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# **Investigation on Mechanical Properties of Epoxy Ly556 Resin Reinforced with Coir and Sunflower Seed Shell Fiber Composite**

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**ABSTRACT:** This project looks at how the strength, tensile, hardness, and impact of epoxy ly556 resin reinforced with coir and sunflower seed shell natural fiber—which is obtained from agricultural waste—can be improved. Tensile, hardness, and impact tests were performed on three composite samples with varying weight proportions of coir and sunflower seed shell fiber in order to evaluate this improvement. The specimens used an exact resin ratio of 10:1.5, and the proportions for coir and sunflower seed shell were 1-SSS 75%, Coir 25%, 2-SSS 50%, Coir 50%, and 3-Coir 75%, SSS 25%. According to the findings, mechanical characteristics significantly improve when the amount of coir fiber is increased. With a larger percentage of coir than Sample 1, Sample 2 showed a 6.36% improvement in hardness and a 14.28% rise in tensile strength. With a tensile strength increase of 46.15% and a hardness increase of 7.76% over Sample 2, Sample 3, which contained the most coir, showed the largest increases. Additionally, the flexural strength increased by 2.18% from Sample 2 to Sample 3, and the impact strength increased by 33% from Sample 1 to Sample 3. Overall, the study shows that coir and sunflower seed shell fiber composites have significant mechanical advantages, making them robust, sustainable material choices for a variety of environmentally friendly applications.

**KEYWORDS:** Coir fiber, Sunflower seed shell fiber, Mechanical testing, SEM Analysis

## **I. INTRODUCTION**

The usage of natural fibers in composite production has significantly increased as a result of the growing demand for sustainable materials. Natural fibers, such as those from sunflower seed hulls and coir, provide a number of benefits over synthetic substitutes, such as improved mechanical qualities, low density, and biodegradability. Because of their durability and moisture resistance, coir fibers—which are made from coconut husks—can be used in a wide range of applications. In the meanwhile, sunflower seed hull fibers help reduce waste and promote environmental sustainability because they are lightweight, renewable, and derived from agricultural waste.

The mechanical qualities and longevity of fiber-reinforced composites are improved by the use of epoxy resins, especially epoxy LY556, as a matrix material. Epoxy resins are perfect for manufacturing composites that can survive tough climatic conditions because of their exceptional adhesion, chemical resistance, and long-term stability. In addition to enhancing the composites' performance, adding natural fibers to epoxy matrices supports the growing movement to create environmentally responsible materials.

The microstructural and mechanical improvements of composites made of coir and sunflower seed hull fibers are the main goals of this project. The study intends to ascertain their applicability for a range of industrial applications by assessing their mechanical strength and durability.

This study uses Scanning Electron Microscopy (SEM) to examine the microstructural alterations in the fibers in addition to the mechanical evaluations. The knowledge gathered from this research will help advance the creation of novel materials that promote sustainable development by advancing our understanding of the efficient use of natural fibers in composite technology. This study aims to evaluate the mechanical

characteristics, microstructural alterations, and durability of composites made of coir and sunflower seed hull fibers. The ultimate goal of this project is to show how natural fiber-reinforced composites may be used as practical substitutes for conventional materials and emphasize how they can help create a more sustainable future.

Notwithstanding the benefits of coir and sunflower seed hull fibers, inadequate fiber-matrix bonding frequently results in composites with uneven mechanical qualities. Their performance in demanding applications is hampered by problems including limited flexural strength, impact resistance, and tensile strength. Furthermore, the potential of these agricultural waste fibers as sustainable material sources is limited by their underutilization. In order to create long-lasting, high-performance composites, this research optimizes fiber proportions and improves fiber-matrix interaction.

## II. MATERIALS AND METHODS

In order to create sustainable composites, this study used natural fibers, coir made from coconut husks, and sunflower seed shells from agricultural waste, reinforced with epoxy LY556 resin and hardener (HY951). To maximize mechanical qualities, the fibers were cleaned, processed, and prepared in particular ratios (25:75, 50:50, and 75:25 of coir and sunflower seed shells). The fibers were manually combined with the epoxy matrix, put into molds, then compacted to eliminate air bubbles using the hand layup technique. After that, the specimens were cured to acquire the required characteristics. The performance of the composites was assessed mechanically using tensile, flexural, impact, and hardness tests, demonstrating the promise of these environmentally benign materials for long-lasting and high-performance applications.

## III. PROPORTIONS

S.NO	COIR HUSK FIBER	SUNFLOWER SEED SHELL FIBER	EPOXY	HARDENER
1	Coir: 7.5g (25%)	Sunflower seed shell 22.5g (75%)	50ml ( 55g)	7.5ml ( 7.125g)
2	Coir: 15g (50%)	Sunflower seed shell: 15g (50%)	50ml ( 55g)	7.5ml ( 7.125g)
3	Coir: 22.5g (75%)	Sunflower seed shell: 15g (25%)	50ml ( 55g)	7.5ml ( 7.125g)

## IV. EXPERIMENTATION

### 4.1. Sample Preparation

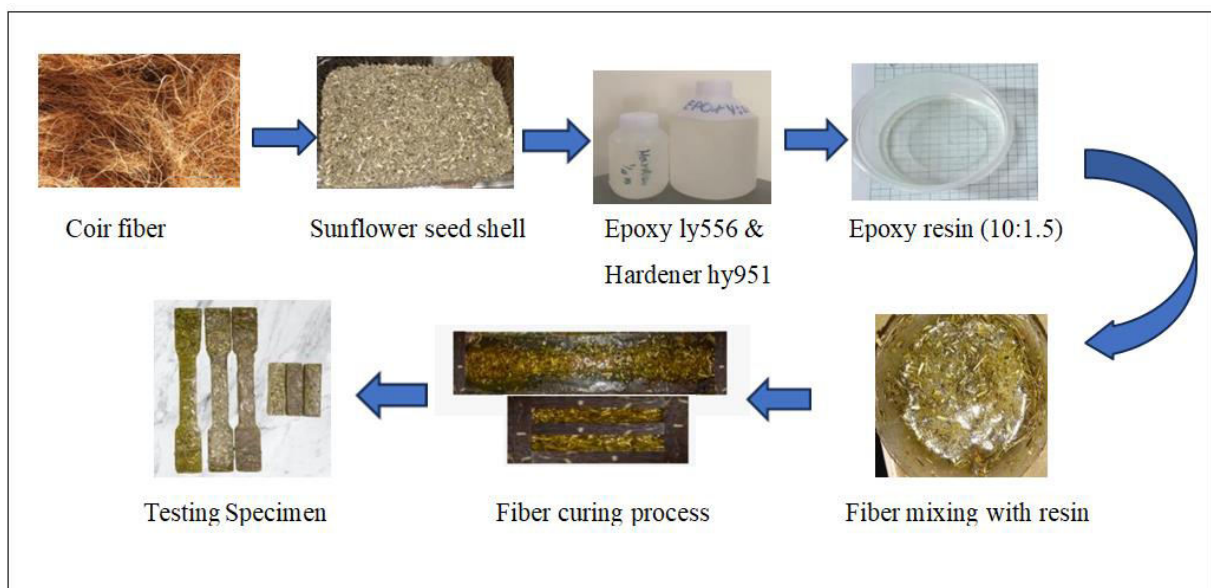
The extraction and processing of fibers is the first stage in the methodical process of creating composite specimens of sunflower seed shell and coir fiber. To improve their compatibility with the resin matrix, sunflower seed shells—a byproduct of agricultural waste—are gathered, cleaned to get rid of contaminants, dried to get rid of moisture, and ground into small particles. The fibers of coir, which are made from mature coconut husks, are separated by mechanical beating after the husk has been softened by retting (soaking), and they are subsequently cleaned and dried. In the composite, these fibers act as reinforcements. Epoxy resin (LY556) and hardener (HY951) are combined precisely in a weight ratio of 10:1.5 to create the matrix. To ensure correct chemical bonding during curing, 55 g of epoxy resin and 7.125 g of hardener are measured using a digital scale, combined in a clean container, and vigorously swirled to create a homogenous mixture.

The prepared fibers are added gradually to the resin-hardener mix to ensure even distribution, resulting in a uniform composite matrix. The mixture is then degassed using a vacuum chamber or by gently tapping the container to remove air bubbles that can affect the composite's structural integrity. Before casting, molds are treated with a release agent to prevent the composite from adhering to the mold surface. The fiber-resin mixture is poured into the mold and spread evenly to minimize voids. The specimens are allowed to cure at room temperature for 24-48 hours,

or per the manufacturer's recommendations, to achieve optimal mechanical properties.

The specimens are carefully demolded, trimmed, and finished to match the specifications needed for testing or use after curing. Composite samples with a well-bonded fiber-matrix interface are created by this method, making them appropriate for assessing mechanical attributes like impact resistance, hardness, and tensile strength. This preparation technique shows an environmentally responsible way to create high-performance, sustainable composites for a variety of uses by utilizing agricultural waste materials.

#### 4.2.FIBER COMPOSITE MAKING PROCEDURE



#### V. MECHANICAL TESTING

This test's objective is to determine the composite's tensile strength. ASTM D638 requirements were satisfied by the 180 x 20 x 6 mm<sup>3</sup> specimen dimensions employed in the tensile test. At both ends of the test, the specimen is constantly loaded in a single direction until it splits in two. As seen in the image below, an INSTRON 4297 DUAL COLUMN FLOOR MODEL Universal Testing Machine was used to conduct the test. 50 mm per minute was the straining rate for the samples.



Fig (a) Tensile testing

The composite material's hardness, or its ability to withstand having its surface indented or punctured. The length of the reading increases with the difficulty of the subject. As seen in the figure below, the Shore D° Hardness Testing Machine was used for the tests. Up to 150 kg of weight can be supported by the machine. The measurements of the specimen (50 x 50 x 6 mm<sup>3</sup>) were established in compliance with ASTM D2240 specifications. The specimen's hardness can be determined by comparing the dial readings under significant stress and under preload.



Fig (b) Impact testing

The purpose of this test is to evaluate the specimen's toughness or impact strength of the composite. For this test, a specimen with a notch is facing the swinging hammer while it is fixed in the anvil. After being raised to a preset height, the hammer strikes the specimen with the notch immediately. The specimen's impact strength is the maximum amount of energy it can withstand before breaking under impact. Additionally, the specimen's notch sensitivity is assessed using this technique. As shown in the following Fig., the test was run using TINIUS OLSEN IT504. The impact test specimen's measurements (55 x 10 x 6 mm<sup>3</sup>) were in accordance with ASTM E23 specifications.



Fig (c) Shore D° hardness testing

## VI. TESTING SAMPLES



Fig (d) Before testing samples



Fig (e) After testing samples

The results of testing the composite samples provided important information about their mechanical performance. Better tensile strength, hardness, and impact resistance were shown by samples with higher coir fiber content, underscoring the contribution of coir to increased durability. The best-performing sample had improved bonding and structural integrity together with a balanced fiber distribution. Nonetheless, certain specimens displayed holes and gaps at the fiber-matrix interface, suggesting processing areas that need improvement. These results highlight the need for optimal fabrication procedures to obtain consistent performance while confirming the potential of coir and sunflower seed shell composites as environmentally friendly materials with intriguing applications.

## VII. TABLE OF REPORTS

S NO	Name of the testing	Method of testing	Sample 1	Sample 2	Sample 3
1	Tensile test (Mpa)	ASTM D 638	4.8	5.6	10.4
2	Impact Strength ( J )	ASTM D 256	3	4	6
3	Shore D° Hardness	ASTM D2250	59	63	68

VIII. TESTING RESULTS

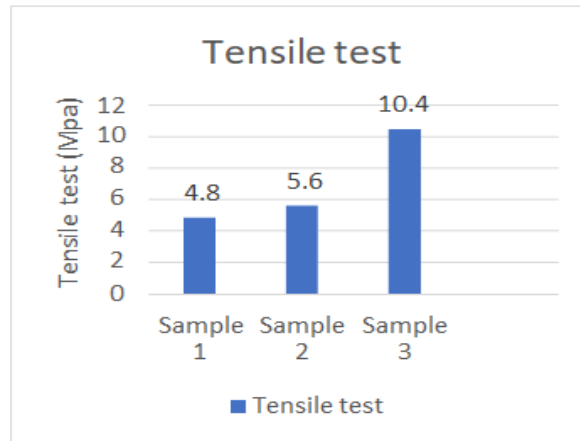


Fig (f) Tensile testing

The main reason we chose hybrid fibers for this testing, including coir and sunflower seed shells, is to improve mechanical qualities like hardness, impact resistance, and tensile strength. Three samples were made, and the mechanical qualities improved as the amount of coir fiber raise. The following are the samples' tensile strength values: The values for Samples 1 and 2 are 4.8, 5.6, and 10.4, respectively. Sample 2's tensile strength increased by 14.28% in comparison to Sample 1, whereas Sample 3's tensile strength increased by 46.15% in comparison to Sample 2.

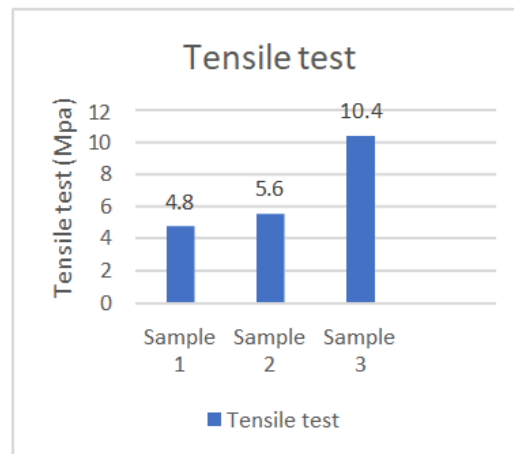


Fig (g) Hardness testing

The primary cause that we selected hybrid fibers, such coir and sunflower seed shells, is to improve mechanical qualities like hardness, impact resistance, and tensile strength. Three samples were made, and the mechanical qualities improved as the amount of coir fiber raise. The samples' hardness values are as follows: The values for Samples 1 and 2 are 59.3, 63.33, and 68.66, respectively. Sample 2's hardness increased by 6.36% in comparison to Sample 1, whereas Sample 3's hardness increased by 7.76% in comparison to Sample 2.

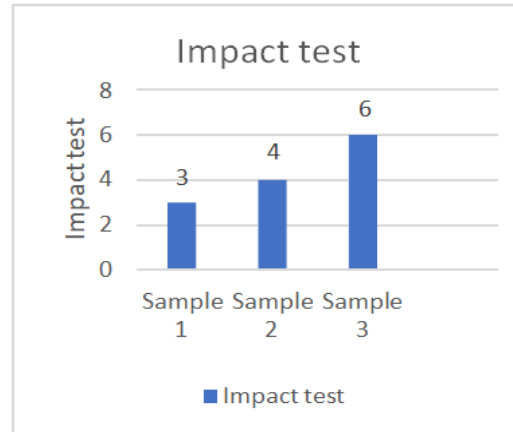
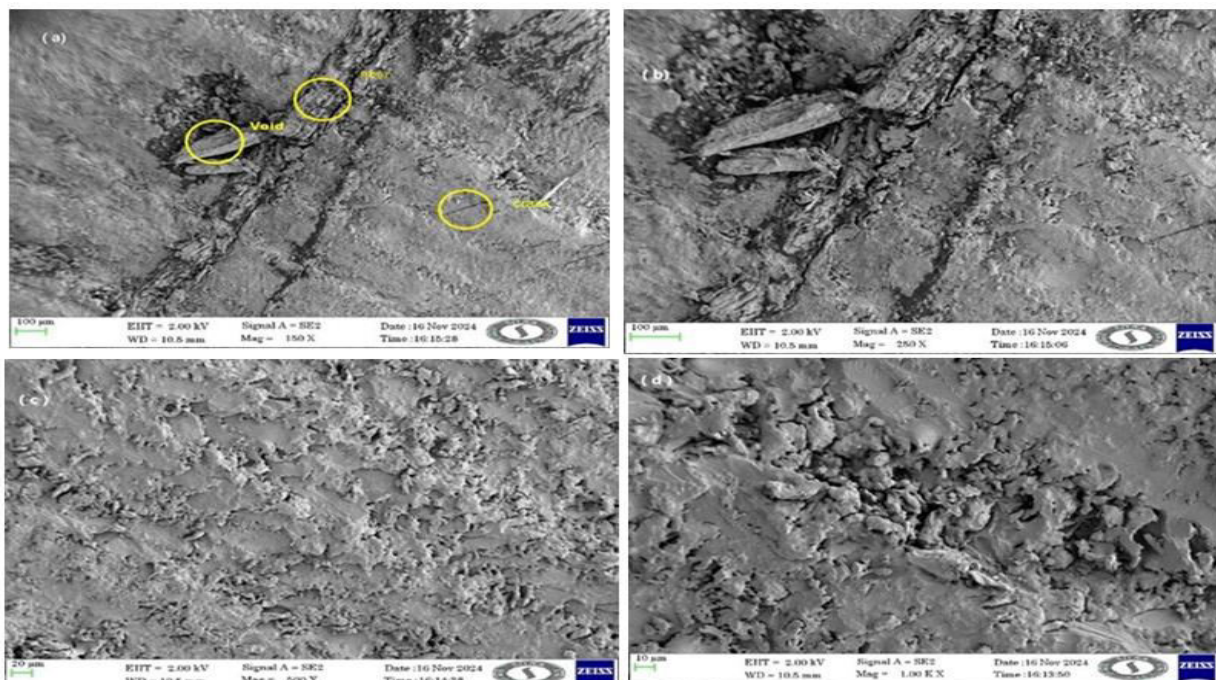


Fig (h) Impact testing

The main reason we chose hybrid fibers, such as coir and sunflower seed shells, is to improve mechanical properties like hardness, flexural strength, impact resistance, and tensile strength. Three samples were made, and the mechanical properties improved as the amount of coir fiber rose. The samples' Impact Strength values are as follows: The values for Samples 1 and 2 are 3, 6, and 4, respectively. Sample 2 had a 25% increase in impact strength over Sample 1, while Sample 3 had a 33% increase in hardness over Sample 2.

### IX. SEM TEST ANALYSIS



Significant information about the microstructural characteristics of the composite made up of 75% coir fibers and 25% sunflower seed hulls was uncovered by the SEM investigation. A well-mixed composite was indicated by the fibers' apparent rather uniform dispersion inside the epoxy matrix and their lack of clumping. However, there were obvious gaps and cavities at the fiber-matrix interface, indicating inadequate bonding, which could have a negative impact on the mechanical performance of the composite. While the sunflower seed hull particles had sharp edges and irregular forms that contributed to stress concentration areas, the coir fibers showed a natural surface roughness

that might help with mechanical interlocking. Furthermore, little porosity and flaws were apparent, which could affect the composite's overall durability and strength. These results emphasize that in order to increase the structural integrity of the composite, processing conditions must be improved. The SEM study also showed that although the fiber distribution in the composite was largely uniform, there were noticeable localized bonding irregularities, especially at the fiber edges. The load-bearing capacity of the composite may be lowered by these areas of poor adhesion, which are likely to serve as the starting locations for cracks under mechanical stress. Additionally, the uneven forms of the sunflower seed husk particles point to the necessity of improved pre-processing methods, including finer grinding, in order to reduce stress concentrations. By addressing these issues with better surface treatments and processing techniques, the composite's durability and structural performance could be greatly increased.

### X. CONCLUSION

The study successfully demonstrated that using coir and sunflower seed shell fibers as reinforcements in epoxy LY556 resin improved the composite's mechanical properties, including tensile strength, hardness, impact resistance, and flexural strength. Increasing the proportion of coir fiber in the hybrid composite led to significant enhancements in these properties, indicating that the hybridization of coir and sunflower seed shell fibers results in strong and eco-friendly composites. Furthermore, the saline treatment contributed to better fiber-matrix bonding, addressing issues such as poor interfacial adhesion and mechanical performance. This research highlights the potential of natural fibers derived from agricultural waste to create sustainable, high-performance composites for various applications.

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