MECHANICAL CHARACTERIZATION OF CITRUS LIMETTA PARTICULATE REINFORCED POLYESTER COMPOSITES

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Abstract
Over the last Century, natural filler and fiber materials are emerging as suitable alternatives to synthetic materials for reinforcing polymers such as polyester due to their environmental friendliness, high abundance, renewability, and cost-effectiveness. In the present study, mechanical properties are investigated for particulate reinforced composites. For this purpose, citrus limetta and polyester resin are selected and fabricated by using hand layup technique. The fabrication of composite is carried out by varying weight fraction of citrus limetta particulate with 0%, 10%, 20% and 30% of composites. Tensile and flexural properties of the composites are evaluated by using the universal testing machine and as per ASTM standards (ASTM D638 for tensile testing & ASTM D790 for flexural testing). The paper signifies outcome as the tensile strength and tensile modulus of the composites decrease gradually with increase in weight fraction of citrus limetta particulate; the flexural strength and flexural modulus of the composites increase gradually up to 20% weight fraction of citrus limetta particulate then decreases with increase in weight fraction of citrus limetta particulate.

Index Terms: Citrus-limetta Particulate, Fabrication of Composites, Flexural properties, Polyester resin, Tensile properties.

I. INTRODUCTION

Composites are becoming an essential part of today's materials because they offer advantages such as low weight, corrosion resistance, high fatigue strength, faster assembly, etc. Composite materials are classified into three categories: particulate composites, flake composites and fiber composites as per the reinforcement arrangement in matrix [1]. Fig. 1 shows the structure of particulate composites. Fig. 2 shows the structure of flake composites and Fig. 3 shows the structure of fiber composites.

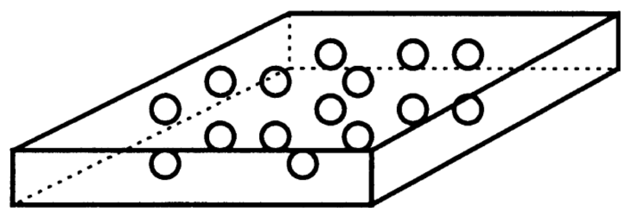

Fig. 1 Particulate composites

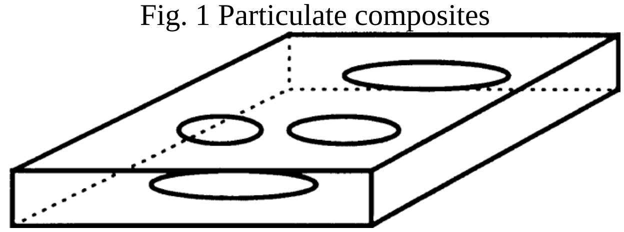

Fig. 2 Flake composites

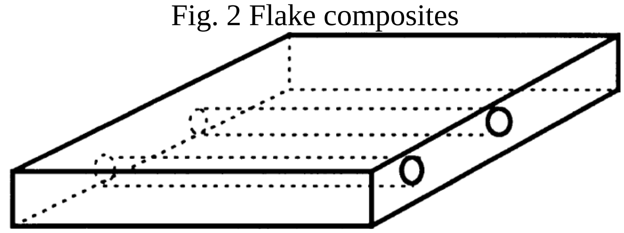

Fig. 3 Fiber composites

Many Researcher focused on filler and fiber reinforced composites and evaluated the mechanical properties of composites [2]-[22]. In the present study, an attempt is carried out for the particulates as a reinforcement in composites and evaluated characterization data for particulate reinforced composites. For this purpose, citrus limetta was procured and distorted into the particulates. Fabrication of citrus limetta and polyester is carried out by hand layup technique. Fabrication is carried out by varying the weight fraction of citrus limetta particulate. Tensile testing and flexural testing are examined and evaluated tensile and flexural properties.

II. MATERIALS AND METHODS

Citrus limetta was procured from the local market of Anand, Gujarat, India. Citrus limetta is selected for the study due to its easy availability from the market. Citrus limetta was procured in fresh condition as per the fig 4. The peels of the citrus limetta were removed and dried under sunlight for 5 days as shown in fig. 5. The crushing of the citrus limetta peel was carried out and converted into the particulates as shown in fig 6. The polyester resin was procured from the local market of Vallabh vidhyanagar, Gujarat, India. Hardener (MEKP) and accelerator (Cobalt) was procured from the local market of Vallabh Vidyanagar, Gujarat, India.

The fabrication of citrus limetta particulate reinforced in polyester resin composites was carried out using hand layup technique as shown in fig. 7. Hardner and accelerator were used to initiate the curing process during the fabrication of composites. The curing process was carried out for 24 hours at room temperature. Four composites plates are prepared by varying the weight fraction of citrus limetta particulate as per table I. A sample composite plate has a weight fraction of citrus limetta particulate of 30%, is shown in fig. 8.

Table I Specifications of Composites Plates.

Composites Plates	The weight fraction of Filler (%)	The weight fraction of Resin (%)
1	0	100
2	10	90
3	20	80
4	30	70


Fig. 4 Fresh citrus limetta


Fig. 5 Dried citrus limetta peel


Fig. 6 Citrus limetta particulate


Fig. 7. Fabrication of citrus limetta particulate reinforced composites.


Fig. 8. A sample composites plate (weight fraction of citrus limetta particulate - 30%)

The tensile and flexural properties of citrus limetta/ polyester composites were evaluated by performing tensile and flexural testing on the universal testing machine (Make: TINIUS OLSEN, Model: H50KL). Tensile testing of citrus limetta/ polyester composites was carried out as per ASTM D638 as shown in fig. 9 and Flexural testing of citrus limetta/ polyester composites was carried out as per ASTM D790 as shown in fig. 10. Here, the tensile properties: tensile strength and tensile modulus of composites are evaluated with varying the weight fraction of citrus limetta particulate and flexural properties: flexural strength and flexural modulus of composites are also evaluated with varying the weight fraction of citrus limetta particulate.

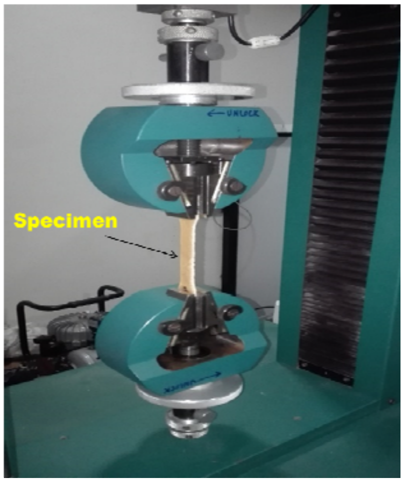

Fig. 9 Tensile testing setup

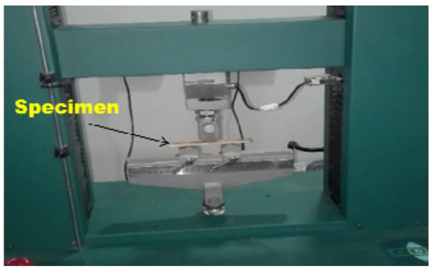

Fig. 10 Flexural testing setup

III. RESULTS AND DISCUSSION

The results through the tensile and flexural testing are shown and discussed below. The average of five specimens is evaluated as a result as per ASTM D638 and ASTM D790. The tensile testing results are shown in fig. 11 and fig. 12.

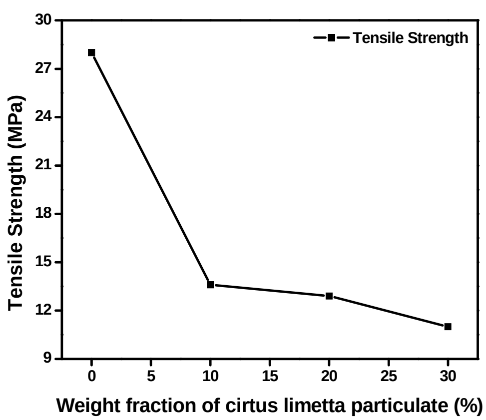

Fig. 11 Results of tensile testing of citrus limetta particulate reinforced composites.

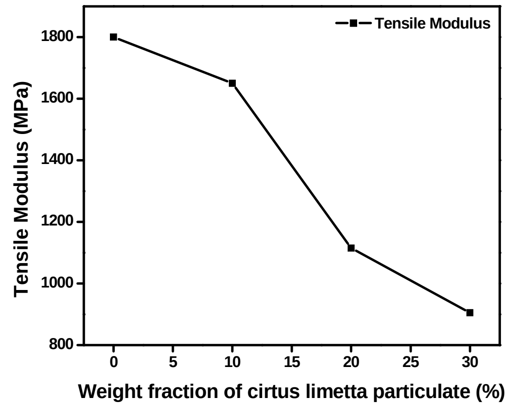

Fig. 12 Results of tensile modulus of citrus limetta particulate reinforced composites.

From fig. 11, it is observed that the tensile strength decreases with increase in weight fraction of citrus limetta particulate. From fig. 12, it is observed that the tensile modulus also decreases with increase in weight fraction of citrus limetta particulate. It may be occurred due to the cracks are formed and propagated at the interface/interphase. Interface/ Interphase is engendered on the surface of citrus limetta particulate and inside of matrix during the curing process.

The flexural testing results are shown in fig. 13 and fig. 14.

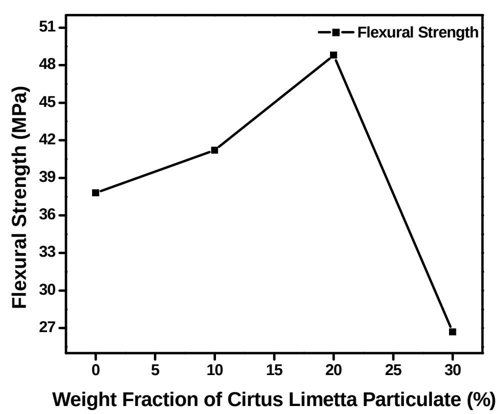

Fig. 13 Results of flexural testing of citrus limetta particulate reinforced composites.

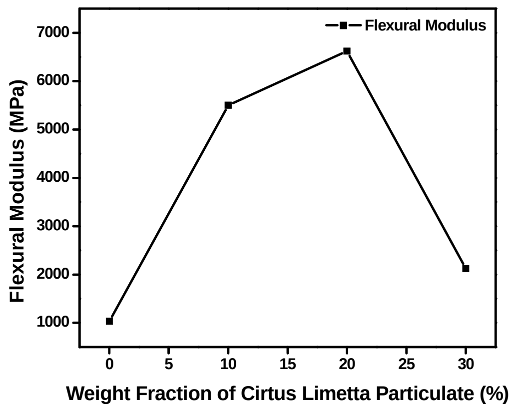

Fig. 14 Results of flexural modulus of citrus limetta particulate reinforced composites.

From fig. 13, it is observed that the flexural strength increases with increase in weight fraction of citrus limetta particulate up to 20% and then decrease with increase in weight fraction of citrus limetta particulate. From fig. 14, it is observed that the flexural modulus also increases with increase in weight fraction of citrus limetta particulate up to 20% and then decrease with increase in weight fraction of citrus limetta particulate. It may be occured because polyester resin is a brittle material and with adding citrus limetta particulates up to 20%, particulates are distributed in composites uniformly and formed interface/interphase on particulates properly. After 20% the particulates are closed to each other and generated interface/interphase intersect with each other. So, proper bonding is not achieved with an increase in weight fraction of citrus limetta particulates after 20% of weight fraction of particulates and failure occurred due to poor bonding. Hence, with an increase in weight fraction of particulates from 0% to 20%, flexural strength and flexural modulus increases gradually and after 20% weight fraction of citrus limetta particulates, the flexural strength decreases gradually.

IV. CONCLUSIONS

The following significant outcomes are concluded through the present study.

1. Particulate reduces the tensile strength of composites. To achieve good tensile properties in composites, particular can be used as a filler material with the combination of fiber in the fabrication of composites.
2. The weight fraction of citrus limetta particulate is suggested 20% of the weight of composites for achieving good flexural properties in composites.

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