

## **Influence of layering sequences on tensile properties of hybrid woven Jute/Ramie fibre reinforced polyester composites**

*Tezara C.<sup>a</sup>; Siregar J.P.<sup>b</sup>; Hamdan M.H.M.<sup>c</sup>; Rihayat T.<sup>d</sup>; Bachtiar D.<sup>e</sup>; Fitriyana D.F.<sup>f</sup>; Prayitno P.<sup>g</sup>*

<sup>a</sup> Faculty of Engineering and Quantity Surveying, Inti International University, Negeri Sembilan, Nilai, 71800, Malaysia

<sup>b</sup> College of Engineering, Universiti Malaysia Pahang, Gambang, Pahang, 26300, Malaysia

<sup>c</sup> Faculty of Engineering and Computing, First City University College, No. 1, Persiaran Bukit Utama, Bandar Utama, Selangor Darul Ehsan, Petaling Jaya, 47600, Malaysia

<sup>d</sup> Department of Chemical Engineering, Politeknik Negeri Lhokseumawe, Aceh, 24301, Indonesia

<sup>e</sup> Department of Mechanical and Industrial Engineering, Universitas Syiah Kuala, Banda Aceh, Indonesia

<sup>f</sup> Department of Mechanical Engineering, Universitas Negeri Semarang, Kampus Sekaran, Gunungpati, Semarang, 50229, Indonesia

<sup>g</sup> Politeknik Ahli Usaha Perikanan (AUP-STP), Jakarta, 12520, Indonesia

### **ABSTRACT**

Many researchers around the globe have shifted their focus onto the renewable resources lately. This trend is due to the number of resources that are almost reaching its critical stage hence the exploration of natural fibre composites has also caught the world's attention. In this research the effect of the number of layers, stacking sequences, and orientation of plain weave jute and ramie fibre single/hybrid composites on tensile properties were investigated. The stacking sequences consisted of two and three layered of laminated composite of pure jute (JJ, JJJ), pure ramie (RR, RRR) and ramie/ramie/ramie (RRR), whereas jute/ramie (JR), jute/jute/ramie (JJR), jute/ramie/jute (JRJ), ramie/jute/ramie (RJR), jute/ramie/ramie (JRR) were included under the hybrid composites category. The comparisons of tensile properties for each of the pure polyester, single, and hybrid composites were evaluated afterwards. The tensile strength and tensile modulus of the composites that was constructed with different fibre direction of warp and weft for each layer were also analyzed. The hand lay-up method was employed for all the fabrication of the composite specimens. From the results, it was observed that the tensile properties of the skin-core type composites (RJR, JRJ) have showed a better performance compared to the skin-eccentric types (RRJ, JJR) with similar ramie content. Attributed to a good fibre rigidity of Ramie fibre, the tensile strength and tensile modulus values could be enhanced with the addition of the ramie content in the composite mixture. The tensile properties were proven to also be improved with the increase number of woven layers in the composite. The Jute/ramie hybrid composite has exhibited very high potential in the future development of the automotive industry.

### **KEYWORDS**

Hybrid composite; Jute fibre; Ramie fibre; Tensile properties; Woven fibre

**ACKNOWLEDGEMENTS**

The authors would like to express their gratitude to the INTI International University ([www.newinti.edu.my](http://www.newinti.edu.my)) for providing the fund under the Seeding Grant No.: INTI-FEQS-02-01-2018/19 and Universiti Malaysia Pahang for providing the laboratory facilities.