A Comparative Analysis on the Mechanical Properties of Abaca, Banana, and Coir Fiber Reinforced Polymer Rebars

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Abstract

In this study, researchers conducted a comparative analysis between abaca, banana, and coir FRP rebars to introduce more local and ecological composite materials to the construction industry. This research aims to analyze the mechanical properties of abaca, banana, and coir FRP composites and to determine the appropriate chemical treatment and fiber content that will yield the most optimum values for each. The values of each composite are compared to each other through bar graphs. The data collected from previous studies were limited to the mechanical properties of tensile, flexural, and impact strength and the parameters of chemical treatment and fiber content. The type of chemical treatment and the amount of fiber are different among the three NFRP composites. Moreover, abaca had the highest flexural strength, banana had the highest tensile strength, and coir had the highest impact strength.

Introduction

Fiber reinforced polymer (FRP) rebars are alternatives to deformed steel rebars since they are lightweight and have high strength-to-weight ratio. FRP rebars are composite materials made of polymer matrix with reinforced fibers. However, fibers of FRP's are usually synthetic which causes high energy consumption during production. An ecological alternative to synthetic FRP's are natural FRP or NFRP rebars. Unlike synthetic fibers, natural fibers are low cost, low density, sustainable, and can cause only minor damage to processing equipment. In this study, NFRP rebars, specifically, abaca, banana, and coir FRP, are compared to each other.

The objectives of this study are:

- Analyze and compare the mechanical properties (tensile, flexural, and impact strength) of Abaca, Coir, and Banana Fiber Reinforced Polymer rebars.
- Investigate the mechanical properties of the natural fiber reinforced polymer rebars when chemically treated.
- Determine the proper fiber content of each natural fiber reinforced polymer rebar that will display optimum mechanical properties.

Methodology

The study used secondary sources published from 2010-2020 and are from Google Scholar, Science Direct, and EBSCO hosts. The numerical data of the mechanical properties were arranged into tables and the values were compared in bar graphs.

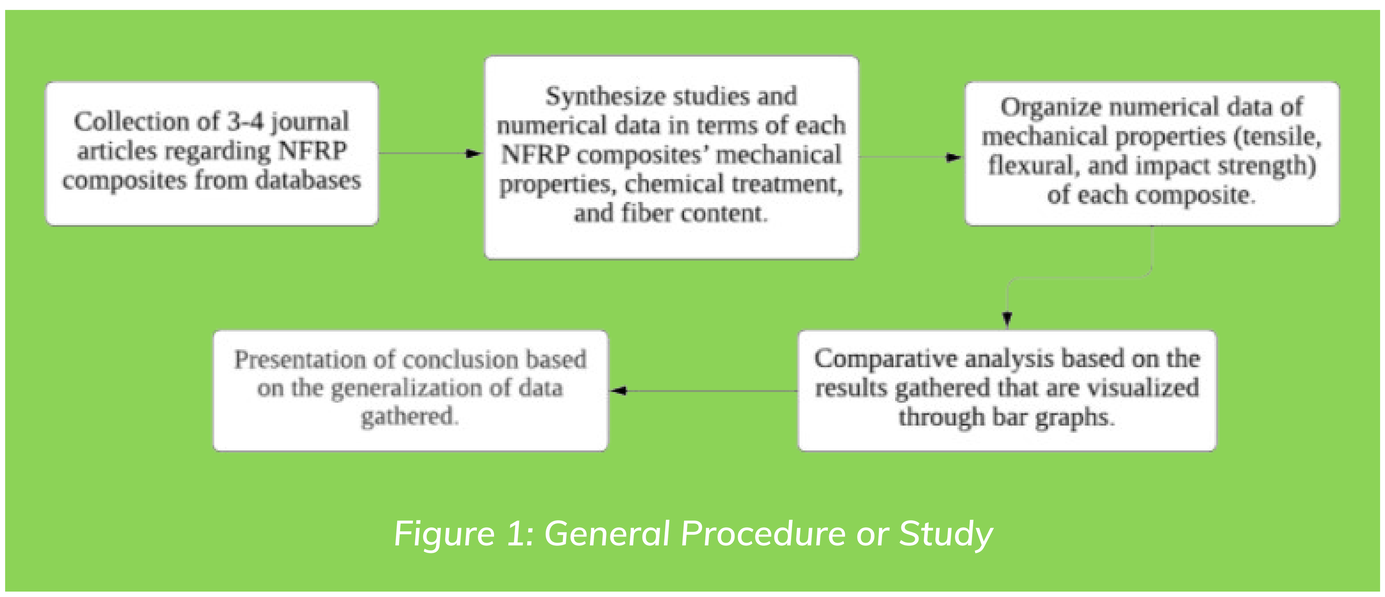

Figure 1: General Procedure or Study

Results

Chemical Treatment and Fiber Content

The type of chemical treatment and amount of fiber in the composite affects the mechanical properties of the NFRP. The chemical treatment improves the polymer-fiber adhesion by making the polymer and fiber more compatible. The appropriate fiber content depends on the compatibility of the fiber and polymer. Bullet points below show the composite with its treatment and fiber content that shows the most optimum mechanical properties

- Abaca FRP - Benzene diazonium treatment; 40% fiber content
- Banana FRP - Alkaline Treatment; 50% fiber content
- Coir FRP - Benzene diazonium treatment; 15% fiber content

Mechanical Properties

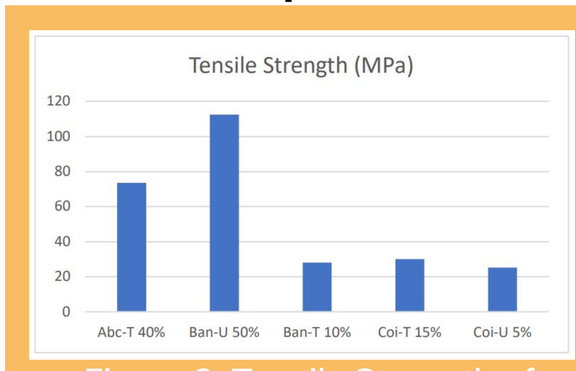

Figure 2: Tensile Strength of Composites

Flexural Strength

- Treated abaca FRP with 40% fiber content had the highest flexural strength
- Flexural strength of abaca and banana fibers is nearer to that of glass fibers

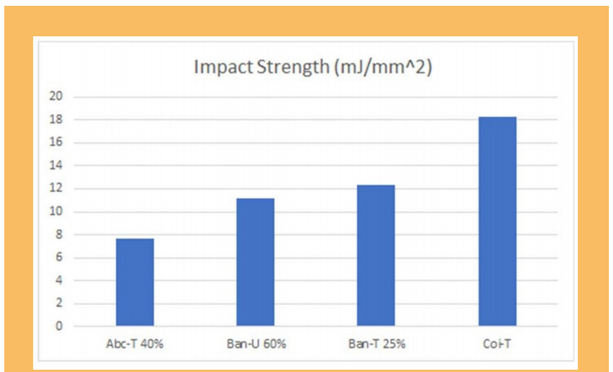

Figure 4: Impact Strength of Composites

Tensile Strength

- Untreated Banana FRP with 50% fiber content had the highest tensile strength
- Raw banana fibers naturally have high tensile strengths
- Untreated banana FRP had appropriate amount of fiber in composite

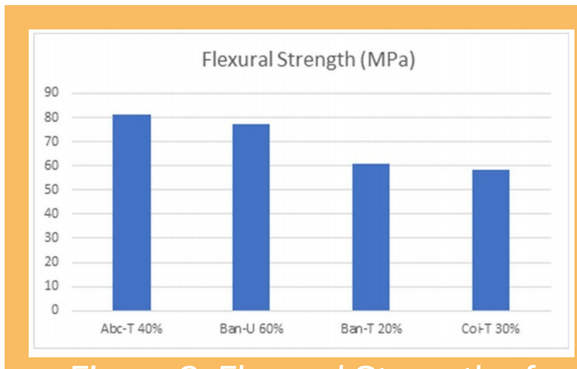

Figure 3: Flexural Strength of Composites

Impact Strength

- Treated coir FRP had the highest impact strength
- Low impact strength is associated with better fiber-matrix adhesion
- Chemical treatment of coir treated is sodium bicarbonate which causes poor fiber-matrix adhesion.

Conclusion

From the studies collected, researchers concluded that the type of chemical treatment and the amount of fiber content are different among the three NFRP composites. Abaca FRP composite is most optimum at 40% fiber content, benzene diazonium treatment. Banana FRP composite is most optimum at 50% fiber content, alkaline treatment. Coir FRP composite is most optimum at 15% fiber content, benzene diazonium treatment.

Comparing the mechanical properties among the three NFRP, abaca FRP had the highest flexural strength (81.2 MPa), banana FRP had the highest tensile strength (112.58 MPa), and coir FRP had the highest impact strength (18.03 mJ/mm^2).