Investigation on Tensile and Flexural Behavior of Bi-directional Natural Fiber Composites by VARTM

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Content

Abstract

This study was performed to understand the tensile and bending performance of Natural fiber (flax) polymer composites fabricated using the Vacuum Assisted Resin Transfer Molding (VARTM) process. Natural bi-directional fibers are fibers derived from nature that can be arranged and processed to provide strength in two directions. The effects of Natural fibers in an epoxy influence the mechanical properties under tensile and flexural loads was conducted by each specimen which was subjected to standardized tensile and three-point bending tests. The mechanical properties, including tensile strength, modulus, elongation at break, flexural strength, and modulus, were measured and analyzed.

Introduction

Composite materials are progressively crucial in engineering applications due to their greater strength-to-weight ratios and customizable properties. In this bi-directional flax fiber composites with epoxy resin using VARTM offer a promising approach for sustainable and lightweight composite parts. The VARTM process, known for its capability to produce high-quality composites with uniform resin distribution and minimal void content, makes an excellent fabrication method for this study. The objective is to assess the effects of combining Natural fibers in a epoxy resin by $bi-directional$ orientation and how this composite influences the mechanical properties such as tensile and flexural loads.

Methodology

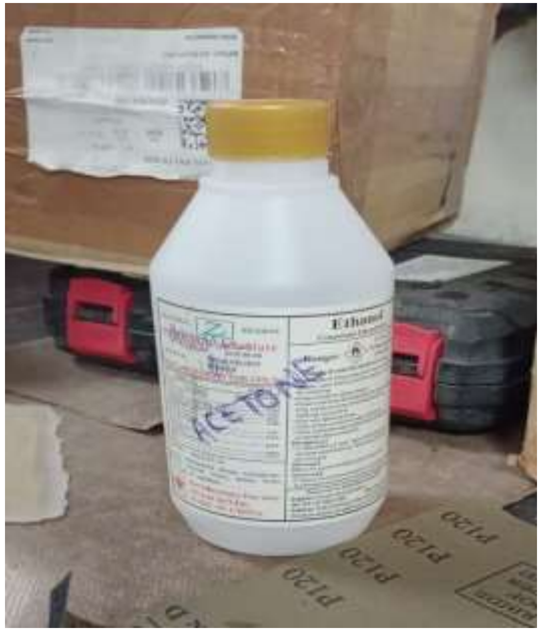
Materials used:

- Fiber:

Bi-directional natural fiber

Methodology Contd.

Epoxy resin and epoxy hardener



Acetone

Sealant

Methodology Contd.

Mesh ply

Peel ply

Vacuum pump

Methodology Contd.

Methods used for the manufacturing of composite

- Fiber type: bi- directional Natural fiber
- Resin infusion: VARTM
- Resin: Epoxy
- Tests done:
    1. Tensile test
    2. 3pt Bending test

Procedure

Step 1: Cleaning of the working glass base for manufacturing using acetone.

Step 2: Wax was applied on the working glass before laying down the dry flax fabric for surface finish and easy removal.

Step 3: Epoxy resin and the hardener are mixed in a beaker at a 100:33 ratio i.e., 150ml resin+50ml hardener=200ml.

Fig. Resin + hardener

Procedure Contd.

Step 4: on the glass base sealant is applied carefully so that there is no air gap.

Step 5: Arrange the Natural flax fiber and Place the peel ply and mesh ply over the fibers.

Fig. Arranging fibers, peel ply, and mesh ply

Procedure Contd.

Step 6: Apply Vacuum cover spiral pipe(easy air removal). Attach the pipe to a vacuum pump and seal the vacuum cover with sealant without any air gap.

Procedure Contd.

Step 7: The pump is switched ON. Excess resin is removed.

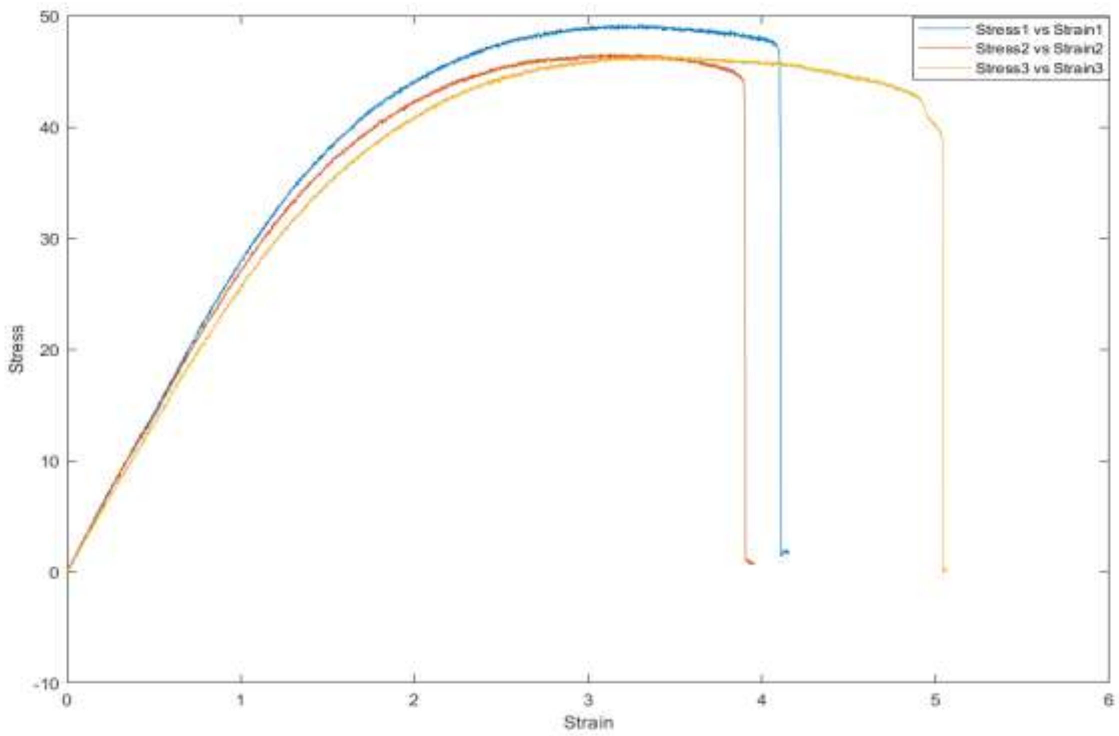
Procedure Contd.

Step 8: Curing the specimen 24 hrs.

Step 9: Post-processing for the specimen.

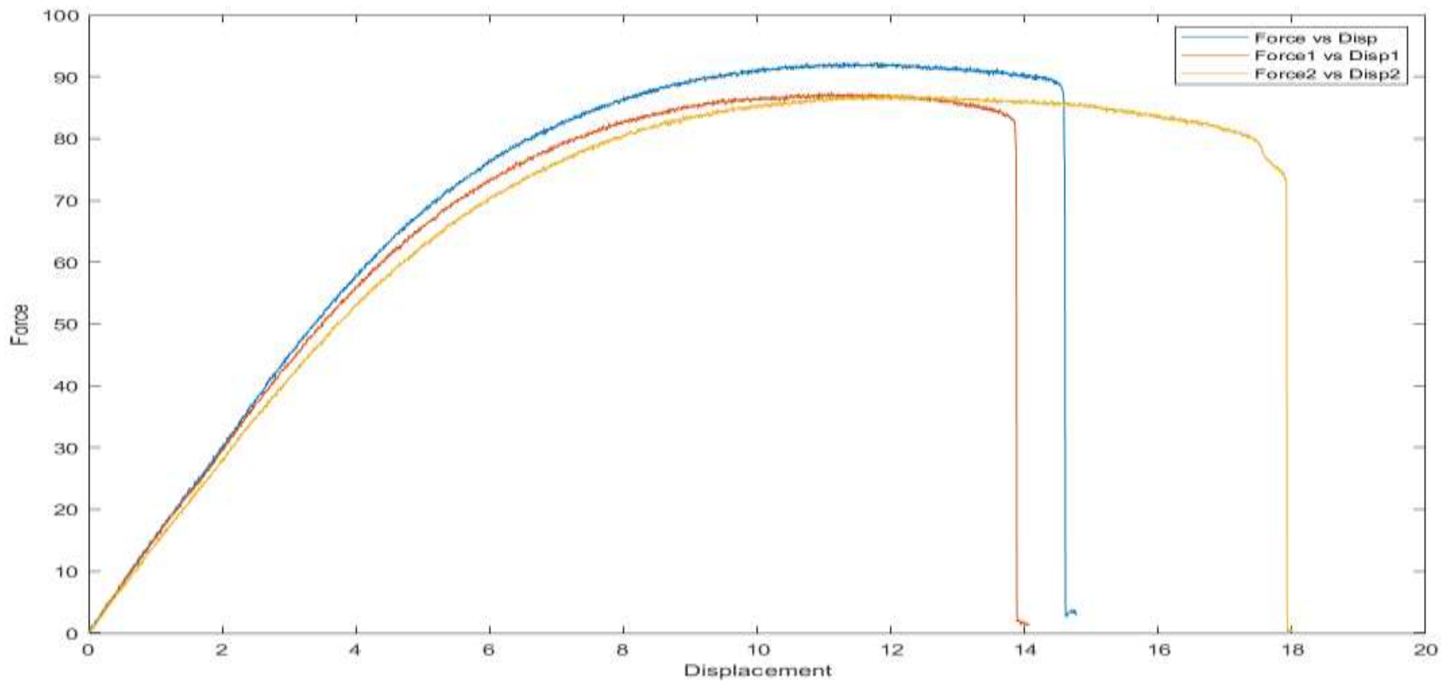
Step 10: Tensile and Bending Tests were conducted.

Results of Tensile test



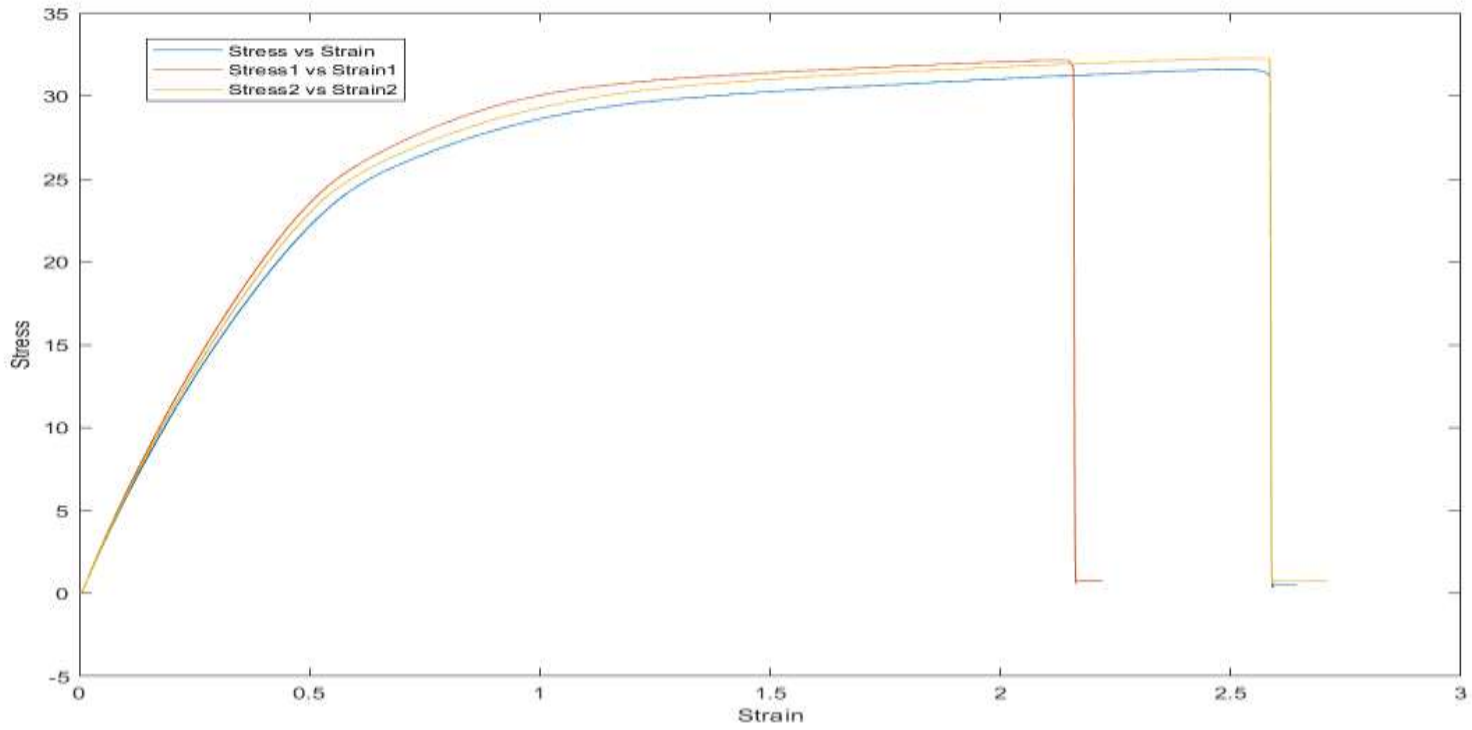
Stress and strain Diagram

Results of Tensile test



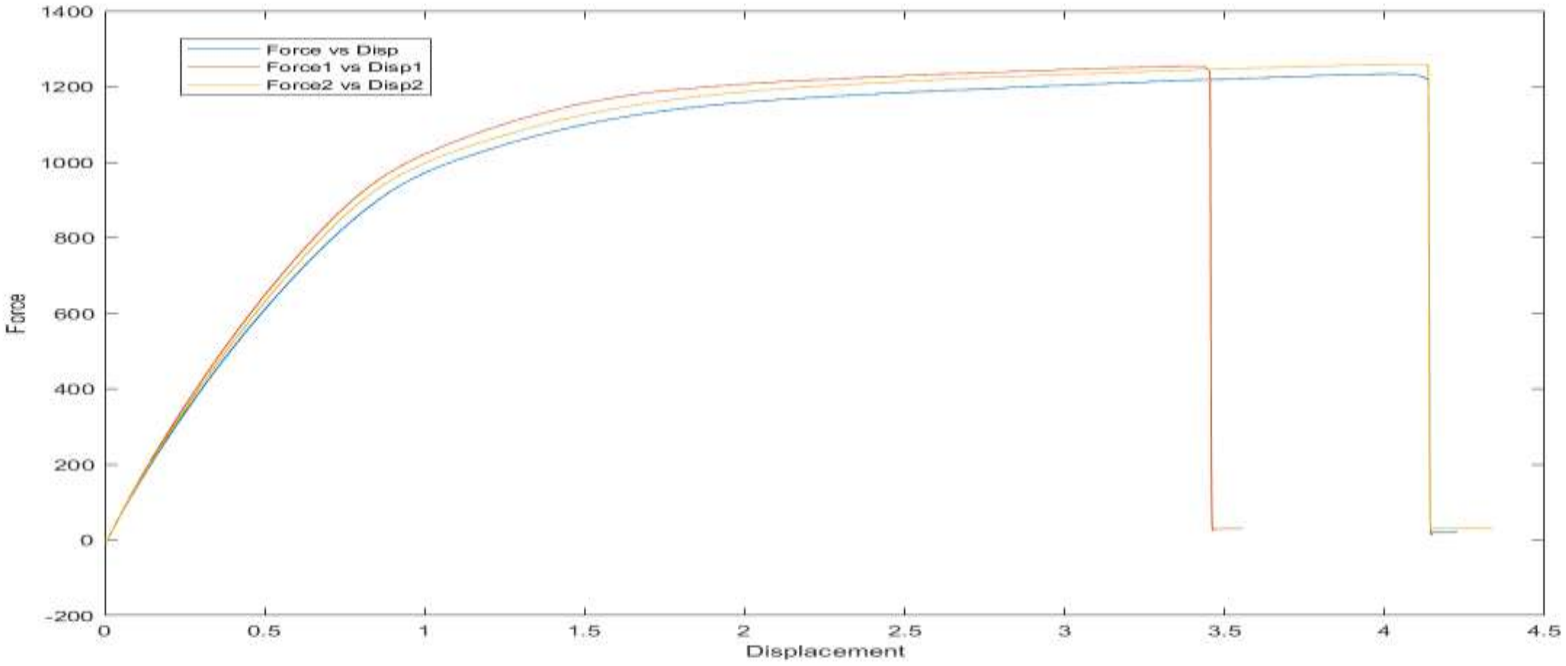
Force and Displacement Diagram

Results of Flexural test



Stress and Strain Diagram

Results of Flexural test



Force and Displacement Diagram

Discussion

- Bidirectional flax fiber orientation offers opportunities to tailor composite materials for specific applications, enhancing mechanical properties through strategic fiber placement.
- Incorporating bidirectional flax fibers in composite materials can improve mechanical properties such as tensile strength, stiffness, and impact resistance.
- By leveraging the benefits of flax fibers and optimizing their orientation in composite structures, engineers can create lightweight, sustainable, and high-performance materials suitable for a wide range of applications.

Conclusions

- The VARTM method can lead to improved mechanical properties, such as tensile strength, modulus, and energy absorption, compared to traditional manufacturing techniques.
- The results from the tensile and 3-point bending tests will help the discussion of the stress-strain and force-displacement graphs and will provide insights into the behavior of the composite under different loading conditions, which can be useful for designing and selecting materials for specific applications.

References

- Stefan Pichler, Günter Wuzella, Thomas Hardt-Stremayr, Arunjunai Raj Mahendran,Herfried Lammer. " **High-Performance Natural Fiber Composites Made from Technical Flax Textiles and Manufactured by Resin Transfer Molding**" Jul 2017 - Key Engineering Materials(Trans Tech Publications, Ltd.)

Acknowledgments

- The research on high-performance natural fiber composites using flax fiber and VARTM was conducted by Stefan Pichler, Günter Wuzella, Thomas Hardt-Stremayr, Arunjunai Mahendran, and Herfried Lammer.
- The research focused on manufacturing high-performance natural fiber composites using resin transfer molding (RTM) technique