Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 200 (2017) 10–17

Procedia Engineering

www.elsevier.com/locate/procedia

3rd International Conference on Natural Fibers: Advanced Materials for a Greener World, ICNF 2017, 21-23 June 2017, Braga, Portugal

Flexural behavior evaluation of needle-punched glass/jute hybrid mat reinforced polymer composites

Defang Zhao[a], Kai Mao[a], Yuqiu Yang[b*], Hiroyuki Hamada[a]

[a] *Advanced Fibro-Science, Kyoto Institute of Technology, Kyoto 6068585, Japan*

[b] *College of Textiles, Donghua University, Shanghai 201620, China*

Key Laboratory of Textile Science &Technology, Ministry of Education, Shanghai 201620, China

Abstract

In this research, the creation of higher mechanical properties in natural fiber mat composites is proposed. The hybrid jute/glass mat was fabricated by needle-punched system, wherein jute mat was placed on glass mat. The ratio of jute and glass mat layers was set to be 1:0, 1:1, 1:2 and 2:1, respectively. The hand lay-up method was employed to manufacture the composites with unsaturated polyester resin after needle-punched process. Three-point bending test was carried out in order to obtain flexural properties of different composites. The results indicate that flexural strength obtained for jute mat composite (JF) was approximately 37 MPa, whereas high flexural strength was achieved in jute mat/glass mat hybrid composites (JF/GF and JF/JF/GF, when the glass fiber layer is placed as bottom side) that exhibited about respective 61.7 % and 62.0 % higher than the values of JF.

Peer-review under responsibility of the scientific committee of the 3rd International Conference on Natural Fibers: Advanced Materials for a Greener World.

Keywords: jute mat; glass mat; needle-punched; composites; flexural properties;

1. Introduction

Glass mat composites have been extensively exploited in the past few decades so that it can be said to be the basic materials of composites. Hand lay-up method is commonly employed to fabricate glass mat thermosetting resin composites, which possess laminate structure. As a result, interlaminar fracture is one of the most common fracture forms for laminates and usually causes serious loss. In needle-punched nonwoven technology, barded needles are

* Corresponding author. Tel.:+0-021-6779-2678; fax: +0-021-6779-2678

E-mail address: amy_yuqiu_yang@hotmail.com

1877-7058
Peer-review under responsibility of the scientific committee of the 3rd International Conference on Natural Fibers: Advanced Materials for a Greener World
10.1016/j.proeng.2017.07.003

continuously pushed into and through fiber web. Some fibers are hold by barbs and their orientation is altered as they transfer into the vertical plane of the resulting fabric. The reorientation and continuous presence of some fibers in both planes produce a coherent structure and affect the properties of nonwoven. Needling also creates web shrinkage along the fiber direction and stretch at right angles to the fiber direction. Moreover, needling changes compactness or packing of fiber assembly. All these events cause the structural changes in the fiber assembly [1]. Needle-punched system can be introduced to prevent interlaminar fracture occurrence.

Natural fibers as an alternative reinforcement in polymer composites for making low cost engineering materials has attracted the attention of many researchers and scientists in recent decades due to their advantages such as good specific strengths and modulus, economic viability, low density, reduced tool wear, enhanced energy recovery, reduced dermal and respiratory irritation and good biodegradability. These composites materials are suitably applicable for aerospace, leisure, construction, sport, packaging, automotive industries and so on [2-7]. The natural fiber components may be wood, sisal, hemp, coconut, cotton, kenaf, flax, jute, abaca, banana leaf fibers, bamboo, wheat straw or other fibrous material [8,9]. In the case of natural fiber mat composites, random natural fiber mat configuration is very common as well as glass mat. However, the main drawback is low mechanical properties compared with glass mat composites. Therefore, natural fiber and synthetic fiber hybrid composites have been studied by many researchers and scientists.

Venkateshwaran *et al.* [10] studied the mechanical properties of woven jute/banana hybrid composite. It is found that the tensile and flexural strength of hybrid composite (Banana/Jute/Banana) is higher than that of individual composites. Similarly, the impact strength of Jute/Banana/Jute hybrid composite is better than other types of composite. It is also found that the moisture absorption of woven banana fiber composite is lower than the hybrid composite. Boopalan *et al.* [11] investigated and compared the mechanical and thermal properties of raw jute and banana fiber reinforced epoxy hybrid composites. This study shows that addition of banana fiber in jute/epoxy composites of up to 50% by weight results in increasing mechanical and thermal properties and decreasing moisture absorption. The work of Venkateshwaran *et al.* [12], the tensile strength and modulus of short, randomly oriented hybrid banana/sisal fibers composite was found experimentally and also predicted using Rule of Hybrid Mixture (RoHM). The comparison between experimental and RoHM showed that they are in good agreement. The effect of stacking sequence on tensile, flexural and interlaminar shear properties of untreated woven jute and glass fabric reinforced epoxy hybrid composite has been investigated experimentally by Ramnath *et al.* [13]. The results indicated that the properties of jute E-glass epoxy and its composites can be considerably improved by incorporation of glass fiber as extreme glass piles.

In this work, the creation of higher mechanical natural fiber mat composites is proposed. The needle-punched system is employed to fabricate hybrid mat using jute mat and glass mat. The composites were fabricated by hand lay-up method with hybrid mat and unsaturated polyester resin. Flexural tests were carried out using a three-point bending test according to ASTM D790-07 measuring at least three replicate specimens for each composite in order to obtain flexural properties of different composites. Finally, morphological analysis was carried out to observe fracture behavior using an optical microscope and scanning electron microscope, respectively.

2. Experimental details

2.1. Materials and fabrication

Jute mat and glass mat were employed as reinforcement. Jute mat is supplied by YANOSEIKEI Company, with areal weight of 820 g/cm^2. Glass mat (Nitto Glass tex Co., Ltd.) with areal weight of 485 g/m^2 was made of cut glass fibers with a length of 50 mm. Unsaturated polyester resin (supplied by Showa High Polymer Co., Ltd.) was used as matrix. Mechanical properties of jute fiber, glass fiber and the unsaturated polyester resin are depicted in Table 1. Here, the composites were fabricated following the flowchart shown in Fig. 1. The hybrid mat with jute and glass mat was fabricated by needle-punched system, in which jute mat was placed on glass mat so that the needle-punched direction is from jute to glass fiber mat layer. The ratio of jute and glass mat layers was set to be 1:0, 1:1, 1:2 and 2:1, respectively. The hand lay-up method was employed to manufacture the composites with unsaturated polyester resin after needle-punched process. Polymer was mixed with the hardener MEKPO (Permek N; NOF Corporation) in a ratio of 100:0.7. Finally, the materials were pressed and naturally cured for 24 hours in ambient temperature. Then post cure was followed in an oven with temperature of 100 ℃ for 2 hours. Schematic drawing of