Jurnal
Teknologi

Full Paper

KENAF AS MATERIAL FOR LABORATORY TABLETOP

Zuraidah Salleh*, Syarifah Yunus, Mohamad Nor Berhan, Koay Mei Hyie, Anizah Kalam, Nik Rozlin Nik Masdek

Faculty of Mechanical Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Article history
Received
2 February 2015
Received in revised form
30 April 2015
Accepted
30 May 2015

*Corresponding author
a_kzue@yahoo.com

Graphical abstract

Abstract

Nowadays, kenaf are gaining attention in the development and is used in many types of engineering application. This new type of composite also contribute towards the green technology making it favorable in various applications. This research is focused on making a laboratory tabletop by utilizing the unidirectional oriented kenaf fiber as the main material which is layered with woven fiberglass. The project methodology is divided into three sections; preparing the specimen, conducting the experiment and testing as well as data analysis. The mould that contains a layer of woven fiberglass and kenaf fiber were poured from a mixture of polyester resin and polyester hardener. The specimen was then compressed and left to dry completely before further testing. Tensile test was carried out by following the ASTM D3039, ASTM D7264 standard for flexural test and ASTM D7136 for drop weight impact test. The results data obtained was found to be suitable for lightweight use only.

Keywords: Kenaf, fiberglass, polyester resin, laboratory tabletop

1.0 INTRODUCTION

Currently, laboratory tabletops are made from epoxy resin, phenolic resin, stainless steel, high pressure laminate and other materials. Epoxy resin laboratory tabletops are a popular choice as it is known for their aesthetics, durability and reasonable cost. In this research work, there are reasons why composite is used as a new material for making the laboratory tabletop. The advantages of composite materials over conventional materials stem largely from their higher specific strength, stiffness and fatigue characteristics, which enables structural design to be more versatile [1,2]. Kenaf fiber which is one of the most widely used natural fibers has been successfully incorporated in a variety of applications including paper products, building materials, absorbents and animal feeds. Kenaf exhibits low density, non-abrasiveness during processing, high specific mechanical properties, and biodegradability [3].

This research presents the results of the mechanical properties of kenaf fiber reinforced composite as a new material for making a laboratory tabletop. The laboratory tabletop was redesigned using kenaf fiber reinforced composite which consist of a unidirectional kenaf fiber and a layer of woven fiberglass which is used as the reinforced fibers. The use of woven fiberglass could improve the damage resistance due to impact. This additional layer of woven fiberglass showed more pronounced strain-rate sensitivity and this strain-rate sensitivity could be mainly attributed to glass/resin layers, whose behavior is typically affected by the loading speed [4]. Polyester resin acts as an adhesive which sticks the woven fiberglass and natural long kenaf fiber together. As it is lightweight, water resistant, highly resistant to chemical deterioration and withstand most solvents, acids and salts, therefore it is found to be suitable in manufacturing the laboratory tabletop. In this study, unidirectional kenaf fiber with woven fiberglass composite was fabricated, and its mechanical performance was investigated in order to replace the current material for laboratory tabletop.

2.0 METHODOLOGY

2.1 Material

Long kenaf were supplied by Innovative PultrationSdn. Bhd. All the kenaf were used without any surface treatment. A standard unsaturated polyester resin and polyester hardener (catalyst) was supplied by Mostrong Industries Sdn. Bhd. The woven fiberglass was provided by a local company.

2.2 Sample Preparation

A combination of hand lay-up and cold press method was used in the fabrication of the composites laminates. The matrix material was prepared from the unsaturated polyester resin and the catalyst at the weight ratio of 50 to 1. The catalyst was added to the polyester and the batch was stirred before pour into a mould. 70 gram of long kenaf fibers were arranged in unidirectional orientation inside the mould and layered by a fiberglass. A mat with average weight 16.5g of fiberglass with nominal size 200 mm x 200 mm was used and put at lower part of a composite laminate. Then, the polyester matrix was pour onto the kenaf fiber and fiberglass in a mould. The size of the mould was 200mm x 200 mm x 10 mm. Plastic firm was swept by the wax and the mould was covered with the steel frame for easy removal and good surface finishing of the laminates specimen. A cold press method (~10kN load) was applied to the laminate specimen for 30 minutes to 40 minutes at room temperature to ensure the specimen has no air bubble and also ensuring the homogeneity of the specimen. The composition of composite laminates was shown in Figure 1. Finally, the specimen was removed from the mould and cured for 24 hours at room temperature to ensure the specimen was hard and dry enough for further cutting process.

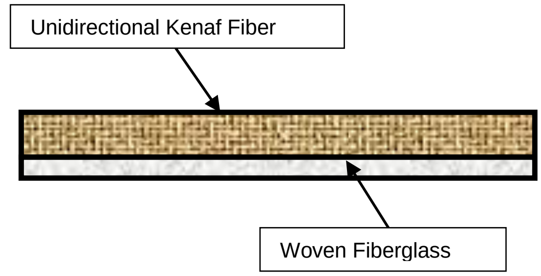


Figure 1 The composition of kenaf/woven fiberglass composite laminates

2.3 Mechanical Testing

Three test had been conducted in this experiment which were tensile, flexural and drop weight impact test. 5 specimens for each test were used according to its standard; ASTM D3039 for tensile test, ASTM D7264 for flexural test and ASTM D7136 for drop weight impact test.

3.0 RESULTS AND DISCUSSION

3.1 Tensile Test

Figure 2 shows the tensile stress-strain graph of the unidirectional kenaf/woven glass composite for all specimens. The curves indicate the pull force acting on the specimens where it finally breaks after reaching the maximum stress. At the fractured point, the unidirectional kenaf fiber/woven glass interface debonds with the fiber sliding against the matrix. Fibers are assumed to behave elastically up to failures [4].

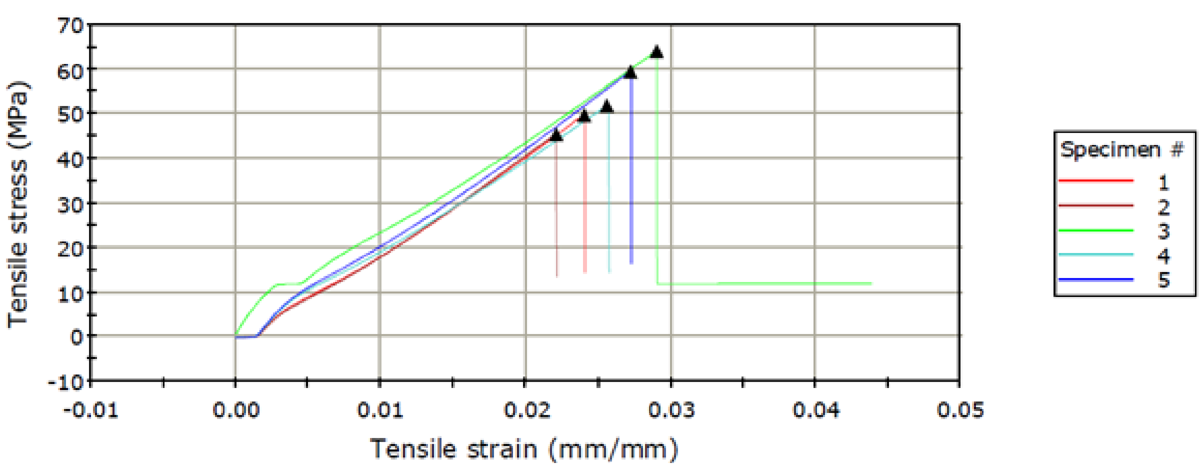


Figure 2 Tensile stress-strain graph of unidirectional kenaf/woven glass composit

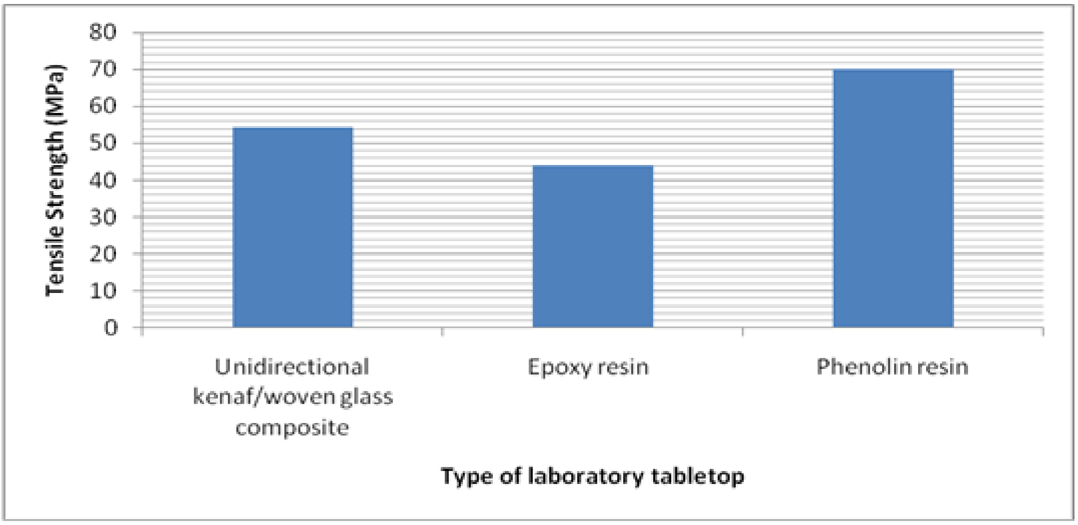


Figure 3 Tensile strength of laboratory tabletop materials

Figure 3 shows the graph of the tensile strength for three types of laboratory tabletop materials. Only one of the materials consists of the green product which is the unidirectional kenaf/woven glass composite. It can be clearly seen that phenolin resin tabletop exhibit the highest tensile strength compared to other materials. Unidirectional kenaf/woven glass composite tabletop showed better tensile strength; about ~54 MPa compared to epoxy resin tabletop. This is due to the additional layer of woven glass in the composites. It has good tensile strength and toughness while also being compatible to the resin system.

3.2 Flexural Test

The flexural test method measures behavior of materials subjected to simple beam loading. It is also called a transverse beam test. Maximum fiber stress and strain are calculated with increments of load. Results are plotted in a stress-strain diagram as shown in Figure 4. Flexural strength is defined as the maximum stress in the outermost fiber. This is calculated at the surface of the specimen on the convex or tension side. Flexural modulus is calculated from the slope of the stress versus deflection curve. If the curve has no linear region, a secant line is fitted to the curve to determine the slope [5].

Figure 5 shows the value of flexural strength of three types of laboratory tabletop materials. It can be clearly seen that phenolin resin tabletop have the highest flexural strength compared to kenaf/woven glass composite and epoxy resin. Kenaf/woven glass composite has slightly higher flexural strength valuewhich is about 74.38 MPa compared to epoxy resin which is 70 MPa.

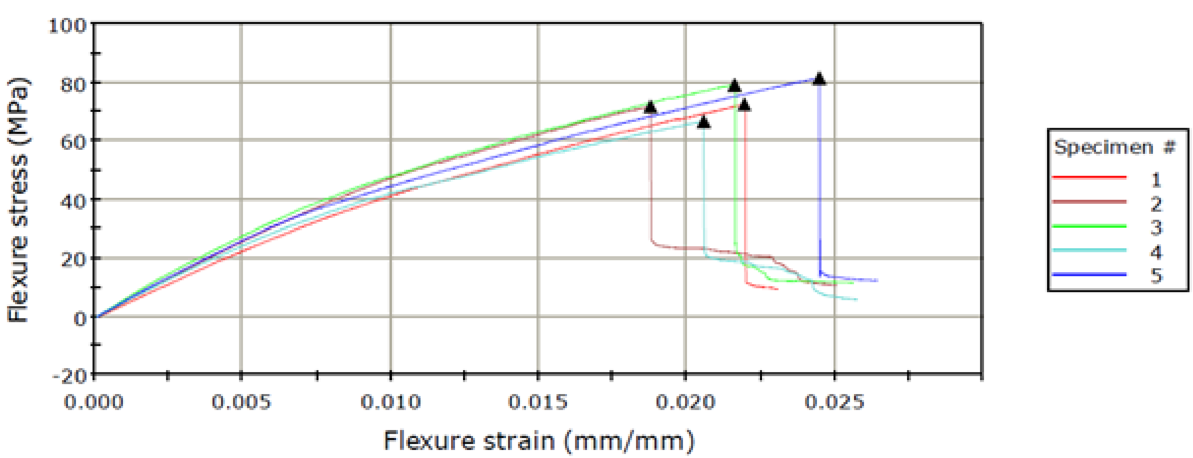


Figure 4 Flexural strength of laboratory tabletop materials

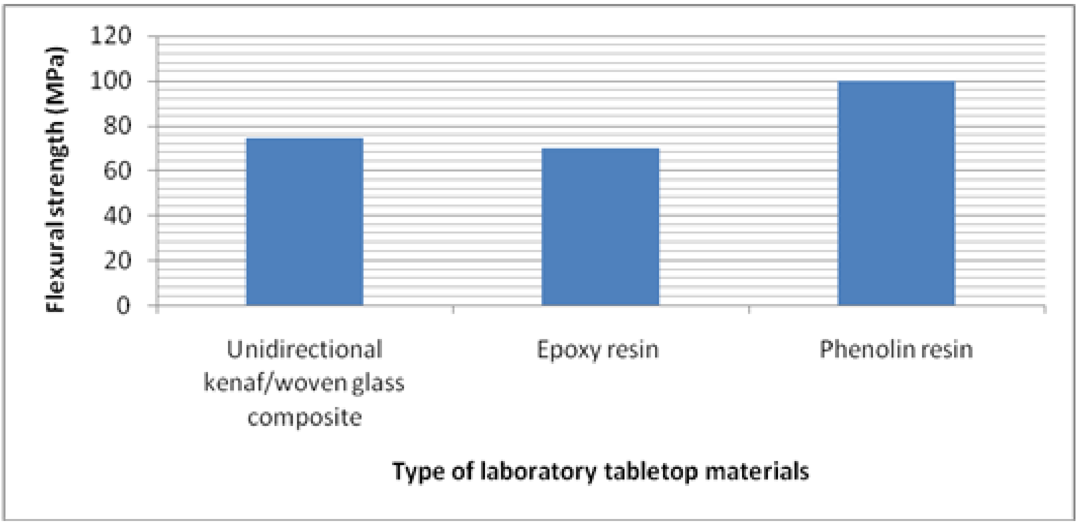


Figure 5 Flexural strength of laboratory tabletop materials

3.2 Drop Weight Impact Test

Drop weight impact testing is another type of low velocity testing, and it is the most common test for composite materials. Drop weight impact tests are done to test the impact behavior of composites, which most closely resemble impact damage in the field. When using a drop weight impact tester, two categories of damage can occur. The first is clearly visible impact damage (CVID), which can easily be seen by the naked eye. The second type of damage is the barely visible impact damage (BVID), which can seldom be seen by the naked eye. This test is focused on the unidirectional kenaf/woven glass composite only.

Table 1 Low velocity impact tes

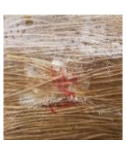
Type of penetration	Not penetrate	Half penetrate	Full penetrate
Top view			
Bottom view			
Impact energy (J)	23	34	45

Table 1 shows the level of penetration of unidirectional kenaf/woven glass after being impacted by a hemispherical impactor of 16 mm in radius. At each level, the use of different energy was applied on the specimen. During the early penetration at about 23 J, the specimen was observed to obtain a little dent on the top surfaces while little crack was observed at the bottom after being impacted. The crack on the top surface started to show few lines of crack after a large value of energy was applied of about 45 J of impact energy which resulted in full penetration of unidirectional kenaf/woven glass composite. After the full penetration, it was observed that the bottom surface of the composite was torn apart while the top surface only had a hole. From this observation, the presence of woven glass does improve the impact resistance of the kenaf composite.

4.0 CONCLUSION

It can be concluded that the tensile and flexural tests of unidirectional kenaf/woven glass composite showed comparable results with phenolic and epoxy resin tabletop materials. This implies that the new composite material could be utilized or replace the current material used for fabricating the laboratory tabletop. Moreover these mechanical properties of unidirectional kenaf/woven glass composite could be improved by optimizing the structural parameters like thickness of the composite specimen.

Acknowledgements

Thanks Allah for His mercy. Syarifah Yunus would like to acknowledge the Ministry of Higher Education (MOHE) of Malaysia for the financial support through grant awards, Faculty of Mechanical Engineering (UiTM) and MyBrain PhD, final year student, Mohamad Fadzlin Bin Mohamad Farik, and also Fakulti Kejuruteraan Mekanikal and Research

Management Institute (RMI) of Universiti Teknologi Mara, Malaysia for facilitating this project.

References

[1] Sakthivel, R., Rajendran, D. 2014. Experimental Investigation and Analysis a Mechanical Properties of Hybrid Polymer Composite Plates. *International Journal of Research in Engineering and Science*. 2(3): 46-57.

[2] Salleh, Z., Koay Mei Hyie, Berhan, M.N., Latip, E.N.A., Anizah Kalam. 2014. Residual Tensile Stress of Kenaf Polyester and Kenaf Hybrid Under Post Impact and Open Hole Tensile. Elsevier.

[3] Bakkal Mustafa, Savas Mehmet. 2012. Develop of Natural Fibre Reinforced Laminated Hybrid Composite. *Trans Tech Publication*. 10.4208.

[4] Hamzah, N., Taib, E. Y. M., Bakar, M. A. A. 2013. Tensile Properties of Untreated and Treated Long Kenaf Fiber/Polyester Composites. *Advanced Materials Research*. 871: 179-183.

[5] Rathnakar, G., Shivanand, H. K. 2012. Effect of Thickness on Flexural Properties of Epoxy Based Glass Fiber Reinforced Laminate. *International Journal of Science and Technology*. 2(6): 409-412.