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Investigation of Mechanical Properties on Vinyl Ester Based Hybrid Composites

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***Abstract*—There is a scope of significance in the natural fibers which is used as reinforcing components for thermo sets matrix and thermoplastics, mainly because of the benefits which ideally offered by natural fibers they are environmentally friendliness, renewability, biodegradability, sustainability, lightness and carbon dioxide reduction in nature, but also as an partial alternative to conventional fiber polymer composites in many industrial applications. The fiber reinforced hybrid composites such as natural and glass will likely have the potential to be used as replacement specifically for the conventional reinforcement material in composites by using only carbon and other such fibers related to it. The hybrid composites are more progressing composites when it is compared with conventional FRP composites. Hybrids can include more than a solo reinforcing phase and a solo matrix phase, a solo reinforcing phase with numerous matrix or multiple phases and multiple reinforcing phases. The natural fibers will have the important properties such as huge availability, affordability and renewability. By combining the Glass fibers with the natural fibers in a hybrid manner some extent of pollution and cost of the composites can be reduced in this project we are comparing with the two different combinations of natural and synthetic fibers to find out the combination including hybrid composites which consist of higher mechanical properties in it.**

***Index Terms*— Hybrid composites, Tensile Strength, Hardness and Impact strength.**

I. INTRODUCTION

Composite materials are also called as engineering materials which are made from minimum two or more constituent materials which remains separate and well difined on a macroscopic level while forming a single component. The constituent materials includes two categories such as: matrix and reinforcement. In each type at least one portion is required. The prime functions of the matrix are to transfer the stresses between the reinforcing fibers or particles ,to defend them from environmental damage and/or mechanical damage whereas the existence of fibers or particles in a composite which leads to the improvement in its mechanical properties. Tensile strength in the composites have 4 - 6 times higher when compared with steel or aluminium (based on the reinforcements), improved torsion stiffness and impact properties. Hence the higher fatigue endurance limit (upto 60% of ultimate tensile strength) will be 30% - 40% lighter for example any particular aluminium structures designed to the same functional requirements. Lower embedded energy

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compared to other structural metallic materials like steel, aluminium etc.
By consolidating various types of fibers converted into a single matrix which led to the evolution of hybrid composites. The way of acting by the hybrid composites is a sum of the individual components in to a more favourable balance between the innate advantages and limitations in to it.. Also, using a hybrid composite that contains of 2 or several types of fiber, the advantages of one type of fiber could complement with what are lacking in the other. As a consequence, a balance in cost and performance can be accomplished by proper material design.
The Natural fibers includes rice husk and also synthetic fibers viz; glass fiber. Fabricating hybrid composites with two reinforcement materials and one matrix material. Keeping glass fiber as a common fiber type which is glass and other fiber - Vinyl Ester as matrix material. Objective of the present work is to fabricate the hybrid composite using Hand layup process, performing tensile test, impact test and Hardness test.

II. MATERIALS

A. Glass Fiber

Fig 1: Glass fiber (e-cloth)

A glass fiber consists of extremely fine filaments of glass. The glass is warmed up by heating it until it reaches molten, then it is allowed to pass in to the superfine passage like holes, to form glass filaments that are extremely thin, those extremely can be better and easily measured in microns. The glass fiber includes the properties which are Incombustibility, Corrosion resistance, High strength at low densities, Good thermal and Sound insulation. If it is differentiated with the carbon fiber will posses lower stiffness and strength but less brittle and economical thereby used for composites.

B. *Rice Husk*

Fig 2: Rice husk

Rice husk is also known as Rice hulls. Each rice husk are safely have a cover for each rice grains and it is very strong. The safety cover protects the rice grains, which results in finding its applications in several sectors such as raw materials for building materials, fuel, fertilizers and insulation materials.

C .Vinyl Ester

Fig 3: Vinyl Ester

Vinyl Ester, or Vinyl ester, is a resin produced by the etherification of an epoxy resin with an unsaturated mono carboxylic acid. The reacted product is then broken down when dissolved in to a reactive solvent, like styrene, 35–45% content by its mass. Hence used as an substitute to polyester and epoxy materials in composite materials or in matrix, where its properties, rigidity, and high cost in between polyester and epoxy.

III. METHODOLOGY

A. Hand layup method

Hand lay-up is one of the simplest way and most significantly used technique used to fabricate several composite process. Reinforcing mat woven fabric or attenuated which is positioned manually in the open mould, and resin is carefully poured, then it is slowly brushed or sprayed over into the glass plies. Ensnared air is separated manually through squeezes or by rollers to accomplish the laminates structure. Then allowed to room or normal temperature for curing epoxies and polyester are most recurrently used matrix resins. Curing is commenced by a catalyst in the resin system. There by it hardens the fiber reinforced resin composite without outer warming or heating it for a high quality surface parts; To the mold surface pigmented gel coat is applied first or in the begining.

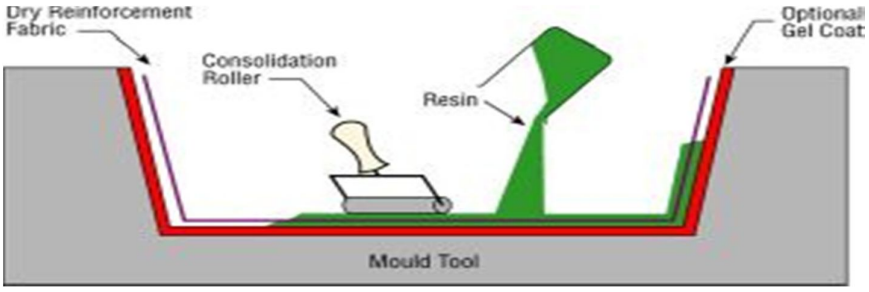

Fig 4: Hand layup process

B. Hand Layup process for Glass-Rice Husk-Vinyl Ester hybrid composites

1. A mould of 250mm x180mm is prepared to fabricate hybrid composite of 3mm thickness.
2. All fibers required for fabrication are cut so that they will fit into the mould.
3. Vinyl Ester is then mixed with promoter, accelerators and catalyst in a bowl thoroughly.
4. Mould is applied with wax initially so that the resin will not adhere to the mould.
5. A layer of resin is allowed and applied then glass fiber is kept on it and another layer of resin is also allowed and applied.
6. Is kept on the mould and again resin is allowed and applied in to it and then a layer of rice hulls is kept.
7. This process is repeated or occurred again and again until the fabrication forms 13 layers of matrix materials and reinforcement material.

Fig. 5: Fabrication of Glass-Rice Husk-Vinyl Ester hybrid composite

C. Post curing

Post curing is a technique used to take to completion in the process of curing or making betterment to obtain the enhancement of the service temperature limits. The post curing, in essence, improves the glass transition temperature (Tg)by increasing of the cured composite laminate. A step post curing cycle has been followed as outlined below

1. The cured specimens were placed in a hot or warm air circulated oven.
2. First specimens is then heated to the temperature of 50ºC and kept sustained at this temperature for 15 minutes.
3. Then the ILSS specimens were then heated to the temperature of 70ºC for 30minutes.
4. Finally the ILSS specimens were further heated to 85ºC for 1 hour and then allowed to cool down to room temperature on its own.

Fig 6: Post curing oven

IV. TESTING

A. Tensile Test

The tensile test is carried out on the specimen. Then a cut occurred using water jet machining (WJM) ,as per ASTM D-638 standard.

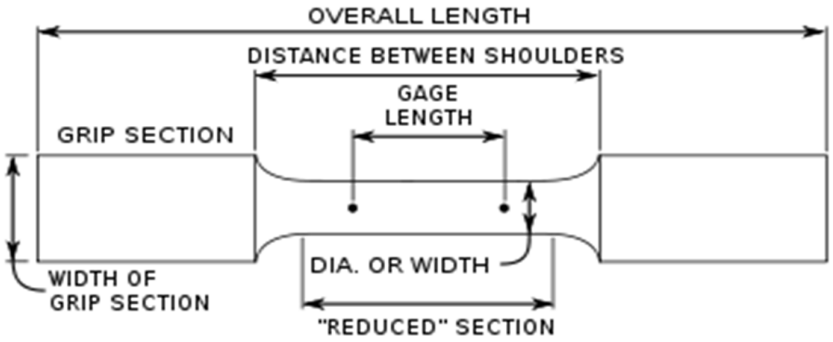

Fig. 8: ASTM D-638 standard

Gauge length=50 mm
Overall length=167mm
Width of grip section=16mm
Width of reduced section=12.5mm
Grip section length=50mm
Distance between shoulders=67mm
Reduced section length=60mm
Glass-Rice Husk-Vinyl Ester hybrid composite (4%)
Width = 25.09 mm
Thickness = 3.83 mm
Initial or beginning Gauge length = 50mm

Fig 7: Specimen before testing

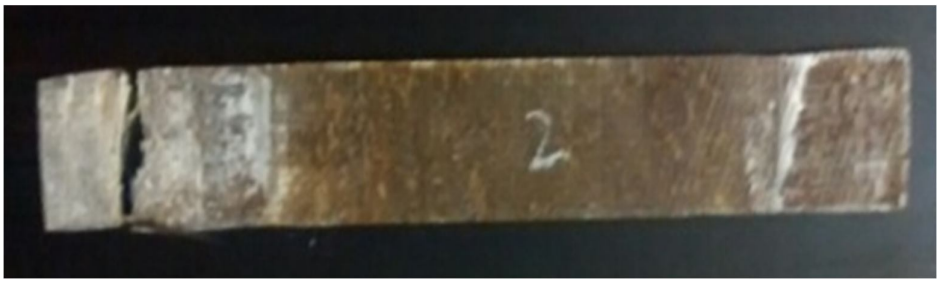

Fig 8: Specimen after testing

Glass-Rice Husk-Vinyl Ester Hybrid composite (10%)
Width = 25.64mm
Thickness = 4.46 mm
Initial or beginning Gauge length = 50mm

Fig 9: Specimen before testing

Fig 10: Specimen after testing

TABLE I. COMPARISON OF TENSILE TEST RESULTS

Specifications	Glass- rice husk (0%)	Glass- rice husk (4%)	Glass-rice husk (10%)
Peak load (kN)	15.12	20.04	19.80
Ultimate tensile strength (MPa)	132.59	208.54	173.15

B. Hardness Test

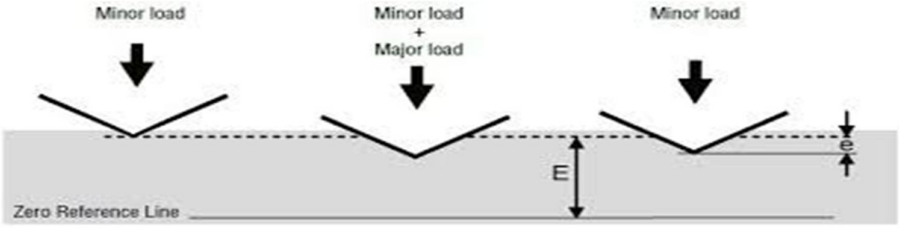

Fig 11: Testing process - Rockwell hardness

TABLE II. COMPARING ROCKWELL HARDNESS NUMBER

Specifications	Glass- rice husk (0%)	Glass- rice husk (4%)	Glass-rice husk (10%)
Rockwell Hardness Number	99	90	96

C. Impact Test

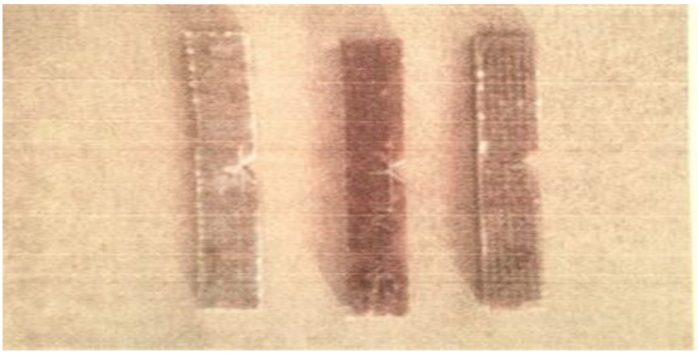

Fig 12: Specimen before testing

Fig 13: Specimen after testing

TABLE III. COMPARISON OF IMPACT STRENGTH

Specifications	Glass- rice husk (0%)	Glass- rice husk (4%)	Glass-rice husk (10%)
Charpy Impact Test (J/mm^3)	766	1167	910

V. CONCLUSIONS

- The Glass Fibre-Rice Husk-Vinyl Ester Hybrid composite has been fabricated successfully by using Simple Hand Layup technique with 0-10% of reinforcement.
- The Glass Fibre-Rice Husk-Vinyl Ester hybrid composite has lower tensile strength when it has 10% of reinforcement and higher tensile strength when 4% of reinforcement.
- Impact energy 910J/mm^3 and1167J/mm^3 was found for 4% and 10% of reinforcement respectively.
- Rockwell hardness number 90 and 99 was found for 4% and 10% of reinforcement respectively.

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