APPLICATION OF GREEN COMPOSITES IN STRUCTURAL UPGRADATION

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ABSTRACT

This paper is mainly focused on partially eco-friendly hybrid fibre reinforced thermo plastics with natural fibres to enhance the desired mechanical properties. These natural fibres are easily available, economical and is completely degradable thus posing no harm to the environment. The best way to reduce the weight of an automobile without sacrificing its safety is to employ fibre reinforced composite material in place of heavy metallic bodies. It helps in enhancing the fuel efficiency and thereby helps in the conservation of continuously depleting fossil fuels. Fibres like Banana (Musa indica) and Sisal (Agave sisalana) were used in making the composites. Based on experimental results, these composites are good replacement for the existing components in the automotive industries in the near future and thus serve as an innovative technology for the sustainable future.

Keywords—Natural Fibres, Polymers, Composites, Tensile, Flexural, DMA.

INTRODUCTION

The development of the natural fiber-reinforced composites is rapid due to their mechanical properties, low cost, processing advantages and low density. The performance of the these composites mainly depends on the fiber matrix and the ability to transfer the load from the matrix to the fiber. Natural fiber composites such as hemp fiber-epoxy, flax fiber-polypropylene (PP), and china reed fiber-PP are the most attractive in case of automotive applications because of their lower cost and lower density. Usually, Glass fibers used in composites have a density of 2.6 g/cm³ and cost between $1.30 and $2.00/kg. In comparison, natural flax fibers have a density of 1.5 g/cm³ and cost between $0.22 and $1.10/kg. Traditionally, natural fibres have been used to fill and reinforce thermosets, but as of now, natural fibre reinforced thermoplastics, especially polypropylene composites, have got a greater attention due to their added advantage of recyclability.

For fuel efficiency to be achieved, the weight reduction plays a vital role in automobiles. Due to safety considerations, the reduction of weight should be achieved without hampering the mechanical properties of the traditional materials. With the introduction of the automotive safety legislation, crash worthiness and safety should be considered as pre conditions in light weightening the beam. Nowadays, Thermo plastics composites are being used in variety of applications such as mass transit, automotive and military structures. They have an edge over traditional materials such as steel and aluminum. Due to their high specific strength, good damping capacity and corrosion resistance, long fibre composites are usually preferred. The matrix in thermo plastic composites is generally comprised of poly propylene (PP), poly ethylene (PE), nylon or other inexpensive polymers.

MATERIALS AND METHODS

Step 1: Extraction of Fibres: The natural fibres - banana and sisal were selected owing to its easy availability, mechanical properties and low cost. The plant sections were cut from the main stem of the plant and then rolled tightly to remove the excess moisture. Impurities in the rolled fibres such as pigments, broken fibres, coating of cellulose etc., were removed manually by means of a comb. Finally, the fibres were cleaned and dried. (Fig. 1 [A])

Step 2: Alkali treatment: The ratio of the strength of chemically treated kenaf fibre to natural kenaf fibre was found to be far superior. Chemical treatment of natural fibre with NaOH shows favourable increase in the strength of the fibres due to the crystalline cellulose that gets dissolved in it, which increases the lignin content of the fibre. Other advantages of the treatment are cleaner fibre surface and weight reduction (by 8-15%).

Step 3: Polymer selection: Polypropylene (PP) or poly-propene is reasonably economical, has a good resistance to fatigue, higher flow rate and hence will fill the plastic mould more easily during the injection process. Maleic anhydride (cis-butenedioic anhydride, toxilic anhydride, 2, 5-dioxofuran) is an organic compound with the formula C₄H₂(CO)₂O. It is referred to as MAPP. They are used as coupling agent in order to improve the affinity and adhesion between natural fibers and thermoplastic matrices.

Step 4: Specimen preparation: The specimens have been separated into four types, to analyse the effect of the length of the fibre on its mechanical properties. The fibres are divided into two types, Particulate (less than 1 mm size) and Short (1-3 mm size). The Composition of 87% PP + 3%MAPP + 13% fibres was being used in all specimens. ‘BP’ refers to Banana fibres with particulate size and ‘BS’ refers to Banana fibres with short size. Similarly, ‘SP’ refers to Sisal fibres with particulate size and ‘SS’ refers to Sisal fibres with short size.

Step 5: Composite Making: Twin screw extrusion is used extensively for mixing, compounding, or reacting of polymeric materials. The samples are fed into the Hopper of the extruder and separately extruded into thin wires. (Fig. 1 [B]). After drying, they are palletized. Then, they are fed into the injection moulding machine, and with separate dies for tensile and flexural tests, the specimens for tests are obtained. (Fig. 1 [C])

RESULTS

Tensile strength test: Specimens were prepared according to ASTM standards (ASTM D 638-03), TYPE I [9]. Using an electronic tensile testing machine with cross head speed of 5mm/min, and a gauge length of 50mm, the tensile modulus and elongation at break were calculated. From the test results, it has been found that sample ‘SP’ has greater tensile strength and has the maximum peak load. (Fig. 2[A])
Flexural strength test: 3-point bending method was used for this test. Samples of ASTM D 790-03 standard [10], were tested using the Lloyd instrument LR 100 KN, at 28°C with 48±2% RH and a cross head of 1mm/min. The specimen dimensions are 127x12.7x5 mm. The flexural modulus was calculated from the slope of the initial portion of the load deflection curve. From the test results, it again concluded that sample ‘SP’ has the greatest flexural force. (Fig. 2[D])

Dynamic Mechanical Analysis test (DMA): The test was carried out in a universal V4.5A TA instrument of model TA Q800 with a temperature range of -150 to 600°C and a frequency range of 1-20 Hz. The specimens were made with dimensions of 30x125x3 mm. The test was performed under isochronal environment at 1Hz with a temperature variation of 30°C and 135°C at a rate of 3°C/min. From the test results, it has been found that Storage moduli of the short fibres (BS&SS) was greater than the one present in the particulate fibres (BP&SP). (Fig. 3[A], 3[B])

**Fig.1 Preparation of specimens:** [A]-collection, drying and cutting of fibres [B]- Extrusion into wires [C]- Specimen preparation after injection moulding

**Fig.2 Comparison of** {A} Tensile strength, {B} Peak load from tensile test, {C} Flexural strength and {D} Maximum force from flexural test

**Fig.3 Comparison of results from DMA test** [A]- Storage moduli [B]- Loss moduli

**CONCLUSION**

From the tests done, it is concluded that, of both banana and sisal taken, sisal is found to be superior. And also, when the fibres are cut into particulate form, rather than short type, due to its increased bonding with resins, the strength further increases. The potential areas of use of our composites in automobiles are, car dash board, cam cover, engine oil filter etc.,

**REFERENCES**


