International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 07 | July 2019 www.irjet.net p-ISSN: 2395-0072

HYBRIDIZATION AFFECT ON MUSA/COIR HYBRID FIBER REINFORCED COMPOSITE

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Abstract - *MUSA fiber reinforced polymer (MFRP) hybrid composites, COIR fiber reinforced polymer (CFRP) hybrid composites and MUSA-COIR fiber reinforced polymer (MCFRP) hybrid composites have been fabricated with different hybridization levels by using the hand lay-up method, and applying force using the compression molding machine. The mechanical properties such as tensile, flexural and impact strengths of these composites are evaluated with the help of the "tensometer" and "izod" impact testing machine. Experiments are done for five samples in each case, and the mean values are used for a complete analysis and to study the hybridization effect and these experimental values are compared with analytical values which are getting by using ansys software. After that, it has been observed that pure Coir composites samples are having higher tensile strength and tensile modulus and the pure Musa fiber reinforced composite next to Coir fiber composite.*

Key Words: Musa, Coir, Hybrid, Flexural strength, Impact strength, Tensile strength

1. INTRODUCTION

Composite materials are the most advanced and adaptable engineering materials. These are heterogeneous in nature and created by the assembly of two or more components with reinforced fibers and a compactable matrix. A composite replaces traditional materials because of their properties, like low weight to strength ratio, high mechanical strength and low thermal expansion. Natural fiber reinforced polymer composites are more attractive due to their high strength, lightweight, biodegradability, and environment friendliness. In this experimental study, Musa–Coir–Hybrid fiber reinforced hybrid composites are developed and their mechanical properties, such as tensile strength, flexural strength, and impact strength are evaluated.

2. COMPOSITE MATERIALS

A composite material is defined as a combination of two or more materials that results better properties than those of the separate components used alone. In contrast to metallic alloys, each material retains their separate chemical, physical and mechanical properties.

2.1 CLASSIFICATION OF COMPOSITE MATERIALS

Composite materials may broadly classified into three categories as given in Fig. 1.

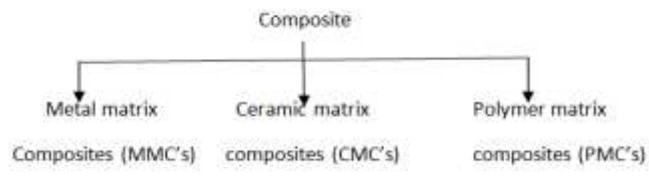

Figure 1: Classification of Composite Materials

2.1.1 METAL MATRIX COMPOSITES (MMCS)

Metal matrix composites have many advantages over other metals, like high specific modulus, high specific strength, good properties at elevated temperature, and have low coefficient of thermal expansion. Because of these attributes these metals are under consideration for wide range of its applications.

2.1.2 CERAMIC MATRIX COMPOSITES (CMCS)

The main objectives in producing ceramic matrix composites are to increase toughness value. Naturally it is indeed often found that there is a better improvement in strength and stiffness of these composites.

2.1.3 POLYMER MATRIX COMPOSITES (PMCS)

The processing of these composites does not involve heavy pressure and heavy temperature. Due to the usage of these polymer matrix composites has grow up rapidly, and becomes popular for a structural materials.

2.2. NATURAL FIBERS

Natural fibers are mostly renewable, cheap and biodegradable materials. Fibers from plants such as cotton, jute, sisal, pineapple, bamboo, banana, etc. as well as wood and seeds of flax are used as the reinforcement.

2.2.1 CLASSIFICATION OF NATURAL FIBERS

Natural fibers are divided into so many categories, based on their origin, derivations of the plant, animal and mineral types, they are shown in Fig. 1.1.

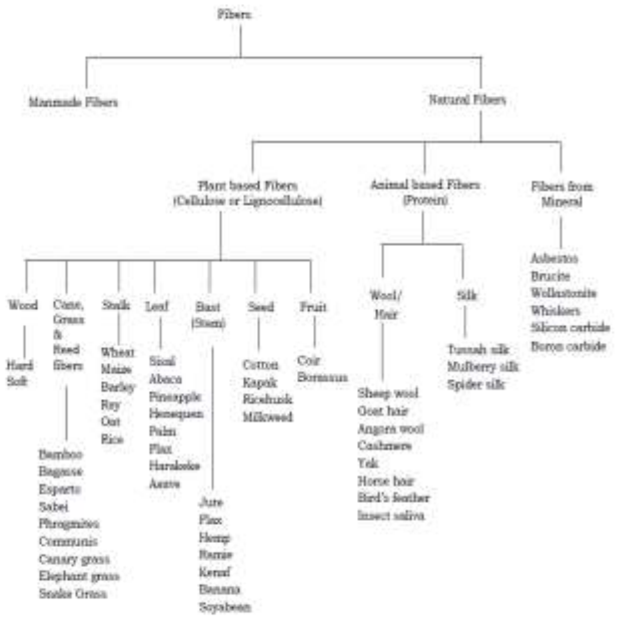

Figure1.1: Classification of Natural Fibers

2.3 MUSA FIBER

Musa fiber is obtained from the stem of the Banana plant, Banana plant or Musa plant or plantain plant not only gives the best delicious fruit but it provides textile fiber also. Musa fiber is a natural fiber. In olden days, Musa fibers are prepared by a hand, and used for an making ropes, carpets and clothing. It is the one of most cultivated plants in the India. The main reason for the ease of cultivation of Banana plant has easy to grow in all kinds of environments.

The view of Musa plant and Musa Fiber are shown in Fig. 1.2.

Figure1.2: Musa plant and Musa fiber

2.3.1 PROPERTIES OF MUSA FIBER

Tenacity	28.99 g/denier
Fineness	17.14
Moisture Regain	13.01%
Elongation	6.44
Alco-ben Extractives	1.60%
Total Cellulose	82.80%
Alpha Cellulose	61.55%
Residual Gum	41.99%
Lignin	15.01%

2.3.2 ADVANTAGES OF MUSA FIBER

[1] Banana fiber is also a natural fiber with high strength, these fibers are easily blended with cotton fiber

[2] Banana Fiber is used in currency paper, packing cloths for agriculture, ships towing ropes etc.

[3] Banana fibers have lower density, max stiffness and renewability. And Also, these fibers are recyclable

2.3.3 APPLICATIONS OF MUSA FIBER

[1] Banana fiber are used for making things like ropes, mats etc.

[2] Banana fiber is also used for making covers, bags, table cloths, curtains etc.

[3] Rugs made from banana fibers are also very popular.

2.4 COIR FIBER

Coir or coconut fiber is an natural fiber obtained from the husk of the coconut and it is used in products such as floor mats, door mats, brushes and mattresses. Coir is the fibrous material obtained between the hard, internal shell and the outer coat of the coconut. White coir, produced from unripe coconuts, is used to make finer brushes, rope and fishing nets. The advantage of coir fiber is not sinking, so can be used for long lengths on a deep water without added weight dragging down boats. The coir plant and coir Fibers are shown in Fig. 1.3.

Figure1.3: Coir plant and Coir fibers

2.4.1 PROPERTIES OF COIR FIBER

- ✓ Length in inches………………..6-8
- ✓ Density (g/cc)…………………..1.40
- ✓ Tenacity (g/Tex)……………….10.0
- ✓ Breaking elongation%..................30%
- ✓ Diameter in mm…………………..0.1 to 1.5
- ✓ Rigidity of Modulus………………1.8924 dyne/cm2
- ✓ Swelling in water (diameter)…………5%
- ✓ Moisture at 65% RH……………….10.50%

2.4.2 Advantages of Coir Fiber

[1] Coir fiber is also a natural fibers available in tropical regions, and is obtained from the husk of a coconut fruit.

[2] Due to low specific gravity of coir fiber, these fibers are favorable as compared to glass.

[3] Coir fibers have very good impact strength.

2.4.3 Applications of Coir Fiber

[1] White coir is used to manufacture ropes.

[2] Brown coir is used to manufacture a carpets, doormats etc.

[3] Coir fiber is used in a home decoration pieces, auto mobiles etc.

2.5 FIBER EXTRACTION

There are so many methods available to extract fibers from their respective plants. Musa fibers are extracted from the bast of the Banana plant by the retting process, and Coir fibers are obtained from the husk of coconut fruit.

2.5.1 Retting Process for Musa Fiber

There are two methods for extraction of Banana fiber, namely Bacnis method and Loenit method.

- In Bacnis method, Banana Fiber is produced from the stem of Banana plant. The outer sheath is tightly covered layers of a fiber. The fiber is located primarily adjacent to outer surface of the sheath and can be peeled-off readily in the ribbons of strips of 5 to 8 cm wide and 2-4 mm thick, the entire length of the sheath.
- In Loenit method, the tuxies are then pulled off the stalk from one sheath at one time. In either of these methods, tuxies are tied into bundles of 24 to 28 kg. In this process, tuxies is pulled under a knife blade, which is pressed tightly against the tuxi in order to scrape away to the plant tissue between fibers. These clean fibers are then air dried and made into bundles for grading. These processes are shown in Fig. 1.4.

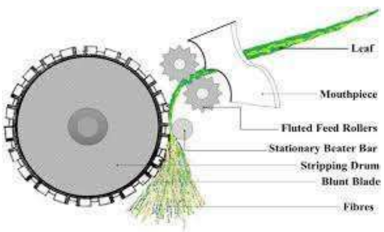

Figure1.4: Musa Retting Process

2.5.2 Retting Process for Coir Fiber

Retting is the curing process, which the husks are kept in the environment. This action partially decomposes a husk's pulp, allow it to separate into coir fibers. Freshwater retting is used for the fully ripe coconut husks, and salt water retting is used for the green husks. These processes are shown in Fig. 1.5.

Figure1.5: Coir Retting Process

2.5.3 MATERIALS

Musa and Coir fibers are used for a fabricating the composite specimen. The Musa and Coir fibers were obtained from Andhra Pradesh. The final Musa and Coir Fibers are shown in Fig. 1.6

. **Figure2.6**: Musa and Coir fibers

2.5.4 Resin Preparation

The process of a resin preparation is shown in Fig.1.7. The accelerator and catalyst solutions are mixed with resin and then it is stirred, using a stirrer as shown in Fig.1.7. After mixing, the quantity of resin solution is used for each layer.

Figure3.7: Mixing of resin solution

3. MECHANICAL PROPERTY EVALUATION

3.1 Tensile Strength

The tensile strength of material is the max amount of tensile stress that can take before fracture. During the test uni-axial force is applied on both the ends of the specimen, and the tests are conducted by a external device called "tensometer" shown in fig.1.8.

Figure4.8: Tensometer and specimens

3.2 Flexural Strength

For determining the Flexural strength, a three point Bending tests is performed. The flexural strength of the material is max amount of flexural stress that can take before fracture. During the tests a force is applied perpendicular to the fiber, shown in fig.1.9.

Figure5.9: Bending test fixture and specimens

3.3 Impact Energy

In mechanics, the term impact is a high force applied over a short period of time when the two or more bodies collide. The IZOD impact test by making V-notch is a standardized higher strain-rate test, which determines the amount of energy stored by a material during failure. Test is shown in fig.2.0.

Figure 2.0: Impact test equipment, fixture and specimens

4. STRESS STRAIN RELATIONS OF COMPOSITES

The stress-strain plots for various composite materials are shown from fig 2.1 to 2.5.

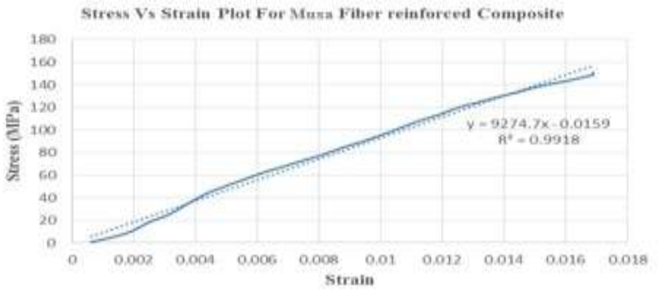

Fig 2.6: Stress-Strain Plot for Musa fiber reinforced composite

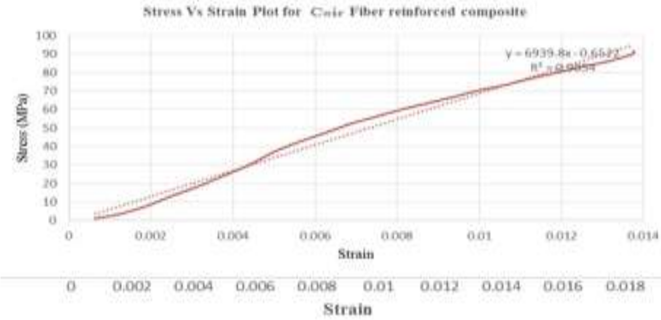

Fig 2.2: Stress-Strain Plot for Coir fiber reinforced composite

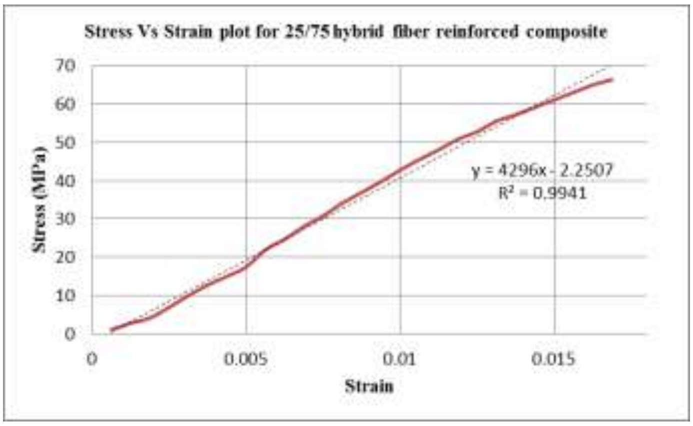

Fig 2.3: Stress-Strain Plot for Hybrid with 25/75 fiber distribution

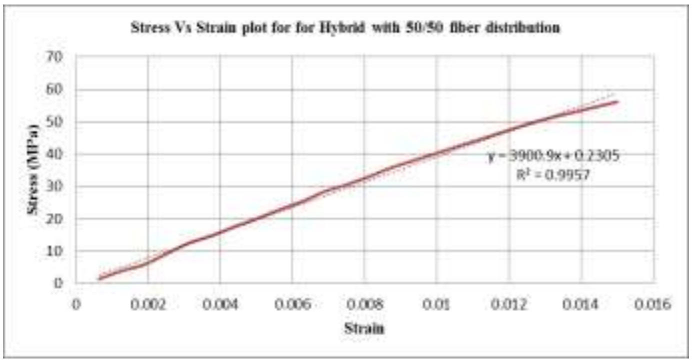

Fig 2.4: Stress-Strain Plot for Hybrid with 50/50 fiber distribution

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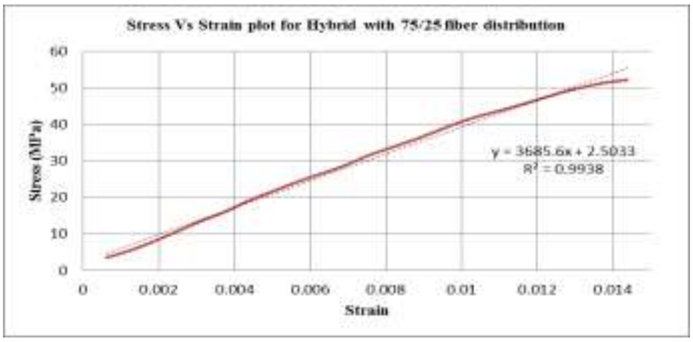


Fig 2.5 : Stress-Strain Plot for Hybrid with 75/25 fiber distribution

4. 1 TENSILE STRENGTH ANALYSIS

The Fabricated samples are subjected to tensile loading and the results are analyzed. The experiments are carried out as per ASTM standards discussed in a experimental section. Based on the results, samples are prepared with Musa fiber, Coir Fiber and Hybrid fiber. The tensile strength of each composite specimen is shown in The Tables from table-1 to table-5.

S.No	Specimen Code	Weight of Composite (gm)	Weight of Fiber (gm)	E_1Value (MPa)
1	2G_Ok_1	8.19	3	8564.99
2	2G_Ok_2	8.55	3	6595.77
3	2G_Ok_3	8.42	3	7063.99
4	2G_Ok_4	9.17	3	9274.77
5	2G_Ok_5	9.15	3	8754.33
				* M- Musa Fiber

Table 1: Longitudinal Modulus of Musa Fiber reinforced Composite

S.No	Specimen Code	Weight of Composite (gm)	Weight of Fiber (gm)	E_1Value (MPa)
1	2G_K_1	8.29	3	8365.55
2	2G_K_2	8.55	3	6939.88
3	2G_K_3	8.53	3	8865.77
4	2G_K_4	9.15	3	9853.44
5	2G_K_5	9.17	3	8249.11
				* C-Coir Fiber

Table 2: Longitudinal Modulus of Coir Fiber reinforced Composite

S. No	Specimen code	Weight of Composite (gm)	Weight of Fiber (gm)	E_1Value (MPa)
1	25/75_hy_1	11.29	3	4296.11
2	25/75_hy_2	10.55	3	3634.33
3	25/75_hy_3	10.96	3	4296.11
				*hy-Musa/Coir Hybrid

Table 3: Longitudinal Modulus of Musa/Coir Hybrid at 25/75 fiber distribution

S. No	Specimen code	Weight of Composite (gm)	Weight of Fiber (gm)	E_1Value (MPa)
1	50/50_hy_1	10.96	3	3331.33
2	50/50_hy_2	10.55	3	3900.99
3	50/50_hy_3	11.29	3	3331.33
				*hy-Musa/Coir Hybrid

Table 4: Longitudinal Modulus of Musa/Coir Hybrid at 50/50 fiber distribution

S. No	Specimen code	Weight of Composite (gm)	Weight of Fiber (gm)	E_1Value (MPa)
1	75/25_hy_1	11.18	3	3685.66
2	75/25_hy_2	10.84	3	3179.77
3	75/25_hy_3	11.05	3	3685.66
				*hy-Musa/Coir Hybrid

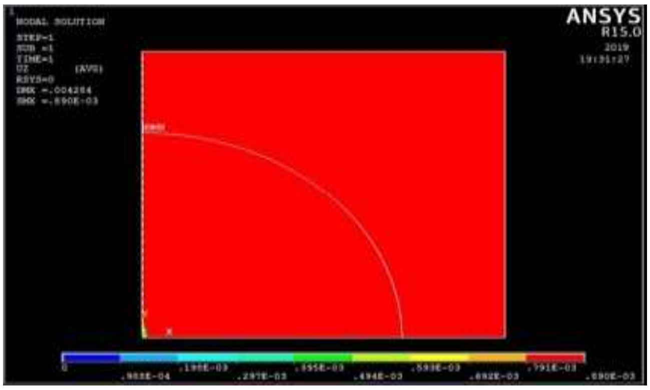
Table 5: Longitudinal Modulus of Musa/Coir Hybrid at 75/25 fiber distribution

4. 2 RESULTS FROM FEM ANALYSIS

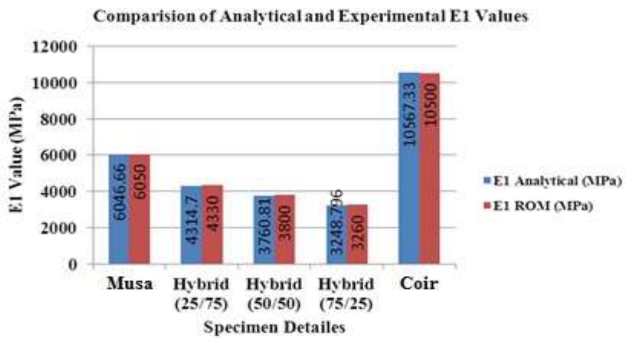
FEM analysis is a best alternate method to analyze the component analytically and it can be helpful to verify the work which was done by others like experimentation, numerical methods etc.

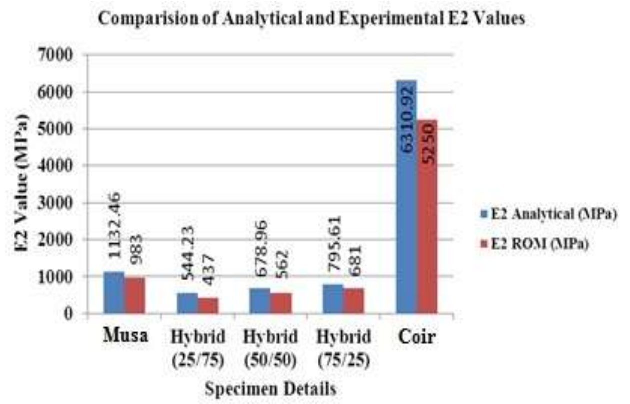
The results we get from the ANSYS is a deformation corresponding to applied force. By the help of some calculations we can verify the Young's modulus.

$$E_1 = \frac{\sigma_1}{\varepsilon_1}$$



4.3 COMPARISON OF ANALYTICAL AND EXPERIMENTAL VALUES FOR E1 AND E2





5. CONCLUSIONS

The Musa, Coir and Musa/Coir Hybrid natural fiber reinforced composites are fabricated by a hand layup method. Tests are conducted on the specimens with pure Musa Fiber reinforced epoxy composite and Pure Coir Fiber reinforced Epoxy composite and also at different levels of hybridization levels like 25/75, 50/50, 75/25 distribution of Musa/Coir respectively to find mechanical properties like tensile, flexural and impact strength and from the results, the following conclusions are obtained.

- ✓ It has been observed that pure Coir composites samples are having highest tensile strength (445 MPa) and tensile modulus (12.5 GPa).
- ✓ The pure Musa fiber reinforced composite stood next to Coir fiber composite in terms of tensile properties with 179 MPa Tensile Strength and 7.04GPa of Tensile modulus.

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