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MECHANICAL BEHAVIOURS, USING LOCAL SPONGE (ACATHUS MONTANUS) AS ALTERNATIVE FIBRES IN THE PRODUCTION OF REINFORCEMENT HYBRID POLYESTER COMPOSITES

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Abstract
This research focused on developing new materials using natural products, which is the valuable or suitable way to solve environmental related issues and increase the income of farmers and industries. The study revolved around using local sponge reinforced polyester composites. The composites are produced by adding fibres at different weight fractions as 10,20,30,40 and 50 percentages. To prepare polyester in which the total weight of matrix is 170g, flexural, hardness, tensile and impact test were carried out on the various samples. The optimum fibre mass fraction required for flexural strength using sponge fibre is 9.10(MPA) and the impact energies and Hardness of the composites were lower than that of the control which were 2.01(J/mm^2) and 2.50(BHN) respectively. The mechanical properties of local sponge reinforced were greatly influenced by the fibres percentages. Descriptive survey method was adopted for this study.
Keywords: Mechanical behaviour, Local sponge, Fibre, Polyester composites

1.0 Introduction

The demand of high strength and less weight has increased more particularly in aircraft and automobile industries (Aladenika, Olarewaju and Olaitan, 2020). Usage of material in a valuable or suitable way to solve environmental related issues and increase the income of farmers and industries (PAV Talpase et al., 2020) Nowadays, the use of natural fibre reinforced polymer-based composites is gradually increasing day-by-day for their many advantages for civil engineering construction applications. (Saira, Munawar and Khan, 2007; Oladele, Omotosho and Adediran 2020b; Yahaya, Sapuan, Zainadin, Zuhri and Ahmed, 2005). Due to their many advantages for polymer-based composite materials are widely used in civil construction, automobiles, aerospace, and many others.

Natural fibres such as jute, kenaf, pineapple, sugarcane, hemp, oil palm, flax, and leaf, et cetera are cheap, environmentally friendly, renewable, completely and partially biodegradable which can be utilized to obtain new high-performance polymer materials.(Uddin, 2013; Wambua, Ivens and Verpoest, 2003). These composites are having satisfactory mechanical properties (that is, tensile properties, flexural stress-strain behavior, fracture toughness, and fracture strength) which make them more attractive than other composites. Due to easy availability and renewability, natural fibres can be used as an alternative of synthetic fibres as a reinforcing agent.

The aim of this paper is to review natural fibres reinforced based polymer composites with mechanical characterization, applications and also to show the opportunities, challenges and future demand of natural composite material towards civil applications. Composite materials have been in use for thousands of years (Xie, Hill, Xiao, Militz and Mai, 2010).

Over the years, people had manufactured bricks using mud which is made based on thousand-year-old technology. The composite term was first used in 1500 B.C. Early Egyptians and Mesopotamian builders and artisans made strong and durable buildings using a mixture of mud and straw (May-pat, Valadez-Gonz'alez, and Herrera-Franco, 2013).

To make ancient composite products, for example, pottery and boats, straw was used to provide reinforcement. From the ancient period, engineers, builders, artisans, and manufacturers tried to develop the application of the composites materials in a different field in a more sophisticated way (Oladele, et al, 2020c).

In 1200 AD, Mongols designed the first composite bows which were made with a combination of bamboo, wood, horns, cattle tendons and silk bonded with natural pine resin (Verma, et al 2012). Using the polymerization

technique, new synthetic resins were converted from liquid to solid state in a cross-linked molecular structure whereas previously, synthetic resins contained celluloid, melamine, and Bakelite (Ramachandram, Bansal and Raichurkar, 2012).

In the modern era, the development of the composites materials was not started until attention was focused on the development of plastics. In the early 1900s, plastics materials such as vinyl, polystyrene, phenolic, and polyester were created and reinforced (Aji, et al, 2009). In 1907, the first plastics Bakelite was made using synthetic components. These new synthetic materials provided better performance than other composites materials (Uddin, et al,2013). However, for structural applications, plastic alone could not provide enough strength and rigidity. So, for the improvement of the strength and rigidity of the structure, it was urgent to provide more reinforcement.

In 1935, Owens Corning first announced the first glass fibre and introduced the fibre reinforced polymer (FRP) industry. The development of resins was started from the 1930s. The methods/ techniques are still used in the composites industry today. Combination of fibre glass and a plastic polymer produces an amazing robust structure. The use of natural or synthetic fibres for the development of composite materials has shown significant uses in variety of fields (Oladele*et al.*, 2020a). In construction industries, for example, fibre reinforced plastics (FRP) composites have been confirmed as a sustainable structural material in bridge construction. Bridge structures use FRP or hybrid FRP–concrete as primary construction materials for bridge components such as girders, bridge decks, and slab-on-girder bridge structures. When likened to reinforced concrete (RC) decks, hybrid FRP concrete decks reveals higher resilience with less toughness weakening under design truckloads (Oladele*et al.*, 2020b).

2.0 Preparation of Local Sponges Fibre

The local sponge stem was collected from Ofi Farm Settlement at Owo, Ondo State, Nigeria. The stem was hammered to fibres. The fibres were air dried for two weeks to evacuate the moisture. The fibres were later cut into five to six centimeter length. The fibre mass fraction Mf were 0, 1, 2, 3,4, and 5% used for this study.



Fig 1: Local Sponge

2.1 Preparation of Polyester

The polyester material was procured from Evro Chemical Ventures Limited, Lagos State. It involved Epoxy Accelerator and catalyst. The total weight of matrix utilized was 170g. This fibre mass fraction was defined as the ratio fitress to constituents of the matrix (polyester) by weight.

2.2 Composite Development

The Sponge fibre-reinforced composite and the control samples were produced by the accelerator of 160g and epoxy of 10g. They were weighed using an electronic weighing balance and mixed together, poured into the flexural and tensile test moulds made of steel. The fibre matrix fractions and 10g of catalyst were added to produce various samples according to the composition.The samples were extracted from the moulds when they were still warm and allowed to cure in the open laboratory air for 3 days before flexural, tensile, impact and hardness tests were conducted on them.



Fig. 2:Specimen for tensile, hardness and impact test

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3.0 Results and Discussion

The following figures below show the results of Tensile, Flexure, impact and Hardness test.

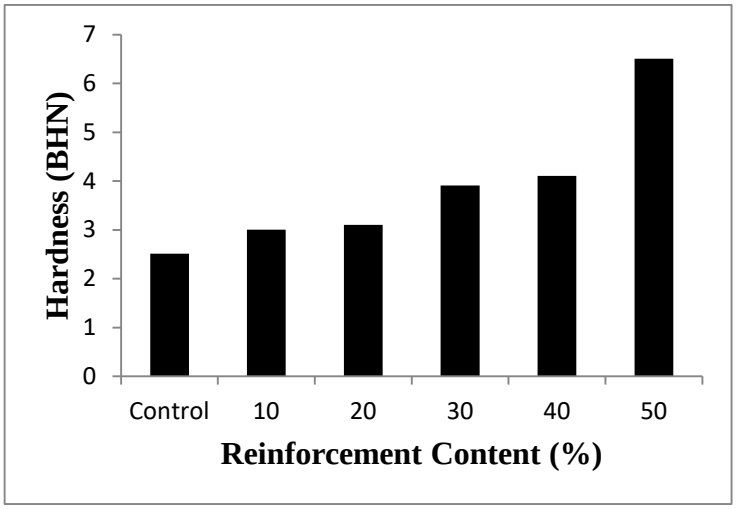

Fig. 3: Showing the graph of hardness against reinforcement content

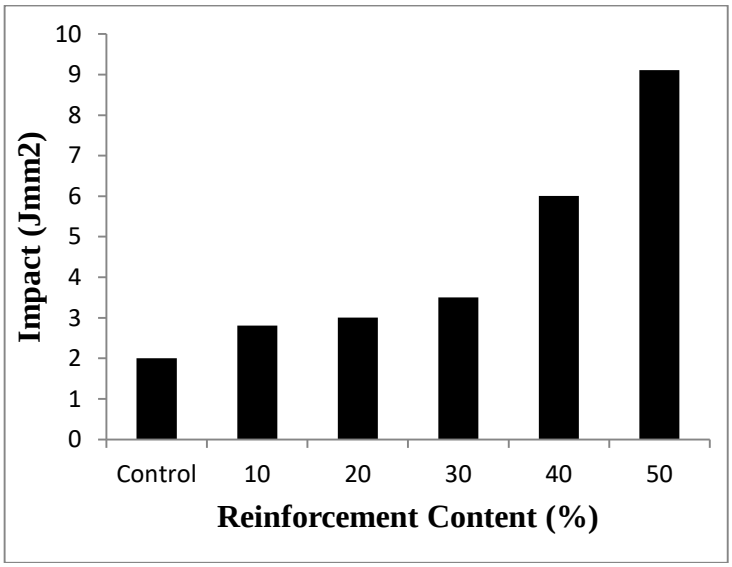

Fig. 4: Showing the graph of Impact against reinforcement content

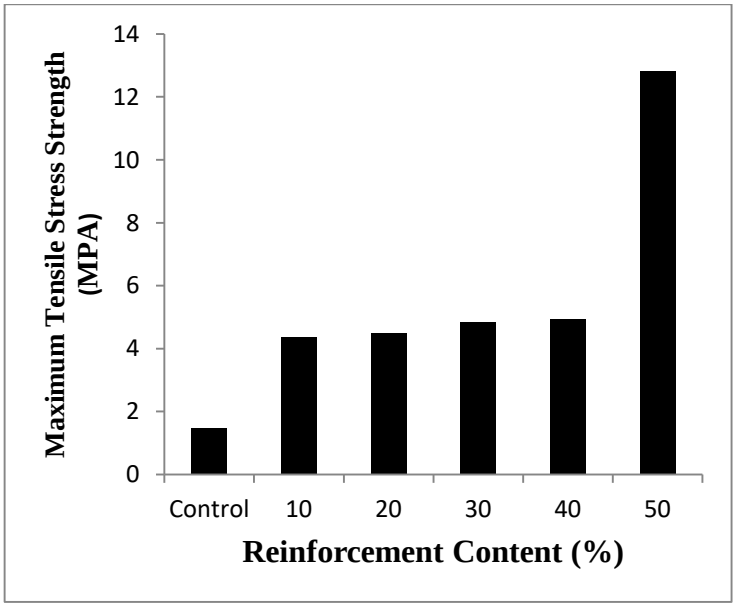

Fig. 5: Showing the graph of maximum tensile stress strength against reinforcement content

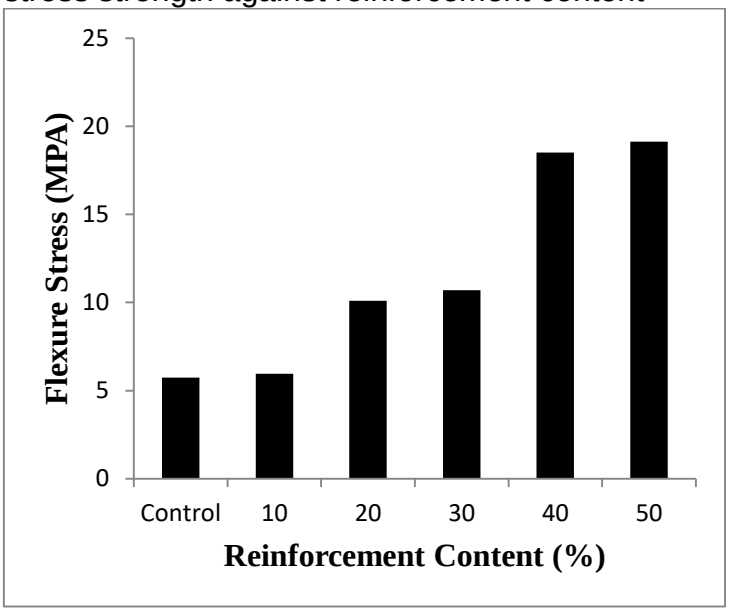

Fig. 6: Showing the graph of maximum flexure stress against reinforcement content

3.1 Impact Test

Impact test was carried out to determine the energy lost per unit cost-sectional area at the notch J/mm^2. It was observed that the Impact energies of the composites were higher than that of the control (2.01J/mm^2). However, among the composites, it was 50% reinforcement content that had the highest impact energy with a value of (9.10J/mm^2). The presence of fibres resulted in reduced toughness of the matrix.

3.2 Hardness Test

Micro hardness values for the samples are shown in Fig. 4 with a trend that is similar to what obtained in impact test. However among the composites, it was observed that control reinforcement content had the lowest micro hardness value of 2.50BHN.

3.3 Flexural Test

Fig. 6 above represents the effect of the sponge fibres on reinforcement content. Flexural strength had higher density at control. It was observed that there were variations in the flexural strength of the composites.

3.4 Tensile Test

The tensile strength result on the control sample and sponge fibres composites are presented in Fig. 5. The results show that the strength of the control sample is lower than the composites strengths. It was also observed that 50% reinforcement contents was the highest value.

4.0 Conclusion

The results from the analysis done in this study indicated that the mechanical properties of Sponge fibres reinforced composites were greatly influenced by the fibre percentages with the observed strength from flexural, hardness, et cetera. The impact of the polyester samples improved the flexure responses of the developed composite materials. Likewise, the work justified the economic consumption of these otherwise waste materials that are detrimental as environmental pollution agent.

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