

The effect of weave patterns on tensile and hemisphere tests of a hybrid Kevlar/jute fiber reinforced composite

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ABSTRACT: An experimental study was carried out in this study to determine the effect of weave patterns such as plain (PJK), twill (TJK), satin (SJK), and mock leno (MJK) on hybrid intraply woven jute/Kevlar fibre. Jute and Kevlar fibres were used as reinforcements, and vinyl ester (VE) was used as the matrix, using a vacuum bagging technique. The tensile and 3D hemispherical tests were carried out in accordance with ASTM standards. The results showed that, regardless of plain Kevlar, the SJK had the highest performance of about 186.58 MPa when compared to other weave patterns. In a 3D clamp test, SJK was found to have a 232.48% increase in maximum load withstand when compared to plain Kevlar. It can be concluded that, the weaving pattern has a significant impact on the performance of hybrid intraply woven jute/Kevlar reinforced composite.

Keywords: Weave pattern, jute, Kevlar

1. INTRODUCTION

In the past years, woven fabric reinforced composite have been dramatically increase in replacing the unidirectional fibre reinforced composite due to their greater formability and higher out-of-plane stiffness [1]. Woven fabric reinforcement is a fabricate product of interlacing warp and weft in a repeating woven pattern that can be plain, twill and satin. Yahya et al. [2] stated that the direction of warp and weft is in 90 degrees angle. Iqbal et al. [3] mentioned that the orientation of fibre could affect the delamination growth and coupling effects of extension shear on composite. They also found that woven fibre composite with higher weft density samples demonstrated a less crimped, more flexible structure resulting in better tensile and compressive properties.

In addition, Zuladek et al. [4] stated that the benefits of utilizing a woven carbon composite are primarily lightweight, outstanding strength, exceptional shock absorption properties, great toughness and high fatigue functionality. Kanaginahal et al. [5] gave a comprehensive review on influence of weave pattern and composite thickness on mechanical properties of bamboo/epoxy composites. They concluded that twill weave has 7% higher strength than plain weave fabric in tensile test. Yuhazri et al. [6] reported that different weave designs of hybrid kenaf/glass fiber had a

significant effect on tensile properties.

According to the aforementioned studies, numerous studies on the effects of weave patterns on various materials have been conducted. However, no attempt was made to look deeper into the hybrid intraply woven composite for jute/Kevlar fibre. As a result, the goal of this study is to investigate the effect of weave patterns on a hybrid intraply jute/Kevlar fibre reinforced composite.

2. METHODOLOGY

Jute fibre was obtained from Fiberglass Sdn. Bhd. Johor with the price of RM 5.00 for 1-meter x 1 meter. Vinyl ester resin and hardener supplied by ML Fibreglass Sdn Bhd in this research. The vinyl ester resin and hardener ratio are 90:10 respectively. The jute and aramid fibre are aligned in the weft and warp directions. In this research, plain Kevlar are used as a control specimen. The weave pattern that will be discussed in this research are PJK, TJK, SJK and MJK as shown in Figure 1.

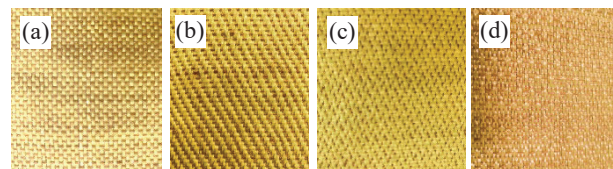


Figure 1 Weave patterns (a) PJK; (b) TJK; (c) SJK and (d) MJK

Tensile test and fabric test were conducted using ASTM D3039. Tensile test done by using Instron universal testing machine. Specimen of tensile test were cut into 250 mm x 25 mm and fabric test of 200 mm x 100 mm. The crosshead speed for tensile test and fabric test were 2 mm/min and 100 mm/min respectively.

3. RESULT AND DISCUSSION

3.1 Tensile test performance

According to Figure 2, the hybridization of jute and Kevlar fiber had no effect on tensile performance. In contrast, Bandaru et al. [7] claimed that the hybridization technique had a significant impact on the mechanical performance of composites. Furthermore, irrespective of plain Kevlar, the highest tensile strength obtained by sample SJK was around 186.58 MPa when compared to other weave patterns. However, interestingly, this is

contrary to a study conducted by Aisyah et al. [8] which found that plain weave is more suitable than satin weave for obtaining tensile strength. In conclusion, the weave patterns gave significant effect on tensile performance of hybrid intraply woven jute/Kevlar reinforced composite.

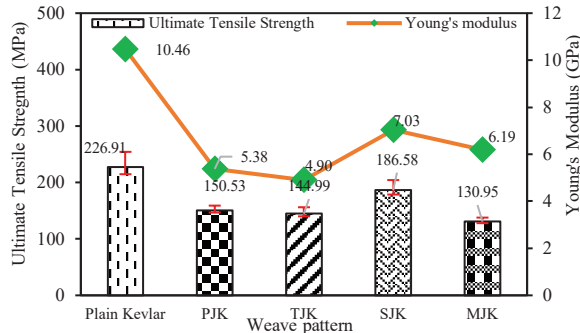


Figure 2 Tensile strength and Young's modulus

3.1 3D hemisphere test performance

Figure 3 shows that the SJK weave has the highest maximum load of 2.03 kN, representing a 232.48% improvement over plain Kevlar. The compaction of Kevlar and jute fibers in SJK samples provided additional supports for the fabric to withstand the given stress. The weakest sample was MJK, which had a compressive load of only 1.71 kN. The orientation of the fibers in sample MJK resulted in poor interlocking between the fibers, allowing the fibres to move easily to less stressed regions of the sample.

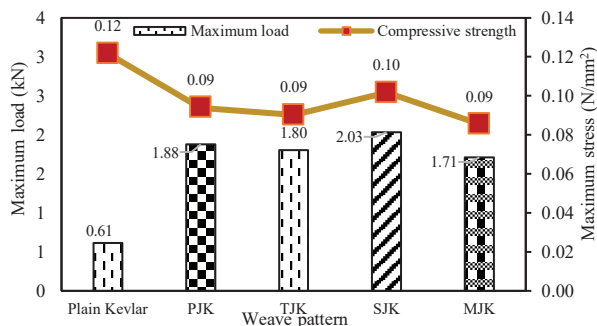


Figure 3 3D hemisphere performance

Interestingly, all hybrid samples were able to withstand higher maximum stress compared to plain Kevlar. The additions of jute fibres into the intraply concept of woven fabric can be noted to improve the performance of plain Kevlar fabric under compressive load. Last but not least, the greater the maximum load, the lower the deformation of the shear stress angle. These were due to the weave patterns that could influence the performance of the fabric and the fabric stretching under a load.

CONCLUSION

This study was carried out in order to develop a hybrid intraply woven jute/Kevlar reinforced thermoset composite. This study found that the hybrid of SJK has the highest tensile strength of 186.58 MPa when compared to other weave patterns. It was also

demonstrated that the SJK weave has the highest maximum load of 2.03 kN, representing a 232.48% improvement over plain Kevlar. The evidence from this study suggests that the different weave patterns of hybrid intraply woven jute/Kevlar had a significant effect on tensile and hemisphere performance.

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