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# STRUCTURAL EFFECTS OF VARIOUS NATURAL COMPOSITE MATERIAL LYRES ON THE CANTILEVER STRUCTURE

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**Abstract:**
Due to its high strength-to-weight ratio, versatility, and non-corrosive nature, composite materials are extensively utilized in low-weight construction and can be considered an acceptable substitute for metals by all parties in the aviation sector. It has been tested under static load, with the same circumstances and stress, but with the layer order altered. Analyzing the material is accomplished with the help of the Ansys workbench ACP-pre. Because of this, various deformations were identified in the results. A value of 14.265 and 0.1235, respectively, is found in the composite 3 illustrations for the minimal z-direction deformation and the minimum overall stain.
**Keywords**: Natural fibre, Natural composite, finite element method

## Introduction

Fibre-reinforced composites (FRCs) have been shown to have a wide range of uses in a variety of industries, including automotive, aerospace, and defense, and are increasingly replacing traditional metallic structures [1]. Long-term projects that don't harm people or the environment are becoming increasingly popular as people become more environmentally conscious. A more environmentally friendly world will be achieved [2] as a result of increasing environmental consciousness. Natural fibers with specific characteristics can be stronger than synthetic fibers in composites in some instances [3]. Natural fiber-reinforced composites are low-cost and, because to their biodegradability, can reduce pollution in the environment [4]. Lignocellulose, a natural fiber component, enhances the matrix bonding of natural fiber. For example, natural fibers have been demonstrated to be non-abrasive and regenerative while also being lightweight, absorbing $CO_2$ during the growing process, and requiring less energy to process [5]. [7]. The combination of natural fibers reinforced with synthetic fibers is an excellent choice among fiber groups. Natural fibers such as kenafs, jute fibers, and cacti [8] are inexpensive, widely available, and simple to remove.

Composite specimens made from five distinct types of fibers were the subject of investigation by Dixit and Padhee [9]. Natural fibers (kenaf, jute, cactus) and synthetic fibers are examples of widely used fabrics (carbon glass). When they combined these fibers, they were able to undertake a FEM analysis. It is possible to mix and match various configurations. Following the design of the specimen, the Mechanical APDL ANSYS is used to perform a variety of finite element methods analysis by applying a point load to the specimen. The deflective effects of hybrid composites were compared in the existing study under the identical loading circumstances. In the long run, it may help to make hybrid composites more long-lasting. A high-resistance material could also be made using a composite material of excellent quality.

Using the film stacking compression molding method, Wambuaet al.[10] investigated reinforced polypropylene composites of natural fibers (sisal, kenaf, hemp, jute, and coir). The diverse natural fiber composites' mechanical characteristics were examined and compared. The characteristics of polypropylene composites of glass-

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reinforced open-literature polypropylene have been shown to be similar. Sisal, Kenaf, and hemp composites all have similar modulus and tensile strengths. However, hemp's effect characteristics appear to outperform kenaf's. Improved kenaf-reinforced polypropylene composite impact strength, modulus and ultimate tensile stress can be achieved by increasing the mass fraction of the fibers. Although the mechanical properties of coir fiber composites are lower than those of kenaf and jute, their impact strength is higher.
[11] Rao and colleagues investigated the tensile, dielectric and flexiural properties of composite materials made by using vakka as a novel natural fiber in the polyester resin matrix. Hand-processed and reset fibers were utilized to make fiber composites for composites. Current composites such as kenaffiber and bamboo fiber have their tensile, flexural, and dielectric properties compared to these newer composites. When it comes to tensile and flexural/dielectric testing, composites should have a total fiber fraction volume of 0.37 and 0.39, respectively. Its flexural strength is superior to that of the kenaf composite and is comparable to that of the sisal fiber composite in terms of volume fraction of the fiber. Compared to kenaf sisal and bamboo composites, the dielectric strength of vakka composite fiber increases as the volume percentage of composite fiber increases. Kenaf, kenaf, and kenaf/kenaf hybrid polyester composites' mechanical characteristics were examined by Alavudeenet al.[15] using weaving patterns and random orientation. Two unique weaving patterns, the plain and the twill shape, were used to create the composites. Compared to the twill weave, the flat weave showed improved tensile performance in all composites. Additionally, single woven hybrid composites showed the greatest gains in mechanical strength when compared to random-oriented composites. In this way, the stress on the composite interface will be minimized because of the fiber-to-fibre transfer of load. NaOH (NaOH) and sodium lauryl sulphate (SLS) treatments, on the other hand, attempt to increase mechanical strength by improving interfacial bonding between the two surfaces.

To make composite materials, four different types of organic fibers are discussed in this work. Ansys' ACP-pre Workbench is used for the structural analysis. It was possible to make composites by varying their ordering, but keeping the same needs and loads that are common to composites. The study's findings will pave the way for the development of stronger composites made from fibers that are identical to those used in the original product. In order to determine how a composite can be made, it is important to select the correct model for the material's design. Kenaf, jute, pineapple, and sisal fibers are laminated five times to make composite paper.

## Numerical solution

Engineering model :
Ansys ACP-mechanical pre's qualities were being tested with this specimen. The specimen's breadth is 20 mm, and its length is 200 mm. There is a wide range of material attributes available in the literature [12]. This sample was opened to 0 degrees and removed from its left to right end. The laminate had a thickness of 0.25 mm, and there were four layers altogether in the design. And the thickness of the entire specimen is 1 mm. Figure 1 shows how the spacers should be used. The

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composite direction (-y) is then applied with a force of 1000 N when all of the above conditions have been met. The composite fixed end and the force direction are shown in Figure 2. This composite has no depth of field (DOF) in any direction.

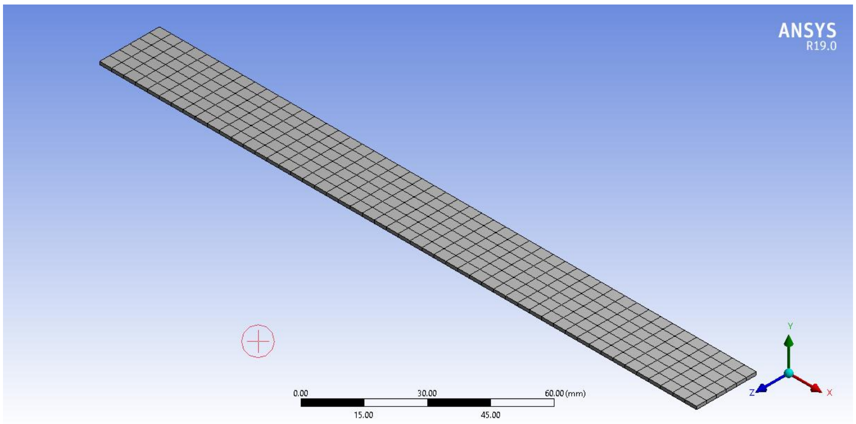


**Figure 1. Spacemen after refinement mesh.**

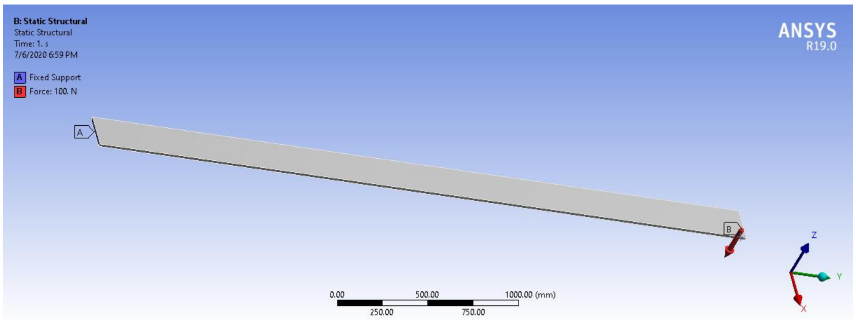


**Figure 2. Fixed support and force direction.**

Numerical modeling

Engineering research relies heavily on numerical simulation technologies because of its unique properties, such as low cost, reliable performance and ease of use. Because of its adaptability, modern computer simulation techniques are becoming increasingly used nowadays. Numerical simulation is also employed in the ACP Workbench 19, a highly specialized procedure for processing composite materials.

[13] ANSYS ACP 19 has a good ability to develop strengthening and its varied directions. ANSYS ACP 19 was subjected to the orthotropic property assignment procedure. With the addition of a matrice, laminate development will eventually become more user-friendly. In order to avoid using an experimental procedure, the facility must ensure the dependability of the composite analysis tests. ANSYS Design Modeler 19 was used to create the basic design of the test sample, and Ansys Mesh was used to discretize the tensile test sample. Ansys ACP 19 is used

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for internal structural analysis of matrix and fibers in composite numerical analysis instead of laminate analysis. Table 1 shows the fibers' properties.

Table 1: Natural fibre properties

| Properties | Sisal | Pineapple | Jute | Kenaf |
|---|---|---|---|---|
| E (GPa) | 604 | 1020 | 486.5 | 641.5 |
| Posionrario | 0.325 | 0.37 | 0.38 | 0.28 |
| Density (kg/m3) | 1450 | 1440 | 1300 | 1350 |

## Results and discussions

### Convergence Test

Sandwich structure has been conducted as preprocessing in ANSYS 16.1 using vibration response tool .in this research meshed model has been created locally. The current type of elements is satisfied with linear loads .As shown in figure 3 seven solutions with different number of elements have been conducted with same applied load 100 N and the out put with a total deflection . Based on the results that has been collected from simulation. the curve of become horizontal at 0.32mm (total deflection )with a 11,564 elements. This test has proven that the meshed model is converged.

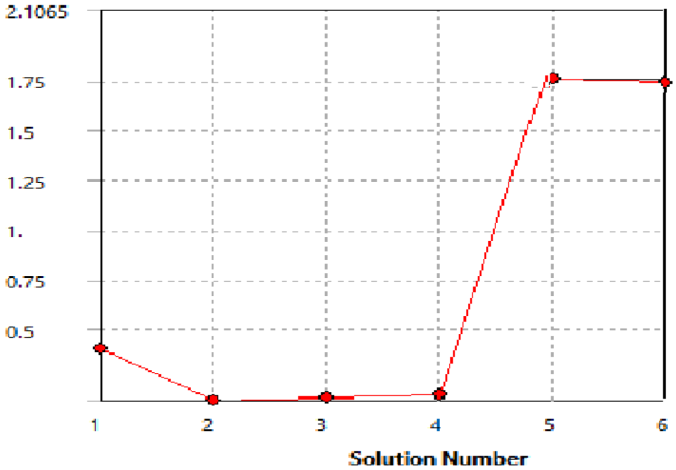


**Figure .3 Convergence test of the cantiliver model in terms of Total Deflection**

### 3.2 Normal tests

ACP Ansys was used to finish critical phases such as fiber construction, component assignment, rosette generation, orientation set-up initialization, fold grouping and solid model building once the discretization procedure was successfully completed. Strengthening and categorizing mechanical properties are the main focus of fabric design. Fiber guiding and cantered configuration are made possible by the rosette. The laminate is pointed in the right direction thanks to this procedure. Students in the modeling sessions worked together to perfect the folds' angles and thicknesses. In the end, the laminate will be properly produced by joining the allotted fibers in the

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matrix using the solid model. Ansys, a static structural analysis tool, is ready to solve FEM's problem. Because of this static structural framework, the support procedure's external charge operation process was made possible [14]. A cantilever chain serves as the test sample, with a tensile load of 1000 N applied to one end and a tensile load of 1000 N applied to the other. Post-processing has been completed in a static structural system where strain energy, directional deformation, and total deformation were plotted and indicated.

Numbers like "Pineapple" as 4, "Sisal" as 3 and "Jute" as 2 are used to help explain the composite nature of these fibers. Table 2 displays the final composite ranking.

**Table 2: Composite order**

| Composite no. | Layup order |
|---|---|
| First layer | 1 |
| Second layer | 2 |
| Third layer | 3 |
| Fourth layer | 4 |

Figures 3-6 depict test specimens with lateral abnormalities such as Z, Y, and X (kenaf, jute, sisal, and pineapple). The cumulative energy of the strain in the test specimen, as shown in Figure 7, is shown.

Compound 1 has a minimal overall deformation, while composite 2 has a minimum x-direction deformation, composite 3 has a minimum y-direction deformation, and composite 1 has a minimum total deformation, according to Table 3. The energy content of Composite 1 is higher as well.

**Table 3: Deformation due to loud**

| No. | x | y | z | Total deformation | Total strain |
|---|---|---|---|---|---|
| First layer | -11.3 | -0.3 | 21.1 | -2.35 | 0.14 |
| Second layer | -12.33 | -0.4 | 22.2 | 1.254 | 0.23 |
| Third layer | -34.11 | -0.45 | 15.35 | -0.56 | 0.98 |
| Fourth layer | -24.23 | -0.465 | 15.1 | -0.90 | 0.12 |

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## Total deformation effects

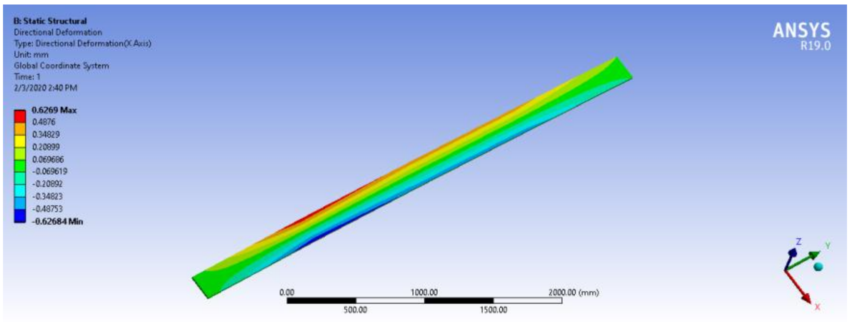


**Figure3. X-directional deformation**

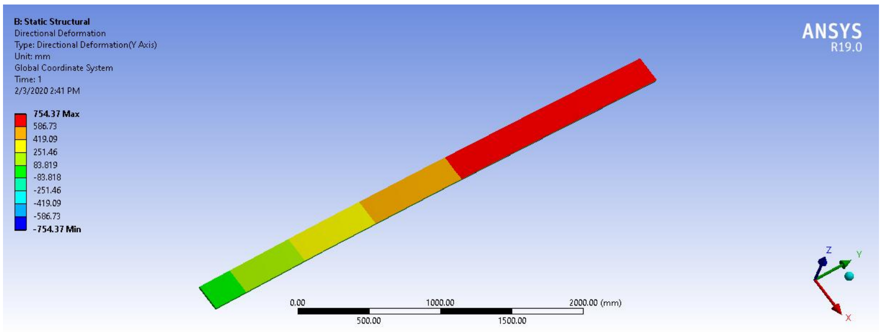


**Figure4. Y-directional deformation**

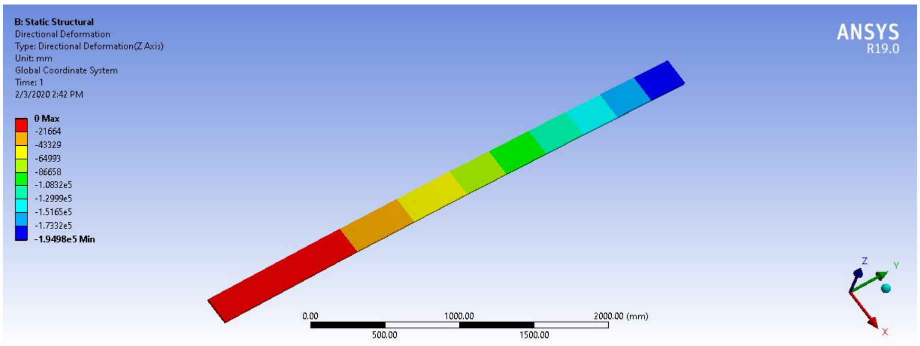


**Figure5. Z-directional deformation**

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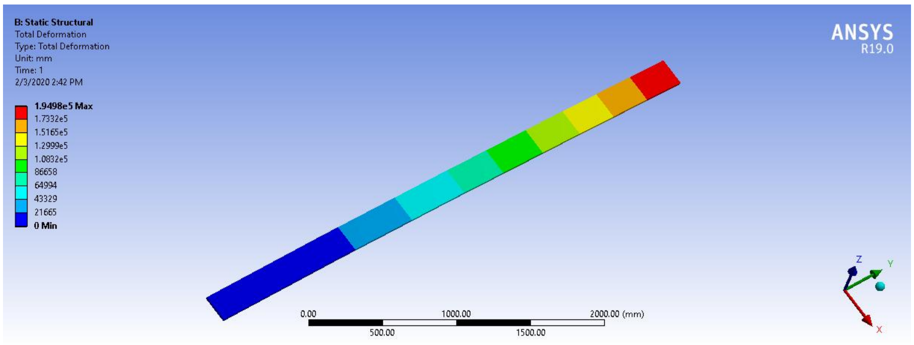


**Figure 6 Total deformation**

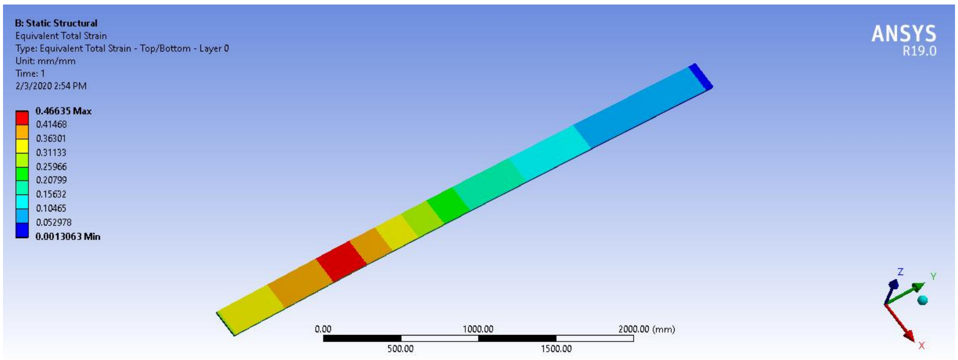


**Figure 7. Total strain**

### 3.3 Von-Mises effect

Von-misses stress has been conducted to assess the capabilitythe cantilever's structure to the different loads. In this study, four attempts with four different layers of the composite have been analyzed accordingly as shown in figure 8.

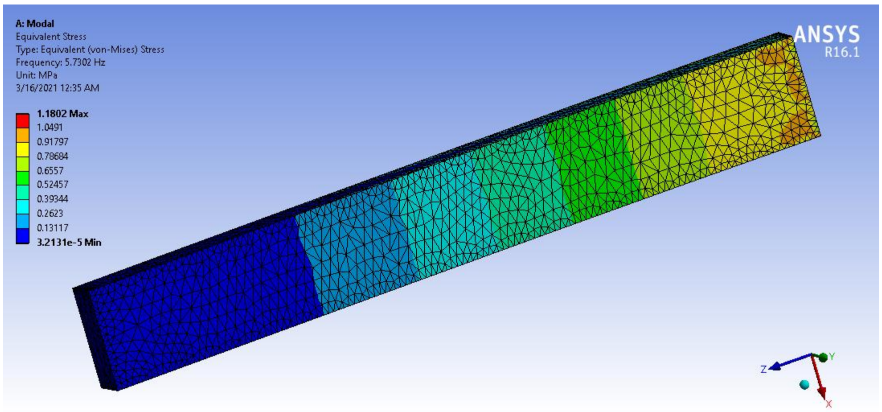


**Figure 8. Von-Mises stresses**

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## 4. Conclusion

Ansys workbench ACP-pre is used in this article to demonstrate a finite element simulation. Natural and composite materials have been tested for their properties. To summarize, composite 3 has the lowest z-direction deformation and the smallest total stain. In order to construct a composite built entirely from a variety of natural fibers, one can use composite 3 (Pineapple-Sisal-Jute-kenaf). Organic fibers, despite the fact that they all contain cellulose, have different mechanical properties. Deformation in the z axis was seen in composite 1 (kenaf, jute, sisal, and pineapple), while the largest strain was found in composite 2.

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