EFFECT OF FIBRE LOADING ON THE FLEXURAL PROPERTIES OF NATURAL FIBRE REINFORCED POLYMER COMPOSITES

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Keywords: Pineapple leaf fibres; natural fibre reinforced composites; mechanical properties

Abstract

The use of pineapple leaf fibres as reinforcement in plastics had increased rapidly in past few years. Thus this project was conducted to determine and compare the flexural strength of pure epoxy and pineapple leaf fibres reinforced epoxy. The natural fibres were mixed with epoxy and hardener by weight percentage fibre content. The process employed to fabricate the specimens was hand lay-up and the natural fibres was oriented randomly. The dimensions of the specimens for flexure test were based on ASTM D790 respectively. The results obtained shows that 15% PALF reinforced epoxy composite achieved the highest flexural strength among the natural fibers reinforced epoxy composites.

Introduction

The study of composite of pineapple leaf is still very rare. Fibrous plant such as pineapple are available in abundant in tropical countries like Malaysia. In this study the effect of fiber loading on the flexural properties of pineapple leaf reinforced polymer composite will be examined. These natural fibers are less health risk, low cost, renewable, biodegradable, low density, relatively low wear compared to synthetic fiber [1].

From the reference it can be seen that the pineapple leaf fiber has good tensile strength and young modulus compared to other natural fibers. However the study of composite of pineapple leaf is still very rare. Fibrous plant such as pineapple are available in abundant in tropical countries like Malaysia. [2].

Methodology

Preparation of materials

Materials used were pineapple leaf which was harvested, cleaned, washed, and soaked into water. Then the leaf was left to dry under the sunlight. The pineapple leaf was then hand scrapped and grinded using grinder machine. Later the grinded fibres were sieved using sieve shaker and fibres with size of 0.5mm-1.0 mm were taken for experiment as it was the highest size fraction sieved. The fibres were placed into vacuum oven at the temperature of 80^{o}C for 24 hours before the experiment.

Fabrication of Specimen

Hand lay-up process is the simplest technique for used to make small amount of volume of composite structure. Fibres are laid on a form and liquid resin is added and distributed randomly throughout the fibres by hand rolling. After the desired thickness is obtained, the product is allowed to cure, either in an oven or at room temperature [3].

The mould was prepared with the dimension of 135 mm (L) x 127 mm (W) x 4 mm (T). The matrix was prepared according to the Table 2

Table 2
Epoxy resin and PALF mixture by weight fraction

Epoxy Resin/PALF Mixture	PALF	Epoxy Resin
Pure epoxy plate	0%	100%
5% PALF reinforced epoxy composite plate	5%	95%
10% PALF reinforced epoxy composite plate	10%	90%
15% PALF reinforced epoxy composite plate	15%	85%
20% PALF reinforced epoxy composite plate	20%	80%

Resistant was sprayed to coat the inner surface of the mould. It is used to prevent sticking of the composite plate to the mould surface. The weighted natural fibres were randomly distributed at the bottom of the mould. The natural fibres were later covered by the weighted matrix evenly. The composite was allowed to cure at room temperature.

Each composite plate was cut into specimen size based on ASTM D790 dimensione which is 4 mm (T) x 12.7 mm (W) x 127 mm (L). The cutting process was done by using hand saw.

Testing

The flexural test was conducted to determine the flexural strength of the composites. INSTRON Universal Testing Machine was used to perform the flexural test by applying the 3 point bending method according to ASTM D790. Seven specimens were tested for each type of composite and the best five specimens were selected for data analyze.The specimens were tested at span length of 50mm and crosshead speed of 1 mm/min.

RESULTS AND DISCUSSIONS

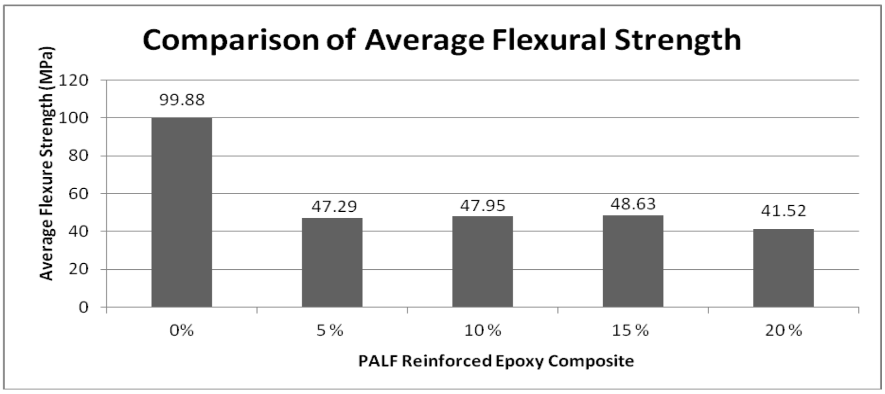

Fig. 1. Comparison of flexural strength of pure epoxy with natural fibres reinforced epoxy composites.

The Fig. 1 illustrates that the pure epoxy obtained flexural strength of 99.88 MPa. The 15% PALF reinforced epoxy composite achieved the highest flexural strength among the natural fibers reinforced epoxy composite which was 48.63 MPa , while the 20% PALF reinforced epoxy composite achieved the lowest flexural strength which was 41.52 MPa. Meanwhile the 10% PALF reinforced epoxy composite achieved 47.95 MPa followed by 5% PALF reinforced epoxy composite which was 47.29 MPa

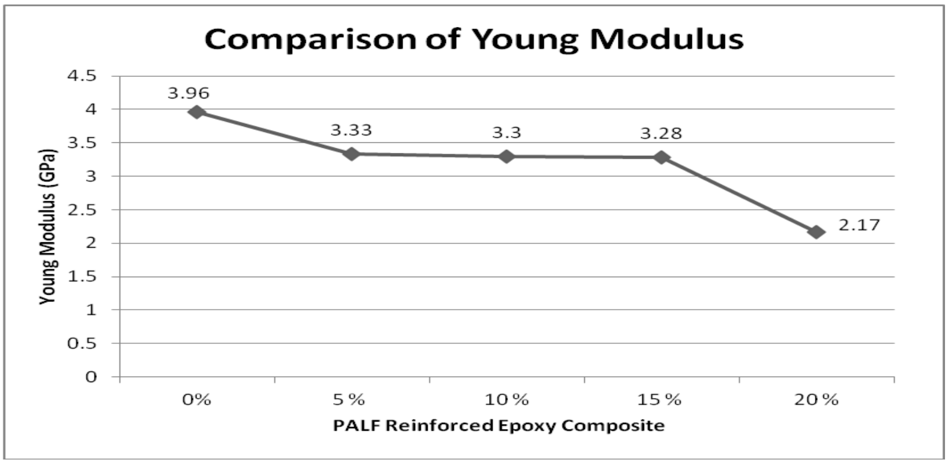

Fig. 2. Comparison of young modulus of pure epoxy with natural fibres reinforced epoxy composites.

The Fig. 2 shows that the values vary in descending order where the pure epoxy which achieved 3.96 GPa followed by 5% PALF which achieved the highest young modulus among the natural fibers reinforced epoxy composites which obtained 3.33 GPa and 10% PALF which attained 3.30 GPa whereas the 15% PALF acquired 3.28 GPa and the lowest young modulus was achieved by 20% PALF which procured 2.17 GPa.

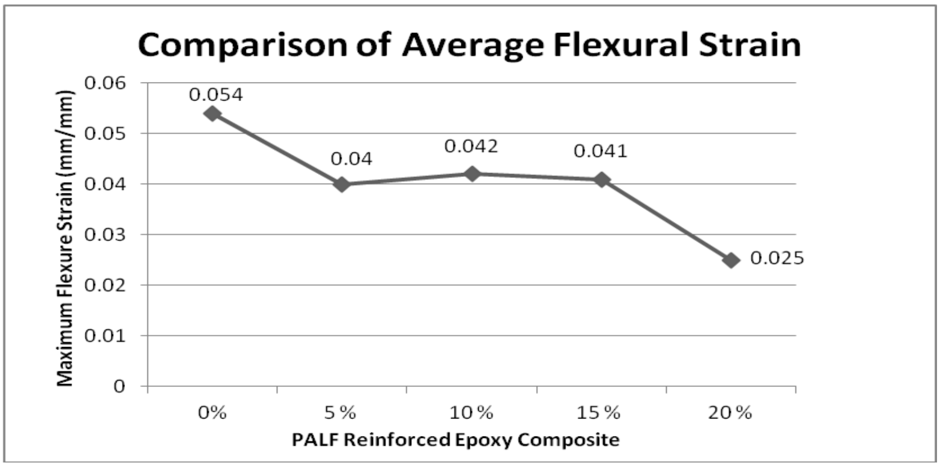

Fig. 3. Comparison of maximum flexure strain of pure epoxy with natural fibres reinforced epoxy composites.

From the Fig. 3, it was observed that pure epoxy achieved flexure strain which recorded 0.054 mm/mm followed by a decrease to 0.04 mm/mm by 5% PALF. The highest flexure strain among the natural fibers reinforced epoxy composites was achieved by 10% PALF which achieved 0.042 mm/mm before having a slight decrease at 15% PALF which acquired 0.041 mm/mm. The maximum flexure strain had a decrease again at 20% PALF which attained the lowest maximum flexure strain among all composite which was 0.025 mm/mm.

CONCLUSION

The results obtained shows that the 15% PALF reinforced epoxy composite shows better flexural strength than 10% PALF reinforced epoxy composite and 5% PALF reinforced epoxy composite. 20% PALF reinforced epoxy composite does not exhibit any extraordinary strength in flexural strength.

The cause of lower flexural strength of PALF reinforced epoxy was not in the scope of the project. From the literature research [2], it was suggested that the cause of lower flexural strength of PALF reinforced epoxy composites might be due to:

a. Poor bonding between matrix and fibres

b. Poor wetting of fibres in matrix at lower fibre content

c. Dryness and age of fibres used

The flexural strength obtained was greatly influenced by the specimen preparation. The process employed to prepare the specimen has a significant effect. For example compression moulding generally yields higher flexural strength compared with hand lay-up method. Cutting process usually lowers the flexural strength because of small irregularities introduced into the specimen.

Theoretically, the epoxy matrix transmits and distributes the applied stress to the natural fibres. Therefore, the natural fibres reinforced composite suppose can sustain higher load before failure compared to the pure epoxy.

The authors studied the effect of fibre loading on the mechanical properties of PALF-polypropylene composite. The result showed decrease in flexural modulus at higher weight fractions (20%) of fibre loading. The authors suggested at higher fibre content, a weak interface was created due to the increase in fibre-to-fibre interactions, the fibres were not perfectly aligned with matrix, void, and dispersion problems. Hence, at higher flexure stress, weak interface cracks could form easily leading to failure [4].

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