

Design and Analyze the Characteristics of Hybrid Fibre Metal Laminate

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ABSTRACT: The main theme and idea of the project focuses on the fabrication of new fibre metal laminate. First one, it is made up of jute, coconut coir, trunk of coconut tree and aluminium. It simply said (**FML-1**) second one, it is made up of human hair fiber, jute fiber and aluminium. It simply said (**FML-2**) by this project we can change the materials used for the automobile applications and building construction etc. We analyzing the wood and ACP (Aluminium Composite Panel) with this hybrid laminate in this project.

In this paper, the FML is designed by using uniform wear theory. The 3D model of Plate material has been prepared using modeling software Pro/E. In this the results are tabulated and graphically shown. Another contribution of this research also provides a platform or method for mechanical engineers to assess and evaluate performance and characters of FML.

I.INTRODUCTION

The development of composite materials and their related design is one of the most important advances in the history of materials. Composite materials are strongly heterogeneous materials. The properties of composites vary considerably from point to point in the material, depending on which material phase the point is located in. However monolithic ceramics and metallic alloys are usually considered to be homogeneous materials, to a first approximation. Many artificial composites, especially those reinforced with fibres, are anisotropic, which means their properties vary with direction.

Laminated composites are gaining wider use in mechanical and aerospace applications due to their high specific stiffness and high specific strength. Fiber-reinforced composites are used extensively in the form of relatively thin plate, and consequently the load carrying capability of composite plate against buckling has been intensively considered by researchers under various loading and boundary conditions. Due to the excellent stiffness and weight characteristics, composites have been receiving more attention from engineers, scientists, and designers.

The use of fibre reinforced polymer based composite have been increasing in various number of applications. Fuel tanks, rocket motor cases, pipes, pressure vessels, etc are made of composite materials.

Natural fibres include those made from plant, animal and mineral sources. Natural fibres can be classified according to their origin.

Plant fibre: Plant fibres are generally comprised mainly of cellulose:
Examples include cotton, jute, flax, ramie, sisal and hemp.

Cellulose fibres serve in the manufacture of paper and cloth. This fibre can be further categorized into following as : Seed fibre are the fibres collected from the seed and seed case e.g. cotton and kapok. Leaf fibre are the fibres collected from the leaves e.g. sisal and agave. Skin fibre are the fibres are collected from the skin or baste surrounding the stem of their respective plant. These fibres have higher tensile strength than other fibres. Therefore, these fibres are used for durable yarn, fabric, packaging, and paper. Some examples are flax, jute, banana, hemp, and soybean

Aluminium Composite Panels (ACP) are mainly light-weight composite material consisting of two pre-finished aluminium cover sheets heat-bonded (laminated) to a core made of polyethylene plastic material, available in 3mm, 4mm, and 6mm thicknesses after finishing and can be curved and bent to form corners.

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These panels are used widely as exterior covering of commercial buildings and corporate houses. While adding to aesthetic beauty of the structure, they are also resistant to acid, alkali salt spray, pollution and provide good thermal as well as sound insulation. These Panels are widely used due easy maintenance in almost any kind of climate through normal wash with water and mild detergent that ensures long lasting performance. There are about 25 brands of ACP available in the Indian market.

Most of ACP manufacturers are now catering to projects directly. The ACP manufacturers are in the process of creating awareness among end users and establishing their network like plywood sales. The industry is making plywood dealers aware about the uses and application of ACP as they are the one who are directly related.

II. FIBRE METAL LAMINATES

The present work focuses on the fabrication of a new Fibre Metal Laminate made up of Jute, Coconut Coir, Trunk of coconut tree, ALuminium (JUAL) and another Laminate is made up of HUMAN hair fiber, Jute fiber, ALuminium (HUAL) to be used in Civil Building Construction and in Automobile applications.

The natural fibre Jute, Coconut Coir, Trunk of Coconut Tree are used along with aluminium to manufacture a strong laminate that would replace use of plywood in automobile platform and prevents trees and thus will be helpful in reducing global warming

Then the natural fibers that are thrown like a waste are made use in this Laminate. These fibers are used to manufacture a strong laminate with improved properties. Human hair in abundant are dumped like a waste but it is a non-biodegradable waste and it creates problem to the persons living nearby area, where the saloon wastes are dumped, it will fly in air and there are chances of mixing in food and may cause dysentery and may cause many other deficiencies. Hence if this project is done in bulk production then wastes are made use of and will reduce their pollution and their dangerous effects

The influence of stacking sequence with respect to Aluminium metal, jute fibre, on the Tensile and Flexure behaviours are studied.

The Fibre Metal Laminates (FML) is a new type of hybrid composites developed at the Delft University of Technology. FML consists of thin sheets of Aluminium bonded with fibre adhesive layers. This laminated structure behaves much as a simple metal structure, but with considerable specific advantages regarding properties such as metal fatigue, impact, corrosion resistance, fire resistance, weight savings and specialized strength properties. This first hybrid metal laminate is known as ARALL (Aramid Reinforced ALuminium Laminate). ARALL showed the damage tolerance and fracture toughness known from the metal laminates together with the strength and crack growth resistance brought in by the fibres. GLARE (GLASS REINFORCED fibre metal laminate), using glass fibres, was then introduced in 1991, due to the good compressive properties of glass. These compressive properties lead to a better loading flexibility of GLARE compared to ARALL since Aramid fibres show a very poor behavior under compressive loading. GLARE is now an accepted Material in the aircraft Industry. While the 20 percent weight reduction was the prime driver behind the development of this new family of materials, it turns out the additional benefits like cost reduction.



Fig 1: Schematic diagram of orientation of FML

ADVANTAGES OF FIBRE METAL LAMINATES

Aircrafts use of fibre metal laminates parts that will reduce overall mass of aircraft without reducing stiffness, strength and reduces fuel costs. For example 0.453 kg of mass reduction in weight saves up to 1360 litre of fuel per year. Fibre Metal Laminates take advantages of metal and fibre reinforced composites with

- Excellent mechanical properties

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- Physical properties
- Durability
- Safety
- Cost saving
- Weight reduction

DISADVANTAGES OF FIBRE METAL LAMINATES

Some of the disadvantages of fibre metal laminates are

- Production method of FML is a long processing cycle of operation.
- Skilled technicians are needed for production.
- Time of curing is more.
- High production cost.

Applications of Fibre Metal Laminates

Fibre Metal Laminates are finding great use commonly in aerospace applications. The applications of existing fiber metal laminates are shown in Figure

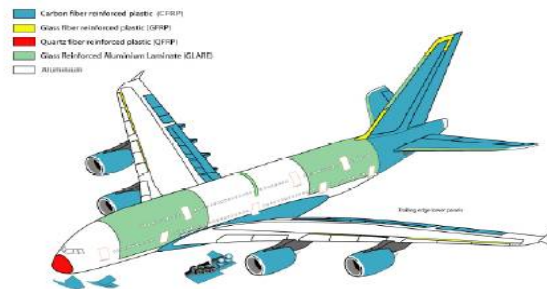


Fig 2: Application of existing FML in airbus

Application of existing fml in airbus

- ARALL – Lower wing skin panels of Fokker27 aircraft.
- GLARE – Bulk cargo floor for Boeing 777 airbus
- HTCL – crown fuselage panels of T38 aircraft

AUTOMOBILE PLATFORM

The automobile platform is mainly used to bear load for long time and duration. So its made of PLYWOOD laminate the current project focuses to replace the laminate with natural fibers which are thrown like a waste

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Fig 3: Automobile Platform

III. ORIENTATIONS

Orientation is defined as the angle between the any of the two axes. In this project we take the three types orientation for design the hybrid metal composite materials

They are

1. 0° orientation
2. 45° orientation
3. 90° orientation

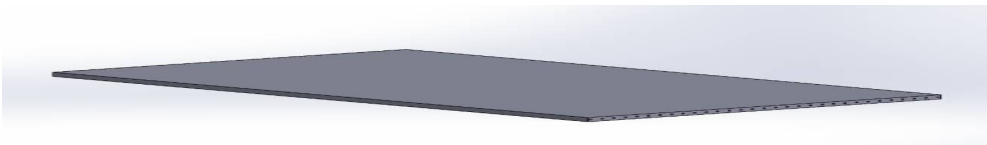


Fig 4: 0 Degree Orientation

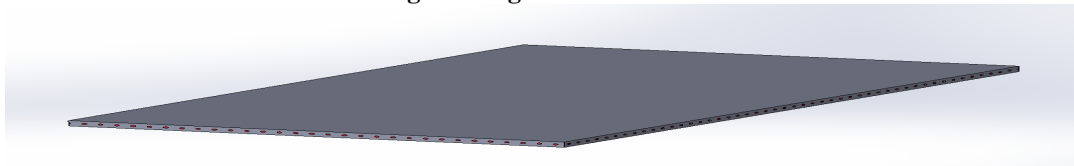


Fig 5: 45 Degree Orientation

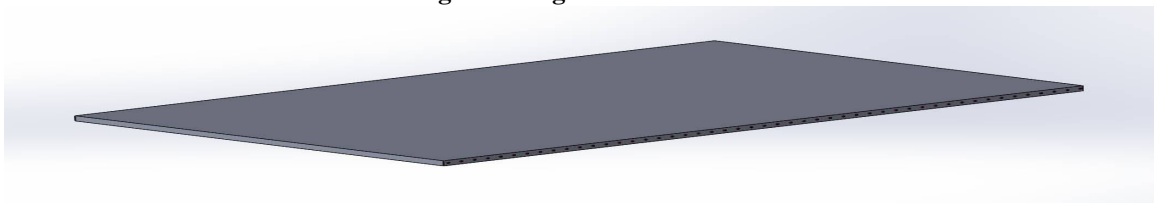


Fig 6: 90 Degree Orientation

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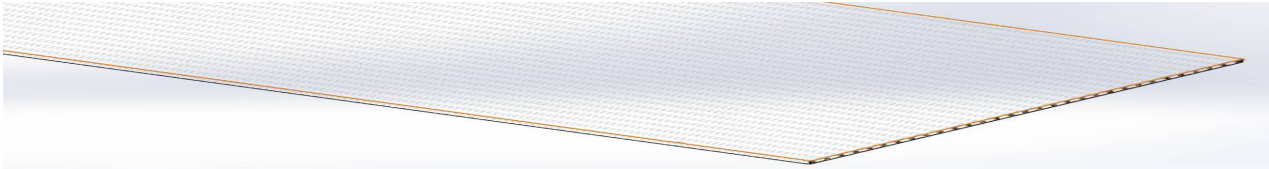


Fig 7: Wire Frame 0 Degree Orientation



Fig 8: Wire Frame 45 Degree Orientation

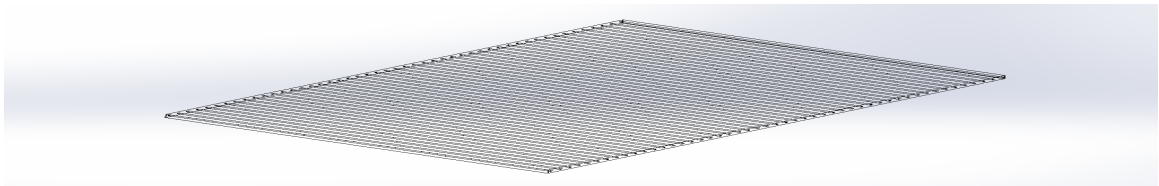


Fig 9: Wire Frame 90 Degree Orientation

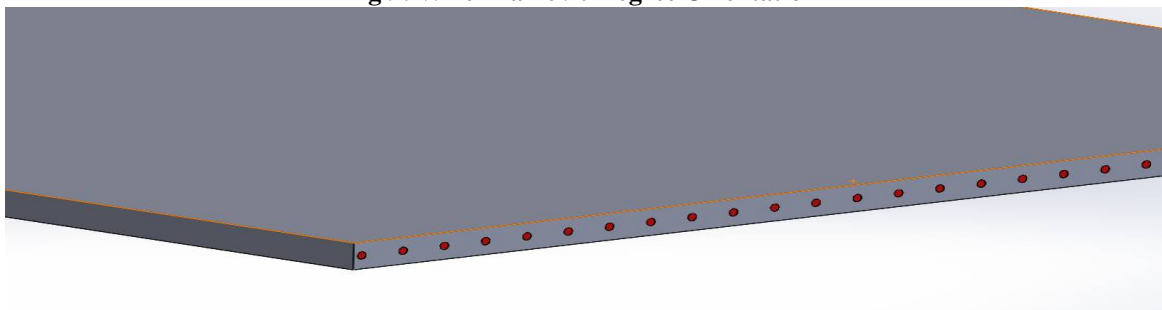


Fig 10: Jute Material inside the Plate at 0 Degree Orientation

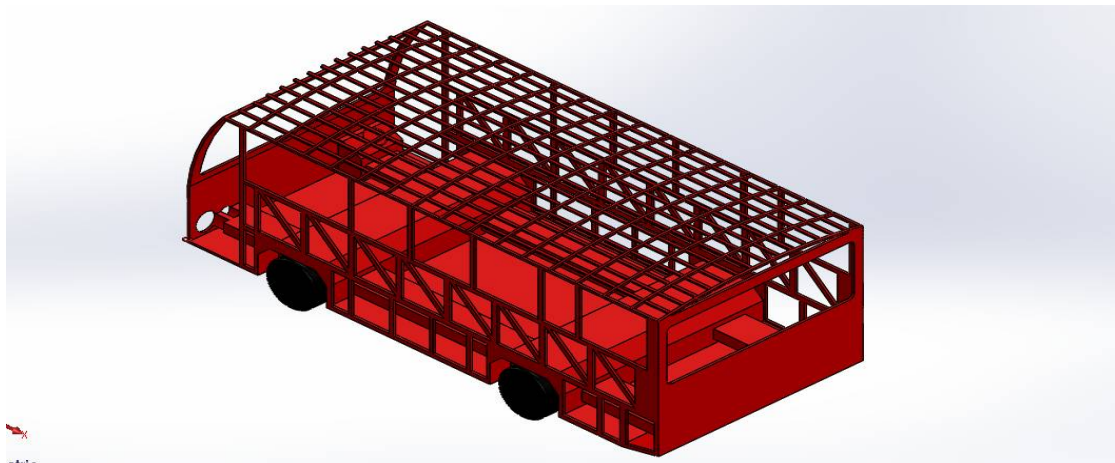


Fig 11: Full Layout of Bus Body

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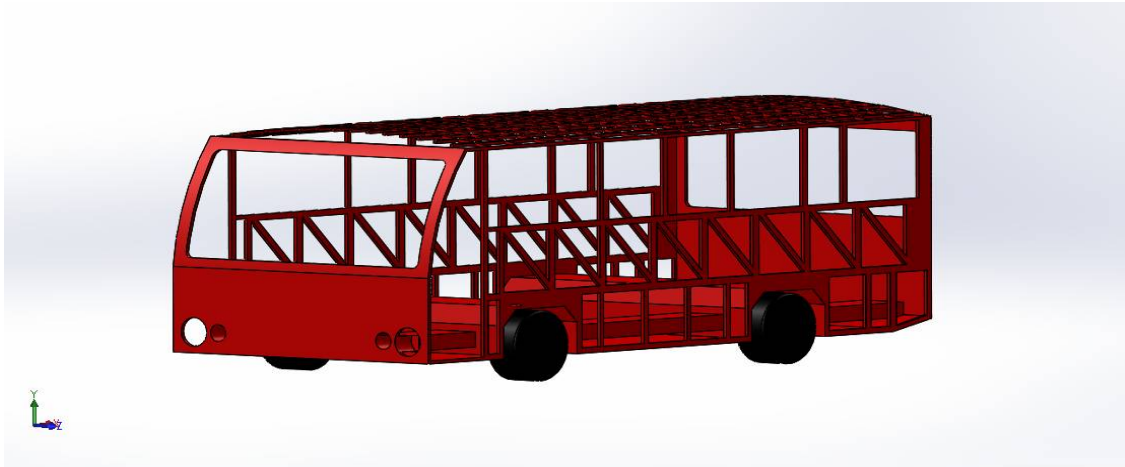


Fig 12: Front View of Bus Body

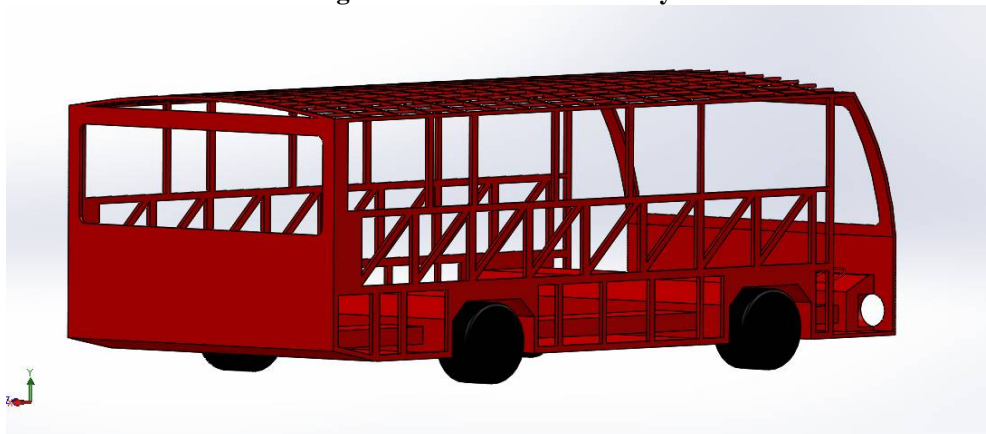


Fig 13: Rear View of Bus Body

IV.RESULT

The fuselage part of Civil Building's panels, Automobile platform, bus body and air bus made up of JUCTAL & HUAL respectively fibre metal laminate had been analyzed for its tensile strength and flexure strength by means of classical laminate theory by converting the semi cylindrical part of fuselage into an equivalent rectangular plate subjected to equivalent stresses and resultants.

The tensile behavior of JUCTAL & HUAL laminate, which is formed by replacing with natural fibers in Jute, Coconut coir, Trunk of coconut tree, Aluminium & Human hair fiber, Jute, Aluminium is studied by varying number of layers for certain arrangement. In this study the stress, strain & Young's Modulus of 8 and 13 layered JUCTAL & HUAL laminate were found. The Maximum stress induced in JUCTAL & HUAL more than PLYWOOD & ACP specimen, which we inferred the behavior that increasing number of layers for same arrangement increase stress withstanding capability of the material.

In this study the Flexure Strength of JUCTAL & HUAL FML were analyzed with different orientations and stacking sequence of fibres. The Flexural Strength, Strain and Flexural modulus were calculated. The Flexural Strength is directly proportional to the number of layers and the stacking sequence of the fibre.

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