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Studies on Mechanical Properties of Bio Material Filler and Jute Fiber-Feathers Reinforced Hybrid Composite

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ABSTRACT

The polymer based natural fiber composites are mostly used in automotive and aviation application because of their specific characteristics including light weight, low density, easy availability and reduced cost. Hence the present work is concentrated on bio-materials like jute fiber, chicken feather reinforced with egg shell as a filler material in composites. The composites samples were fabricated with various weight percentages of (Eggshell 10%,Eggshell 15%) combined with epoxy resin using hand lay-up method and various test were carried out like tensile, impact strength, hardness with the fabricated composite samples as per the ASTM standards.

Keywords: Feather, Jute Fiber, Eggshell Powder, Mechanical properties.

I. INTRODUCTION

A composite material (also called a composition material) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials.

Today, composite materials are the subject of an intensive development and use. These materials have significantly better mechanical and other characteristics than their constituent elements. Properties of composite materials that make them more specific than other materials are: large strength, high stiffness, small density and mass, resistance to corrosion and high temperatures, the ability to create complex shapes.

Most of composites are created in order to improve the combination of mechanical characteristics of materials, such as stiffness, toughness and strength in conditions of environment influences, or at higher temperatures. These materials also have a considerable potential for absorbing kinetic energy during crash

Epoxy, Polyester is used as matrix and Emu feathers are used as fibers for producing the composites. The specimens are produced by varying the weight percentages 0%, 2%, 4%, 6%, 8% of fiber loadings. The mechanical properties such as Tensile strength, Impact strength and Flexural strength are evaluated[1].

Thesis on a composite using coconut shell as the dispersed phase. The composite was found the Tensile tests were performed at room temperature. Tensile strength increases upto 20 wt % of filler reinforcement beyond that it decreases. Value of Young's modulus increases significantly which indicates greater resistance to the applied load in composites[2].

Concluded that considering the enormous amount of feather produced in the poultry Industry as a waste material and its low density, it is proposed to use it as a reinforcing material for composites. From the morphological point of view and the presence of hollow structures makes poultry feather fibers to use as a fluid absorbent. Also, concluded that, non-woven produced using CFF and composition with grass and paper are easy to handle during preparation of complicated components using hand layup technique and can be used for interiors in passenger transportation vehicles. Scope for further work is to test the nonwovens for its physical and mechanical properties. These nonwoven sheets can

be used to prepare composites using hand layup technique[3].

Processing and properties of natural fibers reinforced thrmoplastic and thermosseting composites ", it was possible to manufacture composites from thermoplastic and thermosetting resins reinforced with jute, sisal and flax. The composite plates were submitted to mechanical testing and the obtained experimental results allow concluding that enough good mechanical proprieties were obtained allowing the use of those materials as materials for structural and no-structural engineering applications[4].

The study shows the tensile property of hybrid composites exhibit a higher value than the individual composites. The fibers in this study are untreated and they are randomly oriented. Proper fiber orientation of the fibers may yield still better tensile strengths[5].

The study and investigated the tensile properties of animal fibre-reinforced low density polyethylene composites. The composites were synthesized by hot compression moulding using chemically modified white and black cow hair bio-fibres as the reinforcing phase of composites[6].

It has been noticed that the mechanical properties of the composites such as Tensile strength, Flexural strength and Impact strength etc. of composites are the also greatly influenced by the fiber percentages[7].

The mechanical properties of nano-CaCO3/epoxy/carbon fibres composites based on the modified epoxy matrix are also enhanced. Chitin whiskers (CHW) and CaCO3 were reinforced with Polyacrylic acid (PAA) and mechanical and thermal properties were characterized Better mechanical properties were measured[8].

This paper evaluated mechanical properties such as tensile and flexural properties of hybrid glass fiber-sisal/jute reinforced epoxy composites[9].

- **OBJECTIVE**

The above Literature survey has provided us with a wide range of information and it has served as a basis for this project. From the available sources it has been found that jute, feather, egg shell powder has a potential to be used in composites. Also its use as a fiber in composites puts an end to waste generation, which is an environmental issue. So the objectives of this project are:

- To fabricate a jute, feather, egg shell powder reinforced epoxy based composite.
- To assess the mechanical properties like tensile strength, impact strength and hardness of the composites water.
- To study the effect of fiber filler content on the mechanical characteristics of composites.

II. METHODS AND MATERIAL

Material Selection

The materials selected for the composites are provided in the table 1.

Table1. Material selection

S.no	Composite Material	Material selection
1	Matrix Material	Epoxy (LY556)+Hardener (HY951)
2	Fiber Material	Jute and Feather
3	Filler Material	Egg shell powder

COMPOSITE FABRICATION

Table 2. Composition of materials

Specimen	%wt of Jute	%wt of Feather	%wt of Egg shell	%wt of Resin
A	25	5	10	60
B	20	5	15	60

The composite fabrication is done by hand layout method. The jute, feather fiber and filler material (egg shell powder) is gathered from local sources. Epoxy is taken as matrix material. The epoxy (LY556) and the hardener (HY951) were blended in a degree of 10:1 by weight as prescribed. Ply woods of size 300x300mm3 is utilized for fabrication of composites. The jute, feather fibers cut randomly and egg shell is powdered by using ball milling machine . Composites of two compositions

are prepared. One composition is made up of 10% of filler material consisting seven layers of randomly applied and seven layers of jute, feather fibers. The other composition is made up of 15% of filler material consisting seven layers of randomly applied and seven layers of jute, feather fibers compositions are briefly presented in the table. The fabrication process was done using PVC pipes as rollers. The ply woods were used as base for laying the composites, epoxy-hardener mixture was applied between each layers of fibre and filler material.

After the composites were fabricated they were subjected to a load of 25 kg for a period of 24 hours. Finally, the specimens of suitable dimensions are cut for mechanical tests.

Figure 1. Fabricated Composites 10% filler material

Figure 2. Fabricated Composites 15% filler material

MECHANICAL TESTING

Samples of engineering materials are subjected to a wide variety of mechanical tests to measure their strength, elastic constants, and other material properties as well as their performance under a variety of actual use conditions and environments.

Because of the need to compare measured properties and performance on a common basis, users and producers of materials use standardized test methods such as those developed by the American Society for Testing and Materials (ASTM) and the International Organization for Standardization (ISO). ASTM and ISO are but two of many standards-writing professional organization in the world. These standards prescribe the method by which the test specimen will be prepared and tested, as well as how the test results will be analysed and reported.

The mechanical properties of composite are depending on the number of fibre layers used. The following properties were studied about the composite materials based on the ASTM standard.

Tensile Test

According to ASTM D 638 test models the tensile test of composites is carried out utilizing Universal Testing Machine (UTM 40). A load was connected to the both sides of composite samples for the testing.

Impact Test

The impact tests are carried out as per ASTM E 23 using an impact tester (Charpy method). Specimen is placed on the anvil as a simply supported beam.

Hardness Test

The hardness tests were carried out in Brinell hardness testing machine with specimen specification as per ASTM E10 standards.

III. RESULTS AND DISCUSSION

A. EXPERIMENTAL RESULT FOR LOAD VS EXTENSION

Load vs Extension Curve for 10% of Egg Shell Powder

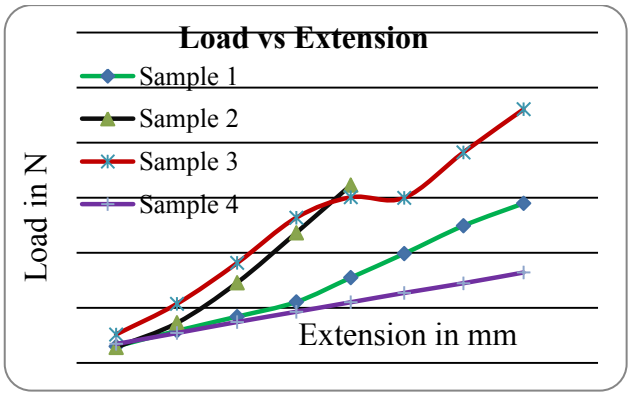

Figure 3. Load vs extension curve for 10% of Egg shell powder

From figure 4.1 shows the above graph load vs. extension curve for 10% of egg shell powder. To obtain maximum load of curve sample 3.

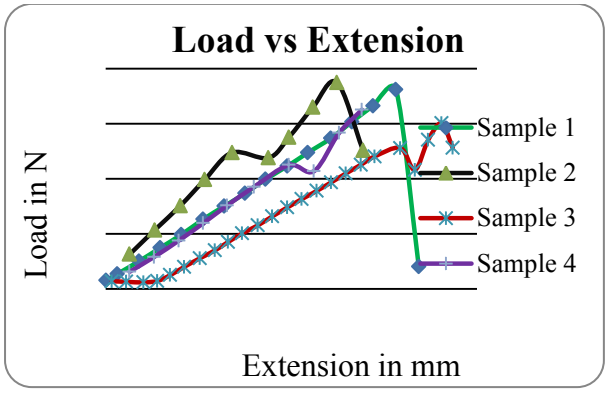

Figure 4. Load vs extension curve for 15% of Egg shell powder

From figure 4.2 shows the load vs extension curve for 15% of egg shell powder. To obtain maximum load vs extension at sample 2 were found.

Weight Fraction in %	Egg shell powder10%	Egg shell powder 15%
Ultimate Tensile Strength in MPa	5.17	5.47
	9.88	8.83
	7.4	13.48
	17.47	4.53

B. EXPERIMENTAL RESULT FOR STRESS & STRAIN

Stress vs Strain Value for 10% of Egg shell powder

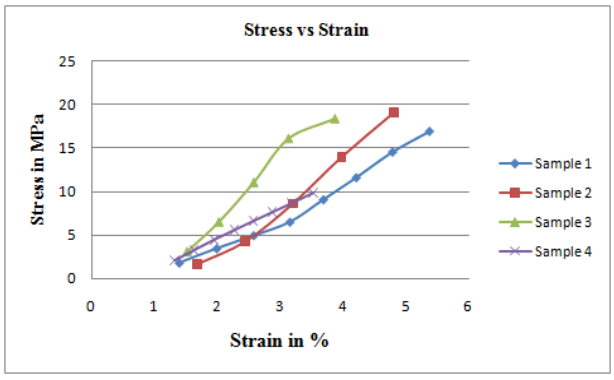

Figure 5. Stress vs Strain Curve for 10% of egg shell powder

From figure 4.3 shows the stress vs strain curve for 10% of egg shell powder.The maximum stress and strain value is obtained for the sample 2.

Stress vs Strain Value for 15% of Egg shell powder

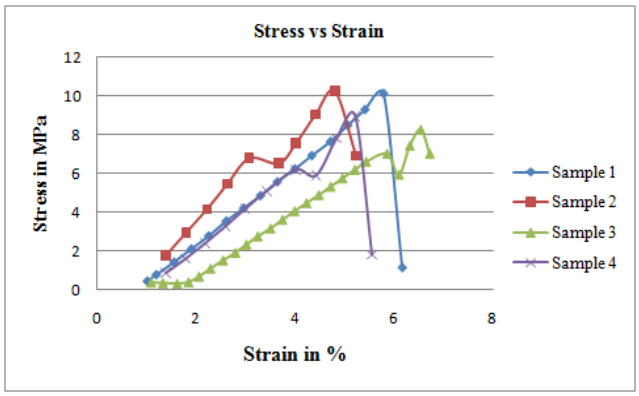

Figure 6. Stress vs Strain Curve for 15% of egg shell powder

From figure 4.4 shows the stress vs strain curve for 15% of egg shell powder. The maximum stress and strain value is obtained the sample 2.

C.COMPARISON OF ULTIMATE TENSILE STRENGTH

Table 3. Comparison of ultimate tensile strength

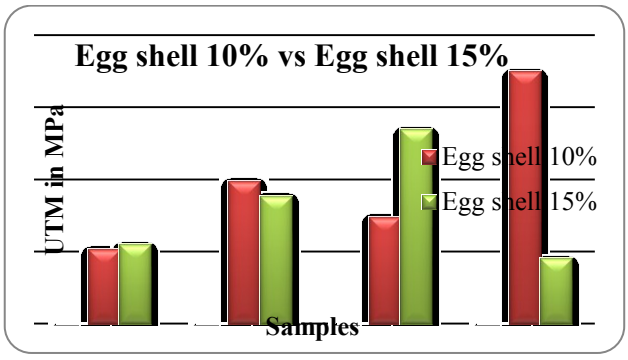

Figure 7. Comparison of ultimate tensile strength

The graph platted above shows the comparison of ultimate tensile strength in MPa for different samples Egg shell powder 10% composition material has yield maximum ultimate tensile strength of 17.47MPa when tested.

D.EFFECT OF YOUNG'S MODULUS

Young's Modulus for 10% of Egg Shell Powder

Table 4.Young's modulus for 10% of Egg shell powder

Egg shell powder 10%+Feather 5% +Jute 25% +Epoxy 60% ASTM D638				
	Sample 1	Sample 2	Sample 3	Sample 4
Young's Modulus (E) in MPa	2.294548536	2.5889452	4.363369297	2.383156327

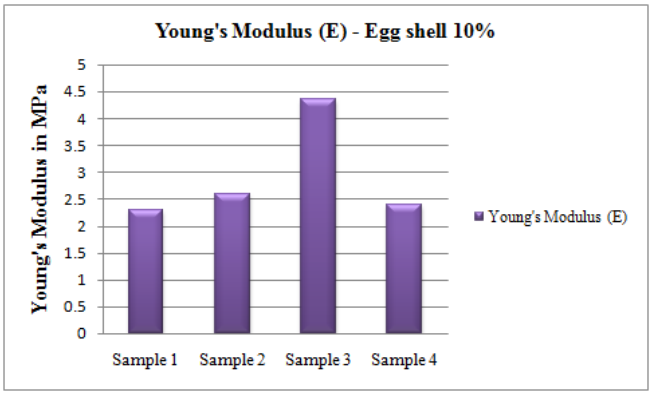

Figure 8. Young's modulus for 10% of Egg shell powder

Young's modulus is defined as the ratio of stress to the corresponding strain within the elastic limit. Under loading test for 10% of composition of egg shell powder sample 3 has yield young's modulus value in maximum which was found to be 4.3633MPa .

Young's Modulus for 15% of Egg Shell Powder

Table 5. Young's modulus for 15% of Egg shell powder

Egg shell powder 15%+Feather 5% +Jute 20% +Epoxy 60% ASTM D638				
	Sample 1	Sample 2	Sample 3	Sample 4
Young's Modulus (E) in MPa	1.259913159	1.8093067	0.859551807	1.206734583

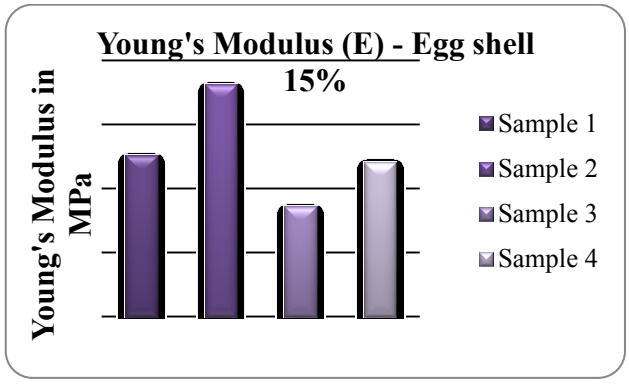

Figure 9. young's modulus for 15% of Egg shell powder

Young's modulus is defined as the ratio of stress to the corresponding strain with in the elastic limit. Under loading test for 10% of composition of egg shell powder sample 3 has yield young's modulus value in maximum which was found to be 4.3633MPa.

E.Comparison of effect of young's modulus

Table 6. Comparison for effect of young's modulus

Weight Fraction in %	Young's Modulus (E)
Egg shell power 10%+Feather 5% +Jute 25% +Epoxy 60%	2.907505
Egg shell powder15%+Feather 5% +Jute 20% +Epoxy 60%	1.283877

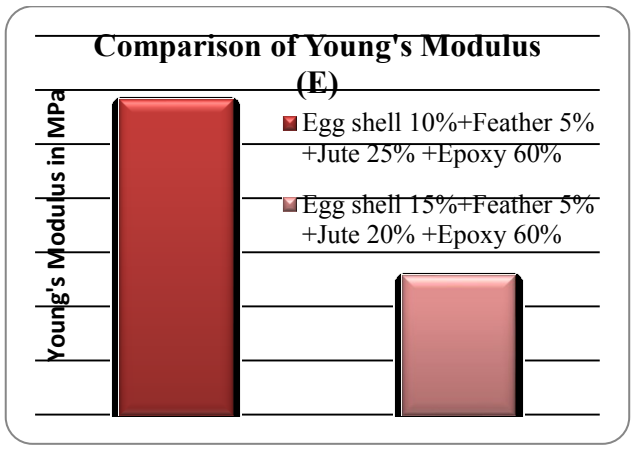

Figure 10. Comparison for effect of young's modulus

Shows the above bar chart maximum young's modulus for 10% of egg shell powder composite is found to be 2.90Mpa when compared to 1.28MPa 15% of egg shell powder composite.

F. COMPARISON OF IMPACT TEST

Table 7. Comparison of impact test

Weight Fraction	S1	S2	S3	S4
Eggshells 10%	4	4	4	4.2
Eggshells 15%	4.5	4	4.2	4.4

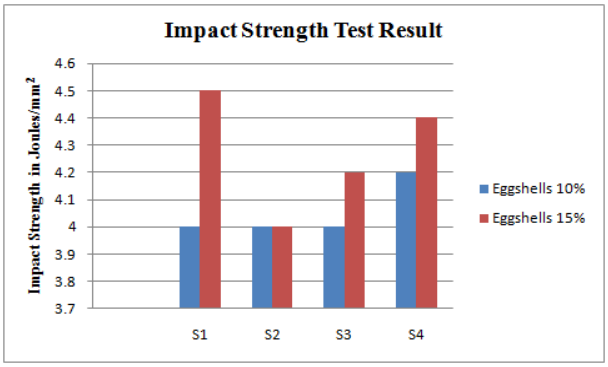

Figure 11. Comparison of impact test

Impact strength of weight fraction in 10% and weight fraction in 15% of egg shell power composite shown in fig 4.9 .the above bar chart shows maximum energy is observed at weight fraction of 15% of egg shell powder.

G.EFFECT OF FIBER ON HARDNESS

Table 8. Effect of fiber on hardness

BRINELL HARDNESS TEST ASTM E10				
Composite	Trial 1	Trial 2	Trial 3	Hardness Average
Eggshells 10%	5851.85	6364.87	6364.87	6193.86
Eggshells 15%	3847.263	3847.263	5851.85	4515.46

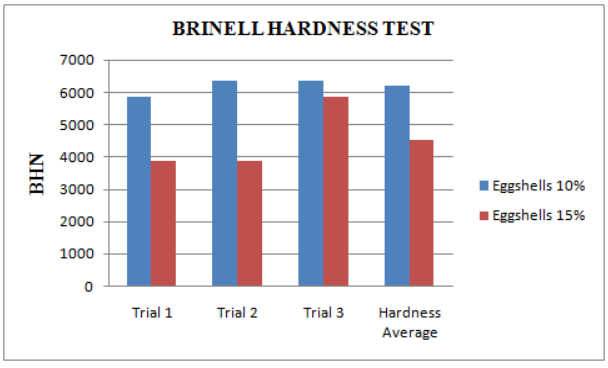

Figure 12. Effect of fiber on hardness

Shows the above bar chart Maximum hardness is obtained 10% of egg shell powder composite is found to be 6193.83 BHN when compared to 4115.46BHN 15% of egg shell powder composite .

IV.CONCLUSION

The polymer composites of Jute/Feather /Egg Shell Powder reinforced epoxy composite were made in order to evaluate Tensile, impact and Hardness properties were studied. There has been a growing interest in utilizing natural fibers as reinforcement in polymer composite for making cost effective construction materials in recent years. This project shows that successful fabrication of a natural fiber reinforced epoxy composites by hand lay-up technique. Among the various natural filler material is of particular interest in that its composites have high impact strength besides having moderate tensile & Impact properties.

The strength of the composites is depends upon weight percentage of the fiber and filler material. The effect of compositions of fibers on these properties was studied. The hybrid composites with different compositions of fibers and fillers were found to possess higher impact, tensile and Hardness properties.

- Maximum Ultimate tensile strength of 10% of egg shell powder composite is found to be 17.47MPa when compared to13.48Mpa 15% of egg shell powder composite.
- Maximum young's modulus of 10% of egg shell powder composite is found to be 2.90Mpa when compared to 1.28MPa 15% of egg shell powder composite.
- Maximum impact strength of 15% of egg shell powder composite is found to be 4.5joules/mm^2 when compared to 4.2joules/mm^2 10% of egg shell powder composite .
- Maximum hardness of 10% of egg shell powder composite is found to be 6193.83 BHN when compared to4115.46BHN 15% of egg shell powder composite.

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