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Manufacturing of Epoxy-based Hybrid Polymer Composites

S. Sudharsan[1], K.U Kalyan[2], C. Nithyadharan[3], A. Pranesh[4]

[1]*Mr. S. Sudharsan, Assistant professor MECH, Sri Ramakrishna Institute of Technology, Coimbatore, India.*
[2]*K. U Kalyan, MECH, Sri Ramakrishna Institute of Technology, Coimbatore, Tamil Nadu India.*
[3]*C. Nithyadharan, MECH, Sri Ramakrishna Institute of Technology, Coimbatore, Tamil Nadu India.*
[4]*A. Pranesh, MECH, Sri Ramakrishna Institute of Technology, Coimbatore, Tamil Nadu India.*

Abstract - *This paper describes about the manufacturing of epoxy-based hybrid polymer matrix composite materials that are mostly used in various working environments such as automotive, aerospace, construction, oil and gas, and marine industries as a result of their low cost, good mechanical properties, high specific strength as well as good heat and solvent resistance. This is one of the main reasons why there is a major need to research and calculate the deformation behavior of epoxy-based composite materials under real world conditions. Based on the studies, the deformation mode of epoxy-based composites is influenced either by the morphology of the epoxy matrix or by filler loading. The properties attained with composites and the ability to tailor the properties is a boon. Epoxy-based composite materials generally have high strength- and modulus-to-weight ratios than traditional engineering metals. These features can reduce the weight of a component by 20 to 30%. The results show that the sample having 4 wt.% silicon carbide and 2 wt.% coconut coir ash had the best mechanical properties out of all the samples.*

Key Words: (**specific strength, deformation, *morphology***)

1.INTRODUCTION

A composite material is a combination of two or more materials with different physical and chemical properties. When they combine, they create a material which is specialised to do a certain job, for instance to become stronger, lighter and resistant to corrosion. They also improve strength and stiffness of the material. The reason they are used over traditional materials only because they improve the properties of their base materials and are applicable in many situations. The fabrication methodology of a composite part depends mainly on three factors, the characteristics of constituent matrices and fibre reinforcements, the shapes, sizes and engineering details of products and end use.

Polymer composite material is a multi-stage mix material of at least two segment materials with various properties and various structures through intensifying cycles, it not just keeps up the fundamental qualities of the first segment, yet additionally shows new character which are not controlled by any of the first parts. Composite material is a material made out of at least two particular stages and having mass properties essentially not the same as those of any of the constituents.

There are a few general classifications, each with various varieties. The most well-known will be known as polyester, vinyl ester, epoxy, phenolic, polyimide, polyamide, polypropylene, polyether ether ketone (PEEK), and others.

1.1 Objective

The objective of this paper is to fabricate a composite based on epoxy resin incorporated with (Sic) and coconut coir ash as a hybrid fiber system. The use of naturally occurring fibers is a boon when it comes to biodegradability and synthesis of fibers, as it will pose zero threat to the environment.

1.2 Polymer matrix composite

Polymer grid composites are regularly separated into two classes: built up plastics, and progressed composites. Boss among the upsides of PMCs is their light weight combined with high firmness and strength along the course of the support. The properties of the PMC rely upon the lattice, and the support materials. There are a wide range of polymers accessible relying on the beginning crude fixings.

1.3 Properties of Epoxy and hardener

The epoxy resin LY 556 was used as thermosetting matrix polymer and the hardener HY 951. Both epoxy and hardener were supplied by COVAI SEENU and CO were used and mixed in the ratio of 9:1. Silicon carbide filler is used along with coconut coir ash fiber as it has some properties such as low density, high strength, good high temperature strength, oxidation resistance.

- Low density.
- High strength.
- Good high temperature strength (reaction bonded)
- Oxidation resistance (reaction bonded)
- Excellent thermal shock resistance.
- High hardness and wear resistance.
- Excellent chemical resistance.

- Low thermal expansion and high thermal conductivity.

Table -1: Synthetic v/s natural fiber

Criteria	Synthetic fiber	Natural fiber
Density	High	Low
Structure	Modifiable	Non-modifiable
Nature	Hydrophobic	Hydrophilic
Durability	High	Low
Renewable	No	Yes
Biodegradability	No	Yes
Specific strength	Low	High
Strength and modulus	High	Low

1.4 Fabrication

Various weight percentages of silicon carbide and coconut coir ash added into the epoxy resin were mixed by mechanical stirring and then mold forming into rectangular shaped samples was done. It was set to dry after pouring into the mold for 8 to 10 hours as prescribed by the manufacturer.

2 MATERIALS USED

The materials used in this project are:

- Epoxy
- Hardener
- Die
- Silicon carbide powder (35-50 microns)
- Coconut coir ash
- 75 microns sieve
- Weighing machine
- Mixing flask
- Blender
- Angle grinder

2.1 Composition

Out of the total composition of epoxy and hardener, 95% of the mixture is taken as epoxy and the remaining 5% of the mixture is hardener. When it comes to reinforcement, the total composition is 5% out of which silicon carbide powder and coconut coir ash is distributed in various composition.

2.2 Die mold

The die was made using MDF wood for its base and reaper wood for the sides. The reaper wood was cut to the required dimensions and bolted onto the base. The dimensions of the die are (200x150x10) mm. The different molding methods for the fabrication of epoxy-based polymer matrix composite structural part may be classified as matched die mold and contact mold (also called open mold).

There are two important stages in all moulding processes: pouring and curing. Pouring is the process in which moulding materials are mixed and poured on a mould in the mould cavity or on the mould surface that conforms to the shape of the part to be fabricated. The process of curing helps the resin to harden by providing the fabricated part a stable structural form and strength. Here the die is made in a rectangular shape so that the pouring operation is easier, also the cured part could be cut easily.

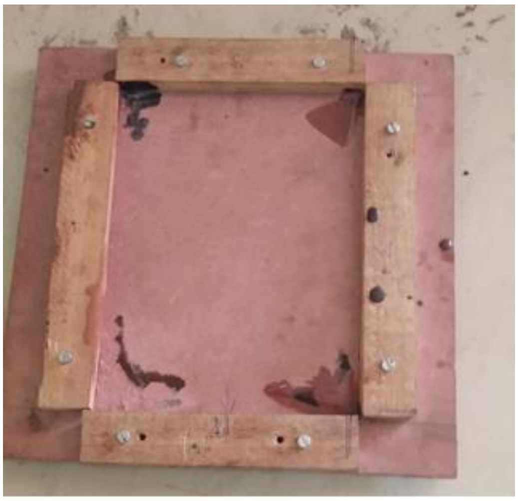

Fig -1: Die made out of medium density fiber board

2.3 Coconut coir ash

Coconut coir was collected from coconut tree and let to dry. After drying it was burnt into fine ash. The ash was then filtered into fine particles in the size of 75 microns so that it can be dispersed easily into the epoxy resin. It was filtered by using a sieve with 75 microns mesh size. A sieve is a fine mesh strainer, also known as a sift which is also commonly known as a sieve. It is a device for separating important elements from undesirable materials or for setting apart the particle size distribution of a sample, it typically uses a woven screen such as a mesh, net or metal.

2.3 Manufacturing

A mixing container is placed on the weighing scale in which the epoxy and hardener are to be poured according to the composition. 101 grams of epoxy resin was poured into the container and the tare weight was calculated.

Fig -2: Epoxy poured according to the composition

Required amount of hardener is poured into the container so that it fulfills the 9:1 ratio of epoxy and hardener. The hardener should not be let to stay still to prevent hardening of the mixture prior to the addition of fibres.

Fig -3: Epoxy poured according to the composition

Weight ratios of Epoxy and hardener were mixed according to the required composition. Particle reinforcements silicon carbide and coconut coir ash were added and stirred for 3 – 5 minutes and then poured into the die. It was let to dry down for 8 hours. This process was repeated five times to obtain samples for all the different compositions.

Fig -4: Mixture let to dry

3. CONCLUSION

There is an abundant availability of fibers and fillers to be used in composite materials Totally 5 compositions were prepared in order to show a gradual trend of changes upon mechanical and microstructural investigations, they were pure epoxy, that is 0 wt.% fiber materials, 0 wt.% coconut coir ash and 6 wt.% Sic, 3 wt.% coconut coir ash and 3 wt.% Sic, 4 wt.% coconut coir ash and 2 wt.% Sic, 5 wt.% coconut coir ash and 1 wt.% Sic.

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REFERENCES

[1] Theng BKG. The chemistry of clay-organic reactions. New York: - Wiley; 1974.
[2] Usuki A et al. Swelling behavior of Montmorillonite cation exchanged for w-amino acids by e-caprolactam. J Mater Res 1993;8(5):1174–8.
[3] Usuki A et al. Synthesis of nylon 6-clay hybrid. J Mater Res 1993;8(5):1179–84.
[4] Kojima Y, Usuki A, Kawasumi M, Okada A, Fukushima Y, Karauchio T, et al. J Mater Res 1993;8(5):1185–9.
[5] McNally Tony, Raymond Murphy W, Lew Chun Y, Turner Robert J, Brennan Gerard P. Polyamide-12 layered silicate nanocomposites by melt blending. Polymer 2003; 44:2761–72.
[6] LeBaron PC, Wang Z, Pinnavaia TJ. Polymer-layered silicate nanocomposites: an overview. Appl Clay Sci 1999; 15:11–29.
[7] Alexandre M, Dubois P. Polymer-layered silicate nanocomposites: preparation, properties and uses of a new class of materials. Mater Sci Eng. 2000; 28:1–63.
[8] Lincoln Derek M, Vaia Richard A, Wang Zhi-Gang, Hsiao Benjamin S, Krishnamoorti Ramanan. Temperature dependence of polymer crystalline morphology in nylon 6/montmorillonite nanocomposites. Polymer 2001; 42:9975–85.
[9] Gilman Jeffrey W. Flammability and thermal stability studies of polymer layered-silicate (clay) nanocomposites. Appl Clay Sci 1999; 15:31–49.
[10] Park JH, Jana SC. The relationship between nano- and micro structures and mechanical properties in PMMA–epoxy–nano clay composites. Polymer 2003; 44:2091–100.
[11] Ren J et al. Characterization and properties of poly (vinyl chloride) compatibilizer organophilic-montmorillonite nanocomposites by melt intercalation. Polyp Testing 2005; 24:316–23.
[12] Barkoula NM, Alcock B, Cabrera NO, Peijs T. Fatigue properties of highly oriented polypropylene tapes and all-polypropylene composites. Polym Polym Compos 2008: 101e13.
[13] De Rosa IM, Santulli C, Sarasini F, Valente M. Post-impact damage characterization of hybrid configurations of jute/glass polyester laminates using acoustic emission and IR thermography. Compos Sci Technol 2009:1142e50.
[14] Zhao Z, Chen X, Wang X. Materials & Design Deformation behavior of woven glass/ epoxy composite substrate under thermo-mechanical loading. J Mater 2015:130e5.
[15] Limited WP. Developments in fiber-reinforced polymer (FRP) composites for civil engineering related titles 2013.
[16] Jin H, Miller GM, Pety SJ, Griffin AS, Stradley DS, Roach D, et al. Fracture behavior of a self-healing, toughened epoxy adhesive. Int J Adhes 2013:157e65.
[17] Irving PE, Soutis C. Polymer composites in the aerospace industry. 2015. p. 257.
[18] Startsev OV, Nikishin EF. Aging of polymer composite materials exposed to the conditions in outer space. Mech Compos Mater 1994:338e46.
[19] Yu B, Bradley RS, Hogg PJ, Withers PJ. 2D and 3D imaging of fatigue failure mechanisms of 3D woven composites. Compos A 2015:14.
[20] Liang S, Gning PB, Guillaumat L. Comportment en fatigue des composites en lin/epoxy fatigue behavior of flax/epoxy composites 2011:1e10.
[21] Ye Y, Chen H, Wu J, Ye L. High impact strength epoxy nanocomposites with natural nanotubes. Polymer 2007:6426e33.
[22] Jin F, Li X, Park S. synthesis and application of epoxy resins: A review. J Ind Eng. Chem 2015;29(25):1e11.
[23] Torabi K, Shariati-nia M, Heidari-rarani M. International Journal of Mechanical Sciences Experimental and theoretical investigation on transverse vibration of delaminated cross-ply composite beams. Int J Mech Sci 2016:1e11.
[24] Morton WE, Hearle JWS. Fiber breakage and fatigue 19.1. In: Physical properties of textile fibers; 2008.
[25] Horrocks AR, Anand SC. Technical textile applications. 2016. p. 442.
[26] Tartaglione G, Tabuani D, Camino G, Moisio M. PP and PBT composites filled with sepiolite: morphology and thermal behaviour. Compos Sci Technol 2008:451e60.
[27] Awaja F, Zhang S, Tripathi M, Nikiforov A, Pugno N. Cracks, microcracks and fracture in polymer structures: formation, detection, autonomic repair Firas. Prog Mater Sci 2016: 536e73.
[28] Group S. Fatigue damage modeling of composite Structures: The ONERA Viewpoint 2015:1e12.
[29] Starke E a J, Cornelia R, Greszczuk LB, Karabin LM, Lewandowski JJ, Saxena A, et al. Accelerated aging of materials and structures: the effects of long-term elevated temperature exposure. National materials advisory board. Natl Res 1996:65.
[30] Jawaid KRHM, Abou el Kacem Q, Rachid B. Nano clay reinforced polymer composites. Springer; 2016.