A Comparison Between Experimental And FEA Results Of Natural Fiber Composite

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Abstract: Composite materials are materials made from two or more constituent materials. It consists of a continuous phase called matrix, and a discontinuous phase called reinforcing material. Both matrix and reinforcing materials have significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual materials. Fiber composites materials offer a combination of strength and elasticity that are better than conventional metallic materials. The anisotropic nature of a FR composite material creates a unique opportunity of tailoring its properties according to the design requirements. Banana fiber composite using banana fibers and suitable matrix can be used in various applications. In order to the determine mechanical properties of the composite various methods can be used like experimental method, Analytical method and FEA methods. Every method has its own advantages as well as disadvantages. The present paper gives the comparison between experimental and FEA results of Banana fiber composite specimen in order find its flexural strength.

Keywords- Banana fibers, composite, FEA, flexural, matrix.

I. INTRODUCTION

1.1. Flexural Test

Flexure tests are generally used to determine the flexural modulus or flexural strength of a material. A flexure test is more affordable than a tensile test and test results are slightly different. The material is laid horizontally over two points of contact (lower support span) and then a force is applied to the top of the material through either one or two points of contact (upper loading span) until the sample fails. The maximum recorded force is the flexural strength of that particular sample.

Unlike a compression test or tensile test, a flexure test does not measure fundamental material properties. When a specimen is placed under flexural loading all three fundamental stresses are present: tensile, compressive and shear and so the flexural properties of a specimen are the result of the combined effect of all three stresses as well as (though to a lesser extent) the geometry of the specimen and the rate the load is applied.

The most common purpose of a flexure test is to measure flexural strength and flexural modulus. Flexural strength is defined as the maximum stress at the outermost fiber on either the compression or tension side of the specimen. Flexural modulus is calculated from the slope of the stress vs. strain deflection curve. These two values can be used to evaluate the sample materials ability to withstand flexure or bending forces.

1.2. Finite Element Analysis

Finite element analysis (FEA) is a computerized method for predicting how a product reacts to real-world forces, vibration, heat, fluid flow and other physical effects. Finite element analysis shows whether a product will break, wear out or work the way it was designed. It is called analysis, but in
the product development process, it is used to predict what's going to happen when the product is used.

Finite element analysis helps predict the behaviour of products affected by many physical effects, including:

- Mechanical stress
- Mechanical vibration
- Fatigue
- Motion
- Heat transfer
- Fluid flow
- Electrostatics
- Plastic injection moulding

II. PREPARATION OF SPECIMEN FOR FLEXURAL TEST

2.1 Raw Materials

2.1.1 Banana Fiber

Banana fiber is extracted from banana plant. Fiber from pseudostem and peduncle of four commercial cultivars of Tamil Nadu viz., Grand Naine, Poovan, Nendran were extracted using banana fiber extraction machine. Banana is a famous well known fruit especially in yellow colour all across the world. Today’s ancients thought giving amazing silk grade banana fiber by turning waste into profit. Banana fiber composed of cellulose, hemicellulose, and lignin so it’s like bamboo fiber but its finesse and spin ability are better than bamboo and ramie fiber.

2.1.2 Epoxy Resin

Epoxy resin has been a dominant matrix material used in the development of advanced composite materials because of its following excellent properties high strength, high adhesion, high electrical adhesion, low toxicity, low cost. It can be used to temperature as high as 175°C and are compatible with all common reinforcement. In general, uncured epoxy resins have only pure mechanical, chemical and heat resistance properties. This process is commonly referred as curing or gelation process.
2.2 Manufacturing Of composite

2.2.1 Hand Lay-up Technique

Hand lay-up strategy is the most straightforward technique for composite preparing. The foundation prerequisite for this technique is likewise negligible. The preparing steps are very basic. Most importantly, a discharge gel is splashed on the form surface to maintain a strategic distance from the adhering of polymer to the surface.

Thin plastic sheets are utilized at the best the base of the shape plate to get great surface complete of the item. Fortification as woven tangles or slashed strands mats are cuts according to the form measure and set at the surface shape after Perspex sheet. At that point thermosetting polymer in fluid shape is blended completely in reasonable extent with an endorsed hardener (curing specialist) and poured onto the surface of tangle put in the form.

The polymer is consistently spread with the assistance of brush. Second layer of tangle is then set on the polymer surface and a roller is moved with a mellow weight on the tangle polymer layer to expel any air caught and additionally the overabundance polymer show. The procedure is rehashed for each layer of polymer and tangle, till the required layer is stacked. Subsequent to putting the plastic sheet, discharge gel is splashed on the inward surface of the best shape plate which is then kept on the stacked layers and the weight is connected.

By using this method composite plate of desired size can be prepared.

![Figure 2.2 A schematic for hand lay-up technique](image)

2.2.2. Compression molding technique

Pressure shaping system to create assortments of composite items. It is a shut trim process with high weight application. In this technique as appeared in figure 2.6 two coordinated metal molds are utilized to create composite item. In pressure dis integrate; base plate is stationary while upper plate is versatile. Support and network are put in the metallic shape and the entire get together is kept in the middle of the pressure decay.

Warmth and weight is connected according to the necessity of composite for a positive timeframe. The material put in the middle of the embellishment plates streams because of utilization of weight and warm and procures the state of shape pit with high dimensional exactness which relies upon form outline. Curing of composite may did either at room temperature or at some lifted temperature. In the wake of curing, shape is opened and composite item is evacuated for additionally preparing. On a basic level, a pressure forming machine is a sort of press which is arranged vertically with two embellishment parts (best and base parts). For the most part, water powered instrument is utilized for
weight application in pressure forming. All the three measurements of the model (weight, temperature and time of use) are basic and must be advanced viably accomplish custom fitted composite item as each measurement of the model is similarly critical to other one. Thus composite plate is formed having thickness 4mm thickness.

Figure 2.2. Compression molding technique

III. SPECIMEN PREPARATION

Once the plate of banana fiber is formed, it is cut to prepare testing specimen. Flexural test specimen is prepared of required dimensions.

Flexural test specimen is prepared as per ASME with dimensions 127 mm length, 13mm width and 4mm thick.

Fig3.1.Specimen for flexural test

IV. EXPERIMENTATION

In order to determine the flexural strength of specimen prepared flexural test is carried on the specimen using UTM machine.

Flexural strength is defined as materials ability to resist deformation under load. This is also called as three point bending flexure. According to ASME standards the test specimen was prepared and used for testing on three point bending machine. The distance between supports was kept at 16 times thickness of specimen. From this test, flexural strength is determined. Maximum load at failure was used to determine flexural strength.
In flexural strength top layers are in compression whereas bottom layers are in the tension. After completion of test flexural strength of Specimen is found to be 49.57 MPa. Load Vs Displacement(elongation) values of flexural test are plotted as given below.
Specimen after failure is as shown below.

Fig. 4.2. Load v/s Displacement plot

Fig. 4.3. Specimen after failure
V. FINITE ELEMENT ANALYSIS (FEA)

FEA is done on ANSYS workbench 16.2 Software. Input given to the software are material properties and boundary conditions. For the given specimen density, Young’s Modulus and Poission Ratio taken as,

| Property                      | Value  |
|-------------------------------|--------|
| Density (kg/m³)               | 1350   |
| Young’s modulus(GPa)          | 3.5    |
| Poission ratio                | 0.25   |

Table 5.1 Properties of composite material

Support locations are given as follows

![Support Location Diagram](image)

Using above conditions specimen can be analysed in software (ANSYS Workbench 16.2). It gives following results.

![Results from software](image)

Hence using FEA the Flexural strength of specimen found to be 44.33 MPa.

VI. RESULT TABLE

| Compressive Strength Of specimen | From Experiment | From FEA |
|----------------------------------|-----------------|----------|
| From Experiment                  | 49.57 MPa       | 44.33 MPa |

Fig.5.2. Results from software
VII. CONCLUSION
There is difference in FEA results and Experimental result due to manufacturing defect in Hand lay up process. This difference can be minimized reducing defects in hand lay up process. In order minimize the defects causes behind those defects should be recognized. Porosity is one of the common defects in the composites. Porosity is the presence of small voids in the matrix. Porosity can be caused by incorrect, or non-optimal, cure parameters such as duration, temperature, pressure, or vacuum bleeding of resin. Infusion of resin into pre-formed dry fibers in moulds, have introduced other potential defects such as fiber misalignment, or waviness, both in the plane of the material and out-of-plane. Stitching of fiber tows (bunches of fibers), to hold them in place and prevent misalignment during cure, can itself introduce numerous regularly-spaced sites for void formation. These defects should be detected properly and should be minimized.

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