Study on Failure Morphology and Water Absorption Behavior of Natural Fiber Reinforced Hybrid Composite Laminate

C.M.Meenakshi[1*], Dr.A.Krishnamoorthy[2],Abishek.A[3], Fehath basha.S[3], George Vinser.A[3], Hari Haran.G[3]

Abstract*: The natural fiber reinforced composites are now gaining more importance in research and development as a new potential material for industrial and commercial applications. However the strength of the material mainly depends on the bonding strength between the resin and the fiber. This work aimed to determine and compare the bonding strength of different types of natural fiber reinforced epoxy composite. Hybrid fiber reinforce composites are prepared with glass , kenaf and aloe vera fiber and their tensile tested sample's failure morphology and their water absorption behavior are studied .Tensile test Specimens are cut from the fabricated laminate and tested according to the ASTM D638 standards. The failure analysis is done using scanning electron microscope (SEM).From the result we understood that the fiber pull out is more in aloevera/glass hybrid composite and better bonding between the resin and the fibers is shown in Kenaf /glass hybrid composite. The water retardation of kenaf fiber composite is also better than aloevera fiber composites.

Index Words : Water absorption behaviour, SEM Analysis, Hybrid composites.

I. INTRODUCTION

This engineering world requires a material to have low weight, low density, eco friendly, high wear and non corrosive material and mainly tailor made material for their products. All this properties can be achieved only with composite materials [1]. Nowadays fiber Reinforced composites are widely used for many applications like structural, marine, aerospace, automobile, windmill blades etc., because of their high strength to stiffness, weight to stiffness ratio [2, 3]. Both Kenaf and Aloe Vera are bio polymers and have the friendly nature to the environment. Using natural fibers polymer composites possessing tensile properties comparable with of conventional polymer composites can be produced [4]. It is observed that SEM is a quick examination, with minimal sample preparation [5]. Both the polymer matrix and the fiber reinforcement contribute for the mechanical performance of the NFPC [7]. Due to the customer's demands for lighter-weight, energy-efficient, and sustainable materials, industries are focusing more and more on renewable materials [8,9] . The various test results of the all hybrid composites infer that Kenaf/Glass fiber reinforced epoxy composite is showing good mechanical strength having 40– 50%higher value to the least performing member aloe vera-glass composite [10]. The main reasons for the interest on these reinforcements over synthetic fiber reinforcements are their low environmental impact, low cost, and high flexural strength, which supports their potential across a wide range of applications [11].

In This work is to determine and compare the bonding strength of different types of natural fiber reinforced epoxy composite. Hybrid fiber reinforce composites are prepared with glass, kenaf and aloe vera fiber and their tensile tested sample's failure morphology are studied also their water absorption behavior is monitor.

II.MATERIALS AND METHODOLOGY [10]

Kenaf and Aloe Vera fibers used in form of biaxial mats are brought from Weaver association, Chennai. The glass fibers used are 600 Gsm biaxial mats from Sakthi fibers, Chennai. The resin used is Epoxy resin (LY 556) and the hardener used is Araldite HY-951, in the ratio of 10:1 The fabrication is done with the hand layup method which is widely considered as the simple method for thermo set laminate preparation. Initially, the Glass, natural fiber mats and are cut into 300*300 mm sizes .In the approximate weight fraction of 30W% of fiber(10% Natural fiber and 20% Glass fiber) and 70 W% resin(Epoxy and Hardener are mixed in the ratio of 10:1). Different types of laminates are prepared with the combination of Glass-Kenaf-Glass and Glass-Aloe Vera-Glass in each combination two laminates is prepared. More care is to be taken to produce a uniform homogenous composite laminate of 300*300*3 mm. This 3 mm is achieved by adding alternative layers,the configuration is given in Table 1 and the samples shown in Figure 1.

Table 1: Configuration of the Laminates

S.NO	Nomenclature	Composite Types	Layer 1	Layer 2	Layer 3
1	GKG	Glass/Kenaf Fiber reinforced Epoxy Laminate	Glass Fiber Mat	Kenaf Fiber Mat	Glass Fiber Mat
2	GAG	Glass/Aloe Vera Fiber reinforced Epoxy Laminate	Glass Fiber Mat	Aloe Vera Fiber Mat	Glass Fiber Mat

Revised Manuscript Received on April 15, 2019.

C.M.Meenakshi, Department of Mechanical Engineering, Bharath Instittute of Higher Education and Research,Chennai,Tamil Nadu,India.

Dr.A.Krishnamoorthy, Department of Mechanical Engineering, Sathyabama Institute of Science and Technology Chennai, Tamil Nadu,India.

Abishek.A, Department of Mechanical Engineering, Bharath Instittute of Higher Education and Research Chennai, Tamil Nadu,India .

Fehath basha.S, Department of Mechanical Engineering, Bharath Instittute of Higher Education and Research Chennai, Tamil Nadu,India .

George Vinser.A, Department of Mechanical Engineering, Bharath Instittute of Higher Education and Research Chennai, Tamil Nadu,India .

Hari Haran.G, Department of Mechanical Engineering, Bharath Instittute of Higher Education and Research Chennai, Tamil Nadu,India .

Figure 1: GAG and GKG fabricated laminate

III. EXPERIMENTATION

A. Failure Morphology study

SEM analysis is done to study the micro structural properties of materials. Here the micro structural study done is to find, where the cohesiveness between fiber and matrix is failed, where the fiber tear is more. With these results the fiber arrangement in the failure zone can be altered for the improvement of the property of the material. The instrument used for testing is Carl Zeiss MA15/EVO 18 scanning electron microscope shown in figure 2

Figure 2: Carl Zeiss MA15/EVO 18 scanning electron microscope

The broken sample under tensile test is used and is cut for about a 3mm.The sample is placed on an aluminum stub with carbon tapes. It is sputtered with in nitrogen atmosphere to make the work piece conductive, so that electrons pass through it. It is placed under the SEM on nitrogen atmosphere and now the electrons can pass through it. Now the magnification is adjusted with computer and the image is obtained. The samples used are shown in figure 3

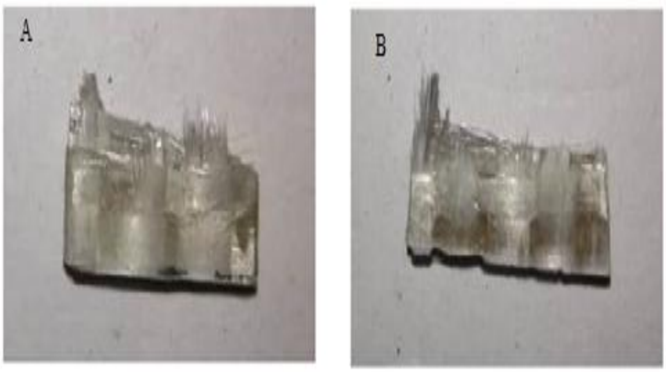

Figure3: (A) Test specimen of GAG. (B)Test specimen of GKG

B. Water Absorption Test:[10]

The natural fiber tends to observe moisture, which has to be carefully noted when it is going to be used in structures which will be exposed to moisture. The Sample used are flat shape (30x30x3) mm oven dried and specimens were weighted accurately using weighing balance of 0.1mg accuracy. Then the specimens are immense in distilled water and weight measured after 24, 48 and 72 hours by taking out the specimen and drying it. Using the two readings the water absorption percentage was calculated as per the formula $\frac{W1-W0}{W0} * 100$ where w_1 is the weight of the sample after taken out of distilled water and w_0 is the initial weight of the sample.

IV. RESULT AND DISCUSSION

The results from SEM tests are shown in figure 4 and 5 .From the figure 5 we can see lot of fiber pullouts in Kenaf only at the surface and the resin fiber bonding is good in the laminate whereas the bonding is weak in the aloe vera . The tensile tests also gives the good strength in GKG when compared to GAG [10] .The pull out of fiber is higher in GAG when compared with GKG and hence this shows that the cohesive bonding is higher in GKG.

A. Water absorption Test

The water absorption test result shows the Kenaf /Glass have less water uptake compare to that of Aloevera/ Glass fiber composite. Therefore hybrid composite can be used in structures which will have limited exposure to moisture. And natural fiber needs to chemically treat to prevent water absorption. The tested samples are shown in Figure :6 and Figure 7 shows the comparison between the results.

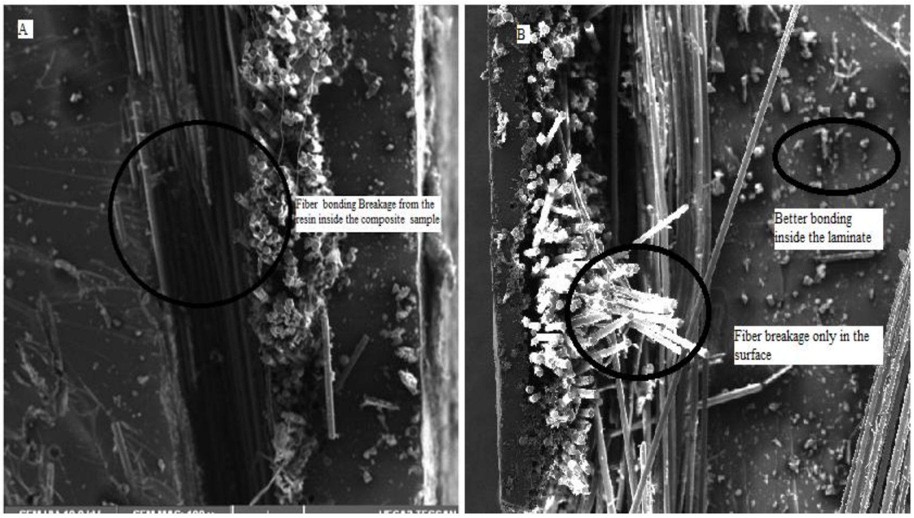

Figure 4: 100x images of GKG and GAG

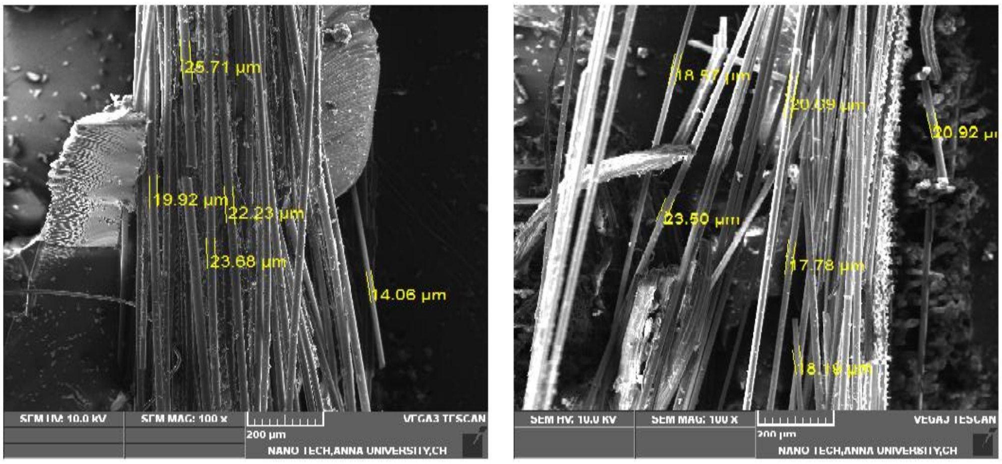

Figure 5: Thickness of GKG and GAG fibers

Figure 6: Water Absorption tested samples

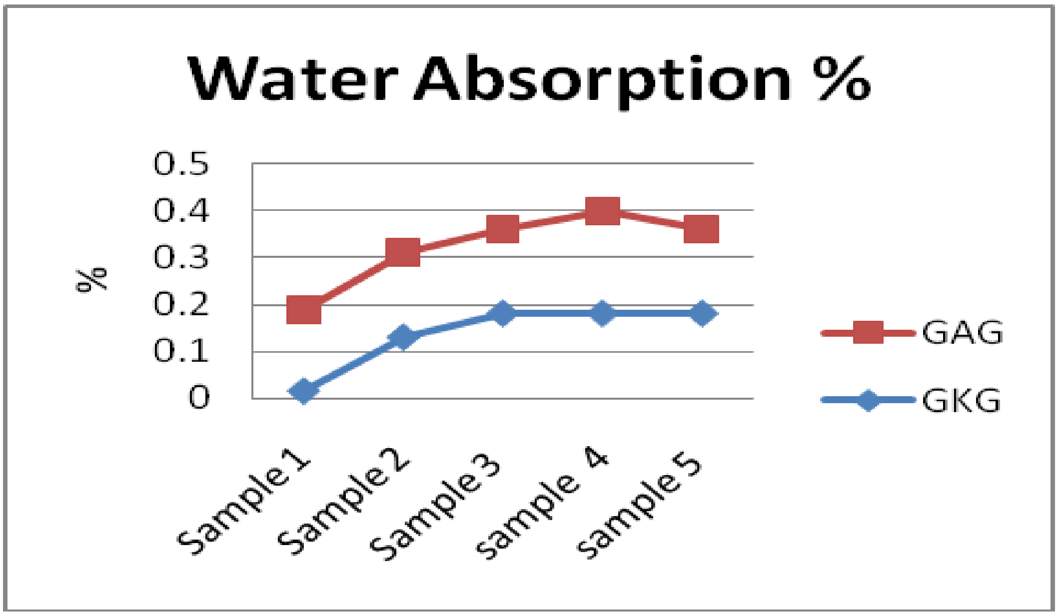

Figure 7: Comparison of water absorption results

V. CONCLUSION

The fabrication is finally made by hand layup method .The failure morphology and water absorption analyses of composites are done.

- The pull out of fiber is higher in GAG when compared with GKF and hence this shows that the cohesive bonding is higher in GKG.
- he water absorption behavior of Kenaf fiber composite is also less compare to other two composites.
- hus from all the above result it is concluded that kenaf and glass fiber reinforced hybrid composite can be used to replace the completely synthetic glass fiber reinforced composites.

REFERENCE

1. vaisanan,T Das O, & Tomppo.L.(2017). A review on new bio-based constituents for natural fiber-polymer composites. Journal of Cleaner Production, 149, 582–596.
2. G. Suresh and l. S. Jayakumari, "evaluating the mechanical
3. properties of e-glass fiber/carbon fiber reinforced interpenetrating polymer networks". Polímeros ,25(1), 49-57, 2015.
4. Irfanahmed. I, r. Rohithrenish, k. Karthik and m. Karthick,"experimental investigation of polymer matrix c0mposite for heat distortion temperature test". Ijmet_08_08_058.
5. Rahman, R., &ZhaferFirdaus Syed Putra, S. (2019).Tensile properties of natural and synthetic fiber-reinforced polymer composites. Mechanical and Physical Testing of Bio composites, Fiber Reinforced Composites and Hybrid Composites, 81–102. doi:10.1016/b978-0-08-102292-4.00005-9
6. Krishnamachari, P., Hashaikeh, R, &Tiner, M. (2011). Modified cellulose morphologies and its composites; SEM and TEM analysis. Micron, 42(8), 751–761. doi:10.1016/j.micron.2011.05.001
7. Zampaloni, M., Pourboghrat, F., Yankovich, S. A., Rodgers, B. N., Moore, J., Drzal, L. T., … Misra, M. (2007). Kenaf natural fiber reinforced polypropylene composites: A discussion on manufacturing problems and solutions. Composites Part A: Applied Science and Manufacturing, 38(6), 1569–1580. doi:10.1016/j.compositesa.2007.01.001
8. Saheb, D.N., Jog, J., 1999. Natural fiber polymer composites: a review. Adv. Polym. Tech. 4, 351e363
9. Fiksel, J, 2003. Designing resilient, sustainable systems. Environ. Sci. Technol. 23, 5330e5339
10. Stokke, D.D, Wu, Q, HanG, 2014. Introduction to Wood and Natural Fiber Composites. John Wiley & Sons, West Sussex, UK.
11. Meenakshi, C. M., & Krishnamoorthy, A. (2018). Mechanical Characterization and Comparative Evaluation of the Different Combination of Natural and Glass Fiber Reinforced Hybrid Epoxy Composites. Lecture Notes on Multidisciplinary IndustrialEngineering,
12. C.M.Meenakshidand krishnamoorthyarunagri, "Experimental study on dynamic and thermal behavior of chopped glass, sisal, and flaxFiber-reinforcedgears".Fibers2018

T

T