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# Analysis of Reinforcement of Arecanut Fibre with Epoxy Resin Composite Material

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***Abstract*—The high cost of synthetic fibres such as nylon, polyester etc, results in high cost of production and products derived from these materials which has necessitated alternative means of materials development. This has also informed the utilization of locally available coir fibre for composite materials development. Natural fibre has emerged as a renewable and cheaper substitute to synthetic materials such as arecanut, which are used as reinforcements. In this work, the objective was to develop, investigate and analyze the mechanical properties of a composite material using arecanut. The fabrication of the composite was carried out using epoxy resin as the matrix and arecanut as reinforcement. Tests were carried out to determine the mechanical properties such as tensile, bending and impact strengths. The results were studied and compared with the conventional materials and it process that the material developed can be used in structural applications with strong dependence on its mechanical properties.**

**Index Terms— Arecanut fibre, Bending test, Epoxy Resin, Impact test, Tensile test**

## I. INTRODUCTION

The use of green composites for engineering applications has gained high attention from industries in recent years as their potential to reduce waste from non-degradable synthetic materials and their carbon footprint. These composites using agro-fibers as reinforcement of thermoplastic materials are attractive to the automotive industry for light weighting of components (such as for automobile interiors) while maintaining strength and cost-competitiveness, leading to improved fuel efficiency as well as to satisfy the public demand for „green cars". Natural fiber composites are also suitable materials to make panels, ceilings, blocks, and partition boards to substitute wood, flooring tiles, etc. in building and construction industry. In comparison with synthetic fibers like glass and carbon, these natural fibers are gaining importance due to its many advantages, such as environment-friendly, reduced greenhouse gas emissions, low energy consumption, low cost, low density, and acceptable.

The Areca nut is the fruit of the areca palm, which grows in much of the tropical Pacific (Melanesia and Micronesia), Southeast and South Asia, and parts of east Africa. This fruit is commonly referred to as betel nut so it is easily confused with betel (Piper betle) leaves that are often used to wrap it (paan). The term areca originated from the Malayalam word and dates from the 16th century, when Dutch and Portuguese sailors took the nut from Kerala to Europe. Consumption has many harmful effects on health and is carcinogenic to humans. Various compounds present in the nut, including arecoline (the primary psychoactive ingredient which is similar to nicotine), contribute to histologic changes in the oral mucosa. It is known to be a major risk factor for cancers (squamous cell carcinoma) of the mouth and esophagus (food pipe). As with chewing tobacco, its use is discouraged by preventive efforts. Consumption by hundreds of millions of people worldwide – mainly with southern and eastern Asian origins – has been described as a "neglected global public health emergency".

Epoxy is a term used to denote both the basic components and the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as polyepoxides, are a class of reactive prepolymers and polymers which contain epoxide groups. Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols. These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing. Reaction of polyepoxides with themselves or with polyfunctional hardeners forms a thermosetting polymer, often with high mechanical properties, temperature and chemical resistance. Epoxy has a wide range of applications, including metal coatings, use in electronics / electrical components, high tension electrical insulators, fiber-reinforced plastic materials and structural adhesives.

## II. EXPERIMENTAL DETAILS

*A) Material and Methods:*

This section describes the details of processing of the composites and the experimental procedures carried out for their characterization and tests which the composite specimens are subjected to the raw materials used in this work are: Selection of fiber are Arecanut fibers, Jute Fiber and , Resin Epoxy (LY-556) and hardener(HY-917).

1) Resin Epoxy (LY-556) based on Bisphenol-A suitable for high performance composite FRP applications like Filament Winding, Pultrusion, Pressure Moulding.
2) Hardener (HY-917).
3) Arecanut Fibre nut is the fruit of the areca palm, which grows in much of the tropical Pacific (Melanesia and Micronesia), Southeast and South Asia, and parts of east Africa. This fruit is commonly referred to as betel nut so it is easily confused with betel (Piper betle) leaves that are often used to wrap it.

### B) Fabrication of test specimens:

The fabrications of composite slab are carried out by conventional hand layup technique. The dimensions of length and breadth is of 300*300mm was used to prepare the specimen. The composite specimen consists of totally 3 Layers of Arecanut Fiber for the preparation of one sample. A measured amount of epoxy is taken and mixed with the hardener in the ratio of 10:1 the layers of fibers were fabricated by adding the required amount of epoxy resin. The Arecanut fiber is mounted on the table and then epoxy resin applies and next layer is jute fiber. Before the resin gets dried, the second layer of natural fiber is mounted over the Arecanut fiber. The process is repeated till 3 layers of fiber. The epoxy resin applied is distributed to the entire surface by means of a roller. The air gaps formed between the layers during the processing were gently squeezed out. The processed wet composite were then pressed hard and the excess resin is removed and dried. Finally these specimens were hydraulic pressed to force the air present in between the fibers and resin, and then kept for several hours to get the perfect samples. After the composite material dried completely, the composite material was taken out from the hydraulic press and rough edges were neatly cut and removed as per the required ASTM standards.

### C) Testing:

The most common type of test used to measure the mechanical properties of a material is the Tension Test. Tension test is widely used to provide basic design information on the strength of materials and is an acceptance test for the specification of materials. The major parameters that describe the stress-strain curve obtained during the tension test are the tensile strength (UTS), yield strength Or yield point (σy), elastic modulus (E), percent elongation (ΔL %) and the reduction in area (RA %). Toughness, Resilience, Poisson's ratio (ν) can also be found by the use of this testing technique. In this test, a specimen is prepared suitable for gripping into the jaws of the testing machine type that will be used. The specimen used is approximately uniform over a gage length (the length within which elongation measurements are done**).**

Bend tests deform the test material at the midpoint causing a concave surface or a bend to form without the occurrence of fracture and are typically performed to determine the ductility or resistance to fracture of that material. Unlike in a flexure test the goal is not to load the material until failure but rather to deform the sample into a specific shape. The test sample is loaded in a way that creates a concave surface at the midpoint with a specified radius of curvature according to the standard in relation to which the test is performed. Bending tests are as popular as tensile test, compression test, and fatigue tests.

Charpy impact test, also known as the Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's notch toughness and acts as a tool to study temperature-dependent ductile-brittle transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply. A disadvantage is that some results are only comparative.

## III. Results and Discussion

### A) Tensile Test:

The test conducted under the ASTM A370:2017. The specimen shape was flat. The width, length and cross sectional area are 13.51mm, 13.25mm and 179.01mm$^2$ respectively. The following results were obtained during the test. We found yield stress at 2.681N/mm$^2$. The tensile strength was obtained at 5.251N/mm$^2$ and elongation was 1.64%. The graph was plotted with respect to stress v/s strain.

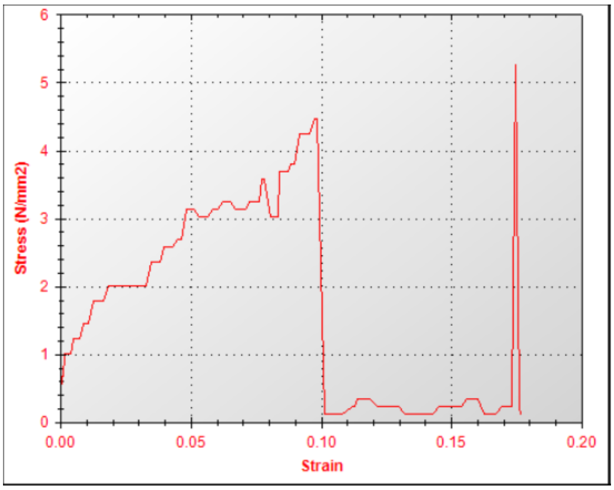


Fig. 1. Tensile test graph (Strain vs. Stress)

### B) Bending Test:

The test conducted under the ASTM A370:2017. The specimen shape was flat. The thickness, width and cross sectional area are 12.75mm, 29.5mm and 376.12mm$^2$. The following results were obtained during the test. We found Peak load at 1.380 KN and bending strength is 3.669N/mm$^2$. The graph was plotted with respect to load v/s elongation.

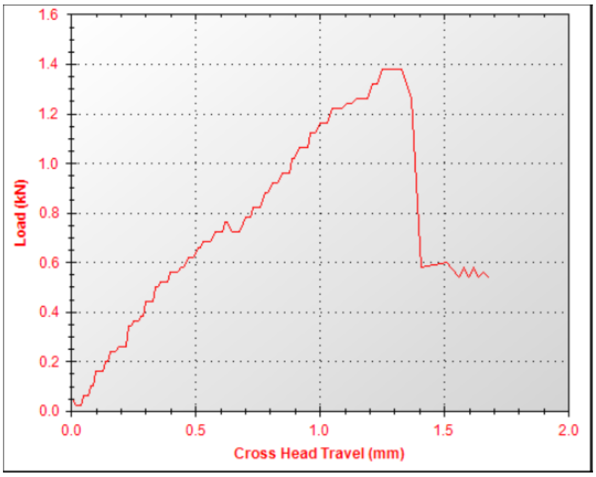


Fig. 2. Bending test graph (Cross head vs. Load)

### C) Charpy Test:

The test method was ISO-148-1:2016. The model was taken under AIT-300-ASTM standards. The capacity was 300 J. The ambient temperature 25.3$^0$ C. The Table-I shown below gives the brief input and output of the test.

TABLE I
SAMPLE DESCRIPTION

<table>
<tr><td colspan="6">Sample Id: Arecanut with Epoxy Resin</td></tr>
<tr><td colspan="6">Testing Facility</td></tr>
<tr><td colspan="3">Machine No : CL/ME/IMPA02<br>Model : AIT-300-ASTM<br>Capacity : 300 J</td><td colspan="3">Validity : 10.11.2018<br>Ambient Temp., ° C : 25.3</td></tr>
<tr><td colspan="6">Test Results</td></tr>
<tr><td>Description</td><td>Specimen Temp., °C</td><td>Thick mm</td><td>Width Mm</td><td>Length mm</td><td>Charpy Impact Energy, Joules</td></tr>
<tr><td>Arecanut with epoxy resin</td><td>Room Temp</td><td>14.55</td><td>11.70</td><td>55.58</td><td>4</td></tr>
</table>

## IV. CONCLUSION

Natural fibres, when used as reinforcement, compete with such conventional fibres as arecanut fibre. The advantages of the conventional fibres are good mechanical properties which vary only little, while their disadvantage is difficulty in recycling. Several natural fibre composites reach the mechanical properties of arecanut fibre composites, and they are already applied, e.g., in automobile and furniture industries. Till date, the most important natural fibres are arecanut fibre. Natural fibres are renewable raw materials and they are recyclable. The tensile and bending, hardness, impact properties of epoxy composites reinforced with arecanut fibre, have been studied and discussed. The following conclusions can be drawn from the present research.

It has been noticed that the mechanical properties of the composites such as tensile strength and compression strength, impact, of the composites are also greatly influenced by the fibre fraction and type.

This work shows that successful fabrication sugarcane & coir, reinforced epoxy composites is possible by simple hand lay-up technique.

The developed coir & sugarcane reinforced composite can be used in different engineering applications based on the available data provided by this research report.

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