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Experimental investigation on effect of ground nut husk filler in banana fiber reinforced polymer composite and its application

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Abstract
In the fast-developing world, the concern for the environmental pollution and the prevention of non-renewable and non-biodegradable resources has attracted researchers seeking to develop new eco-friendly materials and products based on sustainability principles. The fiber from the natural sources provide indisputable advantages over synthetic reinforcement materials such as low cost, low density, non-toxicity, comparable strength, and minimum waste disposal problems. In the present experiment, banana fiber reinforced unsaturated polymer composites are prepared and the mechanical properties of these composites are evaluated. The composite samples with different fiber volume fractions were prepared by using the hand lay-up process and apply pressure at a compression moulding machine. The samples were subjected to the mechanical testing such as tensile, flexural and impact loading. Similarly ground nut husk was powdered and were added as filler along with the banana fiber for different fiber volume fractions. The results were compared and are interpreted for suitable applications.
Key words*- non-biodegradable, banana fiber, unsaturated polymer, ground nut husk*

1. INDRODUCTION

The growing global concern over the environment is now encouraging the use of renewable sources of materials that do not harm nature and come from an alternative source of.good economic potential. Fiber composites are having lot of advantages and applications which are bio degradable, economical and non-toxic. Hence, they are replacing conventional materials in aerospace, automotive, agriculture and construction industries. A composite material is defined as a combination of two or more completely dissimilar materials with significantly different physical and chemical characteristics, which when combined form a single material with superior properties compared to the properties of the individual components. The individual materials that form a composite are known as constituents. The utilization of composites is increasing in a rapid manner mainly due to ease of production and good mechanical properties compared to that of conventional materials.Usually a composite is made up of two constituent materials, reinforcement and a matrix. The reinforcement provides strength and stiffness. Typically the reinforcement is stiffer, stronger and harder than the matrix. In general, reinforcement can be in the form of fiber or a particulate.

The matrix is in continuous phase, which is a polymer, metal or a ceramic. The matrix binds the reinforcement and helps to transfer the load among the reinforcement and also protects the reinforcement from environmental effects.

2. LITERATURE REVIEW

2.1 Faizur Rahman et al

A. Faizur Rahman et al evaluated the mechanical property of various volume fractions of banana and sisal woven roving's polyester based composites. The results of the study revealed that the ultimate tensile strength, flexural strength and impact strength are found comparatively higher in sisal fabric

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composites than banana fabric composites. And how the volume affects the strength of composites is also studied.

2.2 Sathish et al

This paper provides idea about some work related to banana fiber based composites and also important properties of banana fiber composites. It also shows the suitability of banana fiber composite for automotive, marine and construction industries.

3. EXPERIMENTAL METHODOLOGY

Apply wax on the surface of the mould, so that the sticking of the resin can be avoided and the produced composite can be easily taken off.After wax is applied, sand paper sheet is used on both top and bottom of the die surface in order to get a good surface finish of the product. Now the banana fibers are cut as per the die size and then they are placed on the mould. Then the resin is poured on the surface of the fiber which is being placed on the mould surface. This resin are uniformly spread with the help of a brush.The second layer of the fiber is placed and a roller is moved on the surface with mildpressure in order to remove the air trapped and the excess resins present. The same process is repeated for each layer of the fiber and the resins, till the required layers are stacked. After the layers are stacked the same sand sheet is spread on the inner surface of the mould, wax is then applied on the inner surface of the mould which is then placed on the stackedlayer and the pressure is applied. curing can be carried out in room temperature and it is kept for 24-28 hours.After curing the mould is opened and the developed composite material is taken out. Similar procedure is adopted for adding fillers of ground nut husk in various ratio.

3.1 Materials used:

The materials used for the preparation of composite material and the hybrid materials are clearly stated, the place of purchase is also mentioned.

Banana fiber:
SCIENTIFIC NAME: Musa sp.
FAMILY: Musaceae ORIGIN: Asian tropics
Extraction process: Retting
Place of purchase: SS enterprises, Tuticorin

Groundnut husk filler:
SCIENTIFIC NAME: Arachis hypogaea.
Collection process: obtained from neighbours and were processed

Hardener : MEKP
Aspect (visual): clear liquid.
Colour ;:; ::;blue

Viscosity at 25 °C (ISO 9371B) :50 - 100 [mPa s].

Density at 25 °C (ISO 1675): 1.20 - 1.25 [g/cm3]

Flash point (ISO 2719): 195 [°C] Storage temperature: 2 - 40 °C. Purchase: The ULTIMATE enterprises, Thiruvanmiyur.

Acetone: (cleaning agent)
Surface tension: 23.32 dyn/cm at 20°C
Molecular weight: 58.08

Boiling point: 56.29°C

Viscosity: 0.36 cP at 20°C

Solubility in water: Miscible in all proportions

4. RESULT AND DISCUSSION

Materials are characterised by their properties. They may be hard, ductile or heavy. Conversely, they may be soft, brittle or light. The mechanical properties of materials are the properties that describe the behaviour of the material under the action of external forces. They usually relate to elastic and plastic behaviour of the material.The mechanical characterisation is done to know about the various physical properties like tensile strength, compressive strength, and flexural strength of the specimen. The testing are undergone in accordance with the ASTM standards. All the test are carried out in Tinius Olsen H50KL series UTM, testing was carried out at composite material lab, NIT-Trichy.
The test carried out are:

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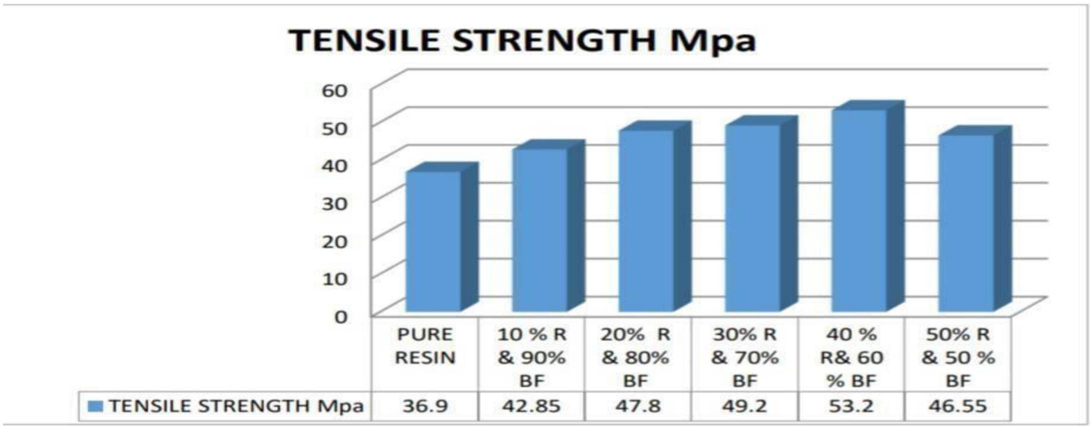
1. Tensile testing.
2. Flexural testing.

The cross head speed is maintained at 0.5 mm/min for both tensile and flexural tests.The gauge length for tensile test is 100 mm and that for the three-point flexural test is 50 mm.

Tensile Test :

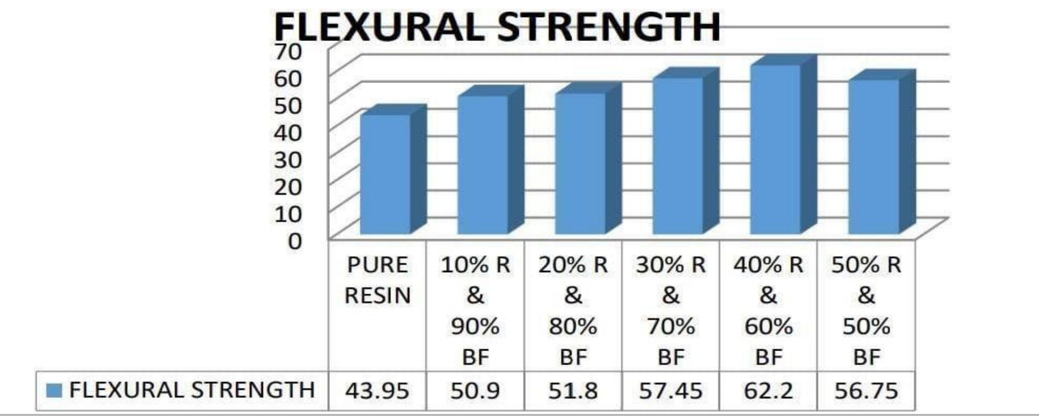
Embedding the fibers in the matrix improves the tensile properties of the composite due to superior inherent strength compared to the matrix Graph 4.1 shows the tensile strength of the various wt% of randomly oriented banana fiber reinforced polymer composite. When the fibers were embedded in the matrix, a shift in nature from brittle to ductile was observed. As the fiber wt. % increased from 10 to 40 wt. %, an increase in strength was noticed. Also, when the fiber content was increased beyond 40 wt. %, fall in strength was observed.



Graph 4.1 Tensile Test(BF+USPR)

4.1 Flexural Test:

Similar to the trend of tensile strength The strength of the pure resin is low due to its brittle nature. At 10 wt. % fiber content, the failure observed was predominantly brittle in nature which was the result of low strength of the composites due to the presence of higher amount of matrix. Between 20 and 30 wt. % fiber content, the tensile strength is marginally increased due to improvement in the interfacial bonding between the composite constituents, whereas the occurrence of failure arising as a result of the brittle failure of the matrix and a ductile fiber pull-out. However, at 40 wt. % fiber content the best performance was revealed due to improved interfacial bonding. The failure occurred was less brittle in nature and largely associated with ductile fiber pull-out as well as fiber- matrix debonding. This proves the enhanced stress transfer between the matrix and fiber. Beyond 40 wt. %, a decreasing trend in the tensile strength was observed. This was due to fiber agglomeration factor (predominant fiber to fiber contact) which leads to inefficient stress transfer from matrix to fiber.



Graph 4.2 Flexural Test(BF+USPR)

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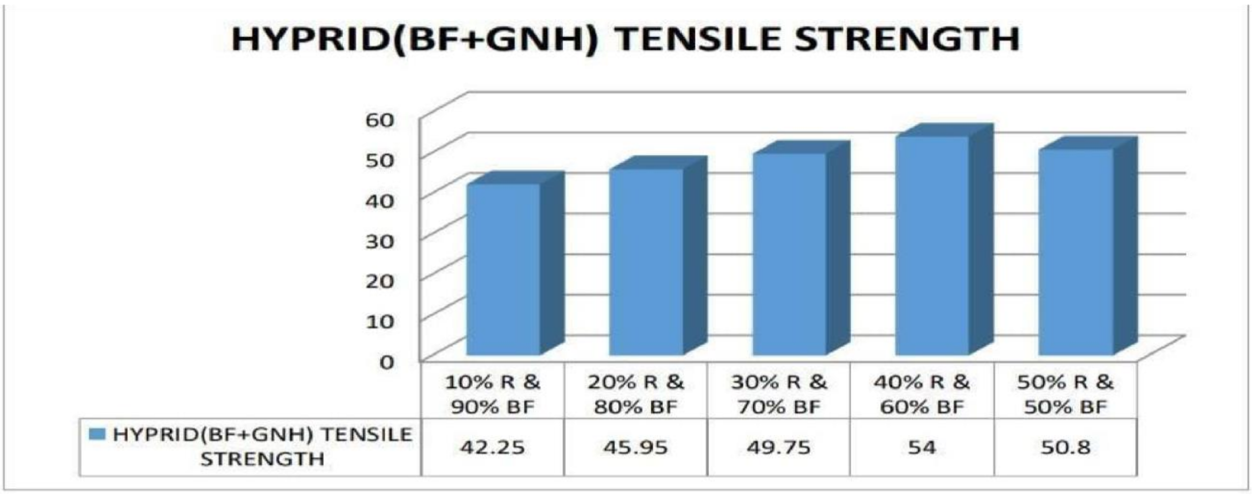
BANANA FIBER + filler + resin A. Tensile Test :

By varying the fiber weight percentage by adding the filler experimental analysis were carried out. At initial stage 10% of fiber (5% of banana fiber and 5% of filler) and 90% of resin is used, similarly the fiber weight percentage was increased up to 50wt%.the result clearly revealed that the addition of filler increases the strength of the composite than the purely oriented banana fiber reinforced composite .this is due to as the fillers are added it occupies the fine voids and finely structured intermolecular spaces to provide more strength than the randomly oriented banana fiber ,also the trend prevails up to 40wt% of fiber content beyond which the strength reduces due to more fiber to fiber contact. **B. Flexural testing result:**

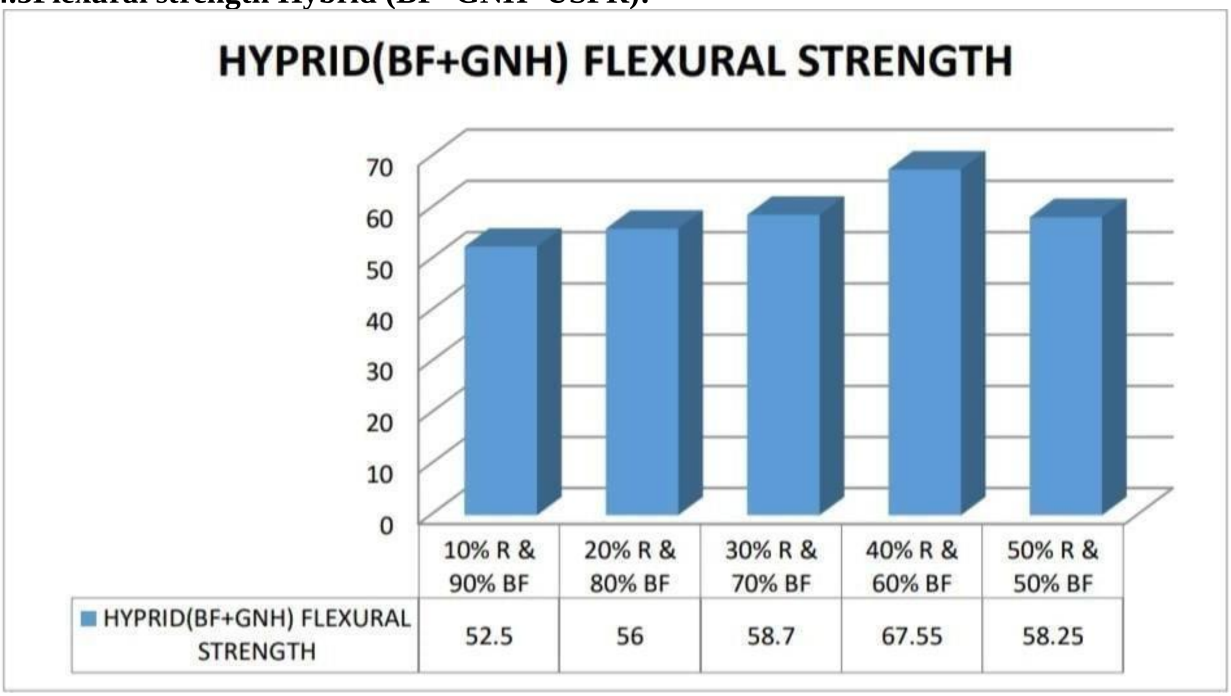
By varying the fiber weight percentage the experimental analysis was carried out. At initial stage 10% of fiber (5% of banana fiber and 5% of filler) and 90% of resin is used, The experiment is carried out till 50% of fiber and 50% matrix composition. The result revealed similar trend as that of tensile strength however the flexural strength was more than the tensile.

4.4Tensile strength Hybrid (BF+GNH+USPR):



Graph4.3 Hybrid (BF+GNH+USPR)tensile test

4.5Flexural strength Hybrid (BF+GNH+USPR):



Graph4.4Hybrid (BF+GNH+USPR)felxural test

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While comparing the test result of both composite material (banana fiber + UPE) and the newly developed hybrid material (bananafiber + groundnut filler+ UPE), the hybrid material shows a very high strength.

5. CONCLUSION

In the characterization process, the discarded ground nut husk filler is tested for its potentiality as a reinforcement in banana fiber composite. The influence of filler content on the mechanical properties such as tensile strength, flexural strength was observed. Both the strength increases with filler content up to 40% Beyond that the strength decreases. So this new hybrid material is capable of withstanding higher value of forces during the time of application. More over discarded materials are used it will be highly economical and eco-friendly.

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