# Investigation on New Eco-Core Metal Matrix Composite Sandwich Structure

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**Abstract:** The introduction of the eco-core sandwich panel composite is contributing a new approach to the designer to achieve high performance and light weight. These advanced natural fibre reinforced composite materials are increasingly being used in many applications including structural, aerospace, and defense and household appliances. However, the practical application for commercial use is not so widespread. High manufacturing cost can be justified if the product life cycle of the component is increased. Efforts have therefore been directed in recent years towards the development of suitable light-weight materials for many engineering applications and polymer matrix composites (PMCs) with phenolic or aluminium foam laminated composite have shown great promise in order to fulfill the current demands for structural applications. In this research project, the new kenaf eco-core sandwich panel will be developed and then laminated with aluminium for the development of new advanced composite with the aim to investigate the effects of sandwich eco-core and variable metal faces on the properties of developed composites. The final goal is to find the optimum eco-core metal matrix composite sandwich structure with maximum mechanical properties such as stiffness and buckling.
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## 1. Introduction

Natural fiber composites are gaining more and more attention due to their eco friendliness, biodegradibility and cost effectiveness. Such natural or bio fibres can generally be classified into three types [1]. "Bast" fibres, such as flax, hemp, jute and kenaf, are noted for being fairly stiff when used as a composite reinforcement. Leaf fibres, including sisal, henequen, pineapple and banana, are noted for improving composite toughness with somewhat lower structural contribution. Finally, seed or fruit fibres — cotton, kapok and coir (from coconut husks) — demonstrate elastomeric type toughness, but are not structural. Within the last five years several studies [2,3,4] have been conducted using such natural materials, like jute, kenaf, balsa, coir etc. Most if not all, of such studies have typically focused on material characterization and morphological knowldge. Now with the ever increasing necessity to go green and utilize natural materials in typical structural and engineering application, focused efforts are required to study viable application of such natural materials.

In this regard, industry incentives especially automotive industry has indeed imparted much attention and attraction to the use of such eco friendly materials on account of their properties like, light weight, eco friendly and lower cost. Now it is required to undertake exhaustive research for natural fiber materials in general so that it could be best exploited for its properties against the required performace parameters in a more cost effective manner. All such efforts are therefore directed towards exploring new alternatives to replace existing synthetic materials with natural fibres having higher strength, lower cost and environmentally friendly attributes and greater sustainability [5].

The present work would be therefore of immense valuable original addition for the greater interest to the application of new eco-core metal matrix composite sandwich structure for automotive bottom part and to the scientific community as a whole. The mechanical performance such as tensile strength and compressive strength of the composites will be reported and validated with journal [1].

## 2 . Materials and methods

### 2.1 Materials

In this research, the sandwich panel is fabricated by using layer by layer method (hand lay-up). The materials need for this construction of sandwich panel are Aluminium for its skin, natural fiber Kenaf for its core and epoxy resin with hardener, EP-B125 Hardener, EP-A125 Epoxy as the adhesive to bond the core and the skin. The length of Kenaf with long fibre is 10cm and 5cm for the Kenaf with short fibre.

### 2.2 Sandwich Panel preparation

The composite core materials consisted of Kenaf/epoxy and Kenaf/ epoxy with rubber having a total thickness of 10mm. Specimens with dimensions of L= 610mm, w= 305mm, 2h = 3.4mm were used.

### 2.3 Mechanical testing

The final products of composites were cut in accordance to the American Society for Testing Materials (ASTM) standards for the mechanical testing of polymer composite materials. The flatwise tensile tests were conducted in accordance to ASTM C297 by using Materials Testing Machine. Compression tests were carried out in accordance to ASTM 365 using a Shimadzu Universal Testing Machine equipped with 25000N load cell with the cross-head speed of 1mm/min. The test results were typically the average of the six specimens of each test.

## 3. Results and Discussion

### 3.1 Tensile properties

In this research, tensile test were carried out on the eco-core composite sandwich structure. The samples are Kenaf long fiber with rubber, Kenaf long fiber and Kenaf short fiber without rubber. Tensile strength is determined at relatively high deformations where any weakness is magnified, reducing in the process of stress transfer. From Fig. 1, long fibre with rubber will give better result compare to others. This is due to the increase in the inherent ductility of the matrix can often only be achieved at the expense of other important properties of the adhesive. The stress that obtained from this test is 31.5MPa for long fibre with rubber, then 27.6MPa for long fibre and 27.5MPa for short fibre.

The tensile strength of Kenaf long fiber is slightly increased by 0.2% compared to Kenaf short fiber. This small increment occurred because of epoxy resin is not well distributed on Kenaf fiber (core). When epoxy is not well distributed it will caused weak interface between core and aluminium plate. A weak interface results in low stiffness and low strength but high resistance to fracture. Another factor causing this problem is by using nonwoven fibers, where the Kenaf fibers will not be distributed uniformly.

The highest tensile strength was obtained for the long fiber with rubber modification. This was due to it possessed long and continuous fibers to resist and transfer the tensile force whereas the short fiber contained short, broken and discontinuous fibers. The distribution of Kenaf fibers plays an important factor to obtain good mechanical properties of sandwich panel. When the stress applied to the matrix, it will be transferred to the fibers across the adhesive. The skin and the Kenaf fiber will experience different tensile strains because of their different modulus. In the region of the short fibers ends the strain in the fiber is less and this result the fibers is stressed in tension.

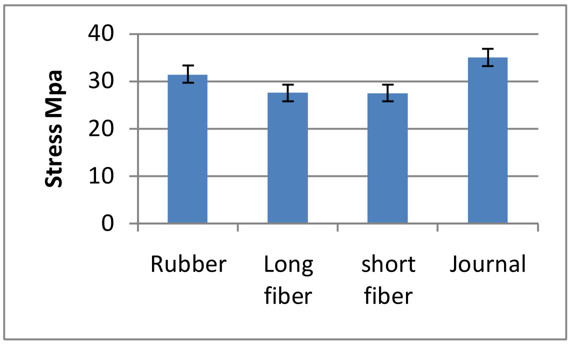


Figure 1. Comparison of the tensile strength for three different types of eco-core with Journal

### 3.2 Compressive properties

The compressive loading is applied to the specimen until the failure of occurs on Aluminium sandwich panel. The compression tests were performed to find different in strength of the sandwich panel when compressive loading was applied to the samples surface. The specimens of flatwise compression test have dimension 150 mm x 30 mm x 10 mm. The compression loading was applied to the specimen until the failure of core occurs. The test result from the Fig. 2 shows that the value of long fibre reinforced with rubber giving the best result compare to long fibre and short fibre without rubber. The increment by 0.4% of Kenaf long fibers with rubber compared to Kenaf long fibers without rubber is due to rubber toughening. It is expected that rubber contributing to toughening by initial yielding in the surrounding adhesive which is the conventional mechanism of epoxy rubber toughening. Rubber plays an important role in order to increase their toughness without significantly impairing the other desirable engineering properties. Thus, such rubber-toughened epoxy adhesives can be used in applications where a very high impact resistance is required for the adhesively-bonded joint.

From the result also, there are some factor may be contributed to the reading. The first factor may be due to fibre criteria. During construction, fibre is sieved manually by hand. This is possibly the reasons for the length of fibre that obtained is inconsistent. In order to get good result, Kenaf length should be measured precisely especially for long fibre and for short kenaf fibre should undergo sieve by machine. In this test, it covers the determination of compressive strength and modulus of sandwich core. These properties are usually determined for design purposes in the direction normal to the plane of facings as the core should be placed in a structural sandwich construction.

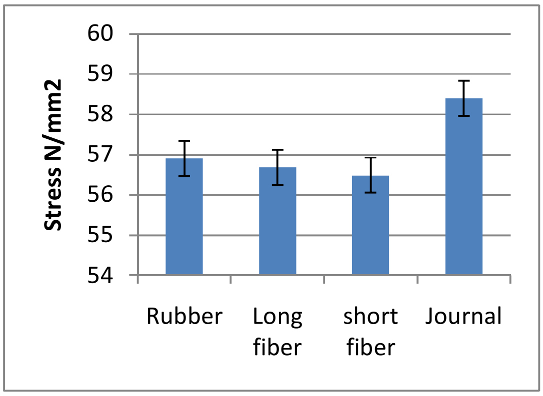


Figure 2. Compressive strength for three different types of eco-core

## 4. Conclusion

Kenaf long fiber with rubber showed great improvement in tensile strength and compressive strength. In addition, by combination of porosity and light weight inner core with the fibrous outer bast, kenaf core will produce strong yet light material. The factors which determined properties of composite materials are the chemical strength characteristics of the interface between the fibers and the matrix is particularly important in determining the properties of the composite [8]. The interfacial bond strength has to be sufficient for load to be transferred from the matrix to the fibers if the composite to be strong. Besides, the shape, size orientation and distribution of the fibers and matrix significantly affect the properties of the composite. Ideally, a composite should be homogeneous. Maintaining a uniform distribution of Kenaf is an important factor to improve the properties of sandwich structure. The orientation of the reinforcement within the matrix affects the isotropy of the sandwich panel. Furthermore, rubber modified epoxy resin help to improve mechanical properties of the sandwich panel.

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