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Determination of mechanical properties of Natural fibers reinforced with epoxy composite filled with groundnut shell powder

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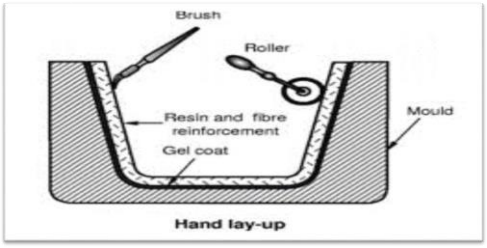
Abstract:
This study effort offers a thorough examination of the mechanical characteristics displayed by epoxy composite containing groundnut shell powder and natural fiber from sisal, jute and pineapple plants. The goal of the study is to investigate how these various components work together to improve the composites 'overall mechanical properties. A number of important factors are included in the mechanical examination, including impact resistance and tensile strength. The investigation's findings provide insight into how these bio-based materials might aid in the creation of high-performing, environmentally friendly composite materials for a range of uses. Groundnut shell powder, a waste by-product, is utilized to enhance the mechanical properties and reduce the environmental impact of the composite. Pineapple fibers exhibited superior mechanical properties compared to sisal and jute fibers due to their higher aspect ratio and inherent strength. Utilization of groundnut shell powder as filler demonstrates the potential for waste utilization and reduction of environmental impact in composite fabrication. The investigation highlights the potential of utilizing natural fibers and waste materials for the development of sustainable composite materials with enhanced mechanical properties. Further optimization of fiber- matrix interactions and filler content can lead to the development of high-performance, eco- friendly composites for various applications.

Keywords: *Pineapple, jute, sisal, groundnut shell powder.*

1.Introduction:

The choice of materials utilized in composite filaments holds critical significance in characterizing the properties and potential applications of these advanced materials. Work centered on characteristic filaments for polymer

composites.[1].Investigates common fiber composite materials for high-performance applications[4].Composite strands are commonly manufactured by amalgamating two or more different materials, coming about in a bound together structure that shows improved execution properties. Displayed underneath may be a comprehensive layout specifying the materials utilized within the generation of composite strands. Common fiber reinforced composites are being examined for basic applications. Plant strands are distant better; a much better; a higher; a stronger; an improved">a much better substitution for engineered filaments in terms of fetched and CO2 emanations [12]. Made strides mechanical properties of composites with diverse weight proportions. Exploratory examination on composites with diverse weight proportions conducted [1]. Composites are utilized in aviation, shipbuilding, car, and wind turbine edge fabricating . Characteristic fiber composites can be utilized in sports applications [12]. Natural-fiber sound hosing characteristics. Frothed items for upholsteries and separator applications. Non-structural components in car applications [10Businesses such as development, building, pressing, shopper products, and military utilize common filaments. Normal strands are utilized in transportation applications like cars, trains, and air ship [9]. Applications for characteristic composites are found in bundling, furniture, and lodging, as well as within the car, flying, and shipping sectors[11]



2.Method of Fabrication

Hand lay-up: The hand lay-up method is a traditional and commonly used technique for manufacturing composite materials. In this method, layers of reinforcement materials (such as pineapple, sisal and jute) are manually placed onto a mold or toolin a specific orientation. After each layer is positioned, a resin matrix (usually epoxy resin and Hardener) is applied by hand or with a roller to impregnate the reinforcement fibers. This process is repeated until the desired number of layers is achieved, ensuring proper resin saturation an air removal between layers.

Overall, the hand lay-up process offers flexibility and versatility, making it suitable for producing a wide range of composite parts with varying shapes, sizes, and complexities. However, it can be labor-intensive and may result in variations in quality depending on the skill of the operator.

3. Natural fibers: Materials:

3.1Pineapple fiber:

Pineapple fiber, also known as Pina, is a natural fiber extracted from the leaves of the pineapple plant (Ananas comosus). It is commonly grown in tropical regions such as the Philippines, Thailand, and Indonesia. Pineapple fiber is known for its strong and durable nature, similar to other natural fibers like jute and sisal. It is lightweight, flexible, and has a fine texture. The fiber is also biodegradable and environmentally friendly.

Fig:1: Pineapple fiber

Pineapple fiber has various applications, including textile and fashion. It can be spun into yarns and woven or knitted into fabrics, which are then used to make garments, accessories, and home furnishings.

3.2: Sisal fiber:

Sisal fiber is a natural fiber derived from the agave plant, specifically the Agave sisalana species. It is commonly grown in regions with a hot and arid climate, such as Mexico, Brazil, Kenya, and Tanzania. Sisal fiber is extracted from the long, sword-shaped leaves of Agave plants.

Sisal fiber is known for its strength, durability, and resistance to deterioration. It has a coarse texture and is typically stiff, making it suitable for a variety of industrial applications.

Fig: 2 Sisal fiber

Sisal fiber has a wide range of applications across different industries. It is commonly used to produce ropes, twines, and cords for agricultural, marine, and industrial purposes due to its strength and durability. Sisal fiber is also used in manufacture of carpets, rugs, and mats.

Overall, Sisal fiber is versatile and sustainable material with a wide range of industrial and commercial applications. Its strength, durability and eco-friendly properties make it a valuable resource for various industries, from agriculture and construction to textiles and manufacturing.

3.3: Jute fiber:

Jute fiber is a natural fiber obtained from the stems of the stems of the Corchorus plants, particularly Corchorus olitiau's and Corchorus capsularis. Jute is primarily grown in regions with a tropical climate, including

India, Bangladesh, andother parts of Southeast Asia. Jute fiber is extracted from the outer stem of the jute plant. The plants are harvested when they reach maturity, typically within 4-6 months of planting.

Jute fiber is known for its softness, flexibility, and high tensile strength. It has a gold brown color and a slightly coarse texture. Jute fibers are relatively long, ranging from 1to4 meters in length, which contributes to their strength and durability.

Fig: 3 Jute fiber

Jute fiber has a wide range of applications, particularly in the manufacturing of textiles, packaging materials, and various industrial products. In the textile industry, jute fibers are spun into yarns and woven or knitted into fabrics for making sacks, bags, carpets, rugs, and upholstery. Jute fibers also used in the production of rope, twine, and cordage for agricultural, construction, and marine applications. Additionally, jute fiber can be blended with other fibers such as cotton or polyester to create composite material with enhanced properties.

Overall, Jute fiber is versatile and sustainable material with a long history of use in various industries. It has unique propertiesmake it suitable for a wide range of applications, and its eco-friendly characteristics make it an attractive choice for environmentally conscious consumers and businesses.

3.4. Groundnut shell powder:

Groundnut shell powder is a byproduct obtained from the processing of groundnuts (also known as peanuts). After the nuts are harvested and shelled to obtain the edible peanuts, the shells are often discarded or used for various purposes, one of which is grinding them into powder. Groundnut shell powder is used for various purposes such as animal feed, fuel, agricultural applications, industrial uses, environmental remediation, crafts and artwork.

Fig: 4 Groundnut shell powder

Groundnut shell powder is often considered a sustainable and eco-friendly material as it is utilizing a byproduct that would otherwise go to waste. However, its specific applications and benefits may vary depending on factors such as the quality of the shells and the processing methods used to obtain the powder.

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3.5. Resin and Hardener:

Resin and Hardener are two components typically used in epoxy resin systems. When mixed together in the correct ratio, they undergo a chemical reaction known as curing, resulting in a hardened material with desirable properties such as strength, durability, and resistance to heat and chemicals.

Resin: This is the primary component of the epoxy system. Resins are usually viscous liquids that contain reactive molecules called epoxides. These epoxides have two or more reactive sites that can bond with other chemicals, such as the hardener, during curing.

Hardener: The hardener is the second component of the epoxy system. It typically consists of amines or polyamines. Hen mixed with the resin; the hardener reacts with the epoxides to initiate the curing process. This reaction forms strong cross- links between the molecules, transforming the liquid resin into a solid material.

Fig: 5 Resin and Hardener

It's crucial to mix resin and hardener in the correct proportions as specified by the manufacturer's instructions. Deviating from the recommended mixing ratio can lead to incomplete curing, resulting in a material with compromised properties. Additionally, the curing time and temperature can vary depending on the specific epoxy formulation and application requirements.

4.MECHANICAL TEST

4.1Tensile Test:

A device known as a universal testing machine is used to perform the tensile test. A standardized specimen is subjected to acontinuously increasing load by the machine until it reaches its breaking point. The apparatus records the specimen's deformation, or change in length, as well as the force exerted during the test.

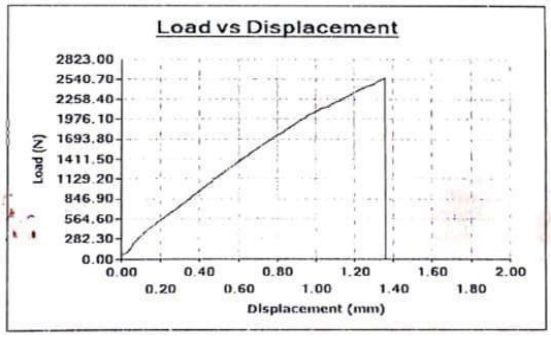
Fig: 6 universal testing machine

Fig: 7 Tensile specimen

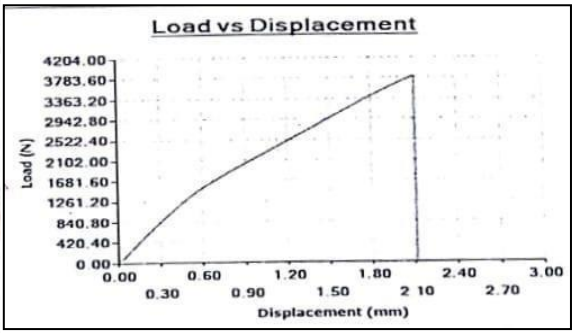
	ULTIMATE LOAD	ULTIMATE TENSILE STRENGTH
SPECIMEN 1	2570	16.48

SPECIMEN 2	3821	23.8
SPECIMEN 3	5272	33.38
SPECIMEN 4	4397	28.42

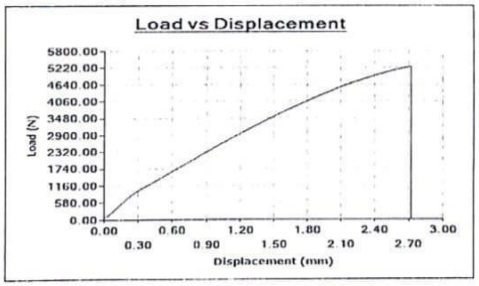
Table: 1 Tensile test results

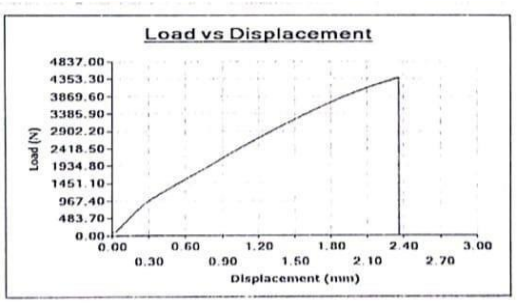


Graph: 1 Tensile test with 0% of groundnut shell powder



Graph: 2 Tensile test with 2% of groundnut shell powder





Graph: 3 Tensile test with 3% of groundnut shell powder. Graph: 4 Tensile test with 4%of groundnut shell powder.

4.2.Impact Test:

An apparatus known as a Charpy impact tester is used to perform the impact test. The apparatus is made up of a fallingweight or pendulum that is elevated to a predetermined height and then let drop to strike the specimen. The device calculates the records, in joules, the amount of energy that the specimen absorbs during the collision.

Fig: 8 Charpy impact test

Fig: 9 Impact Specimen

	IMPACT STRENGTH
SPECIMEN 1	4
SPECIMEN 2	2
SPECIMEN 3	2
SPECIMEN 4	2

Table: 2 Impact strength results

5. Conclusion:

The mechanical tests of all the specimens were evaluated. The experimental investigation the composites with differentratios had been carried out in the present work are:

1.The highest tensile strength of 33.38MPa was achieved at 3% groundnut shell powder and an ultimate loadof 5272N.

2. At 0% groundnut shell powder and impact, the maximum impact strength measured is 4.0 joules.

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