WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Synthesis and Characterization of Natural Fibre Reinforced Polymer Composites

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ABSTRACT:

The creation of eco-friendly materials is a result of growing public awareness of the harm that synthetic materials do to the environment. The development of such materials that can take the role of synthetic materials has attracted a lot of interest from researchers. As a result, there has been a surge in demand for natural fiber-based composites for commercial usage across a variety of industrial sectors in recent years. Natural fibres are abundant in nature and are sustainable building materials with benefits including affordability, lightness, renewability, and high specific characteristics. Natural fiber-based composite materials are currently utilised increasingly commonly across a variety of production sectors due to their sustainability. In this study, we looked at the many natural fibre sources, their characteristics, the ways they can be changed, how therapies affect natural fibres, etc. We also provide a quick outline of the main uses for natural fibres and discuss how effective they are as reinforcement in polymer composite products..

KEYWORDS: Natural fibres, sustainable and renewable resources, eco-friendly composites, uses for natural fibres, reinforcement for composite

INTRODUCTION:

Composite materials provide a number of advantages over traditional materials, including increased specific strength, stiffness, and fatigue properties that allow for more flexible structural design. Composite materials are defined as having two or more constituents that can physically separate into different phases. However, a composite material is only recognised as such when the component components have distinctly different physical properties. Composites are substances that have strong load-bearing material (referred to as reinforcement) embedded in a weaker substance (referred to as matrix). In order to support the structural load, reinforcement offers strength and stiffness. The reinforcement's position and orientation are maintained by the matrix or binder (organic or inorganic).

The reinforcement, which can take the form of platelets, particles, or fibres, is typically added to the matrix material to enhance its mechanical qualities, such as stiffness, strength, and toughness. The most effective load transfer is provided by long fibres that are pointed in the loading direction. This is because only a tiny portion of the fiber-matrix interface is covered by the stress transfer zone, and disturbance effects at fibre ends may be disregarded. In other words, the length of the ineffective fibre is short. Glass, carbon, and aramid fibres are common fibres that are offered as continuous filaments for use in high performance composites.

Objectives of the Research Work

The following lists the project's goals.

- To explore the possibilities of coir fibre by creating a new class of natural fiber-based polymer composites.
- To investigate how the length of the fibre affects the mechanical properties of coir-fiber reinforced epoxy- based composites.
- Analysing mechanical attributes such impact strength, tensile strength, micro-hardness, and flexural strength.

PREPARATION OF SAMPLE

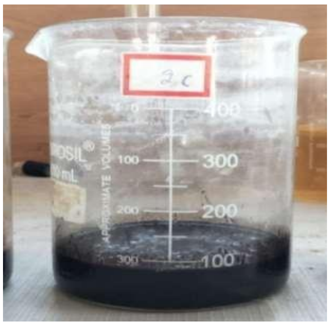
1.COCONUT COIR

When combined with its high microfibrillar angle and higher lignin content compared to other common natural fibres, coconut fibre offers a number of beneficial properties, including resilience, strength, and damping, wear resistance, resistance to weathering, and high elongation at break. • The coir fibre is used to make ropes, mats, mattresses, and brushes, as well as in the construction, agriculture, and upholstery industries. • To prepare the powder in this technique, a total of 5gms of coir are utilized.

FIGURE :COCONUTCOIR

CHEMICAL TREATMENT

- Lignin, pectin, waxy substances, and natural oils make up the outer layer of the fibre cell wall in natural fibres.
- Sulphuric acid (H2SO4) is one of the chemical agents employed in the process that changes the structure of natural fibres.
- To neutralise the surplus H2SO4, the H2SO4 was heated to 20 °C for approximately 48 hours.Researchers looked at the thermal characteristics, surface morphology, and crystallinity index of both treated and untreated fibers.

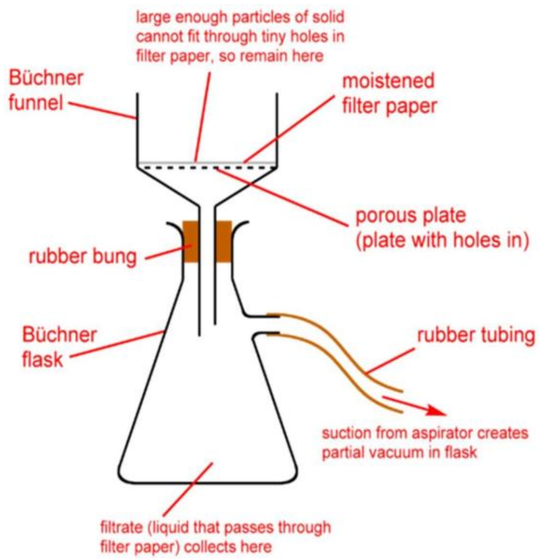


EFFECTS OF TREATMENT ON NATURAL FIBERS

- The chemical processing of natural fibres improves the fiber's wettability, surface shape, chemical groups, and mechanical properties in addition to altering the fiber's microstructure.
- The natural fibres are altered by various chemical processes, changing their characteristics and enhancing those of natural fibre composites.
- The fiber's chemical treatment improved the thermomechanical characteristics of the composite by increasing the interfacial adhesion between the fibre surface and polymer matrix.

VACCUM FILTRATION

The procedure of separating a solid from a liquid through a filter element is known as vacuum filtration, sometimes known as suction filtration. The particulates cake on the outside of the filter as the vacuum provides a driving force that draws the liquid through it. A higher level of dryness is also made possible by hoover, which increases yield and returns purer liquid. This kind of filtering is used in production settings at full scale and in laboratories.



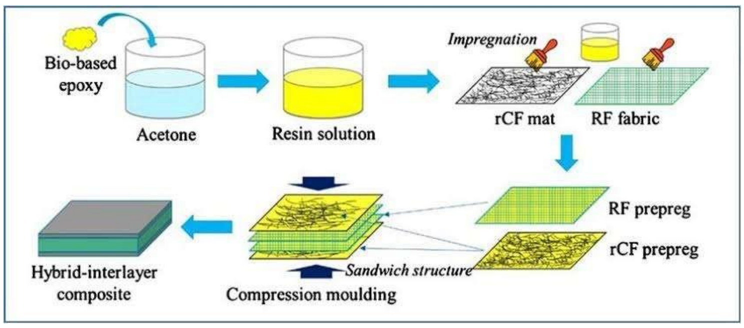
Preparation of Epoxy resin and Epoxy hardener

Epoxy and coir fibre nanoparticles were mixed together directly to create the epoxyresin nanocomposites.The mixture was first manually mixed using a glass rod to prevent coconut coir from volatilizing, and then mechanically mixed for 10 minutes at 1500 rpm to produce macro-dispersion of coir in epoxy.High shear forces generated by a high shear mixer operating at 5000 (rpm) for 15 minutes were used to accomplish micro-dispersion of into an epoxy resin.

The curing ingredient (hardener) was added to Epoxy in a resin-to-hardener ratio of 10:8 after the mixing operations had been finished, and the mixture was gently stirred by hand using a glass rod.

Composite fabrication

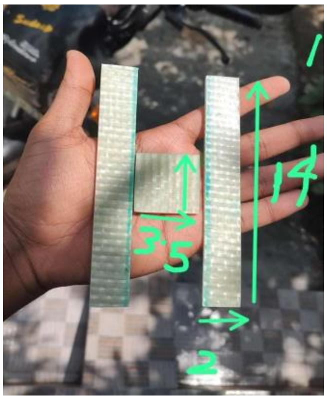
A roller was employed to aid in the impregnation of fibre in the hand-made, CF/epoxy resin-based composite material. As mentioned in the preceding paragraph (5.1), the epoxy resin was first produced. It was then brushed onto the surface of the CF. The epoxy-brushed fibre tape was carefully packed and aligned, added a 50Kg load, and compressed before being crushed and kept at room temperature for 24 hours.In the same manner, composite materials based on CF/phenolformaldehyde resin were created.



Preparation of composite samples

Cutting operations cause the material being treated to fracture. The component that is typically split away comes in small pieces known as chips. Sawing, shaping (or planing), broaching, drilling, grinding, turning, and milling are examples of common cutting techniques. Although the actual cutting apparatus, tools, and procedures look very different from one another, the fundamental mechanism that causes the fracture remains the same.

The workpiece is a shape that may completely enclose the final part shape in all machining operations. To remove the extra material and produce the finished product is the goal. Usually, this cutting has to be finished. In the illustration below, the composite material is cut to the necessary dimensions.



TESTING

TENSILE TESTING

A mechanical test called a tensile test, also called a tension test, is used to ascertain how a material will behave under the effects of stretching. In this test, a sample of the substance is dragged lengthwise in opposing directions until it fractures or breaks.

The material's ultimate tensile strength (the maximum stress it can withstand before breaking), yield strength (the point at which it starts to deform plastically), and elongation (the amount of stretching it goes through before breaking) are all measured during the test.

Metals, polymers, and other materials used in engineering and manufacturing applications are frequently subjected to tensile testing to determine their mechanical characteristics. The results of a tensile test can be used to assess a material's appropriateness for a given application and to spot any flaws or weaknesses in the material.

Figure :Tensile Testing machine

- 3 Point Bend Test

1. A mechanical test used to ascertain a material's flexural strength and elastic modulus is the 3-point bend test, sometimes referred to as the flexural test. A 3-point bend test involves the following broad steps:
2. Sample preparation: The material to be tested rectangular bar or beam specimen is made in accordance with specified dimensions and surface polish requirements.
3. Mounting the specimen: The specimen is mounted on two support points that are fixedly spaced apart on a testing apparatus. On top of the specimen, a loading point or probe is put in the middle of the space between the support points.
4. Alignment and calibration: The apparatus is calibrated to make sure it is correctly aligned and able to exert a consistent force on the specimen. Additionally, the loading point and support points are altered to place them in the ideal positions.
5. Loading: At the loading point, the machine starts to exert a force on the specimen that progressively increases. Until the specimen fractures or breaks, the force is delivered steadily.
6. Data collection: Throughout the test, different data points are logged, including the force exerted, the specimen's deflection, and the amount of time that has passed.
7. Analysis: After the test is finished, the recorded data is examined to ascertain the material's flexural strength and elastic modulus..
8. Reporting: A detailed report is generated to summarize the results of the test, including any relevant graphs, tables, or charts. The report may also include recommendations for th

Figure:3 point bend test

HARDNESS TEST

The hardness test is a mechanical procedure that assesses a material's resistance to being scratched or indented. Rockwell, Vickers, and Brinell hardness tests are only a few of the various types of hardness tests available. A typical hardness test involves the following broad steps:

1. Sample preparation: The material to be evaluated is prepared with a level, polished surface and any surface blemishes or roughness are eliminated.

2. Choosing the indenter The kind of indenter to use will depend on the kind of hardness test being conducted. Usually, the indenter is constructed from a hard substance like steel, diamond, or tungsten carbide.

4. Applying the load: The indenter is driven into the material's surface with a known force for a predetermined amount of time. The amount of force exerted is commonly expressed in Newtons (N) or kilogrammes (kg).

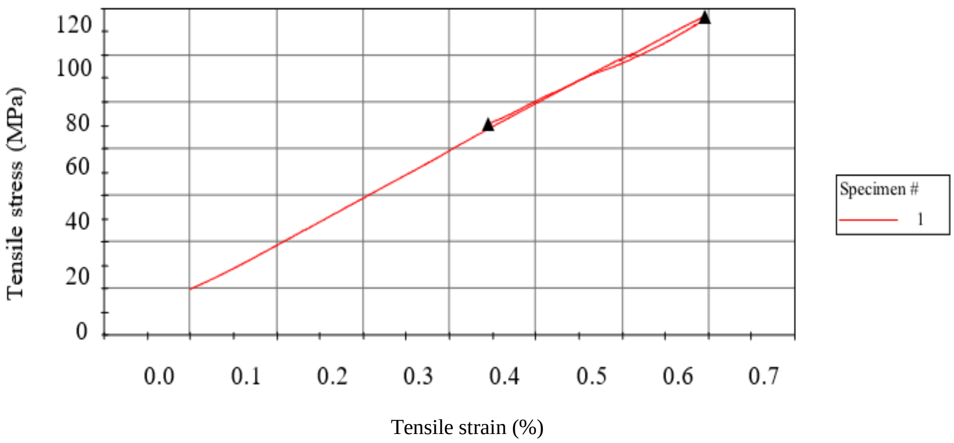
5. Measuring the indentation: A microscope or other measuring tool is used to determine the width and depth of the indentation that the indenter has left behind.

6. Determining the hardness: The amount of force exerted as well as the size, depth, and location of the indentation are used to determine the material's hardness.

Figure :hardness testing machine

RESULTS

TENSILE STRENGTH SAMPLE 1(WITH OUT FIBRE)



	Specimen label	Maximum Load (N)	Load at Break (kN)	Ult. Tensile Strength (MPa)	Tensile stress at Yield (Offset 0.2 %) (MPa)
1	Fiber1	8378.98105	5.05	116.37	-----

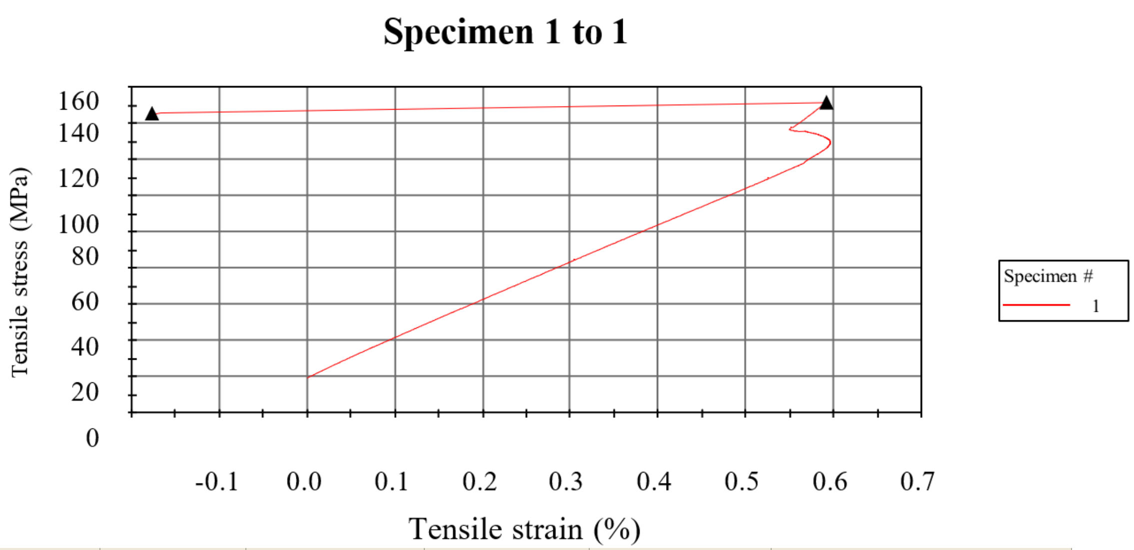
	Time at Yield (Offset 0.2 %) (sec)	Load at 2% strain (kN)	Extension at Break (Standard) (mm)	Tensile extension at Break (Standard) (mm)
1	-----	-----	7.41973	0.08613

	Tensile strain at Break (Standard) (mm/mm)	Axial Gauge Length (Strain Source) (mm)	Tensile strain at Maximum Load (mm/mm)	Tensile extension at Maximum Load (mm)
1	0.00345	25.00000	0.00595	0.14887

	Tensile stress at Tensile Strength (MPa)	Modulus (E-modulus) (MPa)	Comment
1	116.37360	-----	

TENSILE STRENGTH SAMPLE -2 (WITH FIBRE)

Specimen 1 to 1



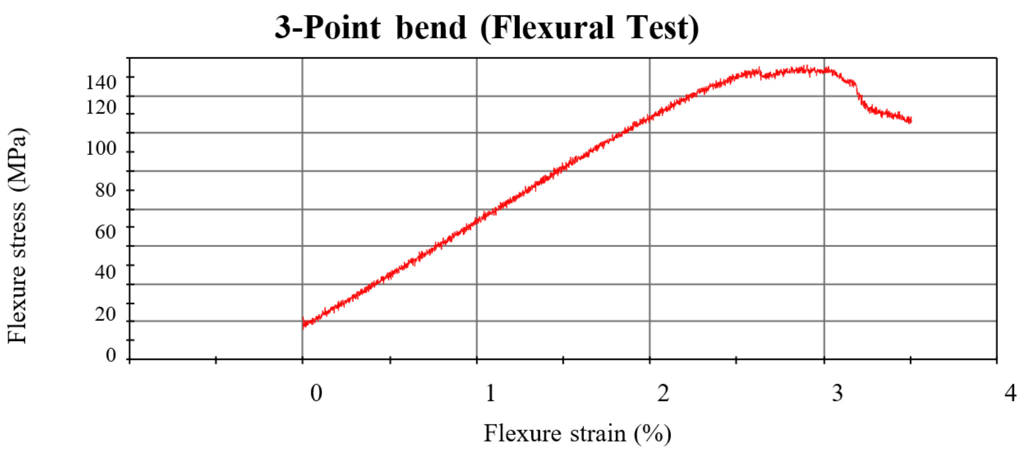
	Specimen label	Maximum Load (N)	Load at Break (kN)	Ult. Tensile Strength (MPa)	Tensile stress at Yield (Offset 0.2 %) (MPa)
1	Fiber1 3	10905.48337	10.49	151.47	-----

	Time at Yield (Offset 0.2 %) (sec)	Load at 2% strain (kN)	Extension at Break (Standard) (mm)	Tensile extension at Break (Standard) (mm)
1	-----	-----	2.79719	-0.04430

	Tensile strain at Break (Standard) (mm/mm)	Axial Gauge Length (Strain Source) (mm)	Tensile strain at Maximum Load (mm/mm)	Tensile extension at Maximum Load (mm)
1	-0.00177	25.00000	0.00590	0.14745

	Tensile stress at Tensile Strength (MPa)	Modulus (E-modulus) (MPa)	Comment
1	129.82237	-----	

Flexural Strength (3-Point bend)



3-Point bend (Flexural Test)

	Specimen label	Width (mm)	Thickness (mm)	Support span (mm)
1	Fiber2	23.00000	3.00000	75.00000
Mean		23.00000	3.00000	75.00000
Standard Deviation		-----	-----	-----
Minimum		23.00000	3.00000	75.00000
Maximum		23.00000	3.00000	75.00000

	Maximum load (N)	Flexural Stress (MPa)	Flexure stress at Maximum Flexure load (MPa)	Flexure strain at Maximum Flexure stress (mm/mm)
1	251.36797	136.61	136.61302	0.02899
Mean	251.36797	136.61	136.61302	0.02899
Standard Deviation	-----	-----	-----	-----
Minimum	251.36797	136.61	136.61302	0.02899
Maximum	251.36797	136.61	136.61302	0.02899

	Load at Maximum Flexure load (N)	Flexure load at Maximum Flexure stress (kN)	Flexure extension at Maximum Flexure load (mm)	Extension at Maximum Flexure load (mm)
1	-251.36797	0.25137	9.05959	-9.05959
Mean	-251.36797	0.25137	9.05959	-9.05959

	Load at Maximum Flexure load (N)	Flexure load at Maximum Flexure stress (kN)	Flexure extension at Maximum Flexure load (mm)	Extension at Maximum Flexure load (mm)
Standard Deviation	-----	-----	-----	-----
Minimum	-251.36797	0.25137	9.05959	-9.05959
Maximum	-251.36797	0.25137	9.05959	-9.05959

	Flexure extension at Maximum Flexure stress (mm)	Modulus (Automatic) (GPa)
1	9.05959	5.60929
Mean	9.05959	5.60929
Standard Deviation	-----	-----
Minimum	9.05959	5.60929
Maximum	9.05959	5.60929

Hardness Properties

Three examples of jute/coir reinforced unsaturated polyester resin hybrid composites with varied fibre lengths underwent the ASTM standard hardness test at five different locations on the same specimens. The average hardness value for all specimens is determined and is displayed in table 5. The findings indicate that the hardness values of 10mm fibre length hybrid composites fall between 38 and 44, 20mm fibre length hybrid composites fall between 42 and 55, and 30mm fibre length hybrid composites fall between 42 and 55

Sno	Hardness properties (without fibre)	Hardness properties (with fibre)
1	526.4	528.2
2	522.7	527.7
3	523.9	527.4

CONCLUSION

As a result of growing environmental consciousness, natural fibre is being used as an efficient reinforcement material in polymer matrix composites. Natural fibres are effective materials that can take the place of synthetic fibres now in use. The main drawback of the fibres, which are typically derived from plants and animals, is that they frequently have a low resistance to moisture. Therefore, natural fibres have been chemically treated to change the material properties by increasing the adherence of the fibres to the matrix and improving the mechanical properties of the composites. Natural fibre will soon replace synthetic fibres in the composites industry as one of the sustainable and renewable resources.

FUTURE SCOPE :

Future researchers have a lot of room to investigate this field of study. This research can be expanded to examine additional characteristics of these composites, such as the influence of fibre content, fibre orientation, loading pattern, and fibre treatment on mechanical performance of coconut coir-based polymer composites. The experimental results can also be analysed in a similar fashion. Future researchers have a lot of room to investigate this field of study. This work can be expanded to examine additional elements of these composites, such as the influence of fibre content, fibre orientation, loading pattern, and fibre treatment on the mechanical behavior of coconut coir-based polymer composites. The experimental results can then be analysed in a manner akin to this The goal of the current study was to investigate the characteristics and possibilities of Coir fibre polymer composites. Various reports on the usage of Coir fibres as reinforcements in the polymer matrix are included in the research. Its goal is to advance coir reinforced composite research by supplying expertise in the field. The composite material used in the final product offers great strength and hardness. To replace glass fibre composites was the goal. Use natural fibre composites with good mechanical qualities in its place. Due to its qualities and availability, coir is currently one of the most significant natural fibres. The applications for the produced coir reinforced polymer composites are numerous

SOME MAJOR APPLICATIONS

- Organic materials Reinforced composites are quickly becoming a viable alternative to ceramic or metal- based materials in a variety of industries, including the automotive, aerospace, marine, sporting goods, and electronic ones.
- Natural fibre composites have good particular properties, although their characteristics are highly variable. With the development of increasingly sophisticated processing methods for natural fibre and its composites, their weaknesses may and will be overcome.

- Important uses: construction materials, packing materials, ceiling panels for thermal insulation, biomedical and paper production

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