room temperature by hand lay-up techniques.
3. The required ingredients of Epoxy resin, hardener, and fillers (CaCo3) are mixed thoroughly in a basin and the mixture is subsequently stirred constantly. They are mixed in the weight ratio of 60:40 i.e., 60% fiber and 40% resin. In that 40% of resin 10% of filler and 10% of hardener is added.
3. The mould is coated with mansion wax as a releasing agent for easy removal.
 The glass fiber positioned manually in the open mold. Mixture so made is brushed uniformly, overthe glass fibers.
4. Entrapped air is removed manually with squeezes or rollers to complete the laminates structure and the composite is cured at room temperature.
5. The prepared E-glass fiber reinforced epoxy composite slabs filled by filler material were taken outfrom the mold.
6. Then specimens of suitable dimensions were prepared from the composite slabs for differentmechanical tests according to ASTM standards.
7. Care should be taken while processing the laminate by wearing gloves, face mask, and clean the mould, equipment and hands thoroughly with acetone.
8.

RESULTS AND ANALYSIS:

In this paper This section presents the results of the mechanical properties of the Eglass Epoxy resin with filler (CaCo3) composites prepared for this present investigation. Details of processing of these composites and the tests conducted on them have been described in the previous section. The results of various characterization tests are reported here. This includes evaluation of Tensile strength, Flexural strength, and Impact strength, has been studied and discussed. The interpretation of the results and comparison among various composite samples are also presented.

TENSILE TEST:

The tensile strength of the composite with filler and without filler is Mpa and MParespectively.

C1= composite with (0%) filler. C2= composite with (10%) filler.

S.no	Specimen label	Maximu mload	Load at break (standard)	Tensile Stress at maximum load	Modulus (automatic young's)	Tensile strain at break (standard)
		(N)	(N)	(MPa)	(MPa)	(mm/mm)
1	C1	5809.95	5487.54	193.67	5737.67	0.08083
2	C2	11297.58	11054.39	141.22	3784.09	0.08134

IMPACT TEST:

The impact strength of the composite with filler and without filler is 5.2 J and 12.2 J respectively.

Z	IMPACT STRENGTH(J)
CaCo3(0%)	5.2
CaCo3(10%)	12.2

FLEXURAL TEST:

The flexural strength of the composite with filler and without filler is Mpa and Mpa respectively.

D1= composite with (0%) filler.

D2= composite with (10%) filler.

RESULTS TABLE				
S.NO.	**SPECIMENLABEL**	**MAXIMUM LOAD(KN)**	**MAXIMUM STRESS(MPA)**	**FLEX MODULUS(MPA)**
1	D1	0.21	117.7	**19818.32**
2	**D2**	**0.99**	**214.5**	**19020.21**

CONCLUSION

These experimental investigations of mechanical behavior of Eglass Epoxy resin with filler (CAC03) composites leads to following conclusions. This work shows that successful fabrication of Eglass Epoxy resin composites with and without filler is possible by simple hand lay-up technique. It has been noticed that the mechanical properties of the composites such as tensile strength, flexural strength of the composites are greatly influenced by the filler percentages. There is an increase in the mechanical properties like flexural strength and impact strength as compared to without filler composite. This increase is because of the presence of aluminum oxide as its flexural properties are high in nature. It is observed that the tensile strength decreases with an increase in filler percentage. This reduction in tensile strength due to the weak interface between the matrix and reinforcement. It is observed that it takes 10 to 12 hours for curing when 10% and 15% of hardener is added to the laminate.

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