

# Shear Properties Evaluation of Natural Fibre Reinforced Epoxy Composites Using V-Notch Shear Test

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# PRESENTATION OUTLINE

- INTRODUCTION
- MATERIALS AND METHOD
- RESULTS AND DISCUSSIONS
- CONCLUSIONS

# INTRODUCTION

Natural fiber composites (NFC) is one of the most emerging natural-based products that recently have attracted more attention.

Natural fiber composites are particularly valued for their tensile and flexural properties [5], while shear and compressive properties are often ignored at early stage of fiber composite development. Almeida Jr et al. [6] stated that only few papers in the literature of fiber composite linked to shear test.

One of the reason is probably due to the complexity of running the test which has to ensure the presence of pure shear stress within the specimen.

Broughton [7] --- A shear test method should provide a region of pure shear stress in the specimen throughout the linear or non-linear response regime.

A comparatively low shear or compressive strength of a fiber composite reduces their promising application although it possess high tensile/flexural properties [8].

One of the most commonly employed method for shear testing is Iosipescu shear test, which also known as V-notched shear test [6]. As the name implied, the test was originally developed by Iosipescu [9].

Among the available shear test methods, the Iosipescu test has been widely used due to its ability to propagate nearly pure shear stress state within the notched section of the specimen [10].

This study aims to investigate the shear properties of two different types of natural fibers, which is jute and hemp fibers, when they are used to reinforce epoxy resin polymer. The shear properties of those composites were provided using v-notched or Iosipescu method.

# MATERIALS & METHOD

## MATERIALS

Woven Jute fiber

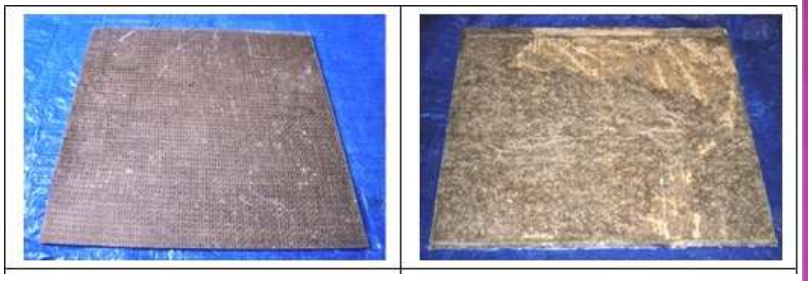
+

Hemp mat fiber

Fibers:
Jute (woven)
Hemp (mat)

Matrix:
Modified low viscosity epoxy resin (R180) + Hardener (H180)

Vacuum Bagging Process



JFC and HFC panels

# METHOD

The Iosipescu or V-notched uses a rectangular beam that loaded by a special fixture applying a shear loading at the v-notch.

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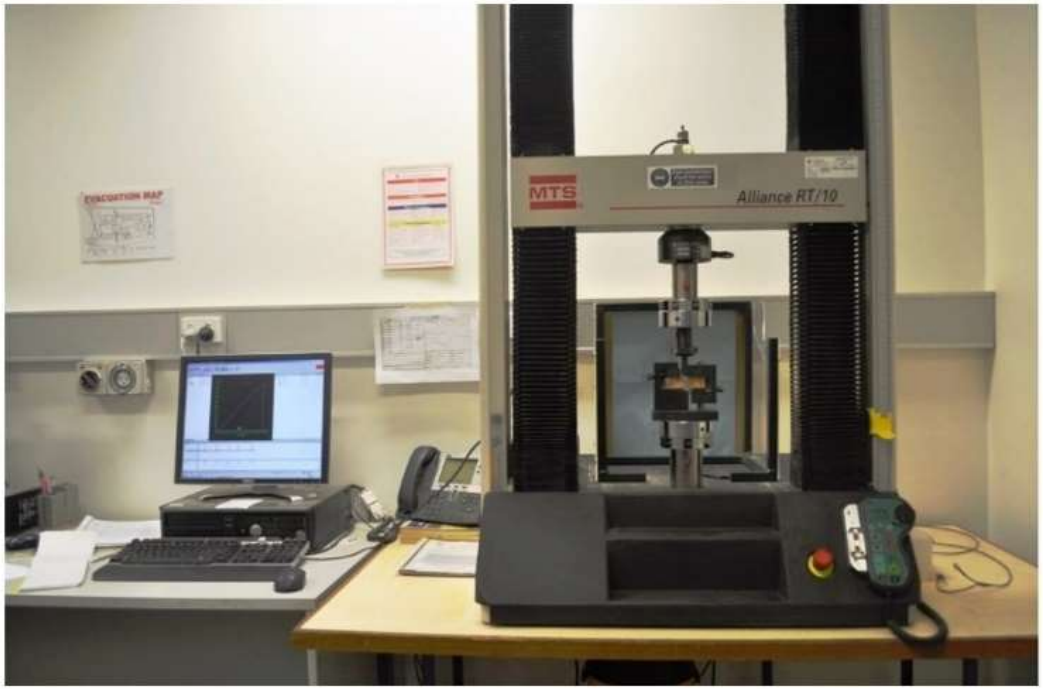



(A)

(B)

# RESULTS & DISCUSSIONS

## SHEAR STRESS

**Table 1**. Shear properties of jute fiber composite (JFC) and hemp fibre composite (HFC)

| Specimen | Jute Fiber Composite (JFC) | | Hemp Fiber Composite (HFC) | |
|---|---|---|---|---|
| | Deflection at Peak (mm) | Peak Shear Stress (MPa) | Deflection at Peak (mm) | Peak Shear Stress (MPa) |
| 1 | 1.71 | 29.83 | 2.08 | 22.94 |
| 2 | 1.64 | 28.90 | 2.25 | 25.69 |
| 3 | 1.99 | 29.68 | 1.98 | 23.48 |
| 4 | 1.31 | 22.39 | 1.66 | 18.51 |
| 5 | 1.66 | 17.03 | 1.89 | 21.69 |
| **Mean** | **1.66** | **25.57** | **1.97** | **22.46** |
| **CV** | **14.46** | **22.21** | **11.17** | **11.75** |

Table 1 shows that the average shear stress of JFC is 25.57 MPa, which is 13.8 % higher than the average shear stress of HFC, 22.46 MPa.

The data obtained in this study were pretty close to other previous studies:

1) Franco and Gonzales [12] found that composite made of henequen fibre reinforced polyethylene has the shear stress of 14 MPa to 19 MPa.
2) Almeida Jr et al. [6] provided a composite from glass fiber reinforced epoxy composite with an average value of shear stress about 22.3 MPa, which is very close to the shear stress of HFC in this study.
3) Fajrin [14], tested the shear strength of sisal/epoxy composite and obtained a shear strength about 12 MPa to 15 MPa.

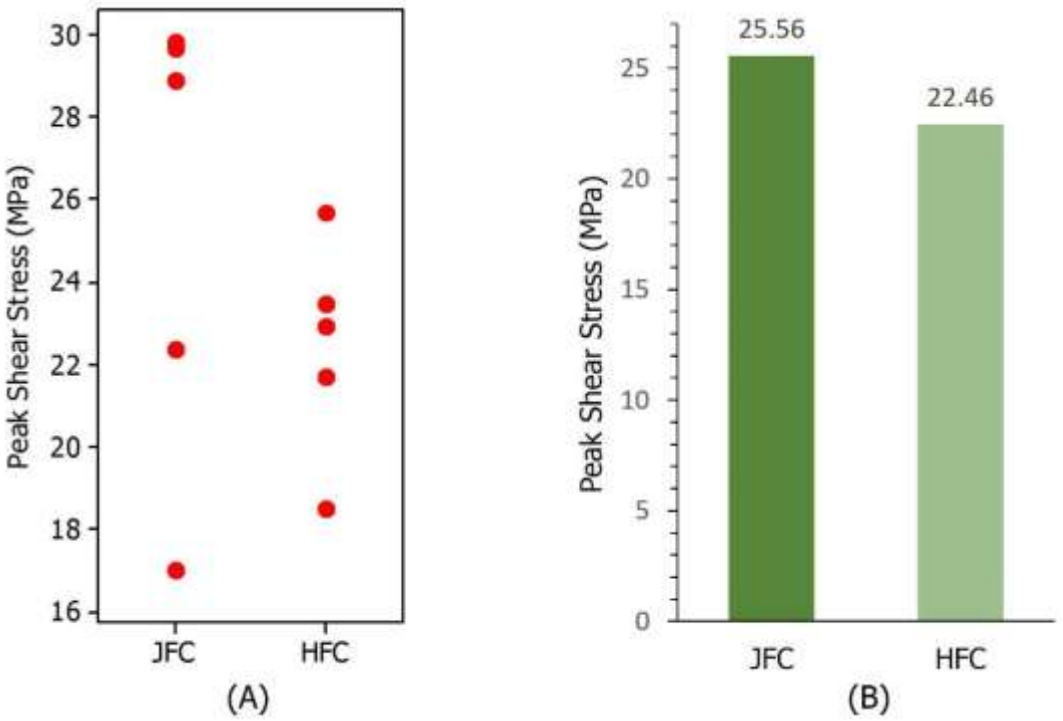



Figure 2 (A), that the data spread is disproportionate, particularly for the data of JFC.

1) The shear stress of JFC ranges from 17.03 MPa to 29.83 MPa, with a coefficient of ratio (CV) of 14.46.
2) The data of HFC distributed much better with a CV value of 11.75. Both are, however, within the acceptable limit of CV values for experimental data, which is according to Patel et al. [15], the value of 33% is the upper limit of CV value.
3) It is also clearly shown in the dot plot diagram that each group data has at least one or two outlier values.

# LOAD-DISPLACEMENT BEHAVIOUR

Hemp Fiber Composite (HFC)

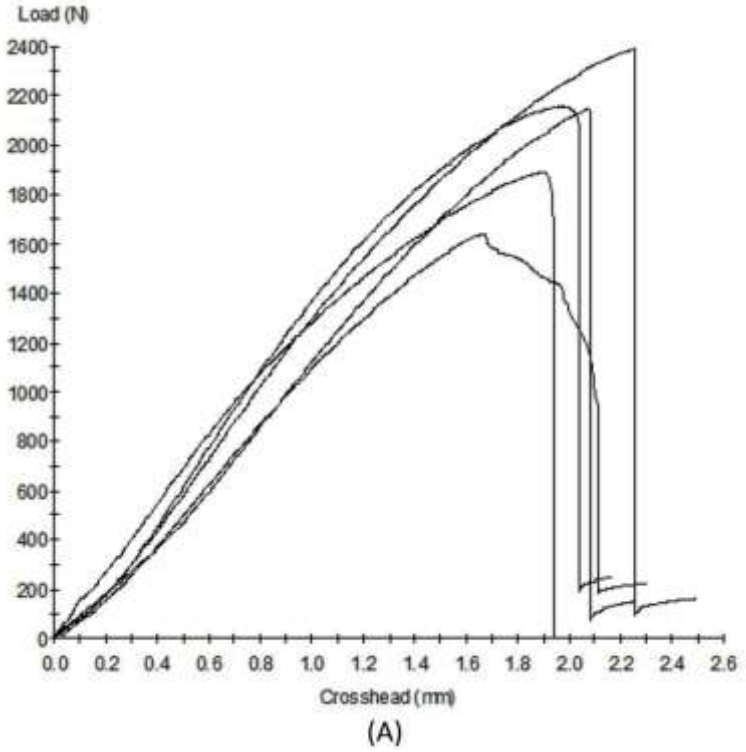
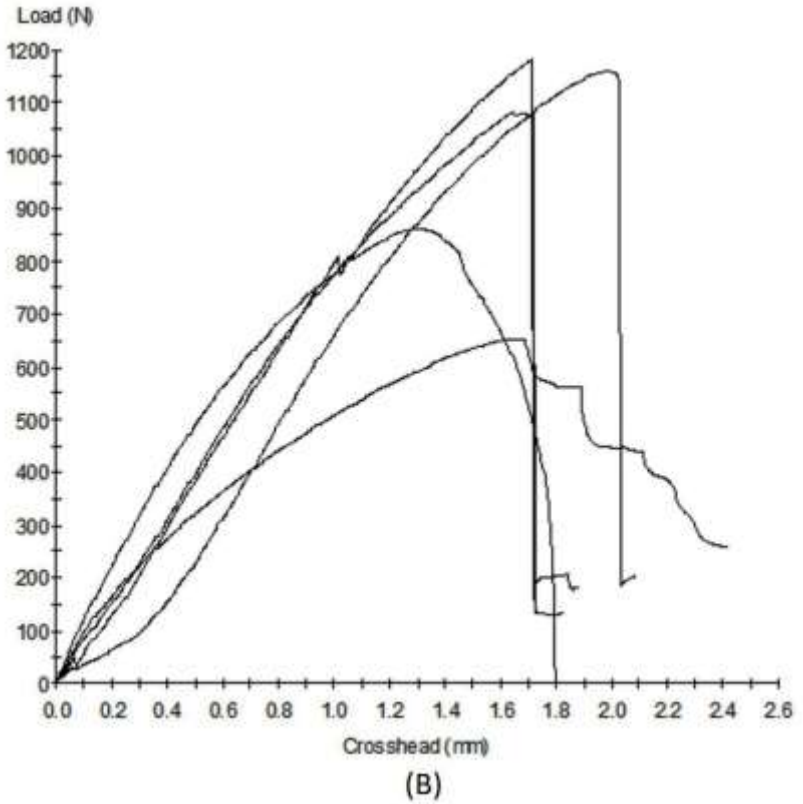



Figure 3(A) shows typical load-crosshead curves of hemp fiber composite (HFC).

1) A quick look at the graph gives an indication that the HFC laminate was properly and well prepared. All the curves for the 5 samples showed a nearly linear trend at the initial stage of loading and slightly deflected prior to reaching a maximum load.
2) Four samples were collapsed in an abrupt mode which is a common failure mechanism of brittle material such as natural fiber composite.
3) One sample behaved just like a non-linear material, revealed a few steps after reaching the maximum value, which is indicating a delamination process within the sample, as reported by Almeida Jr et al. [6].

# LOAD-DISPLACEMENT BEHAVIOUR

Jute Fiber Composite (JFC)



(B)

The typical load-crosshead curves of jute fiber composite (JFC) is depicted in Figure 3 (B).

1) As clearly shown in that figure, the stress-strain curves show a linear elastic behaviour at the initial stage and after some point there is a reduction on the stiffness of material until the final failure.
2) The graph also shows that three out of five specimens failed in a sudden mode of failure, while two specimens formed a non-linear behaviour after reaching the maximum load.

# FAILURE MODES

Hemp Fiber Composite (HFC)

(A)

Figure 4 (A) shows a typical failure pattern of HFC specimens.

1) Four out of five specimens were fractured in a diagonal cracking, which also known as an off-axial failure mode as shown in the figure.
2) Only a single specimen was actually failure across the notched section, which is strongly desired in this type of shear test.

# FAILURE MODES

Jute Fiber Composite
(JFC)

(B)

The failure mode of JFC specimens was also dominated by diagonal cracking, as shown in Figure 4(B).

1) It seems that the crack was initiated at the upper or lower notched surfaces. The crack then developed along the direction which is nearly 45 degree from the principal axis.
2) A similar failure mode was also reported by Yuan et al. [10], who explained that a uniform or pure shear stress is generated in the center of the notched section when the specimen is under shear loading during the test. Archila et al. [16] explained that the pure shear stress between the notched is propagated by the action of two applied loads of equivalent magnitude subjected to the tested specimen.

# CONCLUSSIONS

1. It was found that the jute fiber composites (JFC) has the average shear stress of 25.56 MPa, while hemp fiber composites (HFC) has the average value of 22.46 MPa. These values were pretty close to the shear stress of other natural fiber composites tested using the same method previously.
2. Regarding the load-displacement behaviour, both JFC and HFC specimens showed a nearly linear trend at the initial stage of loading and slightly deflected prior to reaching a maximum load.
3. Most of the specimens in both groups, JFC and HFC, were fractured in a diagonal cracking, which also known as an off-axial failure mode. Few specimens were collapsed across the notched section. Both are acceptable failure modes under this type of shear test.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