Analyzing the Effect of Tensile Strength on Chicken Feather Reinforced with Polypropylene Composite Board

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Abstract— Composite materials are light weight, high strength to weight ratio and stiffness properties and these properties of composites used to replace the conventional materials like metals, woods, etc. Presently, feathers might be considered as waste because their current uses are economically marginal and their disposal is difficult. In this study chicken feathers were used to produce composites boards. The waste chicken feathers were collected from poultry units and are cleaned with a polar solvent like ethanol and dried. These feathers in pre-determined weight proportion are processed to make random orientation and made into a composite using polypropylene as a matrix by compression moulding technique. The composite boards were subjected to tensile tests and the fractured surfaces were observed under SEM as declared.

Key words: chicken feather, polypropylene, compression molding

I. INTRODUCTION

Chicken feathers (CF) are very special structures which distinguish birds from other animals and have important physiological functions. Recognizing feather "waste" as a potential source of usable fiber studies were begun to demonstrate and develop that usefulness by making commercial value added products [2]. A chicken has about 5% to 7% of its body weight in feathers so chicken feathers are an important by-product in the poultry industry. Over four billion pounds of chicken feather "waste" is generated in every year [1]. Materials derived from CF can be used advantageously as the reinforcing materials in polymer matrix composites. Such applications can potentially consume the huge quantity of feathers produced annually as a by-product of various poultry units worldwide.

Fiber reinforced polymer composites (natural fibers) have raised great attention and interest among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibers in fiber reinforced composites [3]. Materials derived from CF can be used advantageously as the reinforcing materials in polymer matrix composites. Such applications can potentially consume the huge quantity of feathers produced annually as a by-product of various poultry units worldwide [4]. To aid the development of successful applications for chicken feather in composite making, this research work has been taken up. The objective of this investigation is to develop an eco-friendly, light weight composite from a cheap and easily available material at a lower cost. In this project we have attempted to produce composite board using chicken feather fiber reinforced composite which combines the advantages of natural fiber reinforcement and good thermal resistance of chicken feather fiber.

II. MATERIALS AND METHODS

A. Chicken Feather:

CF is approximately 91% keratin, 8% water and 1% lipids by mass [5]. Keratin is a protein with 95 amino acids and has a molecular weight of 10.168 kDa. Chicken feather fibres are found to possess high toughness, good thermal insulation and acoustic properties, non abrasive behavior, more hydrophilic and less hydrophobic in nature. In this project work CF was collected from suguna chicken poultry farm.

B. Polypropylene:

Polypropylene (CH2 =CH-CH3), the byproduct of the oil refineries, is one of the constituents obtained from thermal or catalytic cracking of petroleum. Under suitable polymerizing condition, propylene produces fiber forming polypropylene. For producing the polymer (iso-tactic) with a regular structure, polymerization should take place [8]. Raw polypropylene is purchased from zenith fibres Baroda.

Since the process parameters were already optimized in the earlier work that optimized parameters [7] were chosen for this project work. The parameters are temperature 185 °c , pressure 15 bar and time 3 min. Proportions chosen to produce compression moulded composite board is Polypropylene matrix / chicken feather reinforcement - 90/10, 80/20, 70/30.

C. Methods:

The untreated CF was washed with the 5% soap solution followed by rinsing. The wet washed CF was dried on moderate heat. Samples of washed CF were dipped at room temperature (21°C) for 30 minutes respectively. Polar solvent and water, with pH adjusted to 8, then rinsed with water, then soaping process is carried out and air-dried.

III. WEB PREPARATION FROM MINIATURE CARDING

In this project, we have planned to produce the composites using compression moulding technique. In order to produce the composites there are different types of laying technique available like dry laid, wet laid, random laid , card laid. We have selected card laid technique. By passing the polypropylene into miniature carding machine, the web is produced.

Fig. 1: Webs produced using the miniature carding machine

Manufacture of Chicken Feather Reinforced Composite: Fibrous webs are cut into pieces (250mm X 250mm with thickness 3mm) according to the aluminum mould and placed on the mould. Feathers are cut and laid over the web layers to get the required weight/unit area (1500 GSM) and compression moulded at optimized parameter. Several of such fiber webs with randomly laid feathers were compression molded to produce composite board.

Fig. 2: Compression Molding Machine

Generally, the web is placed on the bottom jaw [Immovable] and then the top jaw [Movable] is activated to move downwards and it compresses the web for 10min.After 10min by using the handle top jaw is lifted and mould is removed from the bottom jaw. And then water is sprayed on to the surface of the mould for cooling. After that the composite is removed from the mould. Finally, the composites are produced. The process parameters chosen for this work is shown in table 1.

Fiber Materials	- chicken feathers
Resin used	- Polypropylene
Polypropylene +CF Wt %	- 90+10,80+20,70+30
Temperature	- 180° C
Time	- 3 Min.
Pressure	- 15 bar
Composite Production Method	- Fiber Reinforced Composites (FRC)

Table 1: Process Parameters for composite manufacturing

This composite manufacturing process consists of four stages,

Step 1: Silica gel is coated on the mould and the randomly arranged CF in to fibrous webs of (250mm X 250mmWith thickness 3mm) is placed on the bottom plate of the mould and kept between the bottom jaws of compression moulding machine.

Fig. 3: Web placed on mould

Step 2: Top plate of the mould also coated with silica gel and placed over the fibrous webs and the parameters are optimized.

Step 3: Compression moulding machine starts and the composite is compressed for about 10min with 10 bar Pressure of about 180° C.

Step 4: Finally the composite is removed from the machine and it is cooled for about 15min and composite is detached from the mould plates.

Fig. 4: Chicken feather Composite Board

IV. TENSILE TEST (ASTM D638-03)

The composites were conditioned in a standard testing atmosphere of 21 °C and 65% relative humidity for at least 25 hours before testing. Fix the Sample in between two jaws and bottom jaw is movable one. After the sample is fixed the bottom jaw is moving at the principle of constant rate of loading (CRL). The tensile tester shows the data in Breaking Load in Newton and Elongation at Break.

Sample Size

The sample size for testing the tensile strength is following

- Length - 150 mm
- Width - 19 mm

V. RESULTS AND DISCUSSION

A. Tensile Strength of Composite:

The composites are subjected to tensile test to determine the tensile strength. Table 2 shows the Results of tensile strength properties of chicken feather composites.

Sample	Proportion	Mean tensile stress (MPa)	Mean tensile strain (%)

1	90/10	4.29	3.00
2	80/20	6.79	3.5
3	70/30	8.04	2.59

Table 2: Results for Tensile Strength of chicken feather Composite

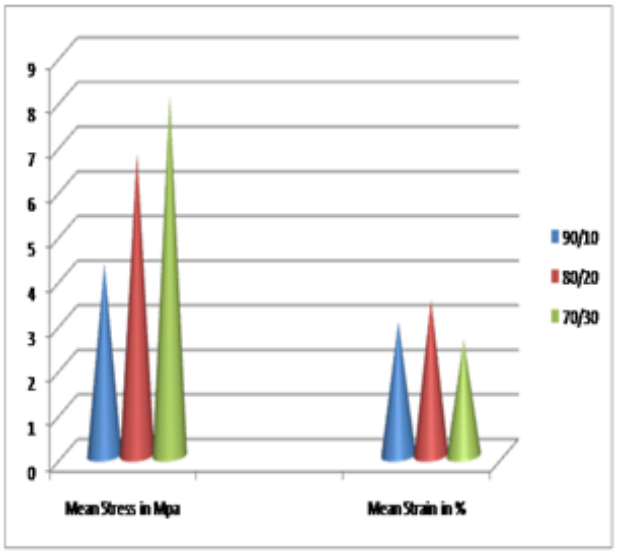

Fig. 5: Results for Tensile Strength of Composite

In figure 5 it was observed that combination 70/30 resin/reinforcement shows better results for tensile strength. When the percentage of polypropylene increases, tensile strength reduced. The proportion between polypropylene and chicken feather should be matched. The higher the proportion of CF increases the tensile strength of composite board. So in order to increase the strength, proportion of CF should be increased.

B. Sem Tensile Fraction Analysis of Chicken Feather Composite Board:

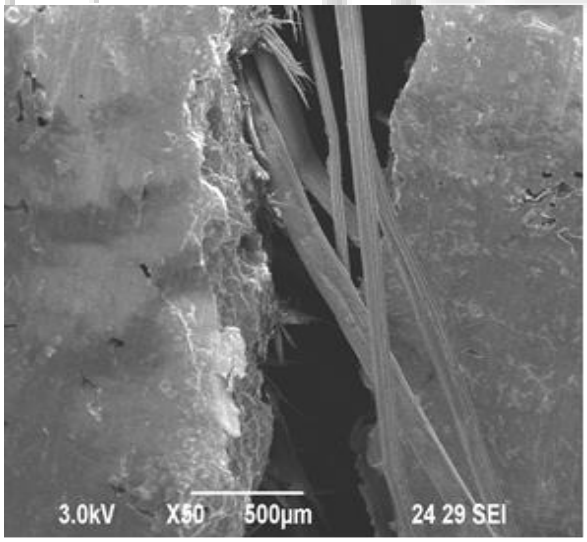

Fig. 6: SEM Image of Fracture surface of tensile strength of composite board

The surfaces of the composite specimens are examined directly by scanning electron microscope. The image shows that significant decrease in tensile strength. The interfacial adhesion between CF reinforced polypropylene composite material is poor. Fiber pull out occurrence was observed in the sample. Some voids between CF and matrix were clearly found from this image.

Tensile Failure

Tensile failure analysis shows that

- Severe damage introduced on the composite board.
- Failure path is shows higher. It increases the damage size.

VI. CONCLUSION

Chicken feather are lighter than many of the other natural and manmade fibers result in lighter composite materials. Morphological characteristics indicate that the feathers have the suitable conditions to act as reinforcement.

The tensile property of the chicken feather reinforced composites was determined. It was found that 70/30 proportion increases the strength of composite board. Thus the utilization of the cheaper goods and applying it in a high performance application is possible with the help of this composite technology.

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