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EVALUATING THE MECHANICAL PROPERTIES OF MAIZE FIBER AND PROSOPIS JULIFLORA REINFORCE POLYSTER RESIN COMPOSITES

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Abstract: The compared to composite materials that are entirely synthetic, natural fibers are more affordable and more plentiful. The goal of the current work is to forecast the compressive and tensile properties of natural fiber-reinforced composite materials. The results were compared. The Prosopis Juliflora and Maize Fiber composite used in this experiment was made by hand utilizing the lay-up technique. Specimens were cut from the manufactured laminate in accordance with ASTM D 638 guidelines for the tensile test. Following that, the experiment is run through a universal testing machine (UTM). The tensile and compressive properties of the Prosopis Juliflora and Maize Fiber composite material were discussed based on the test findings. Because of their superior qualities, Prosopis Juliflora and Maize Fiber are widely utilized in a variety of engineering applications as a suitable substitute material.

Index Terms - NFRC, Prosopis Juliflora, hand-lay-up method, tensile & compressiveProperties, UTM,

I. INTRODUCTION:

Composite materials are becoming more and more popular in terms of both research and practical uses. Because of their superior particular properties—such as stiffness, fatigue characteristics, and tensile, impact, and flexural strengths—composite materials offer an advantage over other traditional materials and allow for more flexible structural design.

Owing to their many benefits, they are extensively utilized in the aerospace industry, as well as a wide range of commercial mechanical engineering applications, including internal combustion engines, automobiles, railway coaches, aircraft structures, thermal control and electronic packaging, machine components, and flywheels. Other applications include process industry equipment that must be resistant to high temperatures, oxidation, corrosion, and wear, dimensionally stable components, sports and leisure equipment, and marine structures.

A material is said to be composite if it consists of two or more separate elements, each of which has a distinct interface and exhibits markedly different macroscopic behavior. It possesses qualities that none of the components alone can capture. Constituent materials are the discrete materials that make up composites.

The general arrangement of a composite's constituents results in one or more discontinuous phases embedded in a continuous phase. The continuous phase is known as the matrix, and the discontinuous phase is called the reinforcement. The majority of a composite typically consists of the matrix phase.

Unique mechanical and physical qualities of the reinforcements are imparted to improve the matrix properties. While the large range of matrix and reinforcing elements enables the synergism to develop material qualities not possible from the individual constituent ingredients the product or structure's designer to select the best possible combination. Because each type of fiber used in composites has unique qualities, they all have various effects on the composite's characteristics.

Composites can be classified according to the kind of matrix that each variety has. The physical and chemical characteristics of the matrices and reinforcing fibers influence the production methods as well.

[1] As the name implies, metal is a component in metal matrix composites. Examples of matrices found in these composites are titanium, magnesium, and aluminum. Silicon carbide and carbon are common components of fiber. Metals are mostly strengthened to meet design requirements. For instance, the addition of fibers like silicon carbide can reduce the thermal and electrical conductivities, significant coefficient of thermal expansion, and elastic stiffness and strength of metals.

[2] Ceramic matrix composites are made of silicon carbide-reinforced ceramic matrix, such as alumina, calcium, or aluminum silicate. High strength, hardness, low density, chemical inertness, and high ceramic service temperature limitations are some of the benefits of CMC. Ceramic materials are inherently resistant to high temperatures, yet they can also break and become brittle.

[3] Fibers constructed of silicon carbide are used to strengthen composites that are successfully created using ceramic matrices. With less density, these composites provide the same high temperature endurance as super alloys. Ceramics are fragile, which makes it challenging to fabricate composites. The majority of CMC production processes typically call for powdered starting ingredients. Glass matrices ceramics are divided into four classes.

[4] Polymer matrix composites are the most widely used advanced composites. Fiber (natural carbon or boron) is used to reinforce thermosetting or polymer thermoplastic polymers in these composites. These materials can be shaped and sized to suit different needs.

[5]They offer excellent rigidity and strength in addition to corrosion resistance. These are the most widely used because of their affordability, robustness, and ease of manufacturing. The remarkable specific characteristics of polymer composites are generally attributed to their low constituent density.

[6] A release anti-adhesive compound is applied to the mold to stop the molded object from adhering to the mold surface. Gel coating is used to build the part's prime surface layer. Tissue with fine fiber reinforcement is covered in a layer. Layers of chopped strands, rovings, or woven fabric are used as reinforcement, together with layers of liquid matrix resin. You can apply the resin mixture with a brush or an oll. Curing takes place, usually at room temperature. The component is taken out of the mold's surface. The low densification of the composites (entrapped air bubbles) and low concentration of reinforcing phase (up to 30%) are the drawbacks of the Hand Lay-up process.

[5] Two distinct sprays are used in the Spray-up process to apply chopped reinforcing fibers and liquid resin matrix to the mold surface. The fibers are cut into 1-2 (25–50 mm) length segments, and an air jet is used to spray both the resin and the reinforcing phase at a specified ratio.

[6]The Spray-up process may quickly generate a homogeneous composite coating, but because continuous reinforcing fibers cannot be used, the material's mechanical qualities are only somewhat good.

[7] Generally speaking, the matrix is less rigid and more ductile. It shares a burden and contains the dispersed phase. Any of the three fundamental material types—polymers, metals, or ceramics—can make up a matrix. The product, element, or bulk form is generated by the matrix. A discontinuous phase is the secondary phase that is embedded in the matrix.

[8] Generally speaking, it is stronger and harder than the continuous phase. It enhances the matrix's overall mechanical qualities and helps to strengthen the composites. The characteristics of the constituent materials, their distribution, and their interactions with one another all have a significant influence on the properties of composites. A combination of features might function in a complementary way to generate enhanced or superior qualities.

[9] The tensile strength, its hydrophobicity and resistance to microbiological harm of coir-polyester composites are all improved through acetylation of the coir fibers. However, when the composite is tested in tension, the fiber loading needs to be more high—45 percent in weight or further—to get an obvious reinforcing effect. Moreover, there is not a rise in flexural strength, even at high coir fiber loading percentages.

[10]These findings show that the mechanical performance of coir-polyester composites was not significantly altered by the typical fiber treatments that have been documented to far. Despite the fact that there are several studies in the literature that address the mechanical behavior of polymer composites reinforced with natural fibers.

[11] Natural fiber-reinforced polymer composite materials are growing progressively more famous in terms of basic and industry research. They are affordable, biodegradable, fully or partially recyclable, and renewable. Ever since materials were first utilized as a source of lignocellulose fibers across history, wood and different plants—including flax, cotton, hemp, jute, sisal, kenaf, pineapple, ramie, sisal, banana, etc.—are being utilized more and more as support for composite components.

[12] Fibers are a kind of material that resemble hair it may consist of either continuous filaments or inconsistent, elongated bits that imitate threads. They can be twisted into rope, thread, or filaments. They are able to be incorporated into composite materials. Additionally, they can be matted into sheets for making products including felt or paper.

[13] Generally speaking, cellulose makes up the majority of vegetable fibers; examples of this include hemp, jute, flax, cotton, ramie, and sisal. Fibers made of cellulose are utilized to make paper and fabric. The categories that follow can be used to further classify this fiber:Whilst sisal, jute, kenaf, and coconut are also frequently used, cotton, flax, and hemp are the most commonly used natural fibers. Ropes and aerofoils are the most common uses for hemp fibers due to their exceptional suppleness and endurance in harsh environments

[14] The building and construction industry could profit substantially from the use of natural fiber composites in the following applications: panels for sections and false ceilings, partition boards, walls, floors, doors and window frames, roof tiles, and prefabricated or mobile buildings that may be used in the event of natural disasters like floods, storms, earthquakes, etc.

[15] Tamil Nadu produces about 4 to 4.5 million metric tons (MT) of paddy in a given year. An annual production of 8 to 9,000,000 metric tons of rice husk is produced from an input paddy yield of 20%. Using biomass gasifier technology, the theoretical potential (TP) of the remaining half, or 4 million MT / year of husk, is estimated to be slightly over 400 MW of capacity, grabbing into account the fact that about half of the husk is used for energy applications such as domestic cooking, steam production for rice parboiling, etc. The Rice Mill Owners' Association of Tamil Nadu reports that there are four "cluster" areas and over 100 thousand rice mills dispersed throughout the nation.

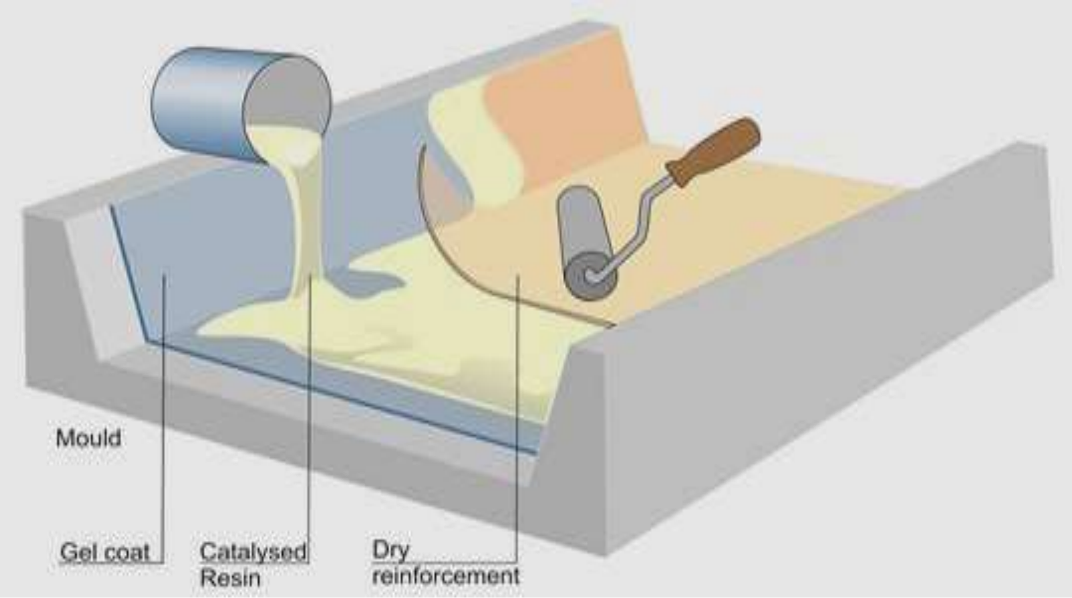
II. SELECTION OF MATERIALS:

The Prosopis Juliflora fiber and the maize fiber are cleaned carefully before being broken into very small pieces. A table displays the chemical makeup of the rice powder and maize powder fibers. These fibers are chemically treated using an alkali method 5% sodium hydroxide (NaOH). They are then completely rinsed with distilled water two or three times, and they are baked for seventy minutes at sixty degrees Celsius. The catalyst and promoter come together with the polymer matrix. The actions taken in the fabrication operation are The Organic Textiles By hand lay-up technique, reinforced polymer matrix composites were created. We cleansed the Prosopis Juliflora fiber and the maize fibers while creating the size mold. molding plate, 230 mm by 270 mm by 5 mmA different mild steel molding plate measuring 230x270x10 mm was utilised.10 grams of fiber and100 milliliter of polyester resin were combined. To attain a homogenous condition, stirring was done. To raise the temperature of recrystallization, 10 milliliters of catalyst were added to the mixture. To stop friction, poly vinyl was used within the mold. The blend was transferred into the mold.

FIGURE 2.1 Prosopis Juliflora Fiber and Maize Fibers Plate

III. HAND LAYUP METHOD:

FIGURE 3.1 Hand Layup Method



The natural fiber reinforced polymer composite was prepared using the hand layup technique. A mild steel mold measuring 230x270x10 mm was used for the tensile and flexural tests, and a second mild steel mold with the same dimensions was used for the compressive test. Although this method is the least expensive to produce, it has certain drawbacks, including a lengthy curing period and a low production rate. In addition, the worker's skill level affects the quality of the composite. After equally distributing the fibers inside the mold, promoter and catalyst were combined with thermosetting resin. The entire surface of the mold is coated with mold release agent. The fiber layering procedure is wrapped using a brush or roller.

IV. PRINTING OF TEST SPECIMEN:

Prosopis Juliflora and Fiber Maize fibers were gathered from a nearby agricultural field, and G V Private Limited, Madurai (TN), India was the source of the catalyst (methyl ethyl ketonese peroxide), promoter (cobalt octoate), and general purpose unsaturated polyester resin (thermosetting polymer). The commercial thermoset polymers known as unsaturated polyester resins have many carbon double bonds (C=C). Being unsaturated allows the resin to cure from a liquid to a solid form. Malefic anhydride, an unsaturated dibasic acid, can be reacted with ethylene glycol to create typical unsaturated polyester. The unsaturated polyester resin matrix properties are displayed below.

FIGURE 4.1 Prosopis Juliflora Fiber and Maize fibers specimens

V. RESULT AND DISCUSSION:

5.1 COMPRESSION TEST:

5.1.1 Machine Specification:

Name : Universal Testing Machine
Modal : BE-SUTM1000
Max Load Capacity : 1000KN
Displacement Rate : 0.25mm/ Min

Table 5.1 Compression Properties of Prosopis Juliflora Fiber and Maize fibers

Sample Number	CS Area [mm²]	Peak Load [N]	essive Strength[N/mm²]
1.	90.000	1735.382	32.237
2.	90.000	1735.382	32.799
3.	90.000	1735.382	32.801
Average	90.000	1735.382	**32.799**

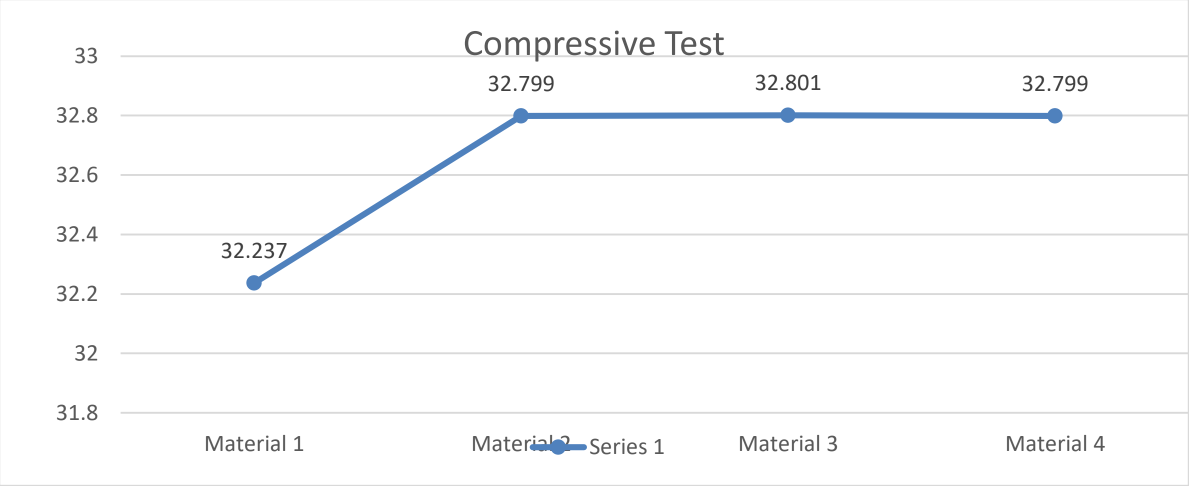


FIGURE 5.1 Compression Test Graph

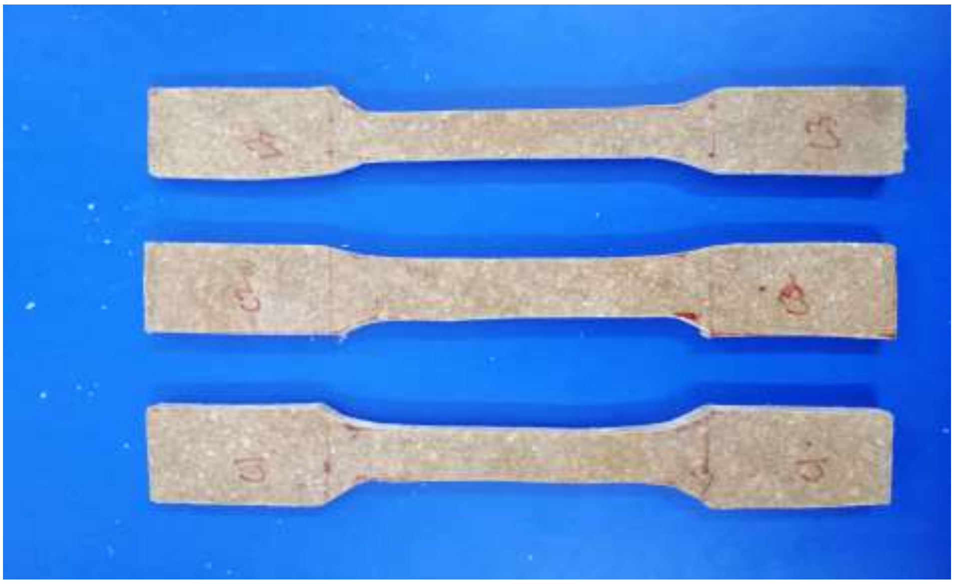


FIGURE 5.2 Compression Test of The Specimen

It was collected from the fragments of maize fibers and Prosopis juliflora fiber that were compacted. Readings are taken and recorded after testing three sample. The compression strength of the very first specimen, as determined by the compression test, is approximately 32.237N/mm2. The compression strength of the second and third specimens is around 32.799 & 32.801 N/mm2. The specimens in question produce an average compression strength of roughly 32.799N/mm2.

5.2 TENSILE TEST:

5.2.1 Machine Specification:

Name : Universal Testing Machine
Modal : BE-SUTM1000
Max Load Capacity : 1000KN
Displacement Rate : 0.25mm/ Min

Table 5.2 Tensile Properties of Prosopis Juliflora Fiber and Maize fibers

Sample No.	S Area[mm^2]	Peak Load [N]	%Elongation	UTS [N/mm^2]
1.	90.000	1869.231	2.560	34.244
2.	90.000	1869.231	2.769	34.677
3.	90.000	1869.231	2.967	34.720
Average	**90.000**	**1869.231**	**2.769**	**34.677**

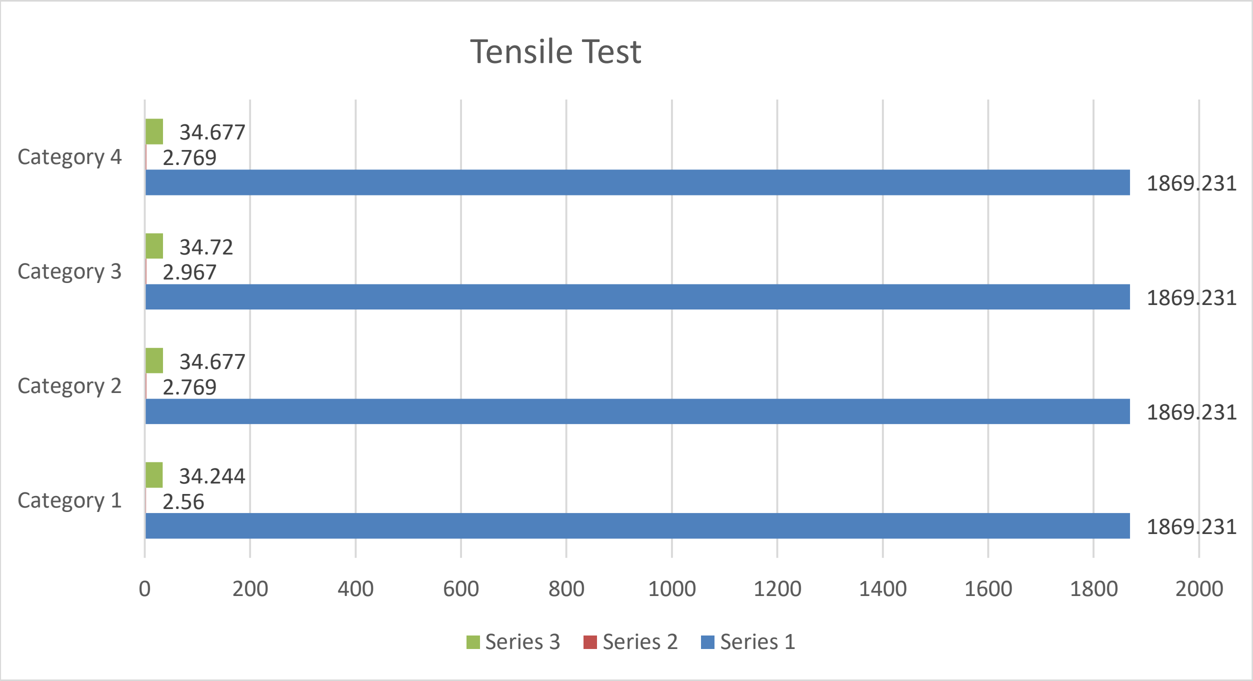


FIGURE 5.3 Tensile strain Vs Tensile Stress Graph

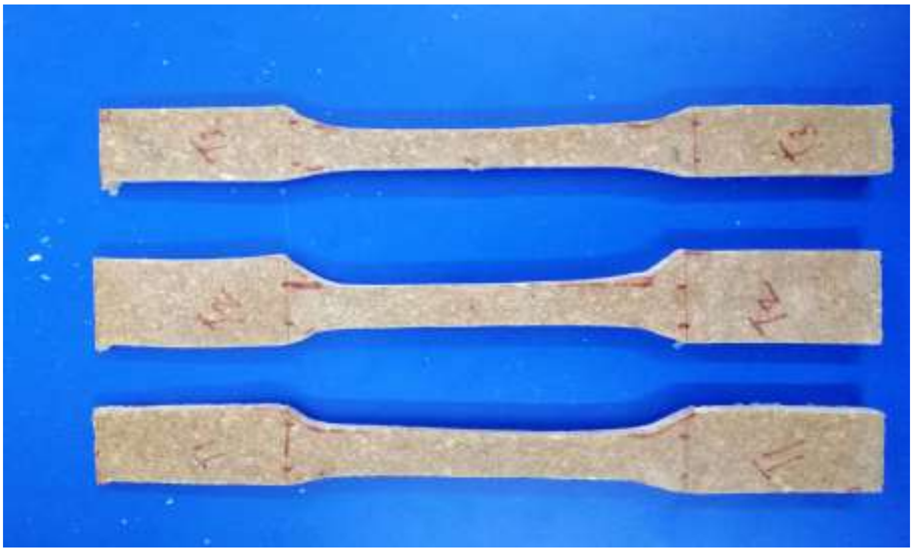


FIGURE 5.4 Tensile Test of the Specimen

Efficient load transfer along the filament's strands results from the filament lines becoming directly aligned with the load when they are perpendicular to the axis of tensile tension. Tensile strength is improved by this alignment because it reduces stress concentrations and encourages an even distribution of forces.

the Instron Computer Controlled Universal Testing Machine, introduce the students to the concept of tensile testing of metals, polymers, and composites. A variety of materials, including soft and hard steel, soft aluminum, brass, copper, plastics, rubber, and more, were used in these sets of tensile tests.

Demonstrate how to operate the tensile testing apparatus across the range of loads and extensions required to acquire reliable mechanical characteristics for materials. This lab focuses on data gathering, tabular and graphical presentation, and report writing because tensile characteristics are the primary approach utilized for material acceptance, quality control, and design restrictions.

5.3 FLEXURAL TEST:

5.3.1 Machine Specification:

Name : Universal Testing Machine
Modal : TUE-100
Max Load Capacity : 100KN
Displacement Rate : 0.1mm/ Min
We have taken three different angles in this experiment. They are as follows

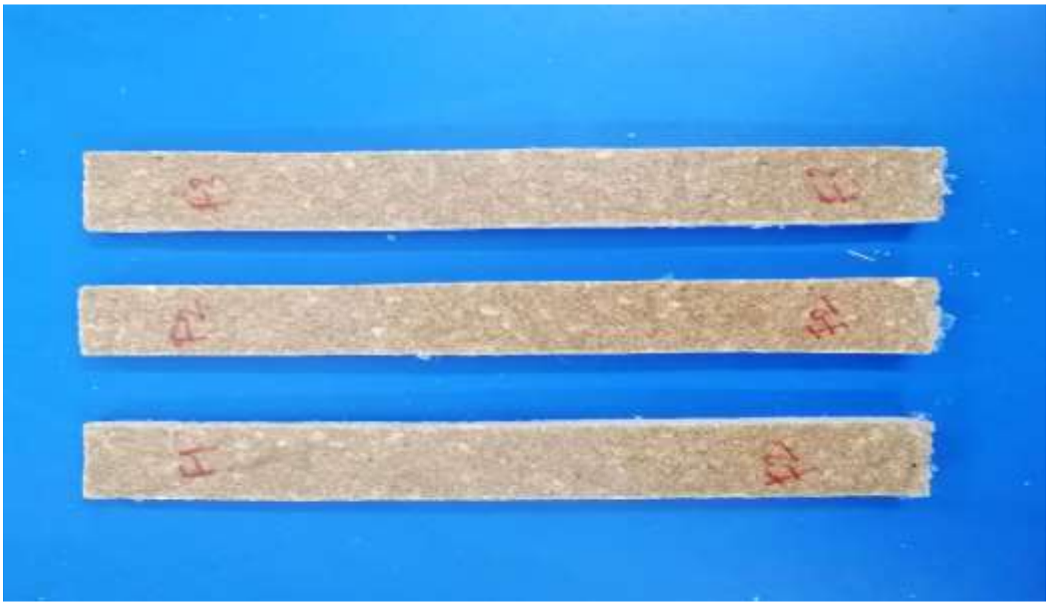


FIGURE 5.5 Flexural Testing Of the Specimen

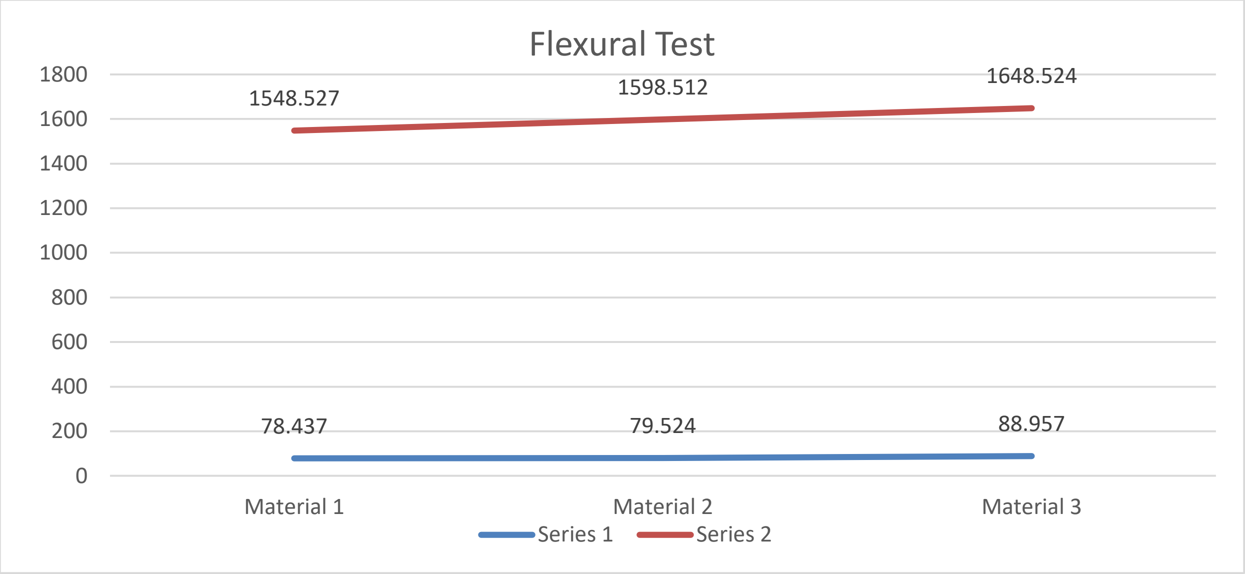
Table 5.3 Flexural Properties of Prosopis Juliflora Fiber and Maize fibers

Fiber ratio	S Area[mm^2]	Load[N]	Flexural Strength (MPa)	Flexural Modulus (GPa)
Sample 1	50.000	98.436	78.437	1548.527
Sample 2	50.000	100.789	79.524	1598.512
Sample 3	50.000	104.850	88.957	1648.524

The three Samples' readings are recorded after being tested on different radio frequencies. The first sample's flexural strength, as determined by the flexural test, is around 78.437 MPa. About 79.524 and 88.957 MPa of flexural strength are produced by the second and third samples. Flexural strength of around 88.957 MPa is best produced by the Prosopis Juliflora 25% Fiber 60.40 ratio Sample.

FIGURE 5.6 Flexural stress Vs Flexural Strain Graph

The panel is measured in the dimensions of 200×30×10 mm for the flexural test. Figure 3.6.3.1 depicts the specimen used in the flexural test. The universal testing apparatus for the flexural test is depicted in Fig. 3.6.3.2. These specimens are undergoing flexural testing in accordance with ASTM D 790.



5.4 IMPACT TEST:

5.4.1 Machine Specification:

Name : Pendulum Impact Tester
Modal : CKE-IKPI-0001
Max Load Capacity : 300 Joule
Displacement Rate : 0.26mm/ sec

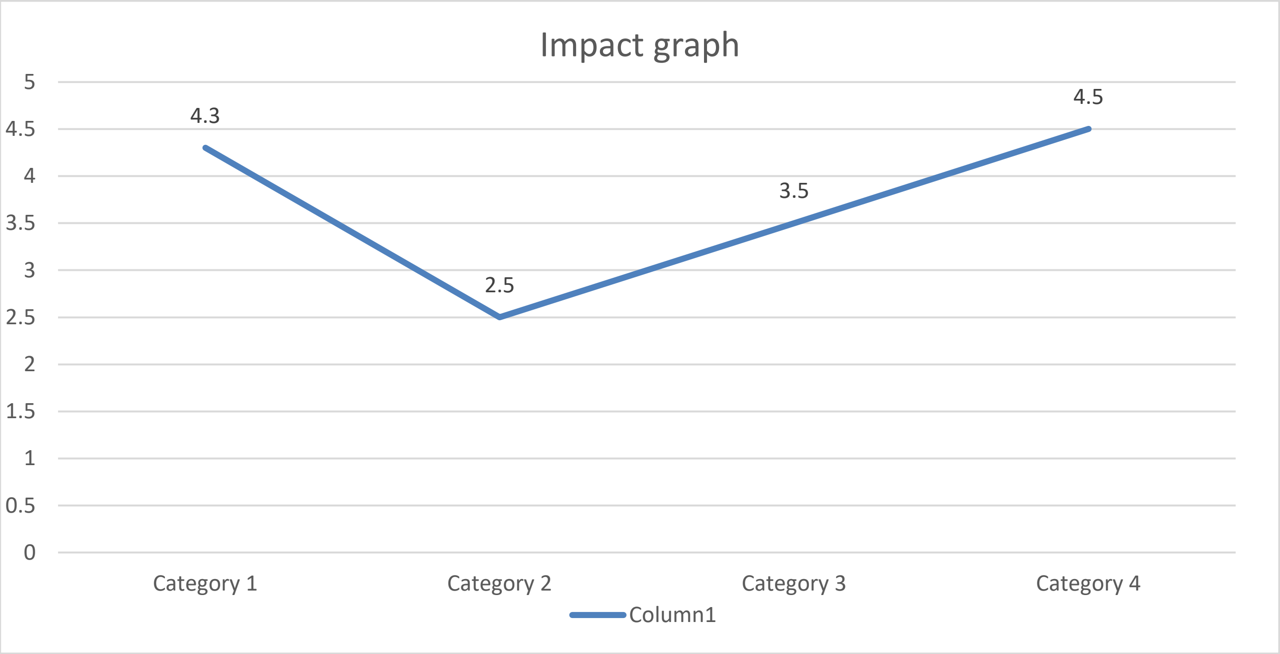


FIGURE 5.7 Impact Stress Graph

Table 5.4 Impact Properties of Prosopis Juliflora Fiber and Maize fibers

SL.NO	Sample Number	Izod Impact value in (J)
1.	Sample 1	21.6
2.	Sample 2	21.8
3.	Sample 3	21.9
	Average	**21.8**

FIGURE 5.8 Impact Testing Of The Specimen

Impact testing evaluates a material's resistance to impact from a swinging pendulum using a single point method. The kinetic energy required to start a fracture and carry it through to the point when the specimen breaks is known as impact. The panel is measured in dimensions of 200×30×10 mm for the impact test. Figure 3.6.4.1 illustrates the impact test specimen.

5.5 WATER ABSORPTION TEST:

the water absorption experiments, the sample measurements were 200 by 10. For every substance, a minimum of two samples were examined. Samples were weighed and then allowed to soak in 25°C distilled water. The samples were taken out at predetermined intervals, instantly weighed, and wiped to remove any extra water from the surface. The water absorption was calculated as the difference between the original mass and the mass after a specific amount of immersion time. These specimens are put through a water absorption test in accordance with ASTM D 570. The specimen for the water absorption test is depicted in Fig. 3.6.5.1. Following varying times, the composites' water absorption properties were assessed using the weight's relative uptake, which was determined by Mt.

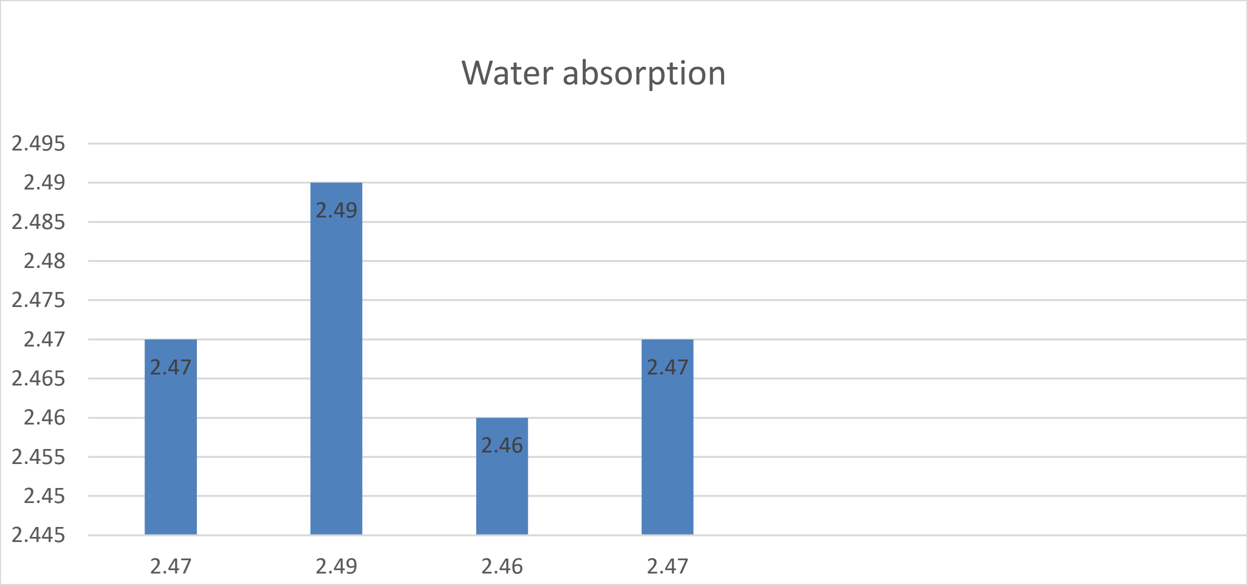


FIGURE 5.9 Water Absorption Graph

Table 5.5 Water Absorption Properties of Prosopis Juliflora Fiber and Maize fibers PETG

Sample Number	**eight beforetest in gsm**	**ght after test ingsm (48hrs)**	**% of water absorption**
1.	2.42	2.47	2.47
2.	2.44	2.49	2.49
3.	2.41	2.46	2.46
		Average	2.47

FIGURE 5.10 Water Absorption of The Specimen

Three specimens are tested and noted based on the Prosopis Juliflora Fiber and Maize Fibers specimen that underwent the water absorption test. Prior to the water absorption test, specimen 1 weighed 2.42 gsm. After 48 hours, specimen 1 is removed from the water and its weight is 2.47 gsm. Consequently, specimen 1's water absorption percentage is 2.25. Prior to the water absorption test, the weight of the second and third specimens was 2.44 & 2.41 gsm. After 48 hours, the second and third specimens are removed from the water; their respective weights are 2.49 and 2.46gsm.Consequently, the percentage of water absorbed in specimens 2 and 3

VI. CONCLUSION:

In the present investigation, composites made of Prosopis Juliflora fiber and maize fiber elements were produced effectively. Here, the mechanical characteristics of the composite—tensile, compressive, and flexural—have been examined and described. From this study, the following conclusions have been reached.

. This work illustrates the effective manufacturing of reinforced composites with Prosopis Juliflora Fiber and Maize Fibers using an elementary hand lay-up technique. Composite samples are useful to evaluate tensile and other mechanical properties. It has provided details concerning the suitability of maize and prosopis juliflora fibers as sources of reinforcement for polymer matrix composites. Higher fiber content in NFR composites results in similar performance although using a fewer polluting base polymer.

The qualities of tensile strength. The specimen yields a compression strength of approximately 34.677 N/mm2 and contains a mixture of Prosopis Juliflora Fiber and Maize Fibers. yields approximately 88.957 Mpa of flexural strength. The average impact strength of these specimens is around 21.8 J, while their average water absorption percentage is 2.45%. It can be applicable in several other fields of technology.

VII. REFERENCES:

1. Vasanta V, Cholachagudda, Udayakumar Paetal (2014), Ramalingaia Mechanical Characterization of Coir and Rice Husk Reinforced Hybrid Polymer Composite.
2. Satyanarayana, et.al(2007) Studies On Lignocellulosic Fiber Of Brazil. Part I:Source, Production, Morphology, Properties And Application.
3. Sakyhi Balan Ganapathy, Aravind Raj Sakthivel, Mohamed Thariq Hameed Sultan, Farah Syazwani Shahar, Ain Umaira Md Shah, Tabrej Khan, Tamer (2022)A Sebaey Polymers 14 (7), 1278.
4. M Aravindh, S Sathish, R Ranga Raj, Alagar Karthick, V Mohanavel, Pravin P Patil, M Muhibbullah, Sameh M Osman(2022) Advances In Materials Science And Engineering.
5. Manoj Kumer Singh, Renu Tewari, Sunny Zafar, Snjay Mavinker Rangappa, Suchart Siengchin(2023) Results In Materials 17, 100355, 2023.
6. Velmurugan Ganesan, Vigneshwaran Shanmugam, Vasudevan Alagumalai, Babu Kaliyamoorthy, Oisik Das, Manjusri Misra(2024) Composites Part C: Open Acess, 100433.
7. Arunramnath Ramachhandran, Sanjay Mavinkere Rangappa, Vinod Kushvaha, Anish Khan, Suchart Seingchin, Hom N Dhakal(2022) Macromoleclecular Rapid Communications 43 (17), 2100862.
8. Y Abhiram, Ashish Das, Keshav Kumar Sharma (2021)_Materials today: proceedings.
9. Khubab Shaker, Yasir Nawab(2022) Lignocellulosic Fiber Sustainable Biomaterials For Green Composite.
10. S Anne Kavitha, R Krishna Priya, Krishna Prakash Arunachalam, Siva Avudaiappan, Nelson Maureira-Carsalade, Ángel Roco-Videla(2023) Polymers.
11. P Madhu, MR Sanjay, P Senthamaraikannan, S Pradeep, SS Saravanakumar, B Yogesha(2019) Journal of Natural Fibers.
12. Tanvir Singh, SK Tiwari, DK Shukla (2020) Effect of Nanoparticles Volume Fraction On Microstrutural And Mechanical Charatheristics Of Frition Stir Welded Nanocomposites.
13. Shishir Sinha, (2022) GL Devnani CRC Natural Fiber Composites Press.
14. SV Gurupranes, I Rajendran, S Gokulkumar, M Aravindh, S Sathish, Elias Uddin(2023) International Journal of Polymer Science.
15. B Surya Rajan,MA Sai Balaji, SS Saravanalkumer (2018)Materials Research Express 6 (3),034302.