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# Mechanical Behavior of Coir Fiber Reinforced Polymer Resin Composites with Saturated Ash Particles

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***Abstract***— ***This work is done in order to determine the influence of flyash on mechanical properties and fracture analysis. The carbon (ash) particles independently integrated with coir fiber polymer composites. The test samples were manufactured with different dimensions of coir fiber such as the powder's size, content and mesh size. Tension, compression, impact and flexural tests are carried out in the composite materials prepared according to the ASTM techniques. Using SEM photos, the fracture faces are analyzed. It was inferred from the final results that ash powder composite provides good flexural and tensile strength than without ash powder composite, while ash powder composite material provides good impact strength and compressive strength with increase in content of ash particles.***

***Keywords:*** ***Ash Particles, SEM, Mechanical Properties, Mesh Size.***

## I. INTRODUCTION

Composite materials play an important role in engineering applications because of numerous specialized applications in aerospace and auto-motive industries due to their high strength-to-weight ratio, good fatigue and creep resistance, a high coefficient of thermal expansion, excellent wear resistance, and good machinability. [1]-[3]. A combination of two or more materials that differ in shape or addition on a large scale is called as composite material which exhibits better properties than that of the individual material[4]-[6]. In a composite, there are usually two phases, such as phase reinforcement and phase matrix. The loads are borne by reinforcement materials and the product matrix is used for linking and transferring the load to fibers. In recent days, polymer-based composites are mostly used in comparison with other composites because of their superior mechanical properties[7],[8]. The development of functionally graded composite beams finds its application under parametric excitation. Power law with various indices as well as exponential law were used to find out the properties along the thickness of the beam. The stability boundaries were established using Floquet's theory. The equation of motion was governed by Hamilton's principle and solved by Finite element method. the Exponential distribution of constituent phases renders better stability in comparison with power law distribution of the phases in the functionally graded material(FGM)[9].

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It is very promising to research the deployment of local cheap renewable fiber sources and fillers available for polymer matrix composite (PMC) production because of extensive polymer composite appliances [10]-[12 ].

Fillers simply increase the volume of bulk resulting in price reductions are called extender fillers at the same time as those enhancing the mechanical properties, mainly tensile strength is called reinforcing fillers. The plastic industry uses several million metric tons of reinforcing filler materials every year. The use of this addictive in plastics is likely to increase with the advent of improved compounding agents that allow the use of high filler / reinforcement content[13],[14 ].

The research on functionally graded materials (FGMs) is rapidly growing because of their continuously varying material properties, which give great advantages over the conventional homogeneous and layered materials[15].An experimental study on the transfer of energy from nanofluids using carbon nanotubes was carried out and the findings showed that the application of carbon nanotube to the E-Glass fiber composites increased the flexural properties[16]. An analysis was carried out with the new strength improvement concepts in fiber and particulate filled PMCs[17]. Particles generally have more strength that acts in PMCs as a reinforcement. Composite size of 75μm gives better results in these laminations compared to other sizes of composites content of particles[18]-[20]. Based on the above-mentioned factors, the development of a coir fiber-based hybrid composite using sea shell powder (SSP) and bone powder (BP) as a filling agent was carried out. The composites were prepared with different layers and ASTM and SEM specifications were used to test the mechanical properties of the BP mixed composite and SSP integrated coir fiber composite. The maximum impact strength of the charpy was also 15 mm fiber length (9.87 kJ / m2).The Experimental results were validated using a numerical method technique in FEA software [21].

## I. SCOPE

There are lot of work has been done to use natural fibers for industrial application but no one has got the significant results which will meet the industrial need. This work will give the better material which will meet the industrial & domestic need. The basic industrial applications where this work can be used are

1. Industrial Helmet shell manufacturing.
2. Dashboards of automobiles
3. Door panels
4. Light boards (Currently fiber & Wood are used), etc.

Apart from these industrial applications some of the domestic applications are

1. Decorative articles

2. Designer walls in hotels & malls
3. Welcome boards, etc.

There are several reports in the literature which discussed the mechanical & thermal behavior of natural fiber reinforced polymer composites. However, very less significant work has been done on effect of additives like cow dunk/ bagasse ash/ coal ash on mechanical & thermal behavior of coir fiber & Banana fiber reinforced epoxy composites. In this context, the current research work was undertaken with the aim of exploring the potential of coir fiber and banana fiber as a reinforcing material in polymer composites and investigating the effect of coal ash on the mechanical behavior of the resulting composites.

## II. OBJECTIVES

1. To functionalize the coir fiber with the Alkali treatment of NaOH.
2. To fabricate laminates of coir fiber/epoxy resin composites with different weights of fly ash particles.
3. To prepare the specimens as per the standards.
4. To carry out experimental analysis for the mechanical & metallurgical properties laminates.
5. To compare the experimental results.
6. To derive the expected conclusions.

## III. MATERIALS AND METHODS:

The coir has been obtained from local resources. Including coir increases the composite samples ' thermal capacity and creates a light weight material. The composite was made using 100µm particle size coir. Coir fiber is a material that is strengthened, a natural coconut item. By its length and diameter, it is generally distinguishable. The length of the coir available is usually between 10 mm and 150 mm and 50 mm length was selected for our experimental sample manufacturing. Likewise, the obtainable coir fiber diameter varies from 0.1 mm to 3 mm and we selected 0.5 mm diameter for composite laminate manufacturing. Epoxy resin was used as a base, cobalt naphthanate serves as an accelerator and MEKTP acts as a catalyst. Mixed with the resin, the accelerator and the catalyst were used to start and finish the healing process. Comparative to traditional massive and standard materials such as wood and metals, fiber-reinforced polyester resin matrix composite is used in load-bearing structures such as aircraft, automobile, buildings and boats due to their greater chemical and mechanical properties and also due to their high strength-to-weight ratios.

Hand lay-up method has been used to manufacture the composite material that is one of the well-known open molding processes and the simplest PMC manufacturing technique. It is a method that consumes slow, manual and labor. In the weight ratio of 70:30, the resin and the powder content were mixed. To stop trapping the constituent on the surface of the mold, the anti-adhesive agent was sprayed on the mould. When the gel coating was applied, the component's primary surface coating was created. The accelerator and catalyst have been combined in a reasonable ratio with polyester resin, this mixture helps to bind the materials The powder substance prepared was then combined with the binding materials. Coir fiber has been distributed across the mold. Instead, without any storage, the resin and powder mixture was poured into the mould. In the mould cavity, the roller was rotated. The cap was placed on top of the mould frame helping to spread the binding material in the entire frame area and the load was applied evenly on the mould. The collection of connections were held for 24 hours in the dry place. After 24 hours, the curing material was removed from the mold. The PMC was finally made. The above mentioned percentage of weight, ash and coir fiber with 10 percent and 15 percent weight each and epoxy resin composite with 70 percent weight were prepared with two types of laminates. Finally, according to the test standards, the cutter machine cut the laminate in different shapes and sizes.

## IV. RESULTS AND DISCUSSION

All produced samples were individually examined and tests were obtained with different mechanical properties. The observed results of 10gm ash particle reinforced composite (FRC) are given in Table I. Similarly the results of 15gm ash particle FRC are given in Table II. The average values were taken for the analysis.

Tensile Strength and Compressive Strength

The tensile strength of composites was compared and the results are given in table.1. The average tensile strength value of composite was 27.4 MPa and 31.0 MPa respectively and it was found that the tensile strength increases with increase in ash percentage. Similarly the compressive strength increases with increase in ash percentage, the comparison results are given in Fig. 2. It was found that the average compressive of composite was 59.23 MPa and 55.04MPa respectively for 10 gm and 15 gm ash particles.

**Table I. Mechanical Properties of 10 gm ash particle FRC**

| Specimen | Tensile Strength (MPa) | Compressive Strength (MPa) | Flexural Strength (MPa) | Impact Strength (MPa) |
|---|---|---|---|---|
| 1 | 26.43 | 58.23 | 52.56 | 70.11 |
| 2 | 28.28 | 61.11 | 54.67 | 68.01 |
| 3 | 27.08 | 57.63 | 53.36 | 68.45 |
| 4 | 27.16 | 59.41 | 51.23 | 65.89 |
| 5 | 28.37 | 59.76 | 51.05 | 67.55 |
| Average | 27.464 | 59.228 | 52.574 | 68.002 |

**Table II. Mechanical Properties of 15gm ash particle FRC**

| Specimen | Tensile Strength (MPa) | Compressive Strength (MPa) | Flexural Strength (MPa) | Impact Strength (MPa) |
|---|---|---|---|---|
| 1 | 31.32 | 54.37 | 54.34 | 61.12 |
| 2 | 30.71 | 55.63 | 56.11 | 61.45 |
| 3 | 32.06 | 53.86 | 55.76 | 62.37 |
| 4 | 31.04 | 57.45 | 58.63 | 60.38 |
| 5 | 29.89 | 55.89 | 56.03 | 60.45 |
| Average | 31.004 | 55.44 | 56.174 | 61.154 |

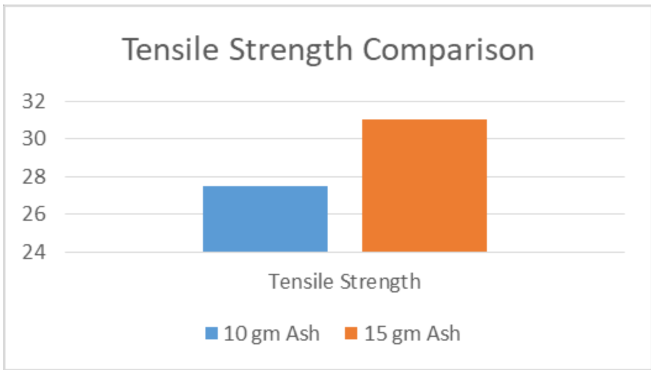


**Fig. 1 Tensile Strength Comparison**

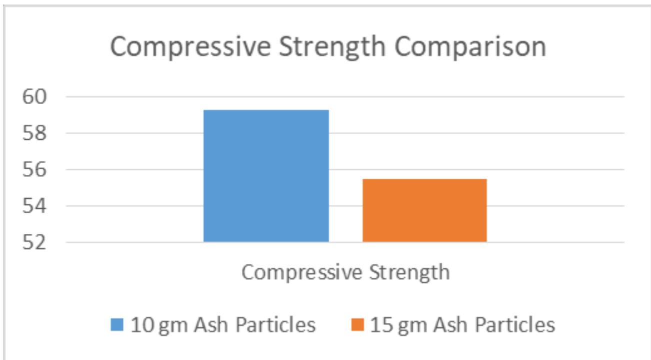


**Fig. 2 Compressive Strength Comparison**

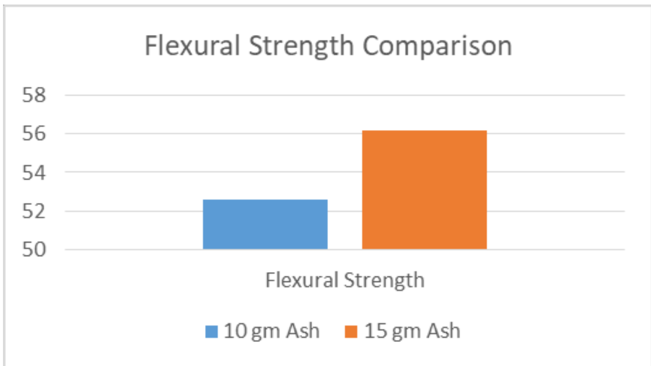


**Fig. 3 Flexural Strength Comparison**

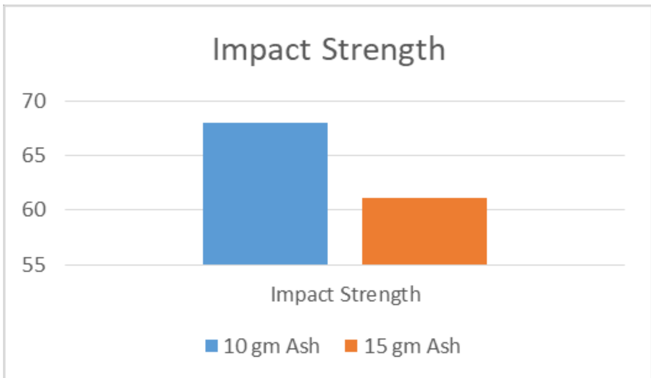


**Fig. 4 Impact Strength Comparison**

### 4.1 Flexural Strength and Impact Strength

The flexural strength of composites was calculated and the comparison results are given in Fig. 3. From the figure, it was observed that the average flexural strength value of 10gm ash particle based and 10gm ash particle composites was 52.574Mpa and 56.174MPa respectively and it was found that the flexural strength of the 10gm ash particle composite was better than 15gm ash particle composite. Similarly the impact strength of 10gm ash particle and 15gm ash particle composites were calculated and shown in Fig. 4. It was found that the average impact strength of 10gm ash particle and 10gm ash particle composites was 68.002kJ/m2 and 61.154kJ/m2 respectively and it was observed that the impact strength of the 10gm ash particle composite was better than 15gm ash particle composite.

### 4.2 Characterization of Composites

The microstructure compositions of the phases present in the 15 gm ash particle based composite was studied using Scanning Electron Microscope equipment. The analyzing specimen was placed over the sample holder and Under different magnifications, the objects are captured. Microscopic layer consists of parallel lines of first-order lamellae and the first-order lamellae in the middle layer are aligned 90 to the inner and outer layers of first-order lamellae. In addition, each lamella of the first order consists of parallel rows of lamellae of the second order, which are directed to the lamellae of the first order of 45. The lamellae of the second order are further divided into lamellae of the third order. The basic building blocks are the aragonite crystals with internal twins in the third order lath-shaped. Especially in the middle layer, the lamellae of the second order alternate the lamellae of the first order with a rotation of 90. Feed alternative first feed lamellae of 90 rotation. As far as the field pressure on the fracture sample is raised, a white area emerges and grows in size slowly. This whitening is an indicator of tablet slipping and inelastic deformations, with the voids created by tablet separation dispersing light (this effect is similar to pressure whitening due to polymer crazing). In the literature on fracture mechanics, for example inelastic field, the system area is referred to as the process zone. Fig. 5 to Fig. 12 shows the Scanning Electron Microscope (SEM) images of fractured surfaces of 10 gm ash particle based composite as well as 15gm ash particle based composite after the mechanical testing.

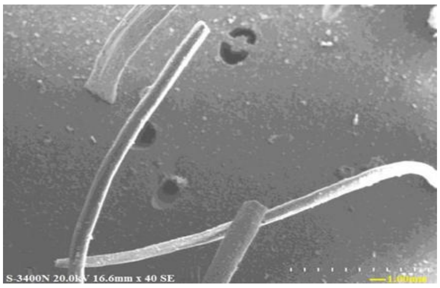

**Fig. 5 SEM Image of 10 gm ash particle based Composite**


**Fig. 6 SEM Image of 15 gm ash particle Based Composite**

The SEM image of 10 gm ash particle-based composite was clearly identified and shown in Fig after the tensile test. 5. Similarly, the SEM image after tensile testing was performed and given in Fig for 15 gm ash particle-based composite. 6. From the SEM images it was clearly noticed that the PMC material was integrated with the composite particles and coir fiber. When these two composite materials were compared, the coir fiber was pulled out in more amounts from the 10 gm ash particle based composite material during the tensile test hence there was a decrease in tensile strength of the BP based composite. Fig. 7 and there's a fig. 8 Display respectively the SEM images of the two composites after the compressive test. Compared to the shell of the ocean, bone material usually has more energy.

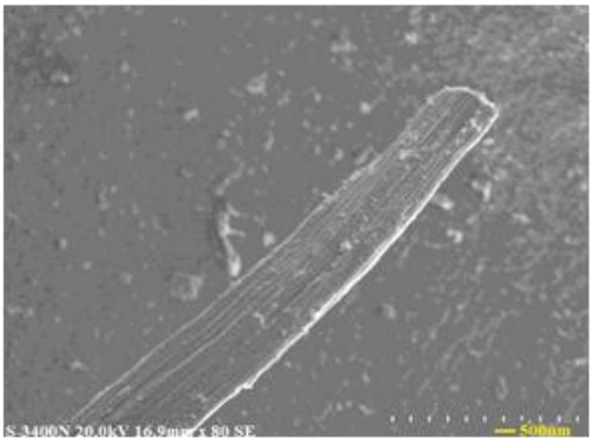

**Fig. 7 SEM Image of 10 gm ash particle Based Composite**

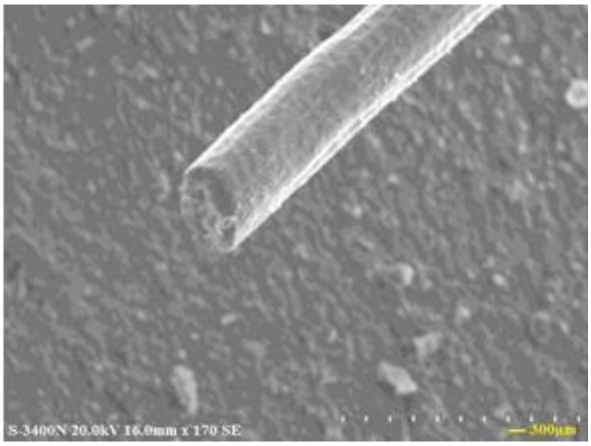

**Fig. 8 SEM Image of 15 gm ash particle Based Composite**

Flexural sample SEM images are shown in Fig of both composite materials. 9 And there's a sec. 10 Correspondingly. It was found that the coir fiber was pulled out of the composite material in a composite based on 10 percent ash particles after the flexural test was conducted, but no blow holes were detected in the composite based on 15 gm ash particles. It was therefore concluded that the composite with ash particles of 15 gm gives better results during flexural testing over the composite material with ash particles of 10 gm.


**Fig. 9 SEM Image of 10 gm ash particle Based Composite**


**Fig. 10 SEM Image of 15 gm ash particle Based Composite**

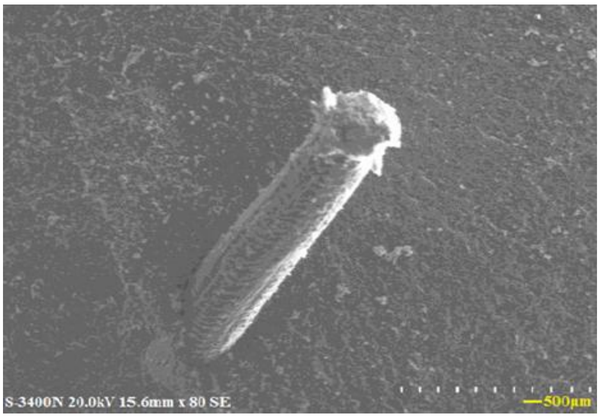


**Fig. 11 SEM Image of 10 gm ash particle Based Composite**

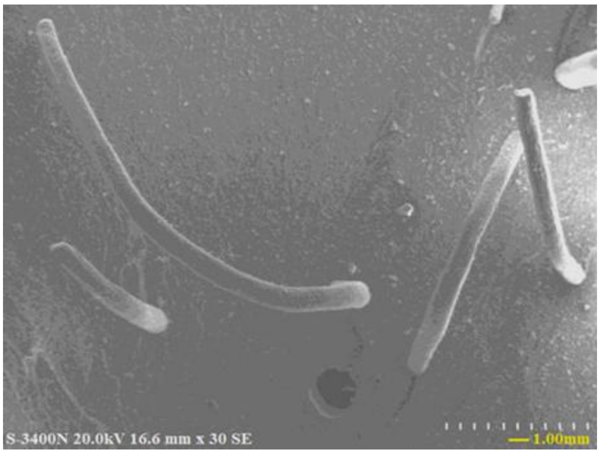


**Fig. 12 SEM Image of 15 gm ash particle Based Composite**

Similarly, after impact testing, SEM images of composite material based on BP and composite material based on SSP are shown in Fig. 11 And there's a fig. 12 Correspondingly. It was observed that after the impact test, the coir fiber was removed from the matrix material in the composites based on the SSP. There was no fiber pull from the matrix in the BP-based composites, and thus fibers are expanded and ruptured. The impact resistance was therefore high in composite material based on BP compared to composite material based on SSP.

## V. CONCLUSION

Based on the above experimental analysis of 10 gm ash particle and 10 gm ash particle added coir fiber composite material, the following conclusions were made. From the results it was found that the 15 gm ash particle filled coir fiber composite prove better results when compared to 10 gm ash particle filled coir fiber polyester composite when subjected to tensile and flexural test. Similarly it was observed that the 10 gm ash particle filled coir fiber polyester composite provides better results when compared to 15 gm ash particle filled coir fiber composite when subjected to compressive and impact test. The fracture surfaces were analyzed through SEM images and the same results obtained through mechanical properties were observed. The research may be extended through similar characteristics related to performance evaluation of composite materials with appropriate techniques.

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