Manufacturing and Stress Analysis of Glass Fiber Composite and Hybrid Natural Fiber Composite

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Abstract - *In this study, bamboo/jute green composites and glass fiber composites are to be fabricated and longitudinal and transverse tensile stress of laminate under tension for both composite have to be investigated. Also various composite manufacturing processes such as hand layup and vacuum bagging are performed in which vacuum bagging was used for manufacturing of glass fiber composite and hand layup process was used for manufacturing of hybrid natural composite . Selection of suitable manufacturing process is done and design of component based on ASTM standard of D3039. We manufactured natural fiber composite by using bamboo and jute fiber by stacking 3 layers of jute fiber and 3 layers of bamboo fiber alternatively by hand lay up process in three orientations 0-0°, 0-45°, 0-90° respectively. Stress analysis of this 3 orientations in longitudinal and transverse direction is done on Ansys 16.1 (ACP-PRE,POST)*

Key Words: **Natural fibers, green composites, tensile test, Bamboo fiber, Jute fiber.**

1. INTRODUCTION

The term composite is attribute to the combination of two or more constituents. The three constitutes of composite are reinforcement, matrix and interface. The reinforcement is load bearing member and composite, while the matrix is the binding medium for the reinforcement. Interface is the common contact surface between reinforcement and matrix. From types of fibers, composites are classified as synthetic fiber reinforced composites and natural fiber-reinforced composites. Synthetic fiber reinforced composites incorporate carbon fiber-reinforced plastic, glass fiber reinforced plastic, Kevlar fiber-reinforced plastic, and hybrid fiber-reinforced plastic. Natural fiber-reinforced composites implicate composites with rice husk, bamboo coir, cotton, sugarcane bagasse, jute, sisal, wool, hemp, etc. Synthetic fibers are fibers produced by a manufacturing process, while natural fibers are available readily on the earth. Natural fiber reinforced composites have been gaining much attention in various applications because of their biodegradability, low material cost, availability, and recyclability. In this project we are going to compare the transverse and longitudinal stresses of the natural and synthetic composites. Because of the high degree of complexity of analytical methods and limitation of their application for a wide variety of structures there were developed very much the numerical methods. Currently, the most widely used numerical method of calculation applied in field of analysis of composite structures is the finite element method (FEM). Finite element analysis software are continuously improved thereby in their library are included finite elements for analysis of composite structures. Therefore the main objective of the present study is

1. To manufacture hybrid natural composite and glass fiber composite.
2. To determine and compare the transverse and longitudinal stress of hybrid natural composite and glass fiber composite.

2. MANUFACTURING PROCESS

The goal in composite manufacturing is to produce components with the desired properties that combine the best properties of the fibers (or particles) and the resin while masking or minimizing their weaknesses. Nowhere is this truer than in composite manufacturing where one makes the properties while manufacturing the part.

There are many different manufacturing processes that have evolved to fabricate polymer matrix composites. These processes were modified or developed to address various needs such as (i) new fiber or matrix systems, (ii) new and improved initial precursor material forms, (iii) composite part geometrical constraints, (iv) cost-effectiveness, (v) multi- functionality of the part, (vii) enhancement of a specific physical, electric or mechanical property and (viii) defect constraints. The composite industry continues to engage in the development of new manufacturing processes that will allow them to fabricate composite parts with higher quality, reduced cost, and embrace emerging opportunities such as new reinforcement systems and new polymer matrix systems. One of the process is Hand lay- up process.[3]

Following are the different process of manufacturing:

1. Spray layup

2. Wet Lay-up/Hand Lay-up

3. Vacuum Bagging (Wet Lay-up)

4. Filament Winding

5. Pultrusion

6. Resin Transfer Moulding (RTM)

7. Other Infusion Processes - SCRIMP, RIFT, VARTM etc.

8. Prepreg – Autoclave

9. Prepreg - "Out of Autoclave"

10. SPRINT®/SparPregTM - "Out of Autoclave"

We used Vacuum Bagging (Wet layup) method for manufacturing of glass fiber composite and Hand lay up method for manufacturing of hybrid natural fiber composite.

Fig 1 : Vacuum bagging process

Fig 2: Hand layup process

3. SOFTWARE ANALYSIS FOR GLASS FIBER

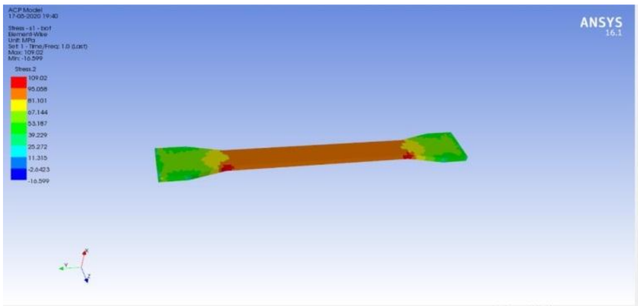

Fig 3: Longitudinal stress

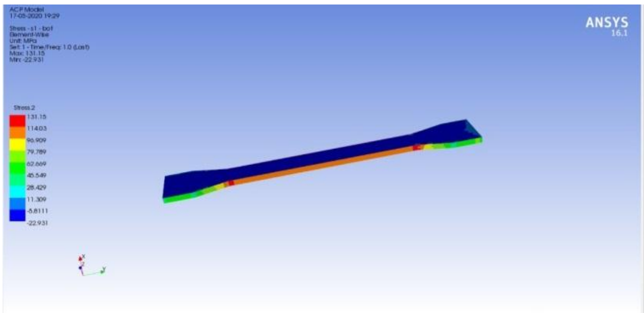

Fig 4: Transverse Stress

4. ANALYSIS OF HYBRID NATURAL COMPOSITE

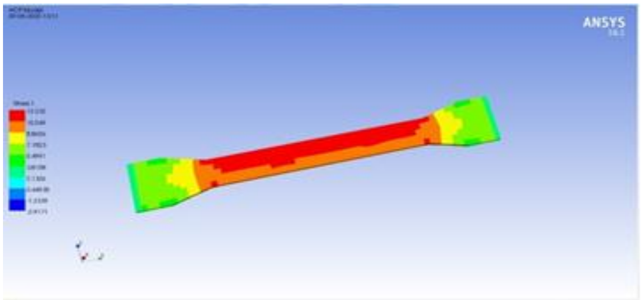

Fig 5: stress 0-0 longitudinal fiber direction

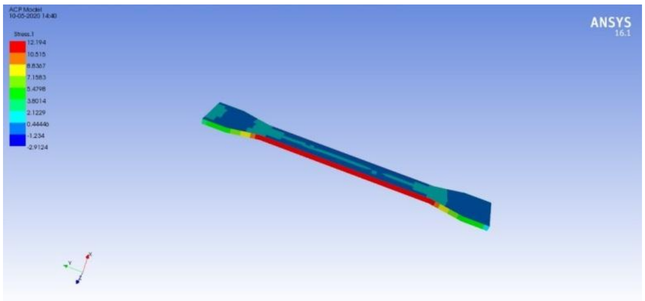

Fig 6: stress 0-0 transverse fiber direction

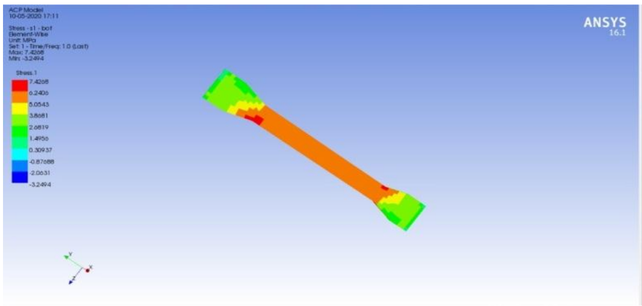

Fig 7 :stress 0-45 longitudinal fiber direction

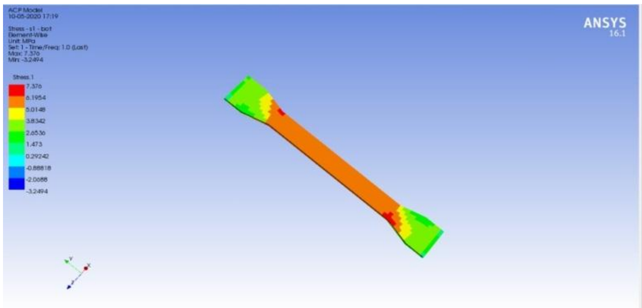

Fig 8 :stress 0-45 transverse fiber direction

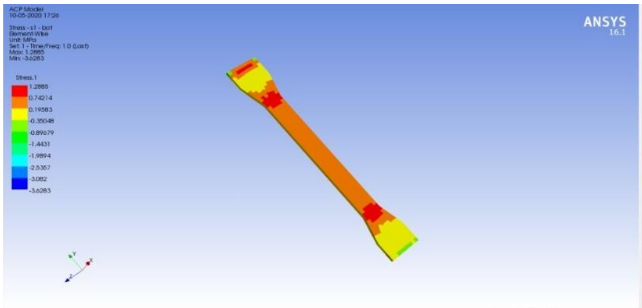

Fig 9 :stress 0-90 longitudinal fiber direction

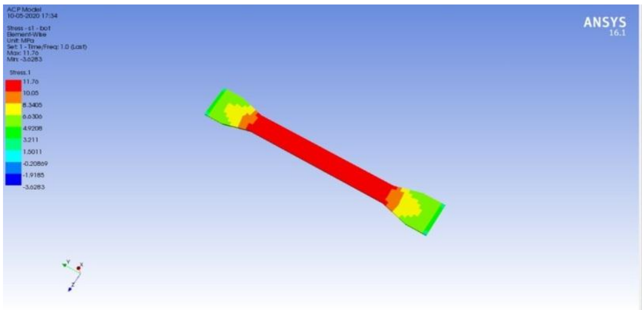

Fig 10:stress 0-90 transverse fiber direction

5. Result

a) For glass fiber

Table 1: Tensile stress of unidirectional glass fiber

Direction	Tensile stress (Mpa)
Longitudinal	109.2
Transverse	131.15

b) For hybrid natural fiber

Table 2: Tensile stress of hybrid natural composite

Orientation	Direction	Tensile stress (Mpa)
0-0	Longitudinal	12.232
	Transverse	12.194
0-45	Longitudinal	7.4268
	Transverse	7.376
0-90	Longitudinal	1.2885
	Transverse	11.76

6. Conclusion

a) In the different orientation of hybrid Natural composites thew largest value of tensile stress can be seen in the longitudinal direction of 0-0 orientation which is 12.232 MPa and the lowest can be seen in the longitudinal direction of the 0-90 orientation which is 1.2885 MPa.

b) From this we can conclude that 0-0 orientation of the bamboo and jute fibers are good for creating Hybrid Natural Composite from them and 0^o direction of jute and 90^o direction of bamboo is the worst.

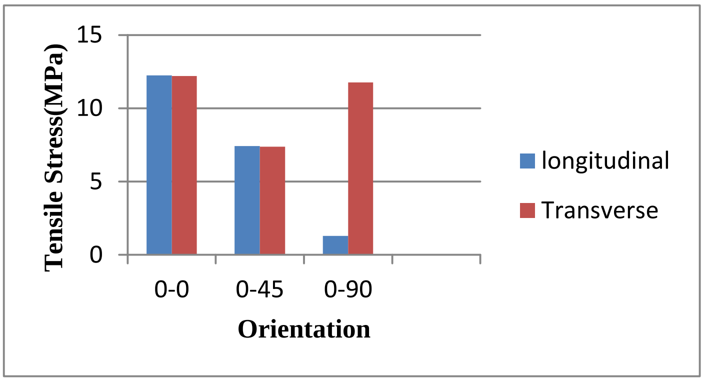

Chart 1: Tensile test on hybrid natural fiber composite

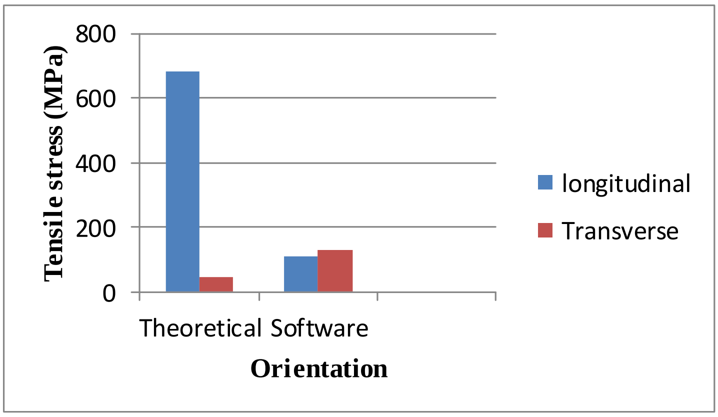

Chart 2: Tensile test on glass fiber composite

7. Future Scope

a) Use different manufacturing process such as resin infusion process to manufacture Hybrid Natural Composite.

b) Performing different tests on the composites using different orientation and combinations of natural fibers.

c) Hybrid natural composite can be made fully degradable by using natural resin

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