Characterization and Synthesis of Epoxy Based Natural Fiber Composite Material for Automobile Applications.

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Abstract: Since only a few decades ago, as the globe has become increasingly concerned about global warming, we have begun to be worried about the environment and how we might protect it. The strategy has now shifted to reducing consumption and pollution. The requirements of weight and fuel consumption reduction in the automotive sector have become a vital research without sacrificing any mechanical strength Composite materials, which originated in the aerospace and aeronautics industries, are now being brought to the car industry. One such endeavour is to design a material that will allow the vehicle to be lighter. This is accomplished through the advancement of existing technologies as well as the development of new ones. Materials engineering is one of these rapidly evolving new technologies. Hence in this work an attempt is made to develop the epoxy based natural fiber embedded composites which may find application in various automobile parts. The composites are made using coconut coir and areca husk along with various amount of ash content which will enhance the fire resistance property of the material.

I. INTRODUCTION

Metallic components which are widely used in avionics, civil structures, automobile are been replaced with the aid of composite materials [2]. It is all because of its strength and also due to stiffness-weight ratio. Compared to particular metals, advanced composites have greater arduousness and good strength but with lesser density. Predominantly as in ceramic materials, the main deprivation is their property of brittleness and lower fracture toughness. After all composite materials have been extensively used for various technical and structural tasks, where it should be lighter in weight but should have gigantic strength and stiffness property [3]. Composite assisted by fibre is apparently used form of material in structural utilization [1]. Majority composites consists two phases. One is termed as discrete phase reinforcing material which may be either fiber or flakes and the other is continuous phase where matrix material shares a major part of composite. The major difference between composite material and the alloy is that the constituents will retain their properties and identity after being embedded. Usually composite may be defined as a special structure that is formed by reinforcing matrix and fiber where the function of fiber may be to withstand the load and enhance the stiffness property and matrix binds the fibers firmly. Ash is being used to amplify the thermal resisting property of the composite material. Here composites are formed by reinforcing matrix and fiber where the function of fiber may be to withstand the load and enhance the stiffness property and matrix material [4] binds the fibers firmly. Ash is being used to amplify the thermal resisting property [5] of the composite material. Here the composites of coir and areca husk as a matrix material [3] are being tested in various manner and the results are tabulated.

II. MATERIALS AND FABRICATION

This section contains the details of materials being used and the steps that are executed during the fabrication of the composite. Raw materials used are:

1) Natural fibres (coir, areca husk with ash)
2) Epoxy
3) Hardener

A. Materials

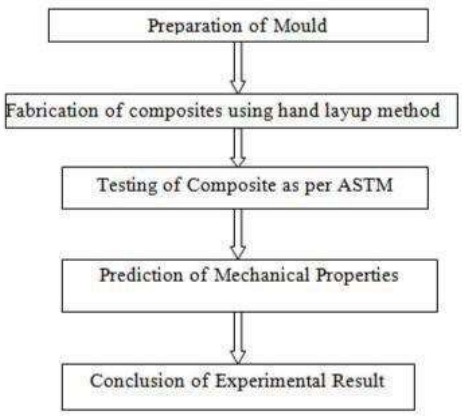
Composite materials are being used widely only for some engineering purpose. Its uses are still being finite only because of some minute reasons i.e. its durability and its ability to predict its performance in the time of service.

Matrix materials obtained from the natural sources are abstracted from local sources. The materials thus obtained are cut into small pieces.

Epoxy resin, which is normally used as binding agent exhibits poor mechanical and thermal property. To enhance the property the resin is made to undergo curing reaction where linear chain of epoxy gets converted into 3D cross linked chain. This gets achieved by the addition of curing agent termed as Hardener which is to be added in ratio of 1:10 to the resin.

B. Fabrication process

Hand layup method is the methodology used in this fabrication process. The binder epoxy resin along with its hardener in the ratio 10:1 is mixed intensely. A releasing sheet is extended in the mould and oil is made to spread across the sheet. The chopped fiber is mixed with the binder gently and then the mixture is poured to the sheet which is placed inside the mould. The reason of spreading the sheet in the mould is just for the easy removal of the composite after curing. The mixture after being poured to the mould is allowed to set inside the mould for about 24hours by the application of pressure equally in all the directions over the cast. In this work of composites embedded with coir and areca husk as matrix material, the composition of the fiber that is 50%, epoxy resin as 40% is kept constant. Thus obtained composite material is then cut into appropriate dimensions to carry out various tests such as mechanical, flexural and thermal tests.



Methodology Flowchart

III. EXPERIMENTAL PROCEDURE

A. Tensile strength and compressive strength

As per the ASTM D3039 standards, the tensile and compressive test of both the composite material is carried out and results are compared. With the aid of universal testing machine (UTM) the test is done. Specimen of standard size 100*15*6 mm^3 is cut from the prepared mould and test at a stable strain rate of 2mm/min is conducted.

Fig 1-UTM Test arrangement

Fig 2-Specimen after test

B. Flexural strength

Ability of the material to withstand the bending load that is applied perpendicular to the longitudinal axis is termed as flexural strength. It is also termed as modulus of rupture or bends strength. The bending test is employed in a specimen of circular or rectangular cross- section till it bends and fracture occurs by using a three point flexural technique. The testing process involves placing the cut piece in the universal testing machine and applying the force continuously until the specimen breaks.

Fig 3-test arrangement

Fig 4-Specimen after testing

C. Impact test

Impact strength is the measure of total amount of energy that a material can absorb before getting fractured. Impact strength of a material depends on its potentiality to develop an internal force increased by the deformation of the material.

Fig 5-Specimen after testing

D. Time to ignition

It is defined as the time period that a material can hold off the exposure to the constant heat flux that is applied to the cut piece of the mould with the aid of flame before it gets ignited by it.Simply speaking, it is the time taken by the material just to start burning. It gives the approximation about the resistance offered by the material for flammability. By this test we can get an idea of using such materials in high fire risk applications. Thus increasing the ignition period will help in reducing the fire hazards in various fields.

Fig 6-Time to ignition test

Fig 7-specimen after test

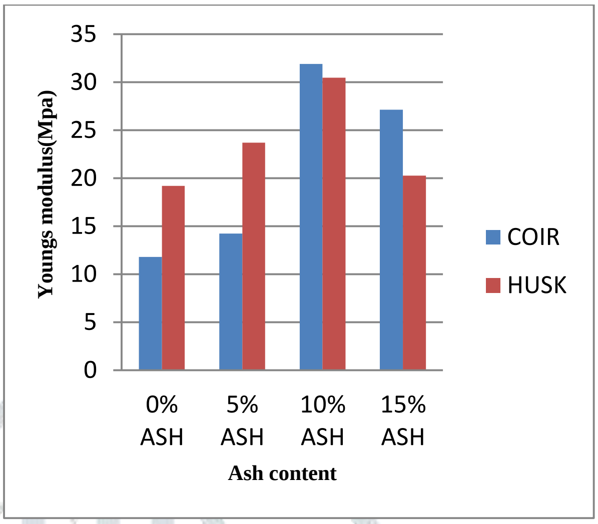
IV. RESULTS AND DISCUSSIONS

A. *Tensile strength*

From the tensile strength test of both the specimen, it was observed that as the fiber length and loading increases the tensile strength of the composite increases.

Filler Material percentage	Youngs Modulus of coir composite (Mpa)	Youngs Modulus of husk composite (Mpa)
0%	11.8	19.2
5%	14.23	23.7
10%	31.905	30.46
15%	27.143	20.28

Table 1-Youngs Modulus Comparison



Graph 1-Comparison of tensile strength

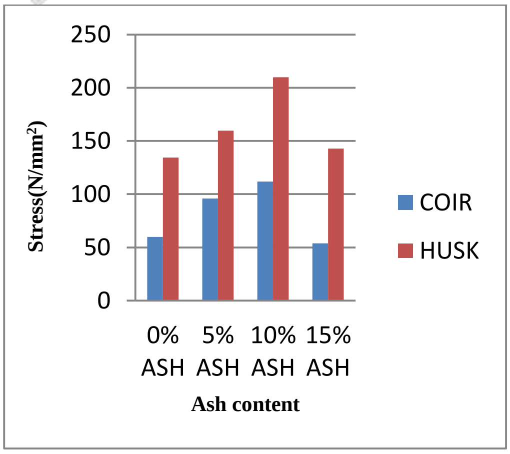
The tensile strength of various composites embedded with coir and husk as matrix material is tabulated as shown in the graph 1.We found that upto 5% of filler material areca husk composite exhibits greater tensile property and as it goes on increasing we observe coir embedded composites have greater tensile strength. Also we observe that excess addition of filler material that is more than 10%, decreases its tensile property.

B. *Flexural strength*

Flexural strength also gets influenced by size of the matrix material. As the length of matrix increases the ability of the material to bend decreases.Upto 10mm length of composite material the flexural strength goes on increasing and then gradually it decreases. Ultimate flexural ability is observed in composite of length 10mm and 15% loading.

Filler Material percentage	Stress of coir composite(N/mm^2)	Stress of husk composite(N/mm^2)
0%	60	134.4
5%	96	159.6
10%	112	210
15%	54	142.8

Table 2-Flexural strength Comparison



Graph 2-Comparison of flexural strength

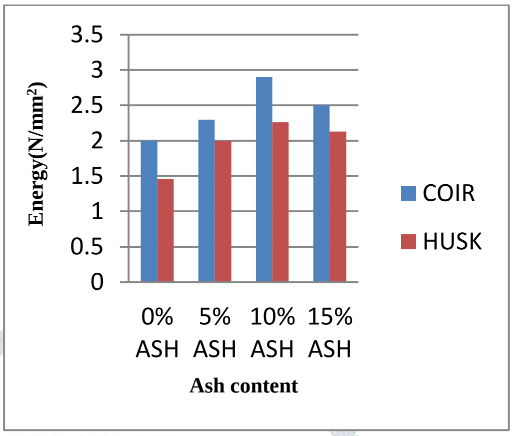
The graph 2 shows the variation of flexural strength of the composite material reinforced using coir and husk. We observe that areca husk embedded composite exhibits greater flexural ability than coconut coir based composite. As the filler material composition goes on increasing the flexural strength also increases and maximum flexural strength is observed in the composite having 10% of filler material.

C. Impact test

By using ASTM standard D256-56 the impact test was done.

Filler Material percentage	Energy absorbed by coir composite(N/mm^2)	Energy absorbed by husk composite(N/mm^2)
0%	2	1.46
5%	2.3	2
10%	2.9	2.26
15%	2.5	2.13

Table 3-Comparison of impact strength



Graph 3-Comparison of impact strength

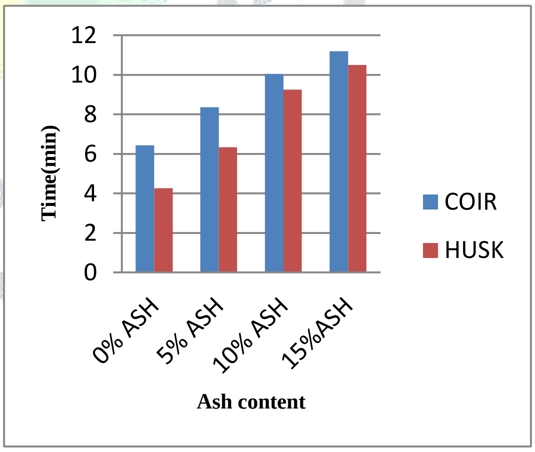
The comparison of impact test on various specimens is depicted in graph 3.We observe the energy absorbed by the composite embedded with coir is more when compared to that of composite made from areca husk. Composite with 10%of filler material exhibits higher impact strength and further addition of filler material decreases the impact strength.

D. Time to ignition

Time to ignition test is conducted on both coir and husk reinforced composite on the basis of varied amount of ash content. The comparison of time required to get ignited are tabulated.

Filler Material percentage	Ignition time for coir composite(min)	Ignition time for husk composite(min)
0%	6.43	4.27
5%	8.37	6.34
10%	10.05	9.25
15%	11.19	10.5

Table 4-Comparison of time taken for ignition



Graph 4-Comparison of time to ignition

The evident shows the variation of time required to burn the composite with various percentage filler material. It is observed that with the increase in the percentage of filler material the time required to ignite also goes on increasing. We also observe that the composite specimen of coconut coir requires more time than areca husk reinforced composite.

1. The obtained result shows that composite reinforced with ash as filler material exhibits low thermal conduction property.

2. With the increase in the content of filler material, the thermal expansion co efficient decreases.

3. Increase in the filler material decreases the time of flame propagation.

4. The flame extinguish time is more than 30sec for the entire specimen and hence it fails to lay under UL-94V rating.

V. CONCLUSION

The comparison of the mechanical and thermal properties of coconut coir and areca husk binded using epoxy is done and the following conclusions are indicated.

1. Composites are made by reinforcing fiber (Coir, husk, bagasse, bamboo) and epoxy with the aid of technique termed as hand lay-up method.
2. From tensile test, it is concluded that as the composition of filler material goes on increasing the tensile strength eventually increases.
3. From flexural test, it is observed that composite reinforced with areca husk exhibits greater flexural strength.
4. From impact test, it is concluded that the energy absorbed by the composite made from coir is greater than that of composites embedded with husk.
5. From time to ignition test, it is observed that as the percentage of filler material goes on increasing the time to get ignited also increases. It is also observed that composite of coconut coir ignites at the slower rate than the composite of areca husk.

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