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Preparation and Analysis of Flexural Strength of Epoxy Based Hybrid Composites Reinforced with Banana/Graphene/Glass Fiber

[1] Ramesh Kumar S, [2] H.K.Shivananad, [3] Madegowda B, [4] Nanjundaswamy
[1][3][4] Research scholar, [2] Associate professor
[1][2][3][4] Department of Mechanical Engineering, Bangalore University, Bangalore-5600 001, Karnataka, India

Abstract: **The role of natural and manmade fibers reinforced hybrid composite materials are growing in a faster rate in the field of engineering and technology due to its favorable properties. In the present unsustainable environmental condition natural fibers are serving better material in terms of biodegradability, low cost, high strength and corrosion resistance when compared to conventional materials. The benefits of components and products designed and produced in hybrid composite materials instead of metals recognized by many industries. The main objective is to fabricate the Banana/Glass fiber hybrid composite filled with graphene as nano filler and to evaluate the flexural strengthof hybrid composites. The different types of hybrid laminates without filler, 0.5, 1 & 1.5Wt % of graphene are fabricated by using banana and glass fiber as reinforcing materials with epoxy resin. The specimen were prepared according to ASTM standards and results shows that the composites with filler gives better results than composites without graphene filler.**

***Index Terms*— Natural fiber, Banana fiber, Graphene, Glass fiber, Hand-layup.**

I. INTRODUCTION

Natural fibers have attracted the interest of researchers, material scientists, and industries, owing to their specific advantages as compared to conventional or synthetic fibers from the past. The attractive and possible advantages, such as reduced tool wear, low cost, and low density per unit volume and acceptable specific strength, along with their sustainable renewable and degradable features are some of the important properties of the natural fibers, which make them suitable to use as filler in polymer composites. Large and wide varieties of natural fibers that are being applied as fillers or reinforcement are well recognized. The tensile strength and the tensile modulus of Glass fiber/Epoxy composite increases in fiber loading and the addition of Nano filler particles to the Glass fiber/ Epoxy composite increases the tensile strength and the tensilemodulus of the composite. Also, the addition ofNano fillerparticles to theGlass fiber/Epoxy composites increase the flexural properties of the Glass fiber composite[1]. Nano composites can be used for high strength and stiffness. Nano composites can be used in aerospace, automobile, marine and lightweight article applications [2]. It has been reported that the addition of Nanoclay to Glass fiber/Epoxy composites increases the interfacial shear strength tremendously[3]. When the addition of filler materials to Epoxy/Glass fiber composites is increased then the thermal expansion coefficient of the corresponding composite gets reduced[4]. The fiber/matrix interface plays a vital role in determining the mechanical properties of glass fiber composites[5]. When the content of Nanoclay is increased beyond an optimal level then the mechanical properties of the resultant composites decreases[6]. The percentage of Nanoclay to be used should be restricted to 5 wt% in order to get good mechanical properties of the composites[7].

2. MATERIALS AND METHODS

2.1 Materials

Reinforcing Fiber as Banana fiber, Glass fiber and graphene as nano filler. Matrix material as commercially available epoxy (LY-556) Resin & Hardener (HY-951).

2.2 Preparation of Resin

A measured amount of epoxy is taken for different volume fraction of fiber and mixed with the hardener in the ratio of 100:10 and Graphene filler is added into that mixer with weight percentage of (without filler, 0.5, 1, 1.5 wt.%)

2.3 Fabrication of the composite laminates

The composite laminates are fabricated by hand layup process. Banana and glass fibers mat were cut into the dimensions of length and breadth is of 300×300mm and 4mm thickwas used to prepare the laminate. The composite specimen consists of totally 6 layers of glass fiber and 5 layers of banana fibers for the preparation of different samples. The layers of fibers were fabricated by adding the

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required amount of epoxy resin. The glass fiber is mounted on the table and then epoxy resin is applied on it. Before the resin gets dried, the second layer of banana fiber is mounted over the glass fiber. The process is repeated till six layers of glass fiber and five layers of banana fiber got over. The epoxy resin applied is distributed to the entire surface by means of a roller. The air gaps formed between the layers during the processing were gently squeezed out. Finally these laminates are kept in press, for over 24 hours to get the perfect shape and thickness. After the composite laminates are dried completely, the composite laminates are cut using water jet machine as per the required ASTM standards to conduct flexural test. Two types of composites were prepared one is with addition of graphene filler (0.5,1,1.5,wt. %) and another one is without addition of graphene filler.

2.4 Properties of Fiber

Table 1.Physical properties of banana fiber

Physical properties	Banana fiber
Density(Kg/m^3)	1350
Tensile Strength(Mpa)	56
Flexural Strength(Gpa)	4
Young's Modulus(Gpa)	3.5
Flexural Modulus(Mpa)	7300
Elongation at Break(%)	2.6
Cellulose(Wt%)	62
Hemicelluloses(Wt%)	18
Lignin(Wt%)	5
Moisture Content(Wt%)	11

Table 2. Physical properties of glass fiber

Properties	Glass fiber
GSM	360gsm
Orientation	Plain-woven fabric
UTS	40 Gpa
Modulus	1.0 Gpa
Density	1.9 g/cc

Table 3. Properties of Graphene

Physical properties	Graphene
Density(gm/cm^3)	0.2-0.4
Tensile strength(Gpa)	130
Young's modulus(Tpa)	1

3. RESULTS AND DISCUSSIONS

3.1 Flexural test

The preparation of the flexural test specimens as per the ASTM D 790-2 standards.The standard dimensions included a span length of 100mm x12.5mm x 4mm and 3-point flexure test is used for testing. The deflection of the specimen is measured and the tests are carried out at an average relative humidity of 50% and the temperature about 32ºC. From the testing machine the flexural load as well as the displacements are recorded for all the test samples.

Fig 1. Flexural test specimens of 0% & 0.5% of graphene

Fig 2: Flexural test specimens of 1% & 1.5% of graphene

3.2Flexural Strength

The composite samples are tested in the universal testing machine (UTM) and stress-strain curve is plotted. The typical graph generated directly from machine for flexural test for Banana/Glass composite without graphene filler and banana/glass with graphene filler composites plotted in Fig 3,4.5 and 6.

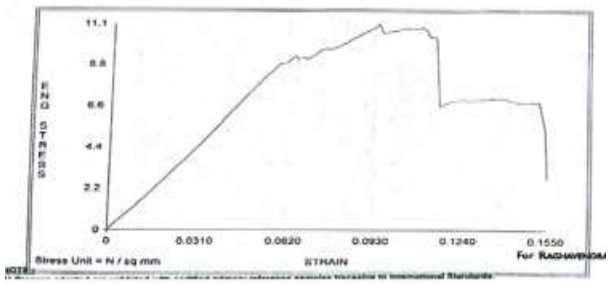

Fig 3. Stress-strain cure of specimen

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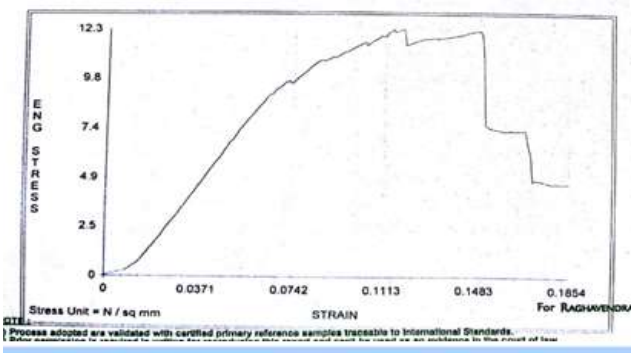

Fig 4. Stress-strain curve of specimen without Graphene with 0.5%Graphene

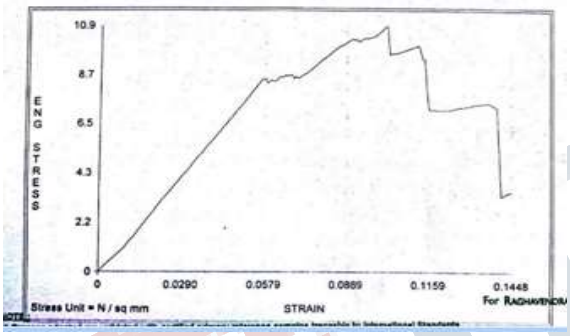

Fig 5. Stress-strain curve of specimen
Fig6 .Stress-strain curve of specimen with 1%Graphene with 1.5% Graphene

Flexural properties of different composite samples are tested and results are shown in table 4. From the fig.7indicate that the flexural strength for the composite with graphene of 1% filler is higher than the other composite with graphene filler and without graphene filler.

Table 4: Flexural strength for different specimens

Samples(Wt%)	Flexural strength(Mpa)
Without Graphene	11.05
0.5% Graphene	12.26
1% Graphene	13.77
1.5% Graphene	10.87

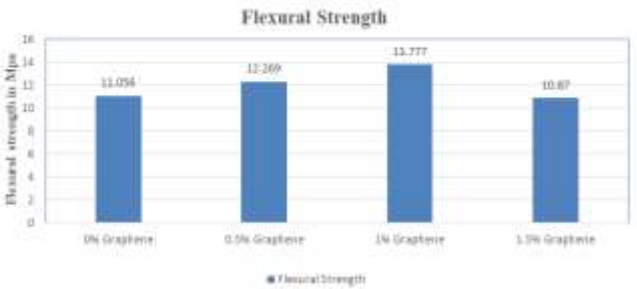

Fig 7. Flexural strength comparison of different composite materials.

4. CONCLUSION

1.The fabrication of Banana/Graphene/Glass fiber reinforced hybrid polymer were prepared successfully by hand lay-up technique.
2.The banana/glass fiber reinforced with 1% of graphene possesses good flexural strength and can withstand the strength upto 13.77Mpa.
3.The performance of these natural fiber with glass fiber is less than that of composites with graphene.

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