COMPARISON OF IMPACT STREGTH OF COCONUT FIBRES WITH E-GLASS FIBRES

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Abstract:
Impact strength of coconut fibreswith E-glass fibres(comparison) is an article which aims at stressing the need for the use of natural fibres for the development of engineering structures for economic benefit, such as car bumpers and air craft wings. Coconut fibres(coir) were obtained, treated, dried and used with polyester resin (matrix) and polyvinylchloride (release agent) to develop composite specimens. Impact tests conducted showed that coconut fibres (having impact strength of $79kJ/m^2$) proved to be a substitute for E-glass fibres (with an impact strength of $95kJ/m^2$).
This means that when properly treated, this lightweight material which isnatural environmentally friendly will compete favorably with the E-glass fibres for economic benefit of the nation.
KEYWORDS: Coconut fibres, E-glassfibres, composites, impact strength.

1.0 INTRODUCTION

Naturally, fibres have been in use for a very long time, from the beginning of life on earth. A direct use of the strength of natural fibres is in Lines, Ropes and other one –dimensional products.Miscellaneous applications include early suspension bridges for on-foot passage of Rivers and Rigging for Naval Ships. Different types of Textile products, Ropes, Canvas and Paper produced from natural fibres are in use today (Terry, 2006).

Natural fibres are environmentally friendly materials due to their biodegradability and renewable characteristics. Natural fibres such as sisal, jute, coconut and oil palm fibres have been proved to be good reinforcement in the thermo set and thermoplastic matrices (Varma et al; 1989).

Nowadays, the use of natural fibres reinforced composites is gaining popularity in automotive, cosmetic and plastic lumber applications because it offers an economic and environmental advantage over synthetic reinforcements and fillers (Murali andMohana, 2007).

One of the main important aspects of the behavior of natural fibres is their response to impact loads and the capacity of the resulting composite to withstandthe loads during their service life. Other benefits from the use of natural fibres are low cost and environmentally friendly. The major limitation of natural fibre reinforced composites lies in their low impact strength,when compared with the E-glass fibre reinforced plastic composites(Rama et al; 2003). In general, assessing the impact resistance of composite materialshas always been difficult, since the damage manifest itself in different forms, such as, delamination at the interface, fibre breakage, matrix cracking and fibre pullout (Wang et al; 2005).

A study has been carried out where coconut fibres (coir) were compounded with composite materials (Ray, 2005). Coir fibres are relatively water- proof and has resistant to damage by salt water and microbial degradation. Coconut fibres, having suitable stiffness and damping coefficients of composites can be adopted in engineering applications, which satisfy the need of their characteristics such as strong ,rigid ,light weight and environmentally friendly materials(Shaikh et al; 2003). An example of the application of coir fibre reinforced composite is in industrial automotive, where, it is used to make cushion for Mercedes etc. Notwithstanding the advantages of coconut fibre reinforced composite material, itstill has certain undesirable properties like dimensional instability, flammability which made it not suitable for high temperature application, degradability with humidity,

ultraviolent lights, acids and bases(Brahim and Cheikh; 2006).
In fibre reinforced composite, high- strength fibres are incased within a tough matrix. The functions of the matrix are to bond the fibres together, protect them against damages and transmit loads within system. According to Harris 1986, the stresses induced in the fibres and matrixes are related to the fibre volume fraction for each composite. This is expressed in equation (1,1)

$$\sigma_C = \sigma_f V_f + \sigma_m V_m \qquad 1,1$$

Where:
σ_c-is the strength of the composite in MPa, σ_f- is the tensile strength of the fibres in MPa, V_m- is the volume fraction of the matrix in m^3,V_f- is the volume fraction of the fibres in m^3, σ_m- is the failure strength of the matrix in MPa.
Harris, 1986 also developed a relationship of the entire composite and the fibre volume fraction and this is given by the expression in equation (1,2)

$$E_C = E_f V_f + E_m V_m \qquad 1,2$$

where:
E_c- is the modulus value forthe composite in MPa,$E_m$and E_f- are the modulus values for the matrix and fibres in MPa respectively
This paper studied the use of locally sourced reinforced materials (coconut fibres) as close substitute for the synthetic (E-glass fibres) ones for economic benefit.

2.0 MATERIALS AND METHODS

The studied composite material was made up of polyester matrix reinforced with coconut fibres which were arranged in discontinuous randomly oriented configuration. The coir fibres were obtained from the coconut husk which was abstracted from coconut fruit. After the abstraction, the fibres were dried at 70°C using a drying oven (Schutzart DIN EN 60529-1P20). To avoid degradation, the fibreswere subjected to treatment processes. The treatment involved immersing the fibres into 5% sodium hydroxide (NaOH) solution for 24 hours to remove the first layer of coir fibres. The fibre were then washed toughly with water to remove the remnant of NaOH before they were dried in the furnace at 70°C for 24hours. The fibres were then soaked into 5% of saline and 95% of methanol solution for 4hours and dried at 70°Cfor 24hours curing time. At the end of drying process, the fibres were cut into smaller pieces (called whickers) to enhance load transfer from matrix to reinforcements.

2.1 Composite preparation

Composites samples were developed at 30% fibre volume fraction. In the first process of preparing the composite, a release agent (polyvinylchloride) was used to clean the mould before applying the polyester resin on the mould. The resin was then mixed uniformly with the coconut fibres by using a brush .The mixture was carefully poured into the mould, flattened appropriating with a roller before being dried for 24 hours . After the composite was fully dried, it was remolded and cut into suitable testing dimensions of 300×20 ×3 mm (Fig 1). Six uniform samples were developed out of the cast composite product.

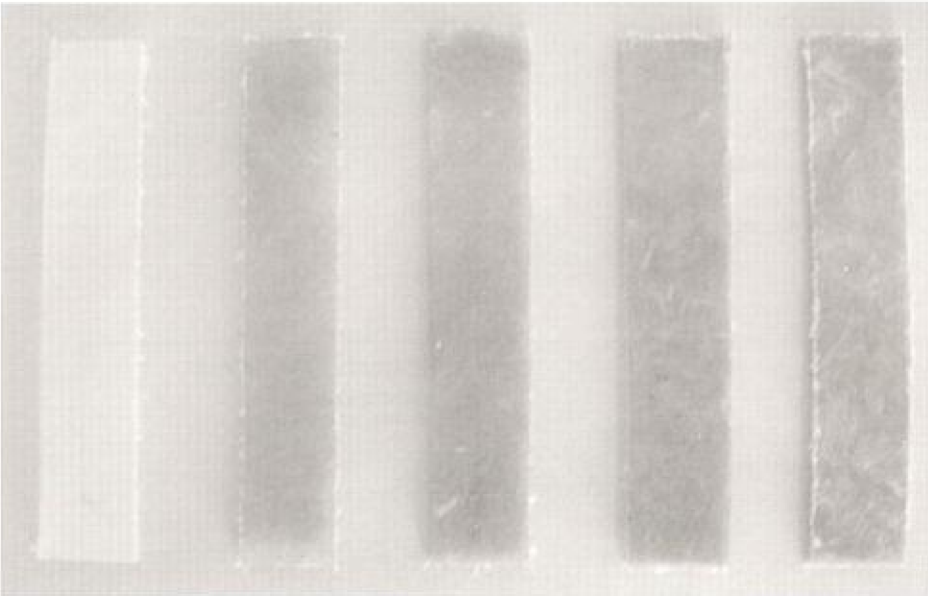

Fig1: Coconut reinforced composite specimens for Impact testing

This method of sample development was repeated with E-glass (synthetic) fibresfor comparison

2.2 Impact Testing

The impact property of a material is directly related to the overall toughness which is defined as the ability of the material to absorb applied energy (Dhakal et al; 2007). Area under the stress-strain curve is proportional to the toughness of a material. Impact strength is a measure of toughness of a material. In this research, pendulum impact test – Notched Izod Impact Test machine (ASTM D256) was used (see*Fig.2)*.

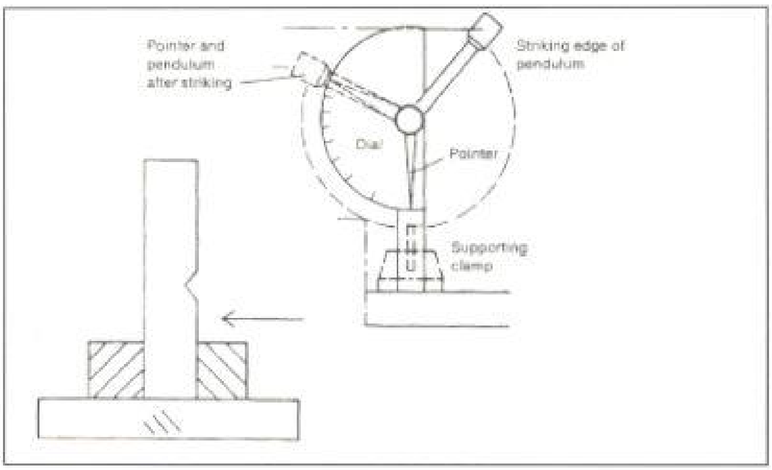

Fig. 2: Pendulum Impact Test – Notched Izod Impact Test machine

In accordance with ASTM D256, test method A (Izod type) was used for the testing. The apparatus involved was Cantilever Beam (Izod Type) Impact Machine. The specimens were notched before putting it on the machine. Notching was done because it provides a stress concentration area that promotes a brittle fracture rather than ductile. Notching also drastically reduces the energy loss due to the plastic deformation.

During the testing, the specimens were clamped vertically as a cantilever beam and then struck by a single swing of the pendulum released from a fixed distance from the specimen clamped. The line of initial contact is at a fixed distance from the specimen and centerline of the notch and on the same face of the notch.

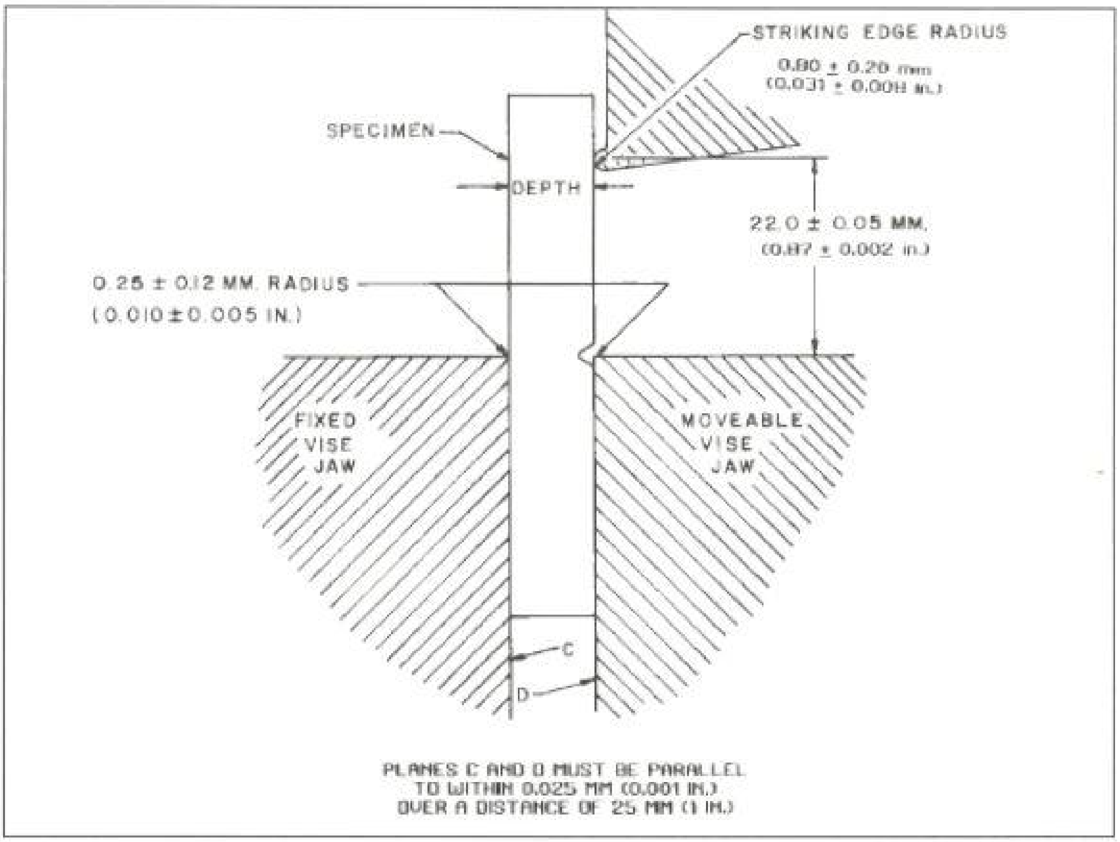

Fig. 3: Relation of Vise, Specimen and Striking edge to each other for Izod Test Method A in ASTM D256

Figure 3 shows the relation of vise, specimen and striking edge to each other for Izod Test. A total of six consistent testing results were selected for each fibre loading in polyester resin matrix, RAY-*RAN* Universal Pendulum Impact System for Izod-Charpy-Tension and Puncture were used to measure the work of fracture for the fibre reinforced composite. There were few parameters that were set according to the standard.These parameters are; Hammer Velocity = 3.46 m/s and Hammer Weight = 0.905 kg.

3.0 RESULTS AND DISCUSSION

The graph of impact strength on E-glass and coconut fibre reinforced composite specimens is presented in fig 4 and 5.

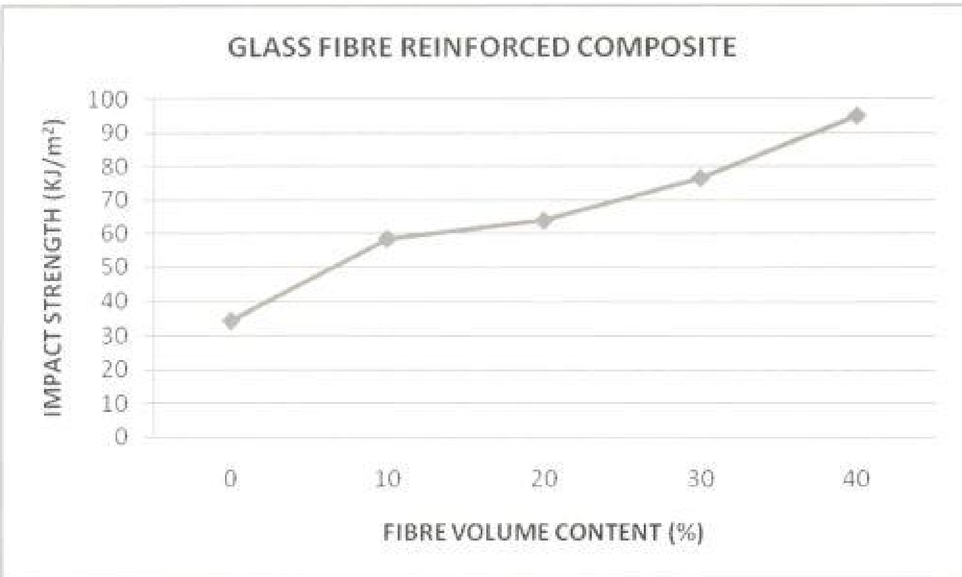

Fig 4: Graph of Impact Strength against Fibre volume content forE-Glass fibre reinforced composite.

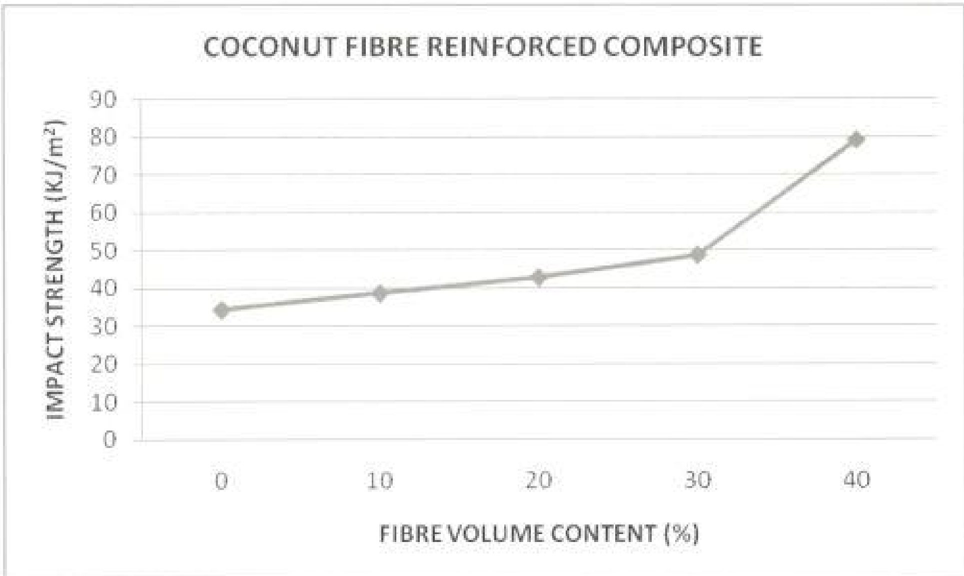

Fig 5: Graph of Impact Strength against Fibre volume content for coconut fibre reinforced composite.

From figures (4 and 5), the impact strength of E-glass fibres reinforced plastic composite which is $95KJ/m^2$ is higher than that of coconut fibre reinforced plastic composite ($79KJ/m^2$). This variation in impact strength of the two different fibre reinforced samples must have occurred due to the following reasons:

The coconut fibres are short fibres with different orientation distribution compared to the E-glass fibres. On this basis, impact strength of discontinuous fibres composites are moderate compared to a continuous fibre reinforced composite (Terry;2006)

E-glass(synthetic) fibres are better treated than coconut (natural) fibres and as a result, more fibre – resin interaction will be generated in the E- glass fibre reinforced composite. This means that there will be a more effective load transfer mechanism in a more homogenous composite. On weak interfacial bonding between the fibre and resins, the impact load can be distributed around the surrounding impact areas which creates a general damage pattern and prevents highly localized strain occurring (Cho and Zhao: 2002)

4.0 CONCLUSION

Coconut fibres are sourced locally at low cost. Composite manufacturers are encouraged to adopt the use of natural fibres for the development of fibre reinforced plastic composite based on the result obtained for engineering applications- where applicable.

In this article, light weight and environmentally friendly coconut fibres have been proved to possess impact strength resistance capable of making them to be close substitutes for synthetic fibres in the development of fibres reinforced plastic composites. The need to maximize the use of local materials and increase local content in engineering applications should be encouraged in other to reduce cost of importation which will go a long way in conserving scarce foreign exchange and job creation. It could however, be assured that in the near future natural fibre reinforced plastic composites will be preferred to steel casting in terms of important engineering applications, such asin automobiles, boat,aircraft constructions etc.

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