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Investigation of Mechanical Properties in Polyester and Phenyl-ester Composites Reinforced With Chicken Feather Fiber

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ABSTRACT
The purpose of the study is to utilize the chicken feather and finding the mechanical properties of the chicken feather reinforcing with polyester and phenyl ester. The bi-directional CFF reinforced composites were produced with phenyl ester and polyester resins with fiber reinforced composites, the chicken feather fibers (CFF) were cleaned, tested to know the mechanical properties and tensile behavior. It is found that the compressive properties of the CFF reinforced composites are significantly better than the control composites, however, the tensile and the flexural properties are determine by tensile, compressive, and flexural test. The CFF reinforced composite have potential applications due to its improved behavior and structural applications. The poultry waste can be utilized and used in any engineering applications, and it will be preferred due to low-cost and superior characteristics and the most importantly it will not cause ecological and health problems.
KEYWORDS: Investigation, Mechanical Properties, Polyester Phenyl-ester Composites, Chicken Feather Fiber.

I INTRODUCTION

1.1 CFF COMPOSITE

Throughout history, technological innovations have helped humankind improve their standards of living, with the rapidness of development and research is so impressive. However, keratin technology also creates a negative environmental impact. Therefore efforts are invested in making use of natural based biodegradable and sustainable material that exist in nature rather than create a new material. Textile structures reinforced composites, specifically with fibres, have gained importance in engineering and technical applications due to their light weight, higher tenacity, superior elasticity and strength, good thermal resistance, low density, and better rigidity. 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 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, non-abrasive behavior 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. The main purpose of this study is to manufacture and determine the mechanical properties of the CFF reinforced phenyl ester and polyester thermo set composites. The chicken feather fibres were tested and analyzed to identify the properties. The CFF reinforced composites were fabricated by hand layup techniques. phenylester and polyester resin were used as matrixes and the composites were manufactured by using three different fibre mixing proportions. The mechanical properties of these composites were determined and compared including tensile, flexural and compressive test properties.

This industry has changed very little throughout ages and still generates money by either

(i) exporting raw materials (jute, flax, sisal or coir, animal) or
(ii) manufacturing

Traditional products such as bags, carpet backing, ropes, baskets, brushes and paper. Both have Suffered a decrease in revenue in the past years due to stiff competition with synthetic Materials and Related products. The strategy discussed in this report aims to add value to the crops by processing the fibres into so called natural fibre composites. Composites are hybrid materials made of a polymer resin reinforced by fibres, combining the high mechanical and physical performance of the fibres and the appearance, bonding and physical properties of polymers. Due to the wide variety of available manufacturing processes, each resulting in their own characteristic products, the design possibilities are numerous. Consequently, a composite product and its manufacturing process can be chosen to best fit the environment in which the products will be made and used. Besides the technical feasibility, manufacturing of composites becomes also financially feasible when using domestically grown natural fibres in combination with simple manufacturing processes. Potential products are roofing panels, fluid containers, bridges and Small boats. Due to the interest of western society in environmental friendly high performance materials, Research institutes such as Delft University of Technology already possesses detailed knowledge on natural fibre composites. Using the natural fibre link, which connects the western composite industry to the traditional rural fibre industry, will facilitate the transfer of this knowledge. This link results in four benefits:

- Matching modern and traditional technology
- Compatibility of different cultures
- Increasing use of sustainable, cheap natural resources

When starting up a natural fibre composite industry, the benefits can be summarized into Economical, Environmental and Technical, as follows:

- The entire production chain can be developed, maximizing the benefits for the targeted
- in terms of money and employment.
- Due to the interest on natural fibre composites in western world, targeted countries can participate in co-operative research, participating in globalization. This is increased when Also the export market for natural fibre composites is aimed at.
- Environmental benefits can be found in the sustainable character of the materials used and the fact that NF composites can replace tropical hardwood.
- Working conditions are improved due to the friendly character of the fibres (no skin irritation) and lightweight property of the products, reducing the physical strain of the work. The latter benefits women largely, since they are well represented in the rural industry.

1.2 GENERAL CHARACTERISTICS OF CFF

In this way, lignin dissolved in styrene could be incorporated into thermosetting matrix and perform The following enhancements:

(a) Acting as a toughening agent
(b) Improving the connectivity in the network
(c) Adding additional stiffening groups to the matrix
(d) Acting as a sizing agent between natural fibers and the resin matrix
(e) Behaving as a co monomer for the resin
(f) Inducing plasticity in the deformation zone at crack tips to improve toughness,
(g) Acting as a free radical trap to reduce radical scission effects during fracture in highly cross linked polymers
(h) Improving flame resistance
(i) Modifying biodegradability
(j) Providing enhanced photo resistance and thermal stability
(k) Expanding fatigue lifetime
(l) Contributing to the green engineering of materials

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 fiberboard (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 quills have commercial applications in shampoo, hair conditioner, hair coloring, and dietary supplements. 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.

1.3 USES OF CHICKEN FEATHER

While feathers are often considered a by-product of poultry production (and often a waste by-product), some produces raise poultry specifically for their feathers. Feathers are used in a number of decorative products such as boas, feather fans, masks, costume accessories, bird ornaments, and even earrings and flowers. Feathers are also routinely used in the production of fishing flies. While chicken feathers don't weigh much, with the amount of chicken produced in the annually, the volume of feathers produced is considerable. For the 8+ billion broilers produced each year, 2-3 billion pounds of feathers are produced. Research has shown that the keratin in the feathers (a protein also found in hair, hoofs, horns, and wool) can be used in the production of a wide variety of products. Feather protein has properties in common with cellulose, the starch that forms wood and paper. Feathers are keratin just like wool but the surface area is much large because the diameter of the fibers is smaller. So the fiber can absorb more than wool or cellulose fibers. The crystal structure of feather fibers also makes them naturally stable and durable. More than 16 million diapers, made from wood pulp, are discarded each year. A year's worth of feathers could replace approximately 25% of the wood pulp used annually for diapers. Three companies – Feather fiber Corporation, Maxim Systems and Tyson Foods - are now working to scale up production of absorbent feather-based products including diapers, filters, insulation, upholstery padding, paper and even clothing. The orderly structure of keratin helps stabilize the structure of plastics, making them stronger. Feather meal is produced by a high-pressure steam processing method similar to autoclaving, followed by drying. Heat and steam hydrolyze the feathers into a cysteine-rich, high protein product that is 60% digestible.

1.4 GENERAL CHARACTERISTICS

1.4.1 Poly ester& Phenyl ester

Polyester fibres are produced by the melt spinning process. Raw materials are heated to a spinning mass, which is then pressed through spinnerets. Manufacturing techniques are now developed to the point where they can produce fibres adapted to suit the widest possible. Applications: they can have round, oval or angular profiles, making them firm to the touch. They can be dull, bright or glittery On care labels polyester fibres are often given the abbreviation: "PES".

1.4.2.Properties

Amongst the most important properties:

- Polyester fibres are particularly resistant to light and weather and can withstand climatic effects.
- They can be used where lightness and fineness are primary requirements.
- Polyester fibres are very well suited to blends with natural fibres.
- Fabrics in 100% polyester, or blends with an appropriately high proportion, are very crease-resistant and retain shape even when affected by moisture. fibres have good moisture transport and dry quickly.
- Polyester is the number one manmade fiber used in fabrics, worldwide. It tends to be an inexpensive fiber to produce and its general characteristics and non crop-based availability have allowed for the creation of inexpensive clothing and fabrics, which transformed the textile industry in 1941. The largest innovation in polyester was the recent discovery of microfibers. This discovery allowed polyester manufacturers to transform the texture and feel of polyester into a super-soft, durable, lightweight fabric.
- Polyester was introduced to the American public in 1951 as the fabric that doesn't need to be ironed. It quickly became known as wash-and-wear fabric. However, it also earned other, less flattering attributions, such as causing skin irritations with some people or being texturally unpleasant to the touch.
- Wearing polyester became associated with being cheap and this connection has continued to affect how consumers perceive the product. This drove more innovation in the industry as manufacturers began to hide or reliable polyester in new blended fabrics.
- The properties of polyester fabrics include: inexpensive cost; superior strength and resilience; lightweight; hydrophobic (it feels dry or moves moisture effects away from touch); it has an unusually high melting point; is resistant to dyes, solvents and most chemicals; stain resistant; resists stretching and shrinking; quick drying; wrinkle, mildew and abrasion resistant; retains heat-set pleats and creases and is easy to launder

III MATERIALS

3.1 CHICKEN FEATHER FIBER STRUCTURE OF CHICKEN FEATHER

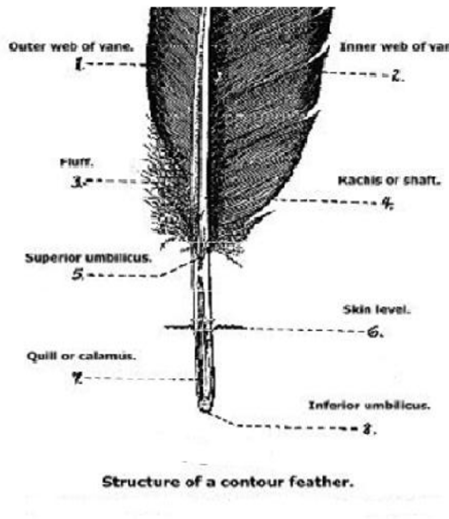


Figure 3.1 Structure of a contour feather

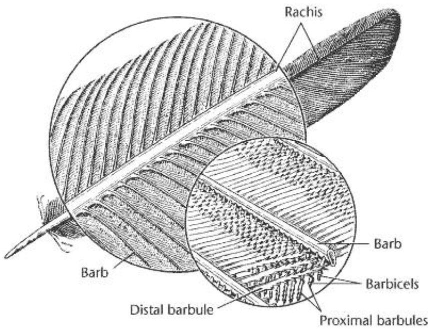


Figure 3.2

Down feathers are smaller than contour feathers and lack barbules and the accompanying hooklets. They are soft and fluffy, located beneath the contour feathers. They provide most of a chicken's insulation. There are several subcategories of down, including natal down, present only at hatching, and powder down, which is a specialized feather type that sheds a fine, white keratin powder. The waxy powder is composed of granules so small that it is unwettable and thus forms a waterproof barrier for contour feathers(Figure 3.1 & Figure 3.2).

The semi plume is a feather type that mediates between the categories of contour and down. Semi plumes share characteristics with both; they have a large rachis and predominantly downy vanes. Filoplumes are smaller than semi plumes, with only a few barbs at the tip of a fine shaft. These likely serve a sensory function in chickens, registering vibrations and changes in pressure. The smallest type of feather is the bristle, which is stiff and has few, if any, short barbs near the tip. Bristles are protective in function and are found on a chicken's head, at the base of the beak, around the eyes, and covering the nostrils. While older and larger chickens would be expected to have relatively more contour feathers. (Figure.3.3 & Figure 3.4)

3.2 PICTURE OF CHICKEN FEATHER

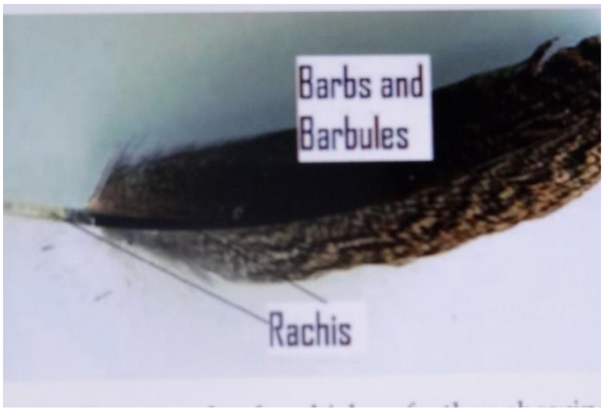


Figure 3.3 Picture Of Chicken Feather

In order to maximize the yield of a desirable type of feathers, feather collection could be Planned for days on which chickens of a particular feather type distribution are processed. Each contour feather has a feather shaft and a flat vane extending from it .The naked portion of the shaft that is implanted in a bird's skin is the calm’s. The portion bearing branches is the rachis, which is filled with a porous substance termed the medulla. Branches are termed barbs and provide an axis from which barbules can branch. Barbules are very closely spaced and interlock via hook lets, or barbicels, in order to provide strength and repel water. Flightless birds, including the emu and the ostrich, have few, if any, hook lets .Thus, it can be assumed that hook lets are not abundant in chickens.

3.3 PRIMARY TYPES OF CHICKEN FEATHER

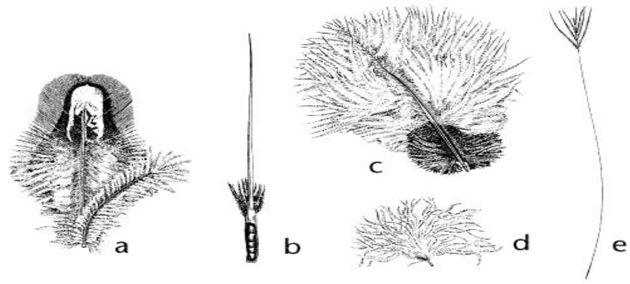


Figure 3.4The five primary types of chicken feathers (a) contour (b) bristle, (c) semiplume, (d) down, (e) filoplume

3.4 PROCESSED CHICKEN FEATHER FRACTIONS

Large contour feathers are approximately half feather fiber and half quill by mass These are useful categories because several companies’ proprietary processing technologies yield these two fractions, fiber and quill, shown in. Also, that fiber keratin and quill keratin are characteristic of the two forms of microcrystalline keratin in feathers. In simple terms, the quill is the hard. Central axis off which soft, interlocking fibers. The fibers are hollow Smaller feathers have a greater proportion of fiber, which has a higher aspect ratio than the quill as is apparent in single keratin fiber has a maximum diameter of 50 μm . Quill fractions are composed of both inner and outer quill; outer quill is more densely structured than inner quill, which is porous, as is apparent in have reported that the presence of quill among fibers results in a more granular, lightweight and bulky material. A typical quill has dimensions on the order of centimeters (length) by millimeters (diameter).

3.5 CROSS SECTION VIEW OF CHICKEN FEATHER

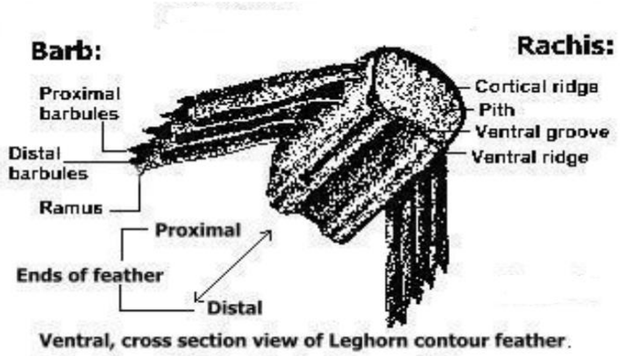


Figure 3.5 Cross Section View Of Chicken Feather

3.6 CONSTITUTION OF CHICKEN FEATHER

- Serine -16%
- Proline -12%
- Glycine -11%
- Valine -9%
- Cysteine-7%

And the rest are numerous amino acids in small percentages

Chicken feather is treated as a waste product from the poultry sector, approximately '$2*10^{13}$ kg of chicken feather generated in India every year.The cross section and the longitudinal features of the different region of the rachis and the Barbs. Hence, the ESEM micrographs of the barbs showed a tertiary structure, i.e. the barbules that are attached to the barbs in a manner similar to the barbs being attached to the rachis. Thus, according to the ESEM micrographs, a feather is composed of four units, i.e. the calm's, the rachis the barbs and the barbules. Show the morphological features of the main units of the poultry feather shows the two principal units, namely the rachis and the barbs shows the secondary and the tertiary units, namely the barbs and the barbules. The barbules are attached to the barbs in a manner similar to the barbs being attached to the rachis shows the primary, the secondary and the tertiary units.

3.7 PREPARATION OF CHICKEN FEATHER

Figure 3.6 Raw Poultry Feather

Figure 3.7 Water Treatment

The concentration of the chemical solutions is function of nature and the desired product. Hence, according to the application, the poultry feathers may be converted to useful products in the form of powder, fiber or wool. In combination with a suitable resin, the aforementioned natural fibres can be turned in to NF Composites. The resin is applied as a liquid and turns solid upon drying. Whereas the fibres add strength to the composite, the resin must at least have the following characteristics:

Figure 3.8 Wool Product

- Good impregnation To allow all the different fibres to act as a single material, even the smallest fibres have to be 'glued' together by the resin. The better the impregnation the higher the load a Composite can carry.
- Control moisture content of the natural fibres After processing, the natural fibres still contain a significant amount of water. The strength of the fibre is highest at a certain percentage of moist. Therefore the fibre must neither be too dry or too moist. The resin must allow evaporation of superfluous moist before it forms an impermeable solid film.
- Non-toxic Since in most of the rural societies health regulations at the work-floor are absent,Application of toxic materials will be an act of violence.
- High availability usually a higher availability results in a reduction of material costs.

3.8 SAMPLE PREPARATION IN POLYESTER

Table-3.1 Sample Preparation In Polyester

POLY ESTER (in gms)	FIBER (Chicken Feather) (in gms)	TOTAL (in gms)	STRIP PREPARATION	FINDING PROPERTIES
80	20	100	BIE-DIRECTION	Tensile
				Compressive
				Flexural Rigidity
70	30	100		
			UNI-DIRECTION	Tensile
60	40	100		Compressive
				Flexural Rigidity

3.9 SAMPLE PREPARATION IN PHENYL ESTER

Table-3.2 Sample Preparation In Phenyl Ester

POLY ESTER (in gms)	FIBER (Chicken Feather) (in gms)	TOTAL (in gms)	STRIP PREPARATION	FINDING PROPERTIES
80	20	100	BIE-DIRECTION	Tensile
				Compressive
				Flexural Rigidity
70	30	100		
			UNI-DIRECTION	Tensile
60	40	100		Compressive
				Flexural Rigidity

3.10 RESIN PREPARATION

Figure 3.9 Wool Product

The matrix material is a general purpose unsaturated polyester resin available from "FIBER CHEM PRODUCTS" In Salem. Due to the fact that the keratin feather fibers are characterized by a very short and classified as a fibers, and they were washed by using a lab dyeing machine with a polar solvent (ethanol). After the washing process the chicken features were rinsed and left to dry for 24 hours under normal room temperatures. The highly filled composites are prepared by a new technique developed. The concentration range was varied from 10%to 30% mixing of feathers because of practical reasons

3.11METHODS

3.11.1 Hand lay-up

Prior to the composite manufacturing, the CFF samples were conditioned for 48 hours at the fibre linear density values were determined in accordance with ASTM and the tensile properties of the fibres were determined in accordance with ASTM. The composites were fabricated with different fibre loadings (10%, 20% and 30%). Initially, polyester resin was mixed in hardener using a mixer in a bowl after the phenyl ester, polyester, resin was also prepared separately. The matrix materials were prepared in a portion of 70% of resin matrix and 30% of hardener by volume. Then, the fibres were spread into mould and covered with the matrix. The composites were manufactured by using a hand lay-up technique with size mould of 210 mm length x 210 mm width x 10 mm thickness. The composites were kept for 24 hours at room temperature and subsequently put in an oven for 8 hours at 80°C for curing. The control and the CFF reinforced composites were evaluated in accordance with ASTM size.

3.12 MOULD PREPATATION

Dimension of the cavity :l x b x t = 200mm x 150mm x10mm.

Figure :3-10 Source Of Feathers

Fig:3-11 Source Of Feathers

Feathers collected at the Gold Kist chicken processing facility had been removed from chickens by hot water and mechanically driven rubber fingers and then diverted from the plant in a trough of water. The feathers were collected by hand from a conveyor belt carrying waste – chicken heads, feet, and feathers – to an offal truck. The feathers were transported on ice and then frozen, because feather masses which are commingled with chicken parts, water, and fats decompose in a biological process that is accelerated at high temperatures. The feathers were later cleaned in a washing machine with approximately 7 L of anti-microbial soap per m^3 of feathers and then dried in a rotary drier.

Figure 3.10 & Figure 3.11 shows the source of feathers and processing information. Processing involves grinding the feathers and separating them into fiber and quill fractions. All examined quill fractions were composed of both inner and outer quill. Details on how the feathers are processed are generally difficult to ascertain, as many of the processing techniques are proprietary. Sample B was cut by hand at Georgia Tech into fiber and quill fractions. The fiber fraction was then chopped with a household coffee grinder until each fiber was separated.

3.13 STRIP PREPARATION

Figure 3.12 Strip Preparation

Figure 3.12 Strip Preparation

Dimensions:
Tensile Test : l x b x t = 150mm x 25mm x 10mm.
Flexural Test : l x b x t = 150mm x 25mm x 10mm
Impact Test : l x b x t =150mm x 10mm x 10mm

As materials suppliers, very little training is required since this segment is already well Developed. The only required training might be to produce spun yarns with a variety in thicknesses and fabrics with different weave patterns. It is also important that as sale of composites increases, local farmers are persuaded to increase fibre production to meet the demand. A point of attention is the fact that today the natural fibres and the related processes are optimized to produce an optimum fibre for textile applications. For natural fibres for composite applications, a different variety of fibres and different way of processing might be more suitable.

3.14 WORK PIECE WITH TESTING FIGURE

Figure 3.13 Strip Preparation and Testing

The development of successful applications for CFM will be aided by an understanding of their mechanical properties. Selecting compatible matrix materials for CFM will specifically require an understanding of the Young's module chicken feather fractions.

IV RESULT AND DISCUSSION

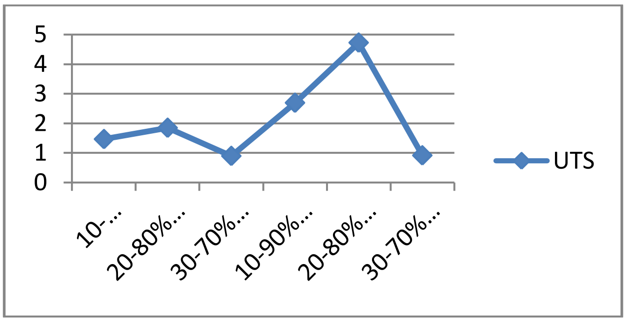
It can be seen that CFF reinforced composite will have potential applications due to its improved the behaviour, the tensile and flexural properties can be enhanced with the increasing percentage of CFF and also different resin. Another way to enhance the composite properties is to determine an effective treatment to eliminate lack of adhesion between matrix and CFF fiber.

4.1 TENSILE TEST PERFORMENCE

The details of Tensile Test of composite for varies percentage of CFF with Phenyl Ester and Polyester mixtures as follows:

4.1.1 COMPARISION OF TENSILE TEST :

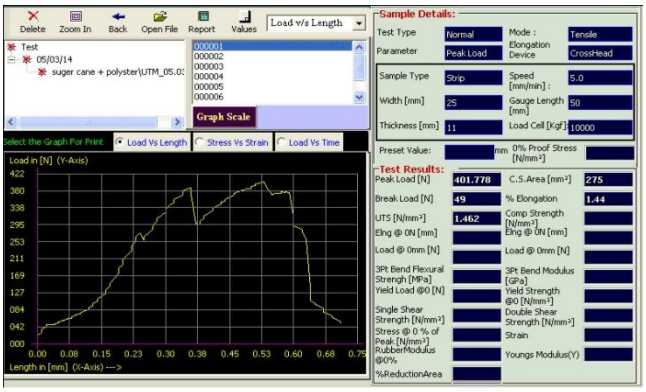
Composites	Cross Sectional Area [mm^2]	Peak Load (in N)	% Elongation	UTS [N/mm^2]
10 CFF- 90% Phenyl Ester	275	401.778	1.440	1.462
20 CFF -80% Phenyl ester	250	461.482	3.380	1.844
30 CFF -70% Phenyl ester	300	268.353	1.560	0.893
10 CFF - 90% Polyester	200	538.020	1.480	2.688
20 CFF - 80% Polyester	**200**	**943.732**	**2.780**	**4.719**
30 CFF -70% Polyester	250	228.867	0.980	0.912



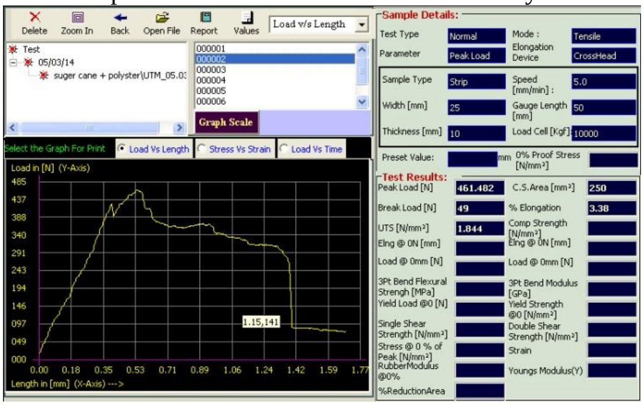
x-axis : composites in %
y-axis : Tensile Stress [N/mm^2]

4.1.2 Graph for Tensile Test

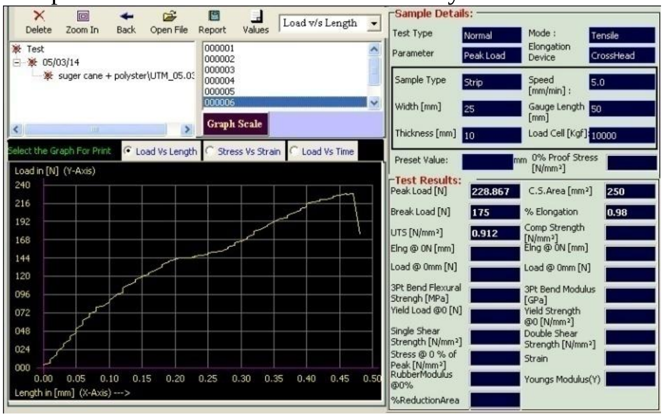
Composite Material : 10%CFF & 90%Phenylester.



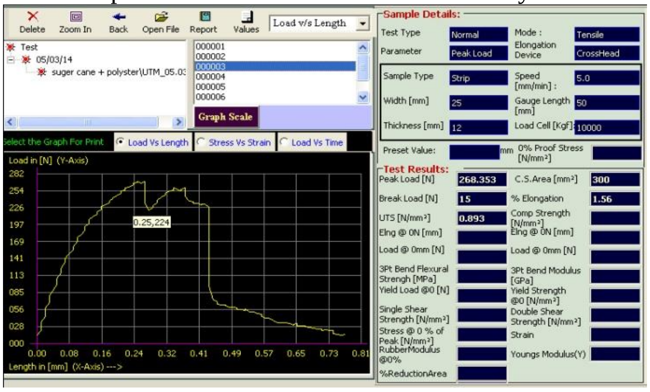
Composite Material : 20%CFF & 80%Phenylester.



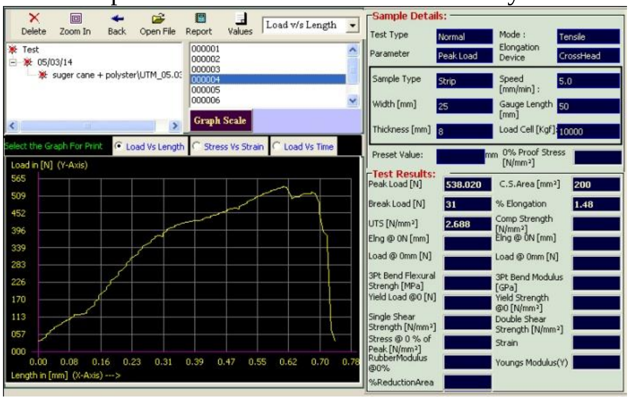
Composite Material : 30%CFF & 70%Polyester.



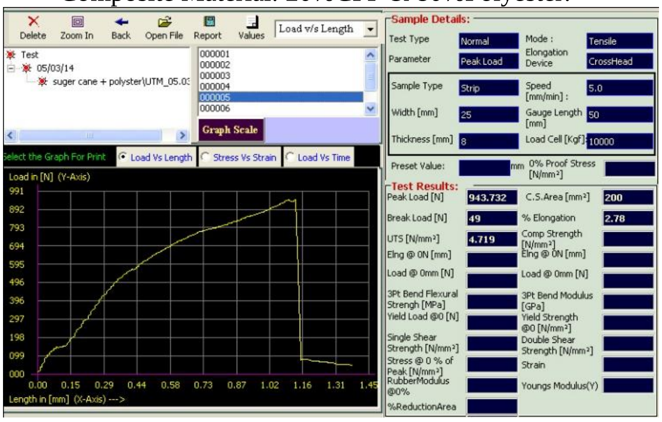
Composite Material: 30%CFF & 70%Phenylester.



Composite Material : 10%CFF & 90%Polyester.



Composite Material: 20%CFF & 80%Polyester.

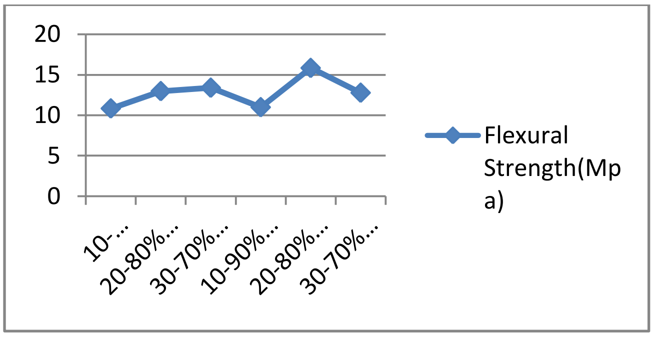


4.2.BENDING TEST PERFORMANCE

The details of flexural Test of composite for varies percentage of CFF with Phenyl Ester and Polyester mixtures as follows:

4.2.1 COMPARISION OF BENDING TEST:

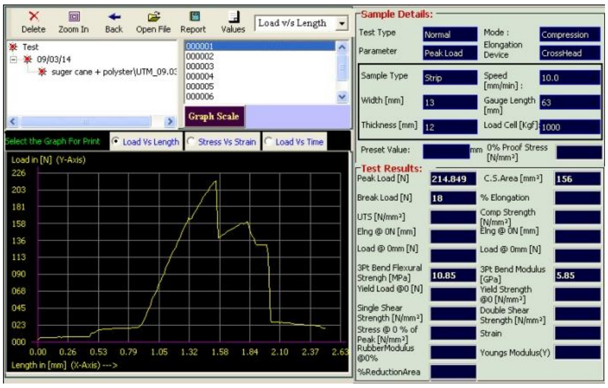
Composites	**Cross Sectional Area [mm^2]**	**Peak Load [N]**	**Flexural Strength (Mpa)**	**Flexural Modulas Gpa)**
10 CFF-90% Phenyl Ester	156	214.849	10.846	5.849
20 CFF - 80% Phenyl ester	104	114.228	12.974	17.765
30 CFF - 70% Phenyl ester	156	265.380	13.391	5.908
10 CFF - 90% Polyester	104	96.825	10.997	13.825
20 CFF - 80% Polyester	**104**	**139.292**	**15.821**	**14.520**
30 CFF - 70% Polyester	130	175.736	12.775	8.749



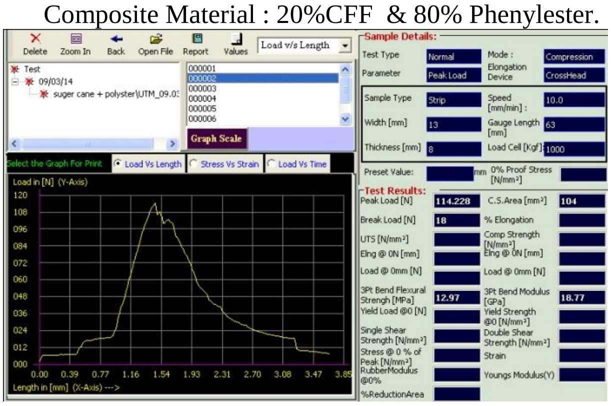
x-axis : Composites in %
y-axis : Flexural Strength(Mpa)

4.2.2 Graph for Flexural Test

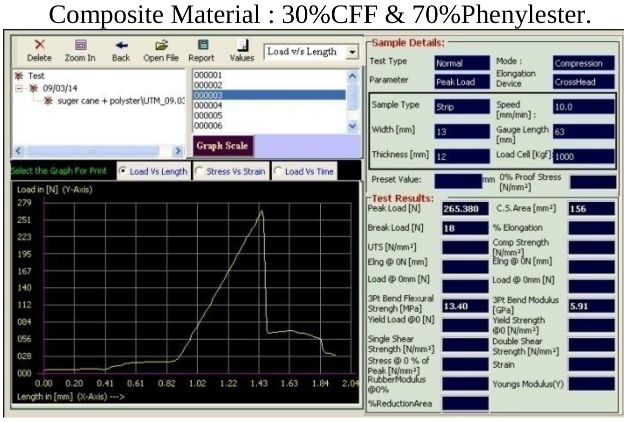
Composite Material : 10%CFF & 90%Phenylester

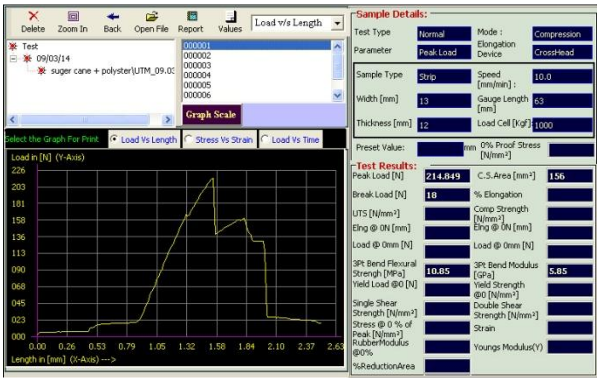


Composite Material : 20%CFF & 80% Phenylester.



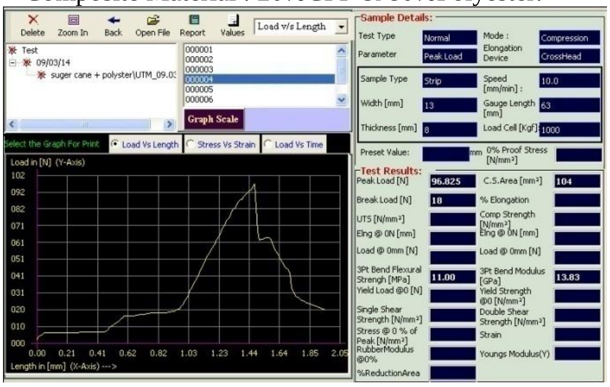
Composite Material : 30%CFF & 70%Phenylester.



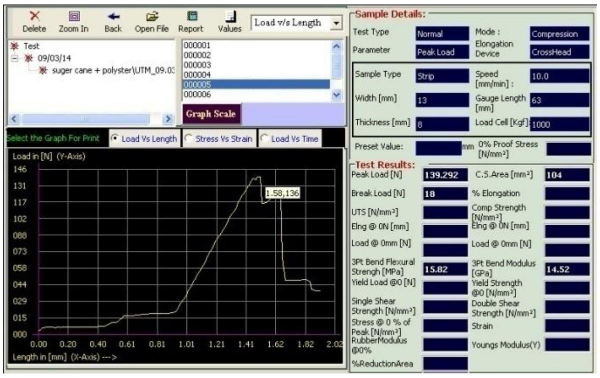


Composite Material : 10%CFF & 90% Polyester.

Composite Material : 20%CFF & 80%Polyester.



Composite Material : 30%CFF & 70%Polyester..



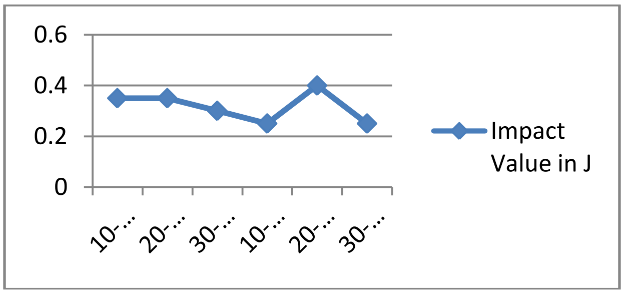
4.3 IMPACT TEST

hWhen the Impact resistance decreases with an increase in the modulus of elasticity, which means that stiffer amaterials will have less impact resistance. Resilient amaterials will have better impact resistance. The details of Impact Test of composite for varies percentage of F CFF with Phenyl Ester and Polyester mixtures as llfollows:

Figure 4.3 Broken Workpiece After The Test

4.3.1 COMPARISION OF IMPACT TEST:

Sl.No	Sample Composites	Impact value for given sample in J
1.	10 CFF -90%Phenylester	0.35
2.	20 CFF -80%Phenylester	0.35
3.	30 CFF -70%Phenylester	0.30
4.	10 CFF -90%Polyester	0.25
5.	**20 CFF -80%Polyester**	**0.40**
6.	30 CFF -70%Polyester	0.25



x-axis : Composites in % y-axis : Impact Value in Joule.

V CONCLUSIONS

Usually the poultry waste are still destroyed by using either burning or burying methods This studies helps that the poultry waste can be utilised and used any engineering applications and it will be preferred due to low cost and superior characteristics and the most importantly it is ecological and health problems. The investigation shows that 20 % CFF and 80% Polyester having highly superior properties such as tensile, flexural and impact value The tensile and flexural property values decrease when the fibre loading percentages increases. Thus, the reinforced composite better than at 5% level and the Tensile and flexural properties of composite are control with the resins Polyester having significantly superior properties to the 25% CFF reinforced composite. The CFF reinforced composite have potential applications based on the mixer of varies different resin and CFF fiber due to improving its behaviour. The tensile and flexural properties can be enhanced with the increasing the percentage of CFF and also with different resin are considered to eliminate lack of adhesion between matrix and CFF fibre.

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