MECHANICAL BEHAVIOUR OF UNBALANCED WOVEN KENAF REINFORCED POLYESTER COMPOSITES

Siti Khalijah Jamal [1], Shukur Abu Hassan[*1], Wong King Jye[1], Umar Abdul Hanan[1]

Centre for Composites (CfC), Universiti Teknologi Malaysia, Johor Bahru, Malaysia
(khalijahjamal@yahoo.com, shukur@fkm.utm.my)

ABSTRACT

Awareness has been arisen towards bio-degradable materials instead of unrecyclable materials which burden the mother earth. The availability of kenaf fibre in Malaysia as an agricultural crops facilitates local researchers to have full control on kenaf fibre starting from planting, handling, fabrication and up to manufacturing finished products. This research involved tensile analyses of unbalance woven kenaf/polyester composite comparing two deferent type of woven density. Woven kenaf fabrics were weaved using lab scale self-designed hand loom, varies in warp's direction. Cold compression method was used to fabricate the 2-ply composite panel at controlled fibre weight fraction. The tensile modulus, ultimate strength and maximum failure strain were revealed in this study in weft's direction. Kenaf with different woven density shows a comparable tensile strength. Failure mechanism analysis have found that fractured was dominant by kenaf yarn. Highest crimp percentage of woven kenaf shows significantly similar responds.

Keywords: Kenaf, Polyester, Tensile properties, Unbalance woven

INTRODUCTION

In recent decades, synthetic fibres such as glass and carbon fibres as reinforcement in composite materials are shifted to the abundant plant based fibres such as kenaf, jute, pineapple leave and flax. This is because of increasing in awareness towards the environment, where plant fibres are less hazardous and biodegradable. In addition, natural fibres are also having advantages of low cost and acceptable specific properties [1], [2]. Kenaf fibre, which is known as Hibiscus cannabinus, is a natural or bio-fibre that are abundantly available in Malaysia. This enables the feasibility of the fabrication of kenaf fibre composites for a wide range of structural applications at comparatively lower cost. It has been reported that kenaf fibre has of high mechanical properties suitable for structural application [3].

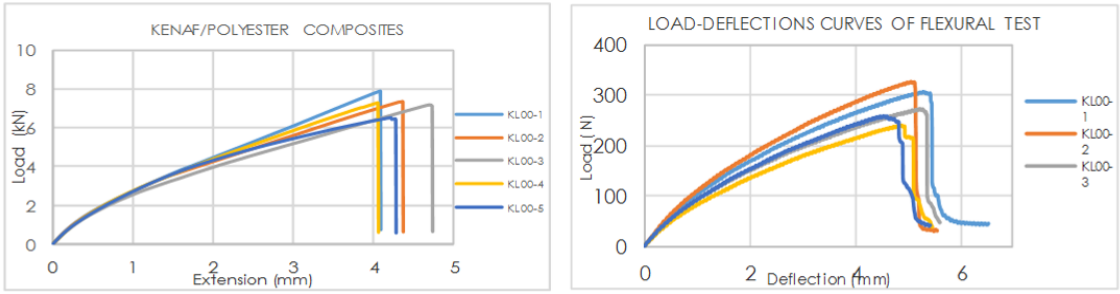
MATERIALS AND METHODS

The resin used in this study was unsaturated polyester. Kenaf yarns with single yarn twisted in S direction. The fabrication of the composites by unsaturated polyester was mixed with 1 wt% of methyl ethyl ketone peroxide (MEKP) hardener as the catalyst. The mixture was then applied on the woven kenaf fabric. Each composite plate consisted of two layers of kenaf fabric stacked in the same orientation and the fibre content was fixed at 30 wt%. The density of polyester resin supplied by manufacturer is 1.3g/cm^3 and density of kenaf is 1.4g/cm^3.

Next, the composite was left in the compression mould for 24 hours at room temperature for total curing process. The cured composite plate was having an average thickness of 4 mm. The composite plate then, cut in the weft direction using band saw into samples of 250x25 mm2 and 150x15 mm2 for tensile and flexural tests according to the recommendation by ASTM D3039 [4] and ASTM D7264 [5], respectively. Tensile test specimens were tabbed using woven glass composites of 50x25 mm^2 size.

MAIN RESULTS AND DISCUSSIONS

Figure 1(a) shows the force-displacement curves of the kenaf/polyester composite obtained from the tensile test. It is observed that the force increased linearly with the displacement and dropped suddenly when peak load is attained. This signifies brittle behaviour of the composite. Figure 1(b) shows the load-deflection curves of the kenaf/polyester composite from the flexural test. It is observed there are slightly shows nonlinear trend. The small gradient observe during deflection range between 1mm to 3mm before its start to fail average at 5mm deflection.



(a) (b)

Figure 1. Tensile Force-displacement curves and Flexural Load-Deflection of kenaf/polyester composites

The average tensile modulus, tensile strength and failure strain are 9.20 GPa, 83.84 MPa and 0.01%, respectively. Based on the calculated results, the average flexural modulus, flexural strength and strain at failure are 4.56 GPa, 119.70 MPa and 0.03%, respectively.

CONCLUSION

The 2-ply unbalance woven kenaf reinforced polyester composite studied in the present work has found to have promising tensile and flexural properties. Experimental values were found to be superior when compared with the results from the literature. From optical micrographs, the major failure mechanism in tensile coupon was kenaf yarn fracture. As for flexural coupon, fibre fracture, delamination and matrix cracking were the observed failure mechanisms.

Acknowledgment: The authors acknowledge Ministry of Higher Education Malaysia and Universiti Teknologi Malaysia for financial support through grant No. 74180 and FRGS No. 4F591.

REFERENCES

1. V. Fiore, G. Di Bella, A. Valenza, G. Di Bella, and A. Valenza, The effect of alkaline treatment on mechanical properties of Kenaf fibers and their epoxy composites, Compos. Part B Eng. (2014), 68: 14–21.
2. S. Mishra, a. K. Mohanty, L. T. Drzal, M. Misra, S. Parija, S. K. Nayak, and S. S. Tripathy, Studies on mechanical performance of biofibre/glass reinforced polyester hybrid composites, Compos. Sci. Technol. (2003), 63: 1377–1385.
3. a. Atiqah, M. a. Maleque, M. Jawaid, and M. Iqbal, Development of kenaf-glass reinforced unsaturated polyester hybrid composite for structural applications, Compos. Part B Eng. (2014), 56: 68–73.
4. ASTM Standard D3039M/D3039M-14, "D3039M-08 (2008) Standard test method for tensile properties of polymer matrix composite materials," (2013).
5. ASTM Standard D7264/D7264M-07, "Standard Test Method for Flexural Properties of Polymer Matrix Composite Materials 1," (2010).