Investigating the Mechanical Behaviour of Coconut Coir – Chicken Feather Reinforced Hybrid Composite

Alagarsamy.S.V[1], Arockia Vincent Sagayaraj.S[2], Vignesh.S[3]

[1]Asst. Professor, Dept of Mechanical Engg, Mahath Amma Institute of Engg & Tech, Pudukkottai, India
[2]Asst. Professor, Dept of Automobile Engg, Shanmuganathan Engineering College, Pudukkottai, India
[3]Lecturer, Dept of Mechanical Engg, Mahath Amma Institute of Engg & Tech, Pudukkottai, India
E-mail: s.alagarsamy88@gmail.com; vignesh2231@gmail.com

Abstract: In present days, automobile industries are rapidly increased. All the automobile industries are in the process of supplying the vehicles at low cost. The major cost of the automobile components is its body parts. As per the any automobile industries concentrate with automotive components end life is very important factor in the design of the automotive. So everybody is concentrating on new materials which will be strong enough, less weight, recyclable with reduced cost. Hence all the researchers are concentrated on the composite materials which have all the above properties. Hence the present work is concentrated on coconut coir fiber and chicken feather reinforced polyester hybrid composites. The composites specimen was fabricated with various weight percentages of natural fibers namely coconut coir (20%, 22%, 24%, and 26%) and chicken feather (10%, 8%, 6%, and 4%) combined with polyester resin using hand lay-up method. So to obtain new composite materials different proportions of coconut coir and chicken feather is added and the mechanical properties such as Tensile strength, Flexural Strength and Impact test were carried out for the samples cut from the fabricated composites specimen to the dimensions as per ASTM standard.

Keywords: Coconut Coir, Chicken Feather, Hybrid Composite, Tensile Properties, Flexural Properties, Impact Strength.

1. Introduction

Natural fibers have been used to reinforce materials for over thousand years. Recently, they have been employed in combination with plastics. Natural fibers are environmentally friendly, fully biodegradable, abundantly available, renewable and cheap and have less density. Natural fibers posses no health hazards and, finally, provides a solution to environmental pollution by finding new uses for waste materials. Currently, many types of natural fibers have been investigated for use in plastics including flax, hemp, jute straw, wood, rice husk, wheat, cane (sugar and bamboo), grass, reeds, kenaf, ramie, oil palm empty fruit bunch, sisal, coir, water, hyacinth, pennywort, kapok, banana fiber, pineapple leaf fiber. Fibers obtained from the various parts of the plants are known as vegetable fibers. Animals can also provide a source of fibers. A wide variety of properties can be achieved through proper selection of fiber type, fiber orientation and fiber reinforcement form. In recent times, light weight and high strength materials have been developed owing to soaring demands from industries and domestic applications. Most of the components of automobiles, aerospace, domestic appliances and packaging industries need waterproof, reasonably good strength and corrosion resistant materials to fight against environmental attack. Interior decorative materials, furniture's and fittings are also to be developed for better aesthetic values. Under such circumstances, it is no doubt that polymeric composites play a very important role in such applications due to its light weight, high strength, moisture, crack and corrosion resistant

Coir comes from the husk of coconut fruit fiber. Coir has more life compared to other natural fibers due to its high lignin content. Coir fiber reinforced with both thermoset and thermoplastic resins. The mechanical property of the composite depends on interfacial adhesion of fiber to the matrix material. The interfacial adhesion characteristics of coir fiber with polyester matrix were tested different aging solutions. Coir fiber reinforced polymer composites developed for industrial and socio-economic applications such as automotive interior, paneling and roofing as building materials, storage tank, packing material, helmets and post boxes, mirror casing, paper weights, projector cover, voltage stabilizer cover. Coir fibers are more efficient and superior in reinforcement performance when compared to other reinforcement composite.

The CFF are commonly described as a waste by-product and they are contributing to environmental pollution due to the disposal problems. There are two main chicken feather disposal methods that exist, a burning and burying. Both of them have negative impact on the environment. Recent studies on the chicken feather waste demonstrated that the waste can be a potential composite reinforcement. The composite reinforcement application of the CFF offers much more effective way to

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solve environmental concerns compared to the traditional disposal methods. Some of the advantages of the CFF are inexpensive, renewable available. The CFF as a composite reinforcement having certain desirable properties including lightweight, high thermal insulation, excellent acoustic properties, nonabrasive behaviour and excellent hydrophobic properties. The CFF has the lowest density value compared to the all natural and synthetic fibers. The found that the CFF keratin biofibers allows an even distribution within and adherence to polymers due to their hydro-phobic nature and they reported that CFF reinforced composites have good thermal stability and low energy dissipation. B.Sudharsan et.al [1] Studied the mechanical properties of tensile, compression tests were carried out using coir/eggshell materials. The tensile strength of composites depend on coir fiber and compression strength of composites depend on eggshell quantity. J.Santhose et.al [2] Developed banana fiber composites and mechanical properties were evaluated. Scanning electron microscopic obtained from the surface modification by alkali treatment has improved the mechanical properties than untreated fiber composites. N.Anupama sai priya et.al [3] Conducted static and water absorption behaviour of randomly oriented coir fiber mixed with reinforced polyester composites. The static and water absorption properties are highly dependent on volume percentage of fibers. Madhukiran.J et.al [4] investigated the flexural properties of banana/pineapple reinforced with epoxy resin. It has been observed that the flexural properties increase with the increase in the weight fraction of fibers to certain extent. Therefore an attempt has been made in the present investigation to develop hybrid composite laminates of coconut coir/chicken feather to satisfy the good needs. The reinforced hybrid composites were fabricated by hand layup techniques. Polyester resin was used as matrixes and the composites were manufactured by using four different fiber mixing proportions. The mechanical properties such as tensile, flexural, impact performances are studied in this investigation.

2. Materials and Method

Matrix: Polyester resin matrix is standard economic resin which is most commonly used and preferred material industry.

Fig.2.1. Resin and Hardener

It yields highly rigid products with a low heat resistance property. The mechanical properties of polyester resin are given in Table.2.1.

Mechanical Properties	Polyester Resin
Density (g/cc)	1.2-1.5
Tensile Elongation at break (%)	2
Tensile Strength (Mpa)	40-90
Compressive Strength (Mpa)	90-250
Young's Modulus (Gpa)	2-4.5
Water absorption (%) 24hr at 20ºC	130-180

Table.2.1. Properties of Polyester Resin

Fiber:

Coconut Coir:

Coir comes from the husk of coconut fruit fiber. Coir has more life compared to other natural fibers due to its high lignin content. Coir fiber reinforced with both thermosetting and thermoplastic resins. The mechanical property of the composite depends on interfacial adhesion of fiber to the matrix material. Coir fiber showed very high interfacial adhesion under dry conditions. Coir fiber is used in a wide variety of ways. Ropes, mats, brushes, furniture, car seat covers, mattresses, packaging, floor coverings, pots and basket liners.

Chicken Feather:

Chicken feathers are a waste product from the processing of chickens for food. Chicken feather fiber (CFF) offers a large, cheap fiber market as an additive for medium density fiber board (MDF). Chicken feathers consist of approximately half fiber and half quill (by weight). Both the fiber and quill consist of hydrophobic keratin, a protein with strength similar to that of nylon and with a diameter smaller than that of wood fiber. The fiber is more durable than the quill and has a higher aspect ratio. Finding a high-volume, high value use for CFF, which is most commonly land filled or used for feed protein, would greatly benefit the poultry industry and would represent another source of fiber for the wood industry.

Sample Preparation:

For the preparation of the composite we calculate the percentage of fibers, polymer and hardener required from the table we come to know about the amounts accurately.

Specimen	% wt of Coir	% wt of Chicken Feather	% wt of Resin	Total % of wt
A	20	10	70	100
B	22	8	70	100
C	24	6	70	100
D	26	4	70	100

Table.2.2. Sample Preparation

Fabrication of Composites:

The moulds are cleaned and dried before applying polyester. Then a coat of wax layer is applied throughout the board to facilitate easy removal of the laminate. The fibers were laid uniformly over the mould

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before applying any releasing agent or polyester. After arranging the fibers uniformly, they were compressed for a few minutes in the mould. Then the compressed form of fibers (coconut coir/chicken feather) is removed from the mould. This was followed by applying the releasing agent on the mould, after which a coat of polyester resin was applied. The compressed fiber was laid over the coat of polyester, ensuring uniform distribution of fibers. The polyester mixture is then poured over the fiber uniformly and compressed for a curing time of 2hour, with load of 5kg. After curing the composites are sized according to ASTM standards. Composites are prepared by changing the weight fractions of both coconut coir and chicken featherfiber.

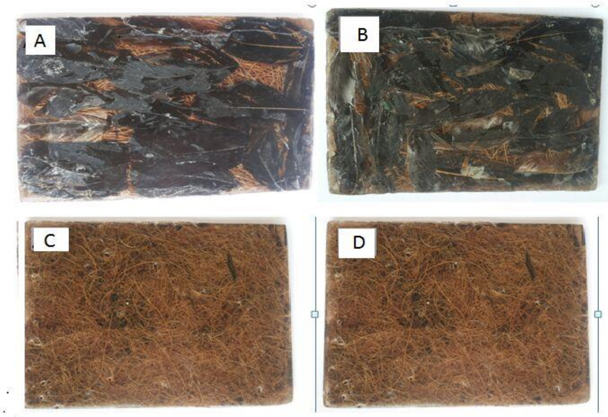

Fig.2.2.Fabricated Composites

Mechanical Testing

Tensile Test:

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. According to ASTM D3039-76 test models the tensile test of composites is carried out utilizing Universal Testing Machine UNITEK 94100. A load was connected to the both sides of composite samples for the testing. The speed of the tensile testing machine is about 2mm/min. The testing is done to measure the force required to break a polymer composite specimen and the extent to which the specimen stretches or elongates to that breaking point.

Fig.2.3. Tensile Test Arrangement

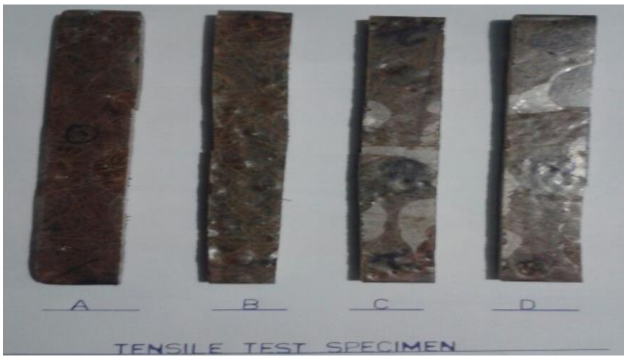

Fig.2.4. Tensile Test Specimen

Flexural Test:

Flexural Strength is defined as a materials ability to resist deformation under load. Flexural test is conducted as per ASTM D790 standard using Universal Testing Machine. The maximum fiber stress at failure on the tension side of a flexural specimen is considered the flexural strength of the material. For the testing, the cross head rate is kept as 2 mm per min and a span of 80 mm is kept up. Four composites specimen were tested for each sample and each test was performed until failure occurred.

Fig.2.5. Flexural Test Arrangement

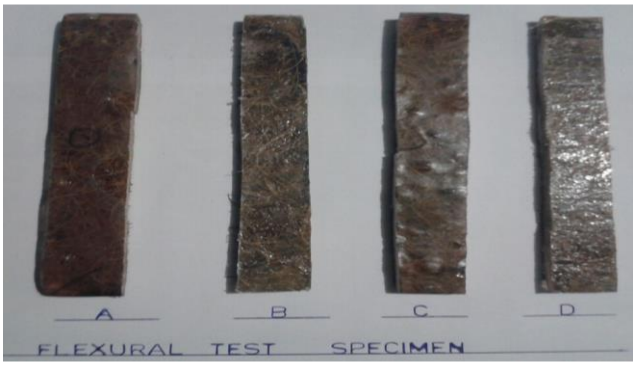

Fig.2.6. Flexural Test Specimen

Impact Strength:

Impact is a single point test that measures a materials resistance to impact from a swinging pendulum. Impact is defined as the kinetic energy needed to initiate fracture and continue the fracture until the specimen is broken. The impact tests are carried out as per ASTM D 256 using an impact tester. Four samples were tested at ambient conditions and the average of impact strength was calculated.

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Fig.2.7. Impact Test Arrangement

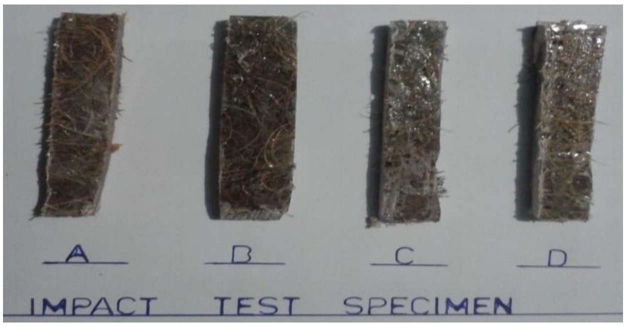

Fig.2.8. Impact Test Specimen

3. Results & Discussion

The characterization of the composites reveals that the fibers percentages are having significant effect on the mechanical properties of composites. The properties of the composites with different fiber percentages under this investigation are presented in Table 3.1.

Specimen	Tensile Strength (Mpa)	Flexural Strength (Mpa)	Impact Strength (KJ/mm^2)
A	10.15	43.2	20
B	10.60	40.8	32
C	11.05	38.4	40
D	11.50	36	48

Table.3.1. Properties of Composites

Tensile Strength:

The Tensile Strength of various composites with varying weight fractions are shown in figure.3.1. The Tensile Strength of composites depends on the quantity and quality of fiber used.

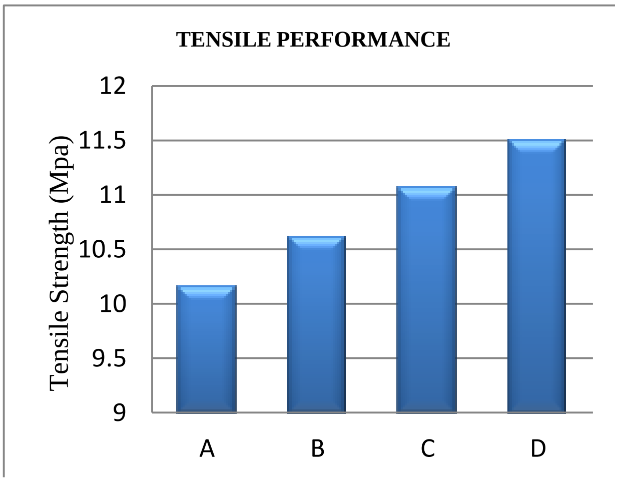

Fig.3.1. Tensile Performance

From the graph the variation of tensile strength with different composites specimen for the maximum peak loads. The specimen A has lowest tensile strength of 10.15 Mpa and the specimen D has largest tensile strength of 11.50 Mpa. The tensile strength of composite is uniformly increasing from A to D.

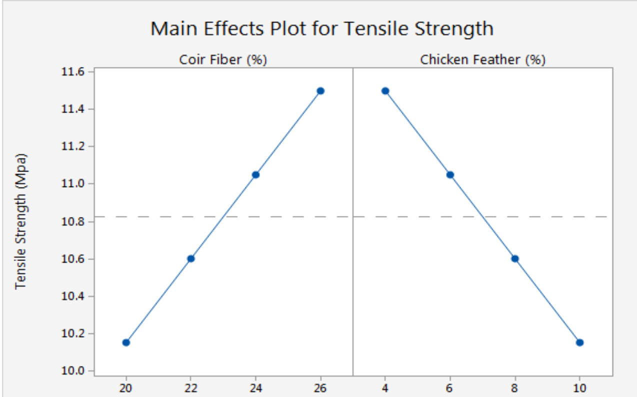

Fig.3.2. Effect of Tensile Strength

Flexural Strength:

The Flexural Strength of various composites with varying weight fractions are shown in figure.3.3. The Flexural Strength of composite mainly depends on the type of natural fiber content used and increases with the amount of fiber content.

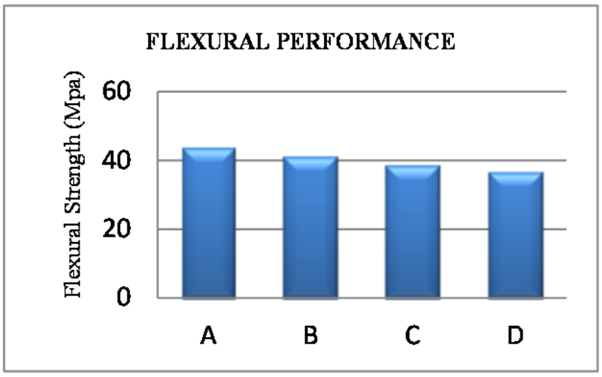

Fig.3.3. Flexural Performance

From the graph the variation of flexural strength with different composites specimen for the maximum peak loads. The specimen A has largest flexural strength of 43.2 Mpa and the specimen D has lowest flexural strength of 36 Mpa. The flexural strength of composite is uniformly decreasing from A to D.

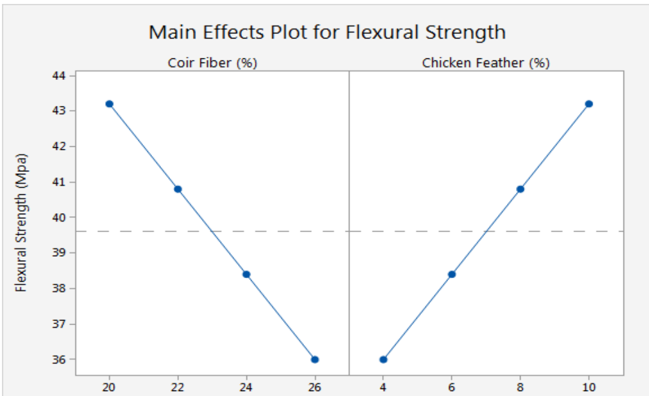

Fig.3.4. Effect of Flexural Strength

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Impact Strength:

The Impact strength of various composites with varying weight fractions are shown in figure.3.5. From the graph the variation of impact strength with different composites specimen for the maximum impact loads. The specimen A has lowest impact strength of $20KJ/mm^2$ and the specimen D has largest impact strength of $48KJ/mm^2$. The impact strength of composite is increasing from A to D.

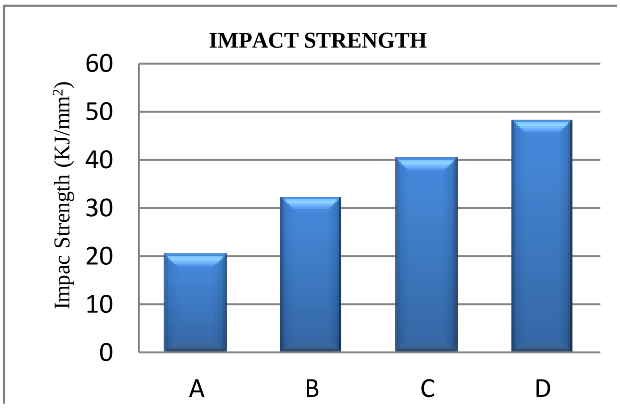


Fig.3.5. Impact Performance

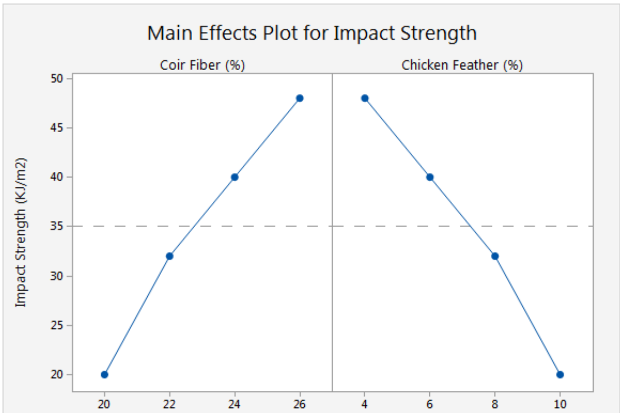
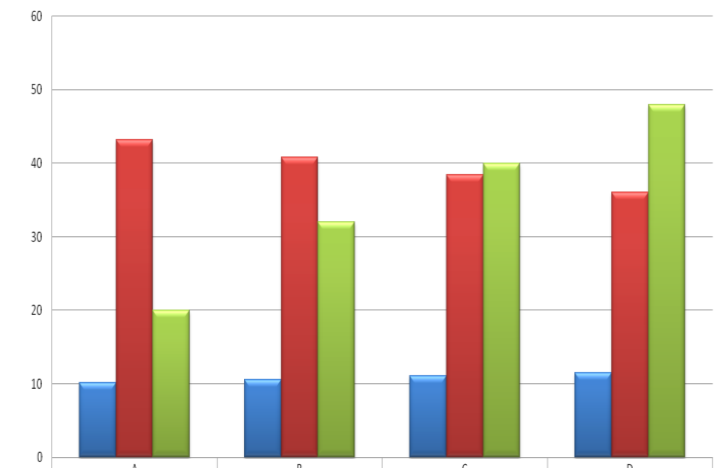


Fig.3.6. Effect of Impact Strength



	A	B	C	D
Tensile	10.15	10.6	11.05	11.5
Flexural	43.2	40.8	38.4	36
Impact	20	32	40	48

Fig.3.7. Comparison Plot

4. Conclusions

This experimental investigation and analysis of mechanical behaviour of natural fiber reinforced polyester hybrid composites leads to the following conclusions:

- This work shows that successful fabrication of a coconut coir fiber-chicken feather reinforced polyester hybrid composites with different weight fraction of fiber is possible by using simple hand lay-up technique.
- It has been noticed that the mechanical properties of the composites such as Tensile strength, Flexural strength and Impact strength etc. of the composites are also greatly influenced by the fiber percentages.
- The result reveals that high Tensile strength is 11.5 Mpa obtained for specimen D, because the coconut coir fiber percentage is more than chicken feather has good tensile properties.
- For high Flexural strength is 43.2 Mpa obtained for specimen A, because the chicken feather percentage is more than coconut coir fiber has good flexural properties.
- For high Impact strength is 48 KJ/mm^2 obtained for specimen D, because the coconut coir fiber percentage is more than chicken feather has good impact properties.
- From the present work it is concluded that the tensile strength and impact strength of composites depend on coconut coir fiber and flexural strength of composites depend on chicken feather quantity.

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Biographies:

Mr. S.V.ALAGARSAMY working as Assistant Professor in Mechanical Department, Mahath Amma Institute of Engg & Tech, Pudukkottai, Tamilnadu, India. He obtained his bachelor of engineering degree in Mechanical Engineering from PTR College of Engineering and Technology, Madurai, 2012. Master of Engineering degree in Manufacturing Engineering from Chendhuran College of Engineering and Technology, Pudukkottai, 2014. His area of interest includes composite materials, Machining, Welding, optimization techniques, etc.

Mr. S.AROCKIA VINCENT SAGAYARAJ working as Assistant Professor in Automobile Department, Shanmuganathan Engineering College, Pudukkottai, Tamilnadu, India. He obtained his bachelor of Engineering degree in Mechanical Engineering from AC TECH, Karaikudi, 2011. Master of Engineering degree in CAD/CAM from Shanmuganathan Engineering College, Pudukkottai, 2014. His area of interest includes composite materials, Design,Analysis etc.

Mr. S.VIGNESH working as Lecturer in Mechanical Department, Mahath Amma Institute of Engg & Tech, Pudukkottai, Tamilnadu, India. He obtained his bachelor of Engineering degree in Mechanical Engineering from Mookambigai College of Engineering, Pudukkottai, 2013. Doing Master of Engineering degree in Manufacturing Engineering from Mother Terasa College of Engineering and Technology, Pudukkottai. His area of interest includes composite materials, Welding, Alternative Fuel, etc.

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