Ilkogretim Online - Elementary Education Online, 2022; Vol 21 (Issue 1): pp. 512-525
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2022.01.34

Consequence Of Titanium Oxide For Woven Jute/ Kenaf Reinforced With Lead Net For Vehicle Applications

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ABSTRACT

Natural fibre-reinforced polymeric composites utility is increased by the automotive industries due to their advantages such as recyclability, cost- effectiveness, light weight, high strength, rigidity and ecological production. The natural polymeric fibre-hybrid composite overcomes the concerns of the mechanical properties of mono-material fibre-reinforced composites.

This investigation involves using Jute (J), and Kenaf (k) fibres in the Hybrid Natural Fibre Polymer (JKFPC) composites for different applications. Natural Fibres Wire Mesh Composite (NFWMC) plates were fabricated using woven A/H/F along with Stainless Steel Wire Mesh (SSWM), aluminium wire mesh (ALWM) and copper wire mesh (CUWM). of samples were fabricated using hand-layup and through compression moulding techniques. The Experimental trial-I samples were prepared with J/K, J/K, J/K and J/K/F combinations along with LY556 and HY951. In trial-II the samples were prepared by adding Titanium oxide in various weight ratios (1%, 3%, 5% and 7 %). The optimum results were obtained for sample with 5% of Titanium oxide addition, and hence the samples uses in the first trial combinations with 5% of titanium oxide were preferred for trial-III. Finally, along with 5% of Titanium oxidethe experimental trial-IV samples were fabricated using stainless steel, aluminium and copper wire mesh.

The mechanical properties of the composite materials were determined by the tensile, flexural, impact and hardness properties. The Visco-elastic properties were estimated by the Dynamic Mechanical Analysis (DMA).

1. INTRODUCTION

The combination of ductile aluminum layers with high strength FRP layers results in a unique FML having lightweight, outstanding fatigue resistance, high specific static properties, excellent impact resistance, good residual and blunt notch strength, flame resistance, and ease of manufacture and repair. The FMLs with glass fibers), and aramid fibers, and carbon fibers name are attracting the interest of several aircraft manufacturers. A sandwich structure consists of two essential constituents, the faces and the core. Face sheets were typically made of metal sheets or fibrous composite layers, and both have some advantages and disadvantages. Searching for new materials with better properties is in progress [1, 2]. For example, was used to manufacture the American C- 17 transport aircraft cargo door. laminates were selected as the upper fuselage materials in the ultra-high capacity Airbus 380 and lower wing panels of the Fokker 27 [2].

Metal sheets are heavy but have better resistance and continuity against transverse loads. On the other hand, although fiber-reinforced plastics benefit from being lighter than metal sheets, they are susceptible to large internal damage areas when subjected to lateral loads significantly impact events and more vulnerable to environmental effects. At present, most commercial applications are based on unidirectional glass fiber prepares, which are laid-up between aluminum alloy sheets. However, FMLs as classical laminates can be tailored to any engineering application by choosing different component layers build-up, so the new generation is under technological and

manufacturing growth [3-5]. For design engineers, the critical property concerning composite structures is the strength to weight ratio, which leads to optimization analysis. It also includes thefailure criteria application to predict loading conditions under which the composite structure collapses. All specified FML features make lower thickness or higher stresses in FML structures possible. Thus, thin-walled FML sections are prone to buckling and may undergo differentmodes of buckling. In the case of thin-walled members buckling load may decide of their capacity not only a strength itself. Various numerical and experimental investigations have been performed to analyze composite structures stability in their buckling and post-buckling state. Comparative analyses employing FEM and semi-analytic methods also were carried out.

Nonetheless, relatively few papers are devoted to buckling strength analysis and load-carrying capacity of thin-walled FML members [6]. High-cycle fatigue life in aligned glass fiber composites is dominated by fatigue cracking in the matrix, which subsequently propagate and rupture the main load-bearing elements, i.e., the fibers. Compared to the high-modulus of carbon fiber composites, glass fibers lower elasticity modulus may impose higher strains in the matrix, leading to fatigue failure. Therefore, the addition of nanoparticles, such as carbon nanotubes (CNTs) or montmorillonite clays (MMTs), is expected to contribute to decreasing the scale of damage mechanisms, leading to an increase in the absorption of strain energy through the creation of a multitude of fine nano-scale cracks [9]. Fiber metal laminates (FMLs) are hybrid materials; consisting of metal layers and fiber. The reinforced polymer combines the characteristics of metals and composites. These materials have excellent fatigue resistance and damage tolerance. The combinations of aluminum with glass, carbon, kevlar, and aramid fibers, respectively, show increasing applications in industries. [7-11]. A review made recently by tensile and impact resistance of FMLs showed that despite many articles concerned with these laminate tensile/ impact behavior, the research on this part of FML Performance is still in the early stages.

The dynamic mechanical analysis (DMA) and differential scanning calorimetry (DSC) are typical analysis that used for characterizing the composite curing progress and state [12&13]. Through the dynamic mechanical analysis, researchers have investigated the storage modulus, loss modulus, and tan delta of glass fiber reinforced polymer composites [14&15], carbon fiber reinforced polymer composites [16&17], hybrid glass/carbon composite [18], carbon/elastomer/aluminum sheets FML laminates [19] and hybrid SS304 wire mesh composite
[20] and Hybrid AL/Cu wire mesh composite [21]. A carbon fiber/epoxy composite viscoelastic behavior was evaluated through dynamic mechanical analysis to study the influence of operating frequency, glass transition temperature, and heating rate. The composite repairing temperature limits can be analyzed through the glass transition temperature data set at various cure states to determine the composite repair system [22]. In the hybrid composite, the addition of glass fibers and carbon fibers in an FML increases the stiffness and the loss factor compared to the neat aluminum and carbon composites [23]. The dynamic tests usually consist of mainly compressive and shear loading. Impact loading damage in automobile

2. MATERIALS AND METHODS

The ingredients of the fabricated composite materials were Kenaf and Flax fiber known for their toughness, high tensile strength, and resistance to energy abrasion, resistance to organic solvents, non-conductive, high melting point, low flammability, and fabric integrity at elevated temperatures, elasticity, and good thermal insulators because of their high ratio of surface area toweight. The matrix epoxy LY556 and the hardener (HY951) were used at room temperature and in a liquid state. The resin was used to transfer the stresses from the reinforcing fibers, and it

Should have better interfacial adhesion between the fibers. The optimum condition ratio for resin and hardener is 10:1 was preferred.

3.Composite preparation

Initially the fibers are subjected to alkaline treatment. A glass plate of (500 mm × 500 mm × 6 mm) has been used to prepare mould. A transparent glass plate is positioned on the bottom of the mould box and a wax layer isapplied over the surface for achieving good surface finish and easy removal of the composite. The hand lay-up technique is employed to prepare four different hybrid woven fiber composites. An epoxy resin layer (1–1.5 mm) has been evenly spread on the mould and the woven Jute, Kenaf and flax fibers are placed in alternate layers. The four different composites Jute+Kenaf (AH), Jute+Kenaf+Titanium oxide (AHB), Flax +Kenaf (FH) and Flax+Kenaf+Titanium oxide (FHB) are prepared. In order to maintain tension in the fibers a weight

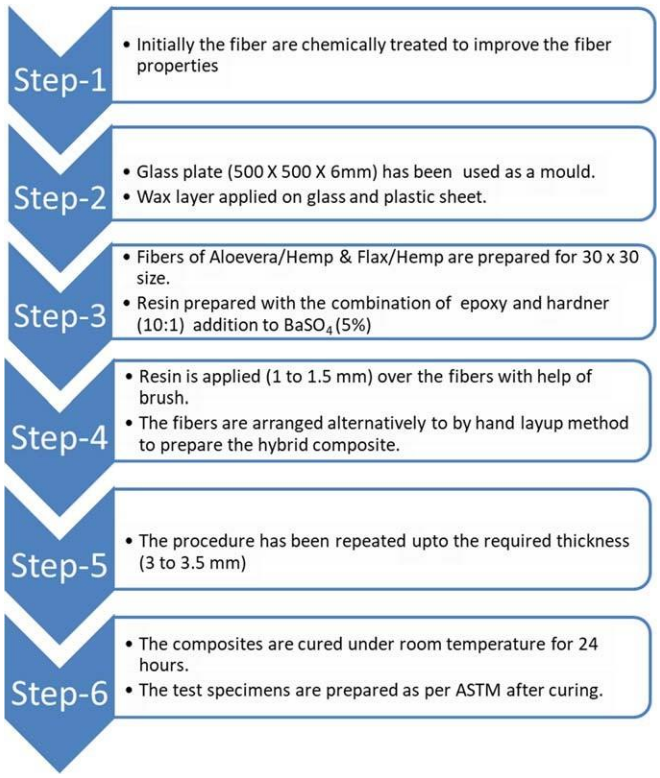


FIGURE 3:Step By Step Fabrication Of Composite

TABLE 1:COMPOSITION OF AHF

S.No	Type of composite	Kenaf	Flax		Epoxy	Filler (Titanium oxide)
1.	HF	9.74	10.34	—	80	—
2.	FH	—	10.80	9.19	80	—
3.	FHC	9.74	10.34	—	75	5
4.	FHC	—	10.80	9.19	75	5

Dynamic Mechanical Analysis

The viscoelastic behaviour such as storage modulus, loss modulus, and tan delta of the hybrid FML composite was analyzed using Inkarp Japan (DMS 6100) dynamic mechanical analyzer (DMA) glassy, transition and rubber regions. The. The composite sample was oscillated by the 5 Hz frequency sinusoidal oscillation and allow to deform successively cooled by liquid nitrogen with a heating rate of 2C/min was preferred for the DMA analysis. The viscoelastic behaviours were analyzed through the operating temperature range of 30 °C to150 °C; in addition to that, thecomplex modulus was estimated to understand the material subjected to stresses under the yield stress. Further, the cole-cole analysis was a suitable model to study the effect of the storage modulus and loss modulus of the FML composites

Figure 2. DMA test specimens of the hybrid composite.

Ballistic Analysis

Experimentally, the ballistic impact performance of hybrid AHL laminates was investigated using low-velocity pneumatic guns at room temperature. The targets were secured in a unique angle fixture in a ballistic impact setup (figure.1) to determine the effects of the FML composite parameters such as type of fiber arrangement, angle of wire mesh, and impactor diameter are discovered. The impactor with conical nose shape was identified, and their effects were investigated.

FIGURE2:BALLASTIC ARRANGEMENT

Sliding Wear Test

The fabricated composite laminates were machined to obtain wear test coupons of 5 mm square using a diamond cutter. Four wear test samples were pasted utilizing an adhesive to prepare 5 mm square shape and 12 mm length pins. The sliding wear test was carried out at sliding velocities of 1, 2, and 3 $m.s^{-1}$ with loads of 10, 20, and 30 N. A constant sliding distance of 1000m was used to carry out this evaluation. The test was performed with a computer-controlled pin-on-disc test rig according to ASTM: G 99-05 standard.

3. RESULT AND DISCUSSION

Different FML composite design's dynamic performance was experimentally analyzed through the dynamic mechanical analysis,ballistic impact analysis, and wear testing at various operating conditions.

Dynamic Mechanical Analysis

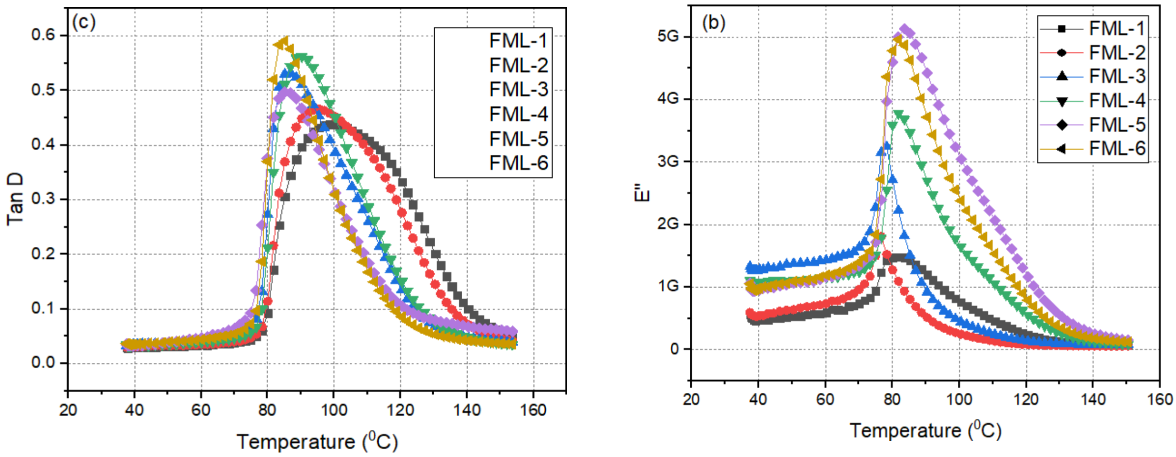


Figure.3 Viscoelastic response of (a) Storage modules (b) Loss modulus and (c) Tan D of the FML composites

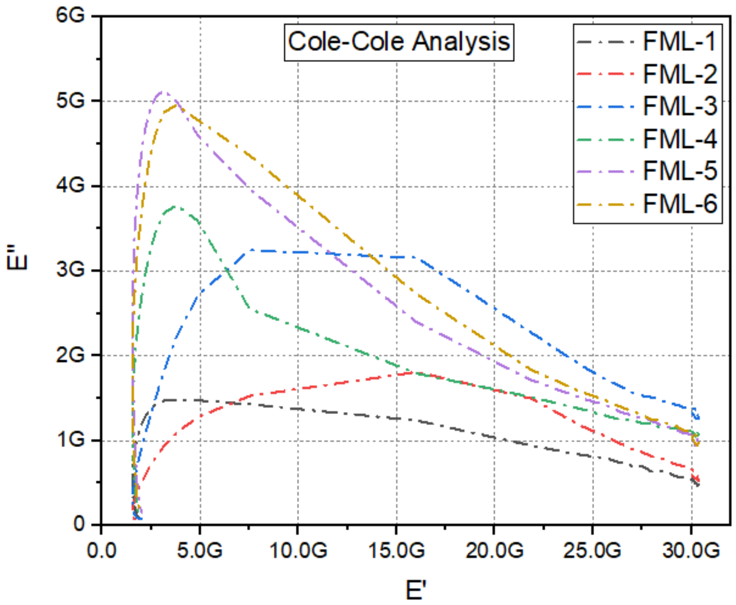
was slightly increased the storage modules in the same region.

The loss modulus is an important parameter to determine the energy absorption capability of the FML composites. From the obtained results, it was observed that the temperature mainly influenced the loss modulus. The peak of loss modulus influenced the addition of Titanium oxide. In the glassy region, not much effect was observed on the E'' up to 60°C in the FMl composites. A vast variation was found in the loss modulus values in the temperature range of 60°C to 120°C. The FML composites hold maximum loss modulus values in the transition region due to the epoxy matrix's flexibility.

region. In the transition region, storage modulus was rapidly degreased in the temperature range between 60°C to 80°C irrespective of the fiber type and the wire mesh angle. This effect may vary due to temperature, and the epoxy matrix loses its stiffness became flexible. The storage module influenced the carbon fiber, and it holds higher E' with 90° orientation of aluminum wire mesh. In the rubber region, the rise in temperatures was incapably affecting E's magnitude. Also,the wire mesh

Effect of Temperature

FML composites with the wire mesh angle 90° and 45° to the fiber orientation were measured in the 3-point bending mode at 5 Hz at 2°C/min. Considerably high stiffness was found in theglassy region and the E' decrease for the fiber type and the wire mesh angles. The addition of Titanium oxide inclusion improves the storage modulus of FML5 and FML6 composites in the glassy

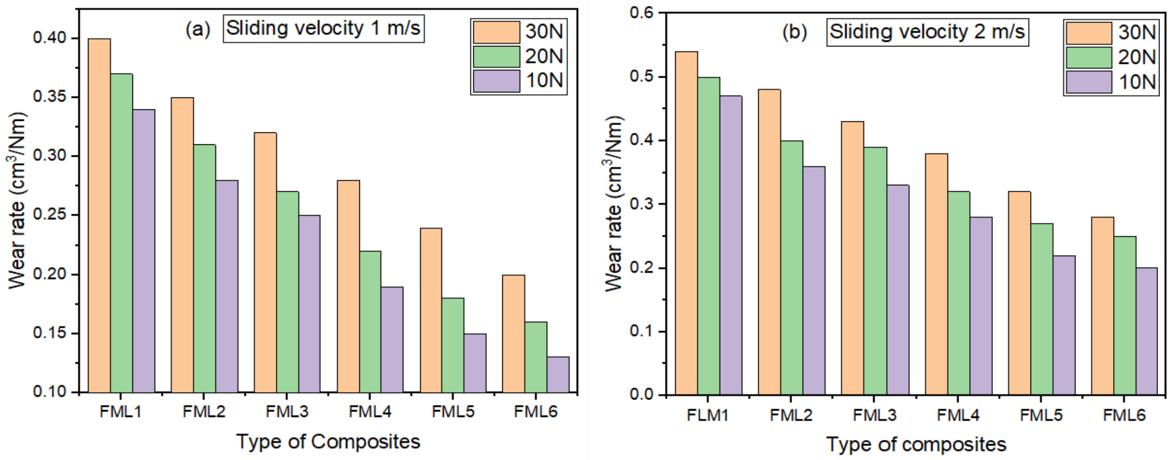


Cole Cole Analysis

Cole–Cole plots are the ideal model used to analyze the correlation among the storage modulus and loss modulus and the effect of distribution parameter [M. Rekaby]. Nevertheless, the cole- cole curves' contours represent the connection fiber, Titanium oxide, and epoxy matrix in the FML composites. From the figure, it was found heterogeneity proportions of the combinations producethe imperfect semi-circle. The imperfect semi-circle may due to the small air voids, micro cracks, little fiber breakage in the fiber bundle, and interlocking between fiber and the wire mesh. The 5% Titanium oxide filler addition FML composite holding closer to the semi-circle curves.The cole cole analyses also showed the bonding between the fiber, wire mesh, Titanium oxide .

Sliding Wear Analysis

wire mesh, which offers more wear resistance. However, carbon and glass fiber's physical properties also play a vital role in enhancing the weight loss of FLM6 (1.5gm) than the FLM5 (2gm) composites. The figure also depicts that the FLM1 composite has shown the highestweight loss than the FLM3 composite. However, the natural fiber composite's wear strength was predominantly dependent on fiber length, fiber length, and fiber bundle thickness



Wear rate of various composite samples at a) 1 m/s b) 2 m/s and

Fracture Surface using SEM

A scanning electron microscope (SEM) images) of the AHC1 to FAC6 composites reveal the fiber/wire mesh failure. In a few regions, the fiber pullout and fiber fracture were observed, indicating a reliable interface bonding between the fiber and matrix. The weft and warp direction of the fiber bundle was clearly seen in figure 10b.

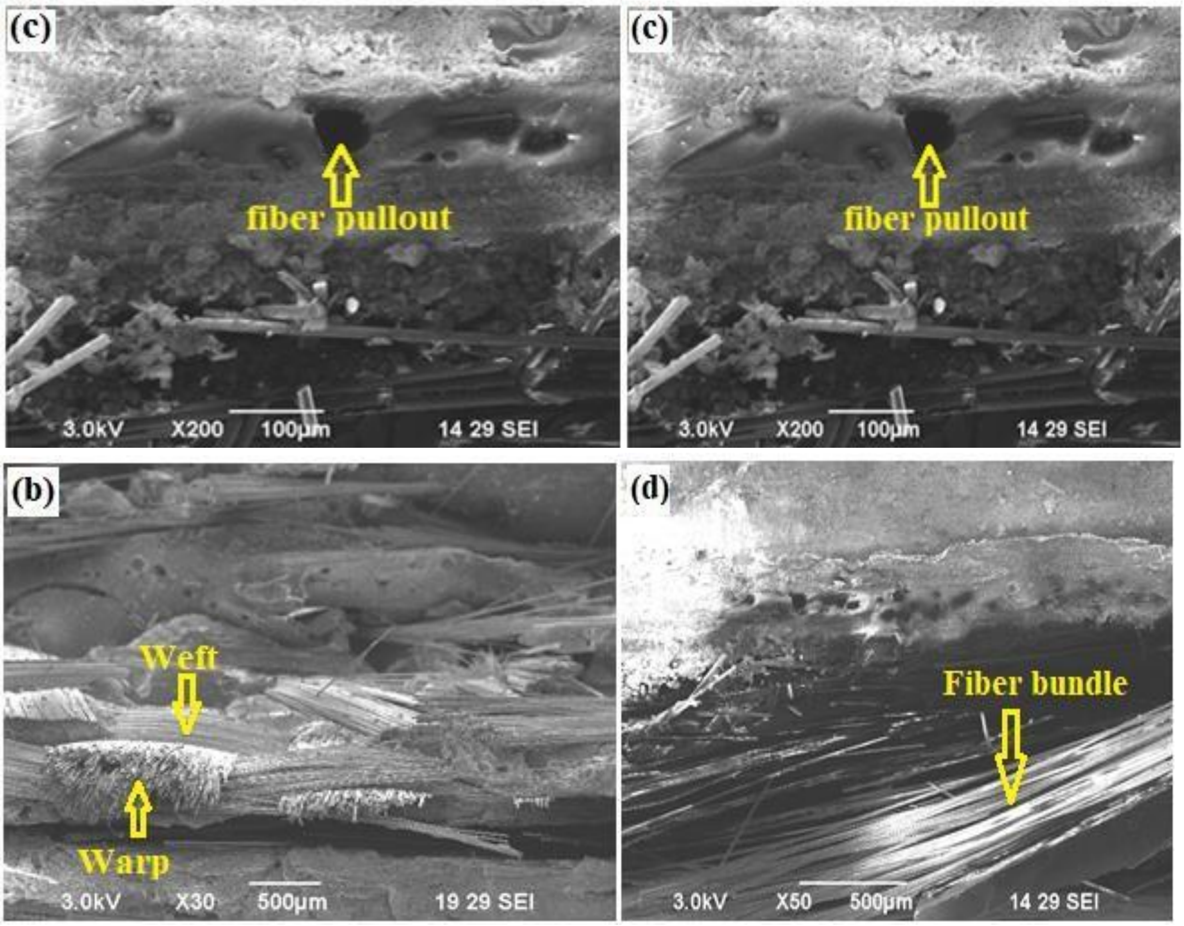


FIGURE 4:SEM image of the fractured samples

4. Conclusion

These mechanically strengthened and impact damage resistance improved hybrid composites could be used in automobile body manufacturing, surveillance aero-plane manufacturing, structural and domestic appliances manufacturing industries. The following conclusion has arrived from the current study.

- High stiffness was found in the glassy region, and the E' decrease for the fiber type andthe wire mesh angles.
- The peak of loss modulus influenced the addition of Titanium oxide. In the glassy region, notmuch effect was observed on the E'' up to 60°C in the Kenaf composites.
- In the flax composites, the Kenaf layer's inclusivity improves the damping factorby 16% due to the high energy absorption to dissipation.
- It was observed from the cole-cole curve the heterogeneity proportions of thecombinations produce the imperfect semi-circle.
- The micro-cracks developed in the conical nose shape in the wire mesh anglearrarangemt direction on the ballistic analysis.
- The obtained wear result discloses that the jute/ kenafcomposite has improved the weight loss up to 5% more than the fhb composite.

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