VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences


www.arpnjournals.com

EXPERIMENTAL INVESTIGATION ON DELAMINATION BEHAVIOUR OF ABACA BASED HYBRID COMPOSITES

P. Sathish[1], R. Kesavan[1] and B. Vijaya Ramnath[3]
[1]Department of Production Technology, MIT Campus, Anna University, Chennai, India
[3]Department of Mechanical Engineering, Sri Sairam Engineering College, Chennai, India
E-Mail: kesavan@mitindia.edu

ABSTRACT

Currently, the development of newer materials is gaining momentum as the automotive industries are mainly focussing on introducing bio degradable materials for their components. In this regard composite materials are playing a vital role. Among the various types of composites, natural fiber composites which use natural fibers like jute, abaca, raffia and neem are widely used in various automotive industries. This paper aimed to fabricate and investigate delamination behaviour of abaca-raffia hybrid composite. In this work, hand layup process is used to fabricate the composites.

Keywords: abaca fibers, raffia fibers, delamination behavior, hand layup process.

1. INTRODUCTION

Nowadays industries are focusing on developing newer materials known as composites to replace conventional materials. Among the various natural fiber composites, it is found that the abaca–jute hybrid composite has better properties than the abaca fiber alone in tensile and shear tests. However, the abaca composite is superior to hybrid composite in terms of flexural and impact strength [1, 2]. Natural fibres used as fillers in polymeric matrix enables the production of economical and light weight composites for load carrying structures [3]. The tensile strength of the chemically treated fibres is very low when compared to untreated fibres [4]. Experimental investigations are made on the mechanical behaviour of jute-flax based GFRP and it has been concluded that the hybrid natural composites show better properties under tensile and flexural loads than single fiber natural composites [5]. The interfacial adhesion was better in epoxy-based composites [6]. Manickavasagam *et al*. (7) investigated tensile behaviour of flax –abaca hybrid epoxy composite and found that ultimate tensile strength of the GFRP + flax + abaca composite is 100.74 N/mm2. Since, the use of composites reinforced by natural fibers is expanding abaca–jute–glass fibre reinforced epoxy composite give good strength and the reinforcement reduce environmental impacts. Venkateshwaran *et al.* (9) evaluated the tensile properties of hybrid natural fiber composites with various compositions of fibers. It is found that natural fiber composites have better mechanical properties and can be used as replacing materials for automotive applications [10, 11].

2. MATERIALS USED

In this work, abaca and raffia fibers are used to fabricate hybrid composites. Epoxy resin (LY 556) is used as resin for making composite. Woven glass fibre is used to form the top and bottom most layers of the composites.

a) Hand layup method

It is easy and widely preferred method for making natural fiber composites. In this method, initially releasing agent is applied on the mould in which the composites are going to be fabricated. Then the GFRP is kept on the top and bottom most layers. Then, abaca and raffia fibers are chopped to required length. They are kept as intermediate layers between GFRP. Now, epoxy resin and hardener mixture are applied over the glass fibre on which abaca fiber is spread. Fibres need to be stacked up within the time period of 15 minutes to avoid drying of epoxy resin. Using a small roller press, the prepared composite is pressed in order to remove the entrapped air. Then, GFRP ply was placed and the previous procedure was repeated in order to get the required thickness of composite. After getting the required thickness, a load 16 Kg is applied on the composite for a curing period of 20 hours on the mould. The same procedure is repeated for making raffia GFP composites and abaca, raffia, GFRP composites.

3. TESTING OF MATERIALS

a) Inter-deamination test

A climbing drum test is a typical peel testing method used to determine the de-lamination characteristics of adhesives used to bond different materials together. This test covers the determination of the peel resistance of adhesive bonds between a relatively flexible adherent and the relatively flexible facing of a sandwich structure and its core. When a relatively brittle adhesive is used, the peel resistance can often indicate the degree of cure. Higher values than the normally realized may indicate an incomplete cure. The test involves a measurement to determine the strength of a laminate's bond to a substrate material. It is equal to the tensile load applied divided by the sample width multiplied by the sample's thickness. The Figure-1 shows the specimen for the inter-delamination according to ASTM standards.

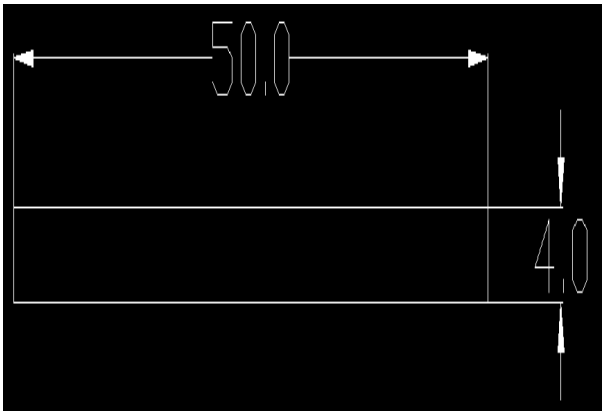

Figure-1. Inter- delamination test specimen [ASTM: D5528].

4. RESULTS AND DISCUSSIONS

a) Inter delamination test

Inter delamination test was conducted on the composite specimens namely ABACA, RAFFIA, and ABACA + RAFFIA and the load Vs. displacement graphs are plotted as shown in the Figures 2,3 and 4 and the values are furnished in Table-1.

Table-1. Inter-delamination test values of different composite specimens.

Composites	Break load (KN)	Displacement at F_{MAX} (mm)	Maximum Displacement (mm)	Ultimate Stress (kN/mm^2)
GFRP + ABACA	0.200	800	4.200	0.009
GFRP+ RAFFIA	0.325	1.200	1.500	0.015
GFRP+ABACA + AFFIA	0.395	0.900	2.800	0.018

Figure-2. Inter delamination test – Abaca.

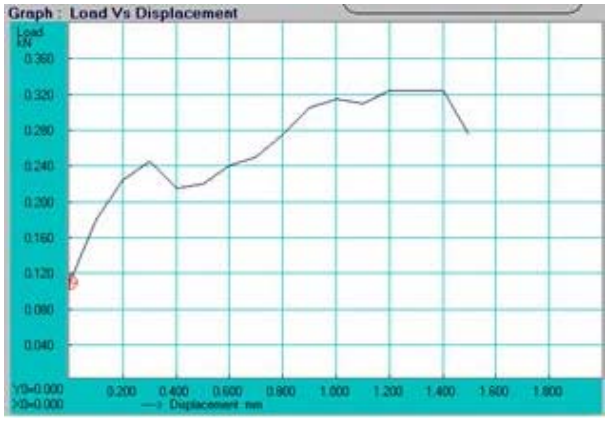

Figure-3. Inter delamination test – Raffia.

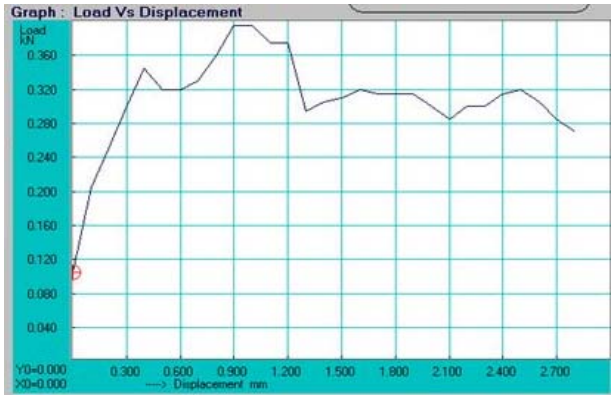

Figure-4. Inter delamination test – Abaca + Raffia.

5. SCANNING ELECTRON MICROSCOPE ANALYSIS

Failure morphological analysis was performed using scanning electron microscope on the tested specimens in order to know the surface characteristics of tested specimens. Initially, the samples were dried and coated with 15–20 nm thick gold layers using an Ion - Sputter coater device. Figure-5 shows the SEM image of delaminated specimen in which fiber pull out found.

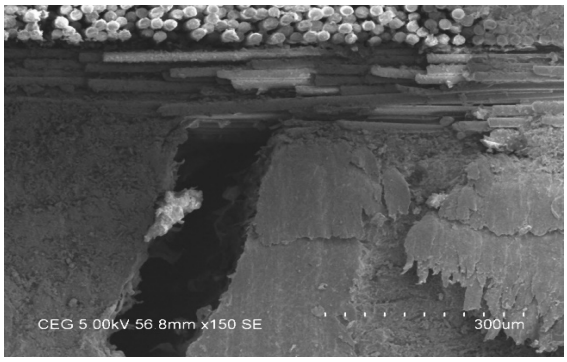

Figure-5. Delaminated specimen SEM image.

6. CONCLUSIONS

The result of inter delamination test shows that among Abaca, Raffia, and Abaca + Raffia composites, the Abaca + Raffia hybrid composite gives better de-lamintion strength than the other two. The ultimate strength of the GFRP+ABACA+RAFFIA composite is 0.018kN/mm^2. This is higher than that of the GFRP+ABACA composite with 0.009kN/mm^2 and GFRP+RAFFIA composite with 0.015kN/mm^2. GFRP + ABACA composite fibre undergoes maximum displacement as compared to others.

REFERENCES

[1] B. Vijaya Ramnath, R. Niranjan raja, S. JunaidKokan, R. Sathya Narayanan, S. Rajesh and V.M. Manickavasagam. "Fabrication and testing of Abaca fiber reinforced Epoxy composites for automotive applications", Advanced Material Research, Vol. 718-720.

[2] Vijaya Ramnath B., JunaidKokan S., Niranjan Raja R., Sathyanarayanan R., Elanchezhian C., Rajendra Prasad A. and V. M. Manickavasagam. 2013. Evaluation of mechanical properties of abaca–jute–glass fiber reinforced epoxy composite. Material Design, Vol. 51, pp. 357–66.

[3] K. Murali Mohan Rao, K. Mohana Rao. 2007. Extraction and tensile properties of natural fibers: Vakka, date and bamboo Composite Structures, Vol. 77, pp. 288–295.

[4] M. M. Kabir, H. Wang and K. T. Lau. 2013. Cardona Tensile properties of chemically treated hemp fibres as reinforcement for composites Composites: Part B Vol. 53, pp. 362–368.

[5] B. Vijaya Ramnath, V. Santhosh Kumar, P. V. Nirmal, S. Karthick, G. Prem Kumar, C. Elanchezhian, S. Rajesh and K. Suresh. 2014. "Experimental Investigation of Mechanical behaviour of Jute-Flax based Glass Fiber reinforced composite", Fibers and polymers, Vol. 15, pp. 1251-1262.

[6] Hamid K., Alain D., bertine K., Abdelkader B., Moha T. and Mustapha R. *et al.* 2006. Short tree fibres – thermoset matrices composites. Compos A. Vol.37, pp. 1413–2.

[7] Manickavasagam V. M., Vijaya Ramnath B., Elanchezhian C., Ramakrishnan G. S. Sathish, L. R. Prasanna Venkatesh and S. Pithchai Pandian. 2015. 'Investigation Of Tensile Behaviour Of Flax –Abaca Hybrid Epoxy Composite', International Journal Applied Mechanics and Materials, Vol. 766-767, pp. 140-143.

[8] B. Vijaya Ramnath, R. Niranjan Raja, S. Junaid Kokan, R. Sathya Narayanan, A. R. Rajendra Prasad, C. Elanchezhian and V. M. Manickavasagam. 2013. "Evaluation of mechanical properties of abaca–jute–glass fibre reinforced epoxy composite", Materials and design, Vol. 51, October, pp. 357-366.

[9] Venkateshwaran N., Elayaperumal A. and Sathiya GK. 2012. Prediction of tensile properties of hybridnatural fiber composites. Compos B 2Vol. 43, pp. 793–796.

[10] B. Vijaya Ramnath, V. M. Manickavasagam, C. Elanchezhian, C. Vinodh Krishna, S. Karthik and K. Saravanan. 2014. "Determination of mechanical properties of intra-layer abaca–jute–glass fiber reinforced composite", Materials and Design, Vol. 60, August, pp. 643-652.

[11] V. S. Srinivasan, S. Rajendra Boopathy D. Sangeetha and B. Vijaya Ramnath. 2014. "Evaluation of Mechanical and Thermal Properties of Banana-Flax based Natural Fibre Composite", Materials and Design, Vol. 60, August, pp. 620-627.