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Mechanical Characterization of Corn Fiber-Polypropylene Reinforced Composites at Different Fiber Weight FractionsEnriched UsingMaleic Anhydride Grafted Polypropylene

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Abstract:-The demand for high strength and less weight materials has been increased more particularly in aircraft and automobile industry. Even though various advanced high strength materials and composites have been emerged still this area has a key focus among the researchers due to its high demand in the industry. Considering the economical aspect and without compromising the strength various researchers has given attention towards the usage of Natural fibersfor composite laminates due to their ease of availability and sustainability. This paper focus on Corn Fiber reinforced Polypropylene Composites areproduced by adding fibers at different weight fractions as 5, 10, 15, 20 and 25 percentage to the weight of the matrix.0.5 % of Maleic Anhydride Grafted Polypropylene isusedas an intermittent connection layer for enriching the composite properties.Mechanical testing such as tensile, bending and impact were also carried out to ensure the mechanical strength of the specimen.

Keywords*: Natural Fiber, Corn Fiber, Polypropylene, Mechanical Properties.*

1. Introduction:

The practice of using natural products has been increased in recent years moreover in all fields. The concern about the environment and awareness about the shortcomings of using high toxic artificial products led to this development. Metal manufacturing industry is not an exemption to this. Researchers focus on developing new materials using natural products without compromising strength. As a part of this various bio based composite materials has been evolved. Factors such as low cost, high stiffness, non-corrosive are added advantages. Considering these factors an attempt was made to manufacture composite laminates using Corn Fiberand Polypropylene as the components. Maleic Anhydride Grafted Polypropylene is also added for enriching laminate properties. The research has been further extended such that Corn Fiber reinforced Polypropylene Composites were produced by adding fibers at different weight fractions as 5, 10, 15, 20 and 25 percentage to the weight of the matrix. Hydraulic InjectionMoulding Machine is used to manufacture composite laminates. Test specimens are made readyas per ASTM standards and tested for mechanical properties like tensile, bending and impact strength were found for laminates with MAPP.

2. Literature Review

The following literatures prevails that natural fiber plays an important role in composite manufacturing composites especially for aircraft and automobile industries. Also the addition of an interface material will further increase the mechanical properties. In recent years various researchers has given considerable attention for the adoption of natural fibers like natural jute, sisal, banana fibers, flax fibers and corn fibers.

Mohanty et al [1] made research on sustainable bio composites and suggested natural fibers such as flux, jute, hemp, banana fiber, corn fiber etc. can be used alternately for composite manufacturing so that the cost can be considerably reduced. NabiSaheb et al. [2] compared the the mechanical properties of various natural fibers with glass fibers and found that the specific moduli of natural fibers are very good than the glass fibers. Myrtha Karina et al. [3] determined the mechanical properties of various natural fiber composites reinforced with polypropylene. Amirhossein Esfandiari [4] found the mechanical properties of flax and glass fiber composites reinforced with polypropylene. The distribution of fiber size and fiber diameter was also considered in this research. Mehdi Tajvidi et al. [5] compared the dynamic mechanical properties of pure plastic with composites made of natural fibers and polypropylene. In this research two sets of laminates were made with 25% and 50% of fibers. Smitamohanty et al. [6] made research on composites made usinng sisal fiber reinforced with polypropylene. Fiber loading and fiber treatment time were considered during the estimation of mechanical properties of the composites. Abu-Sharkh et al. [7] carried research on composite laminates made using palm fibers and polypropylene. 1% MAAP is also added with this composition and the material experiences good mechanical strength. Shinoj et al.[8] suggested that the use of large amount of fiber content will improve the tensile properties to a great extent. Arbelaiz et al. [9] investigated the mechanical behaviour of flax fiber composites reinforced with polypropylene and conclude that matrix leads to better mechanical properties than fiber. Fung et al.[10] investigated and concluded that by using Maleic anhydride-polypropylene copolymer the composite has become more effective. Al-Oqla et al. [11] examined the possessionsof jute and plastic composites in accumulation to their appropriateness to the automotive and aircraft industry for making composite components. Mechanical Properties of Natural Fibre Mat with Fibre Composites were studied by P H V Sesha Talpa Sai et al.[12] due to their advantages of low weight , non-toxicity and abrasion resistance and also they are biodegradable and available at low cost. They reported that the tensile strength in the epoxy-reinforced compound was maximum as 14 MPa and flex strength was 131.25 MPa. They also reported sisal showed higher resistance of 58 HRB compared to other fibers.

3. Experiment

3.1 Materials

The fiber used for this study is available in nature and is extracted from corn. The culms of corn stem were collected and their bottom and the leaves at the hubs and bottom of the culms were cut. The culms were dried out for a time of about a month.The strips are exposed to a manual procedure, by beating them delicately with a plastic hammer so as to remove the fiber. Later the filaments are kept in anelectric oven at a temperature of 800^{o} C for 2 hours to evacuate the moisture contents. Polypropylene is used as the matrix material for the preparation of composite laminates. Maleic Anhydride Grafted Polypropylene is used as an interface joining agent.

3.2 Composite Preparation

Composite laminates are prepared with the processed corn fiber, polypropylene and MAPP using Injection moulding machine which is shown in Figure 1. Corn Fiber reinforced Polypropylene Composites are produced by adding fibers at different weight fractions as 5, 10, 15, 20 and 25 percentage to the weight of the matrix. 0.5 % of Maleic Anhydride Grafted Polypropylene is added as an intermittent coupling layer for enriching the composite properties.

Figure 1: Injection Moulding machine

3.3Specimen Preparation

Tensile, bending and impact test are performed to find the mechanical strength of composite laminates. Specimens are prepared using ASTM-D638M for tensile test, ASTM D790M 86 for bending test and ASTM D256M for impact test.5 specimens are prepared for each weight fraction and are tested. The cut specimens for tensile, bending and impact test are shown in Figure 2.

Figure 2: Specimens for Tensile, Bending and Impact test

4. Results and Discussion

4.1 Tensile Strength

A 2 ton Electronic tensometer is used to find the tensile strength of the specimen. A load cell of 2000 Kg is used for the present study. The results of the tensile test are plotted below in Figure 3-8.

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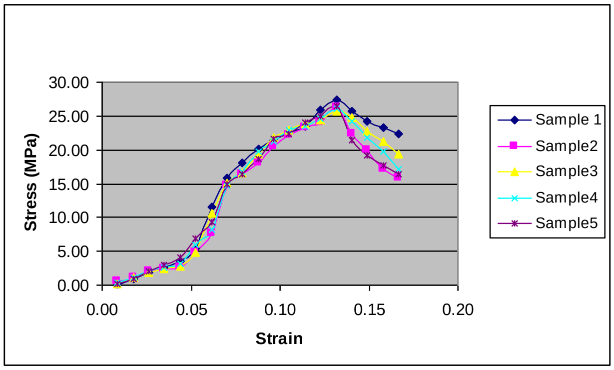


Figure 3: Stress Vs Strain at 5 % fiber weight

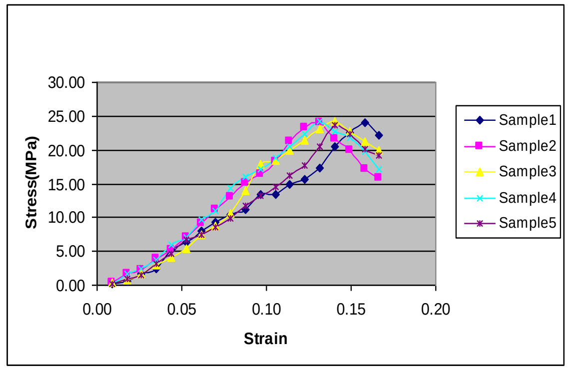


Figure 4: Stress Vs Strain at 10 % fiber weight

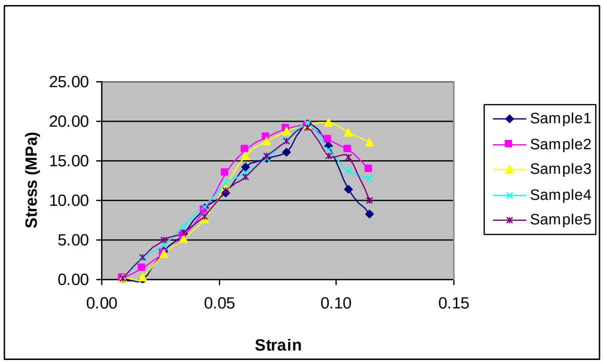


Figure 5: Stress Vs Strain at 15 % fiber weight

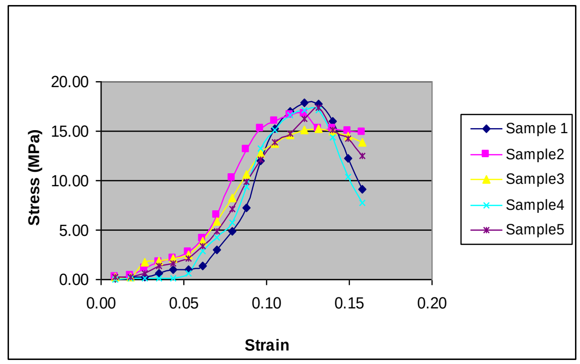


Figure 6: Stress Vs Strain at 20 % fiber weight

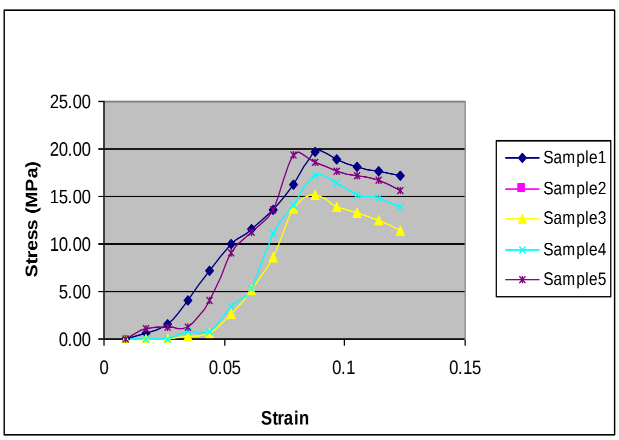


Figure 7: Stress Vs Strain at 25 % fiber weight

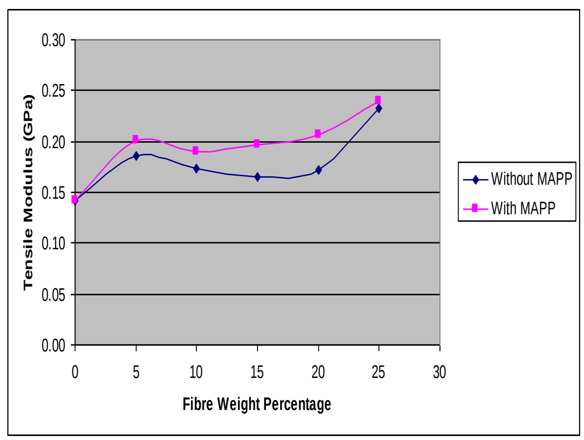


Figure 8: Tensile Modulus Vs fiber weight

Figure 3, Figure 4, Figure 5, Figure 6 and Figure 7 shows the Stress Vs Strain at different values of fiber weight such as 5%, 10%, 15%, 20% and 25%. The maximum obtained tensile strength of the Corn composite is 26.35 MPa and it occurs at 5% fiber weight percentage. Therefore at upper weight percentages of fiber the tensile strength becomes reduced. Figure 8 shows the Tensile Modulus Vs fiber weight. The maximum value for Tensile Modulusoccurs at 25% fibre weight percentage with and without MAPP. The maximum value for Tensile Modulus with MAPP is 0.24 Gpa.

4.2 BendingStrength

Three point bend tests are performed in the test samples as per ASTM D790 M86 and the results are plotted below.

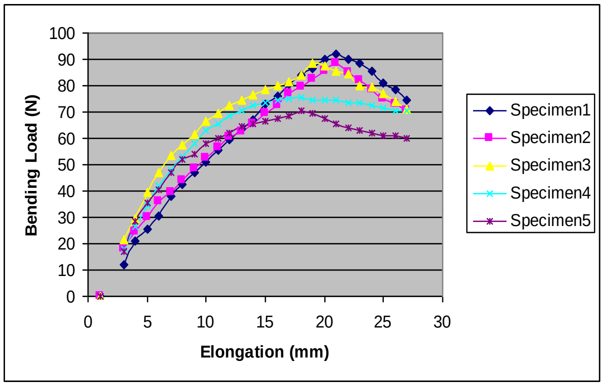


Figure 9: Load Vs Elongation at 5% fiber

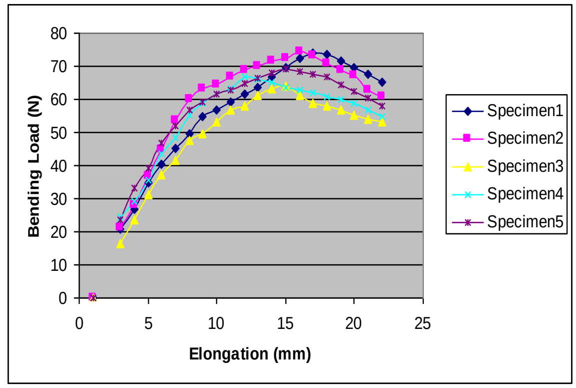


Figure 10: LoadVs Elongation at 10% fiber

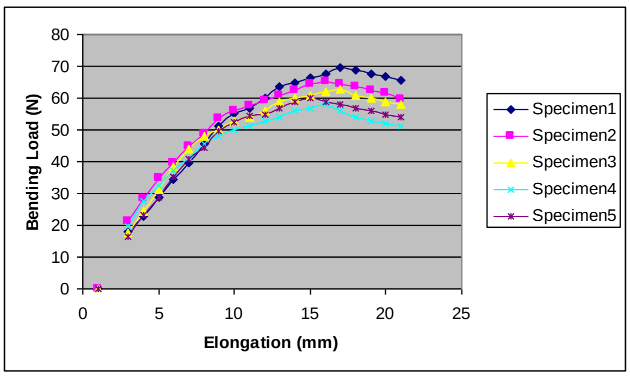


Figure 11:LoadVs Elongation at 15% fiber

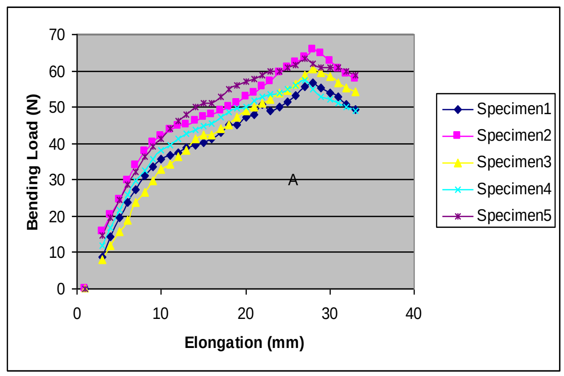
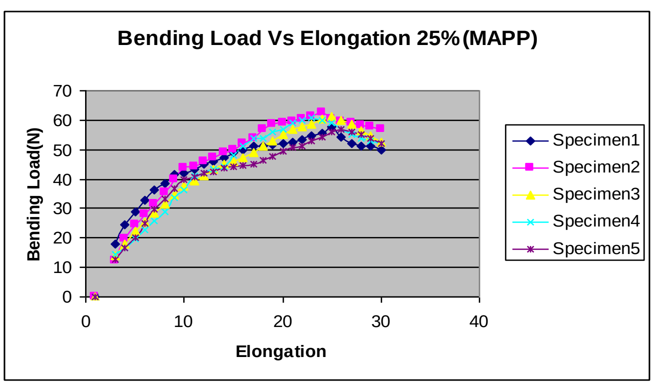


Figure 12:Load Vs Elongation at 20% fiber



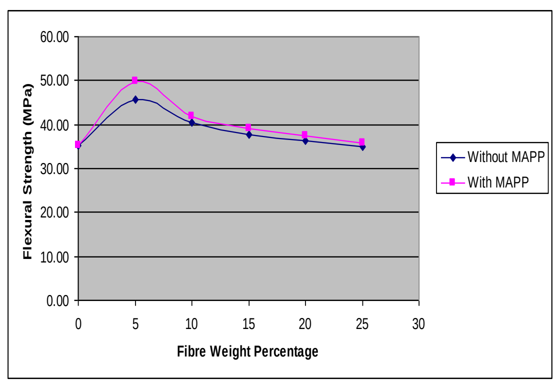


Figure 13: Load Vs Elongation at 25% fiberFigure 14:Flexural strength Vs fiber weight

Figure 9, Figure 10, Figure 11, Figure 12 and Figure 13 shows the Bending load Vs elongation values at different fiber weights. It is observed that for MAPP added composite the maximum flexural strength occurs at 5% and is 49.82 MPa. Further increase in fiber will decrease the flexural strength value. Figure 14 the Flexural strength Vs fiber weight for with and without MAPP. The maximum flexural modulus of the corn fiber composite occurs at 5% for both with and without MAPP and the value is 1.29 GPa for MAPP added composite.

4.2 Impact Energy

Impact test is performed by using an analog Izod/charpy impact tester and the results are plotted below in Figure 15.

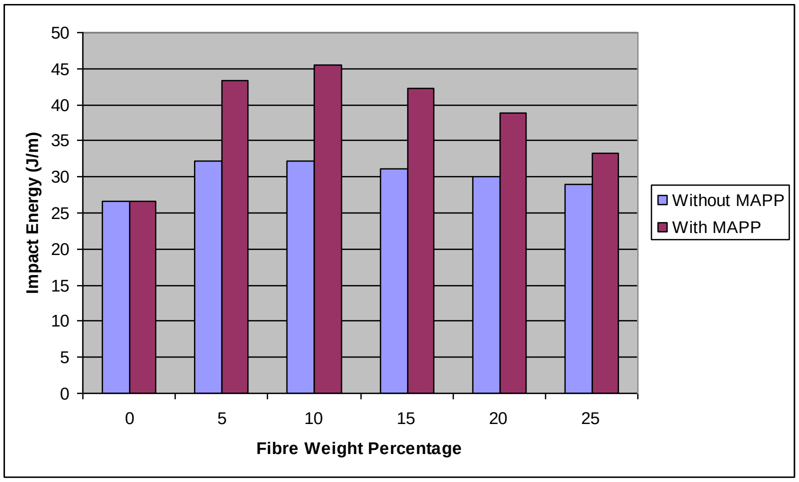


Figure 15: Impact Energy Vs Fiber weight percentages

The maximum Impact strength of the corn composite without MAPP occurs at 5% and the value is 32.2 J/m. For MAPP added composite the maximum impact energy occurs at 10% and is 45.6J/m.

5. Conclusion

This paper describes the chance of using the Corn fiber which is richly accessible at low cost. It is found that the addition of high percentage of fiber leads in reduction of strength however the addition of a least percentage of corn fiber with propylene matrix has brought down good improvements in the result. The accompanying ends are made based on the above examination. The idea of consolidating Corn fiber into the polypropylene matrix comes about a reasonableenhancement in the tensile, bending and impact strength.

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