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Analysis of Mechanical Properties on ABS Thermoplastic Infused with Jack Fruit Rags

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Abstract

Currently, experimental studies are being carried out on fruit fibre reinforced plastics on a large scale. The reason behind its considerable growth is the merits that come with it, such as being environmentally friendly and abundancy in availability. The natural fibre reinforced are environmentally friendly as the polymers are mixed with natural fibres that aid in decomposition after the shelf life of the product manufactured using the natural fibre reinforced plastics. Many automotive, aerospace, sporting goods and building industries are shifting from traditional plastics and are moving towards more environmentally friendly natural fibre reinforced plastics in order to reduce the carbon footprint. In this research acrylonitrile butadiene styrene (ABS) along with chopped and air-dried jack fruit rags of about 1 - 1.5 mm in length are used to make a composite specimen of 85%:15% and 80%:20% of thermoplastic polymer to rags ratio. Novelty in this research is the usage of jack fruit (Artocarpus heterophyllus) rags instead of fruit fibres. These jack fruit rags are generally considered waste and discarded which then get decomposed. The rags from the jack fruit are hydrophilic in nature and they attract water particles towards them thereby making the composite wake. In order to make the composite strong enough to withstand the forces, the composite has to be made hydrophobic by chemical treatment. There are many kinds of chemical treatment but in this research, we have gone for NaOH treatment. After changing the nature of rags to hydrophobic, the rags are reinforced with ABS using compression moulding technique to form a natural fibre reinforced polymer. The composite is then machined as per ASTM standards to form a test specimen that is analysed for its tensile and flexural strength. The results from these tests indicate that the composites exhibit commendable tensile and flexural properties.

Keywords: Acrylonitrile Butadiene Styrene, jack fruitrags,compression moulding, tensile test, flexural test.

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1. Introduction

Recently many researchers and industrialists are taking tremendous efforts to bring down themass of their componentto improve its overall efficiency and as a cost cutting measure.This is generally achieved by replacing metals with plastics, but with the people becoming more and more environment conservative they are opting to shift from regular plastic material to alternate materials. This paradigm shift made the manufacturers to think of materials other than regular plastics for their components in order cope up with the paradigm shift. This shift enabled the researchers and industrialists to look out for materials that are environment friendly and are also as light and flexible as plastics. After extensive research and testing, researchers were able to come up with fibre reinforced plastics (FRP) that are as light as regular plastics andenvironmentallyfriendly [7,9].

TheseFRP materials were far easier to degrade that the conventional plastics. Recently many manufacturers are replacingplastics with FRPin the possible areas of their product so as to cut down the overall mass of the product and thereby experiencing greater efficiency and leading to higher margins in profit [11]. Combination of two or more materials that arechemically and physically different properties. Composites possess totally different characteristics when compared to an individual component. Composites consists of two main components i.e. matrix and reinforcement.In a composite,matrix supports the reinforcement and helps in keeping thereinforcements in proper orientation and position. They are responsible for the toughness of the composite. Reinforcements are the ones that are embedded inside the matrix and they are responsible for improving load carrying capacity of the material by imparting strength to the composite [8].

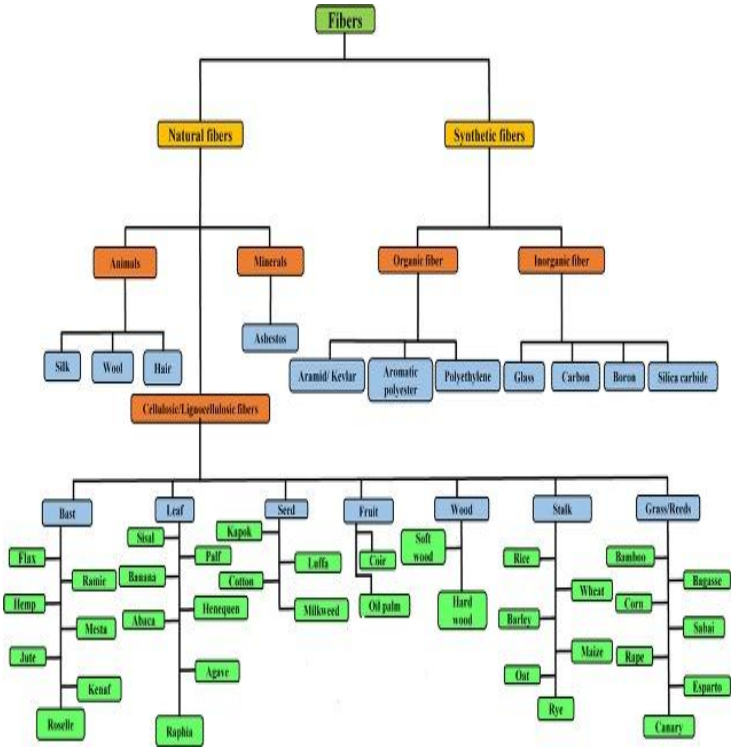


Fig.1. Types of natural fibers

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Generally, reinforcements are harder than matrix. Most used matrix material are polymers. The main reason for choosing a polymer is because of the following reasons: Processing a polymer does not involve high amount of pressure and temperature, nor the equipment required for fabrication of composites are simple and budget friendly. They possess comparatively less strength and stiffness which can be compensated by fibres. Extensive research and development have gone into variety of natural fibres from various parts of plants and trees. These include fibres from leaf, fruit, seed, bark and even their by-products [4]. Figure 1 [5] indicates the major natural fibres and other potential fruit fibres. Fibres from the above-mentioned products act as an alternative reinforcing material for composite. They are thin, and demand comprehensive analysis of its morphological, structural and mechanical properties [6].

The current research work focuses on infusing Acrylonitrile Butadiene Styrene (ABS) with jack fruitrag fibres to enable them to be ecologically friendly. ABS stand for Acrylonitrile Butadiene Styrene [1]. Itisknown for its dimensional stability and its resistance to chemical reaction[3]. ABSplasticshavea meltingtemperatureofabout110°C[2]. They are generally usedtomake pipes,certain musicalinstruments,heads of golfstick,automobile bodyparts, andtoys.

Table 1. Mechanical & physical properties of ABS [4]

Matrix	**Tensile Strength (MPa)**	**Bending Strength (GPa)**	**Melting temperature (°C)**	**Density (g/cm^3)**
ABS	27.6–55.2	1.1–2.9	110	1–1.2

Jackfruit (Artocarpus heterophyllus)trees belong to the family of Moraceae. They are abundantly available in India, Bangladesh and in many parts of South East Asia[8,10].The major parts of jack fruit are as shown in figure2.The rags are then treated and infused with ABS sheets to create a composite. The composite is machined as per ASTM standards and tested. The specimen made ofthe composite has been tested for its mechanical properties and it has been found out that they exhibit a satisfactory weight to strength ratio.

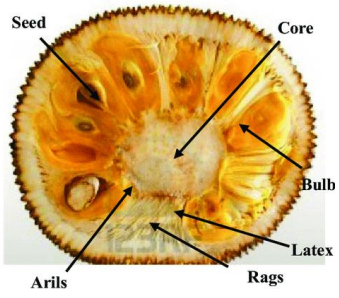


Fig.2. Cut section of jackfruit

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2. Composite Fabrication

The step by step procedure for preparation and testing of composite is as mentioned in figure3.

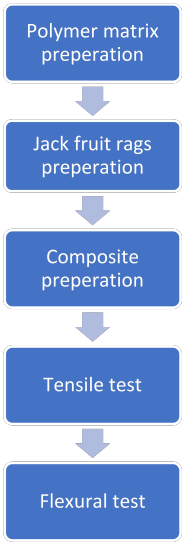


Fig.3. Process Chart

STAGE – I - Polymer matrix preparation:Acrylonitrile Butadiene Styrene (ABS) sheets of 285*285*1mm was sourced from Ghanshyam Polyplast, Coimbatore.

STAGE – II –Jack fruit rags preparation[12]:Jack fruit rags were sourced from Kerala, India.Before reinforcement the jack fruit rags were chopped and segregated in terms of their length ranging from 10 to 15 mm. The chopped rags are thenthoroughly washed with distilled water,then placed in hot air oven at 70^{o}C for a period of 24 hoursto dehydrate the rags. The dehydratedrags were thensoaked in 6% Sodium Hydroxide (NaOH)solution for a period of 10 minutes at 5^{o}C. The rags are then treated with 1% of Hydrochloric Acid (HCl) [12]. Treated rags were thenthoroughly washed with distilled water, andfinally dried in open air atmosphere for a period of 48 hours.

STAGE – III - Composite Preparation: The jack fruit rags of 15% & 20% to the weight of ABS are insertedin between 3 layers of ABS in a scattered or random manner. The composite sheet is then placed and heated in a compression moulding machine for3 hours' period. Due to the heat and pressure from the compression moulding machine the ragsgets infused between the layers of ABS and hence making anABS composite.

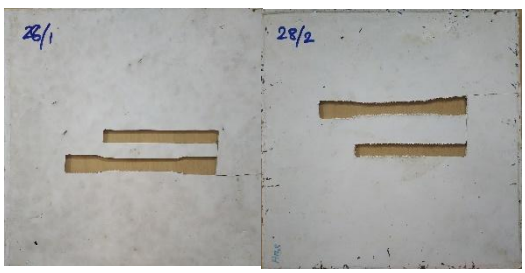


Fig.4. Composite with 15% and 20% jack fruit rags

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3. Experimental Procedure

The compression moulded sheet is then machined as per ASTM standards to carry out tensile and flexural testing.Work piece as per the ASTM D638 & ASTM D790 are tested for their tensile and flexural strength.



(a) **(b)**

Fig.5. Test specimen – Tensile (a) 85% ABS & 15% rags, (b) 80% ABS & 20% rags

3.1 Tensile Test

Tensile test was carried out at a testing laboratory in Erode and the results obtained from the tensile tests are tabulated in table1.



Fig.6(a). Tensile Test on Specimen (a)



Fig.6(b). Tensile Test on Specimen (b)

Table 2.% of elongation

ABS: Rags ratio	Peak Load (N)	% of Elongation
85:15	555N	3.04
80:20	824N	3.11

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3.2 Flexural Test

Flexural test was carried out at R&D laboratory, Erode and the results obtained from the flexural tests are tabulated in table2.



Fig.7(a). Flexural Test on Specimen (a)



Fig.7(b). Flexural Test on Specimen (b)

Table 3. Flexural strength

ABS:Rags Sample	Peak Load (N)	Flexural Strength (MPa)
85:15	77.8	62.91
80:20	136.8	110.5

4. Results and Discussions

The tensile test carried out on the specimen (a)at a peak load of 555N yielded an elongation percentage of 3.04, similarly the tensile test carried out on the specimen (b) at 824N yielded an elongation percentage of 3.11.

The 3point flexural test carried out on the specimen (a) at a peak load of 77.8N yielded yield strength of 62.91MPa, Similarly the 3point flexural test carried out on the specimen (a) at a peak load of 136.8N yielded a yield strength of 110.5MPa.From the results it is clearly visible that the specimen (b) i.e. with 85% ABS and 20% jack fruit rags withstood better tensile and flexural load.

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5. Future Scope

The same material can be tried with other combinations and test such as wear and compression test. Similarly, the results can be compared with ABS reinforced with other fibres in order to justify the results obtained from ABS reinforced with jackfruit rags. Results can also be compared with untreated and treated jack fruit rags.

6. Originality

According to the literature survey, to the best of the authors' knowledge, this study is the first research work regarding the tensile and flexural performance on ABS- jack fruit rags-based composites.

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