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Mechanical Characterization of Balsa wood, Depron and Glass fiber Composite for Aircraft floor panel and Luggage Compartment

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Abstract

The present materials record greatest usage of composites in automotive and aircraft industry. Parts of aircrafts are experimenting materials with respect to mechanical properties which should have more strength to weight ratio, resistance to buckling, high ultimate tensile strength, high resistance to vibration, and high fatigue. Composite materials filled the requirement for making high strength to weight ratio components. This paper aims to study the Mechanical Characterization of Balsa wood, Depron and Glass fiber. The fabricated composites is highly suitable for manufacturing of floors in aircrafts instead of carbon fiber reinforced epoxy composite. Also, it will be used for luggage compartment. Using Hand Layup process specimens were prepared and the tensile test, Temperature Test and Flexures test has been performed as per ASTM standard. We observed 12%-17% more bending strength from this experiment which suits well for aircraft floor panel.

Keywords: *Balsa wood, Depron, E-Glass Fibre*

1.0 Introduction

Composites are made up of two or more materials that, when combined, generate desirable qualities that none of the constituents could achieve on its own. Because of their high specific strength, composites have greater structural performance. high modulus to density ratio and strength in today's rapidly expanding aerospace industry, a rise in disposable income has resulted in an increase in air travel, resulting in an increase in the later, rise in aircraft was caused by the production of reasonably priced and commercial aircraft. market for floor panels as a result, the replacement of outdated floor panels eventually drives. The rise of the aviation floor panel market, as well as the demand for lightweight, it is envisaged that thermally stable, low-smoke, and fire-resistant floor panels will be developed. as a result of technological and system advancements manufacturers of aircraft composite materials are in high demand, and looking for composite materials that are both lightweight and strong. Proportion of weight at present, majorly metal honeycombs are used as floor panels that is high in maintenance and a lot of budget is required. These aluminum honeycombs for a robust impact they deform and won't revisit into its original form and size they don't have shape memory alloy property; thus, makers are trying to find light-weight compactable composite material. during this project we've selected wood depron and glass fiber. Reason behind its recent study confirms that balsa wood has higher toughness

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compare to different rarity materials used as core materials. wood together with depron and optical fiber provides higher tensile strength, Flexural strength and temperature resistance. Glass Fiber reinforced polymers have many applications like in structural components, storage tanks and in automotive sector. The composites are mainly used in small passenger aircraft interiors etc. Also used in high load parts in smaller aircrafts.

2.0 Methodology

Selection of materials

Balsa wood: The materials which are considered in our project is Balsawood, E-glass fiber, Depron sheets and the resin used is Epoxy L-12 with K-6 hardener. We considered balsawood because it is lightweight and it has high strength-to-weight ratio. As we require sandwich composite with high stiffness and balsawood has it. It is the material which is from natural resources. It has density around 160 kg/m^3 and it has good insulating properties. It is easily available.

Depron: Depron is a material which is also a lightweight material and it is inexpensive foam. Depron foam has very good strength and stiffness in bending with balsawood. It has density that varies around 35 to 40 kg/m^3 depending on the size. Depron has melting temperature above 160™. It is also called as "Extruded polystyrene foam".

Figure 1: Balsawood

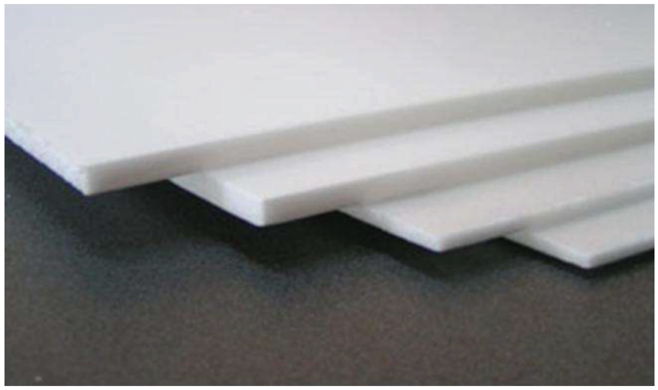

Figure 2: Depron Sheet

E-glass Fibre: Glass fiber is strong and less brittle. It can be molded into different shapes. Glass fiber is the original fiber reinforcement of modern composites. It is cost effective when compared to carbon fiber. In our project it is used as reinforcement agent. E-glass is

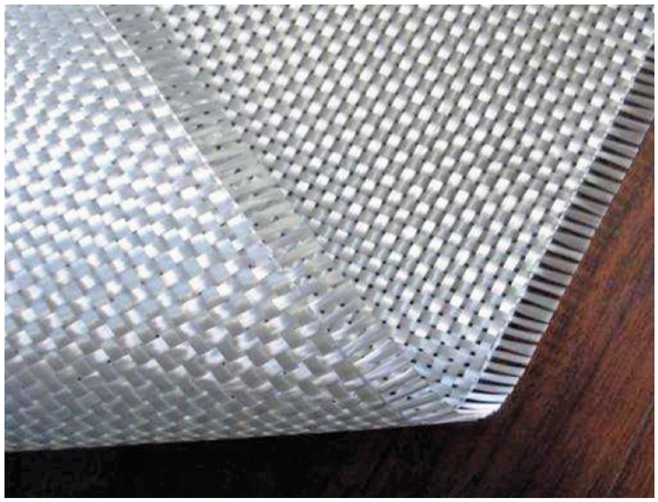

Figure 3: E-Glass Fiber

Figure 4: L12 Epoxy Resin and K6 hardner

highly electrical resistive and alkali free. It has density around 2.6g/cm^3 and its maximum operating temperature is 550™.

Epoxy resins are considered for their high strength and adhesive properties. It sticks quickly to other materials like wood, glass, fabric and metals. Hardeners are called the catalysts of the epoxy resin. They cure at room temperature. In this project we are using L-12 epoxy resin with k-6 hardener.

Modelling

- We will do two combinations of composites: Balsawood-Depron-Balsawood, Balsawood-Glass fibre-Depron-Balsawood.
- Dimensions:
  Length=300mm,
  Breadth=100mm,
  Thickness=4mm

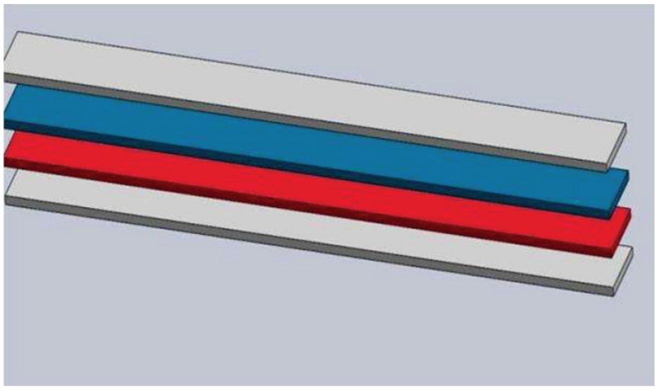

Figure 5: Composition of Balsawood-Depron-E- glass fibre Balsawood

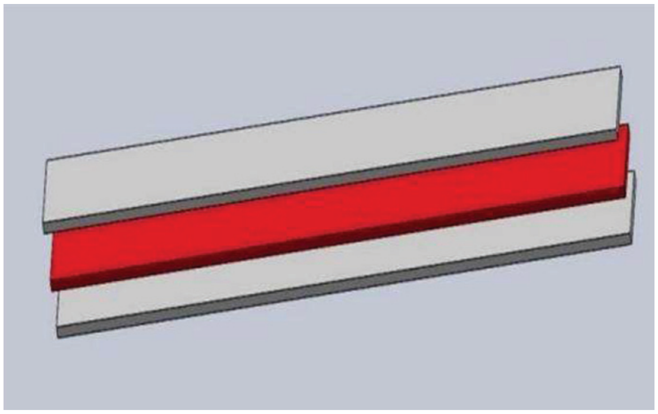

Figure 6: Composition of Balsawood -E-glass fibre-Balsawood

Fabrication

Combination 1

B-G-B composite is an arrangement of Balsawood-E-glass Fiber-Balsawood. As it is a hand layup process, the materials are taken according to the dimension specified.

The wax is used as a release gel; Balsawood is placed on it. Epoxy resin and hardener which is priority mixed in ratio of 10:1 is applied on it with the brush and E-glass fiber is placed on it. Final layer of balsawood is placed above the resin. The composite is applied a hydraulic pressure under 5 tonnes and left for a day.

Combination 2:

B-G-D-B composite is an arrangement of Balsawood-Glass fiber-Depron-Balsawood. The hand layup process is used to fabrication the composite with specified dimension. The wax is applied as a release gel more amount of wax should be applied as the first layer is wood which can stick to the mold. The Balsawood is placed on it. Epoxy resin and hardener of ratio 10:1 is applied on it and E-glass fiber is over laid

Figure 7: Fabrication of materials by hand lay up

Figure 8: Fabricated materials

on it then followed by the epoxy-hardener layer Depron was placed on it. Then a layer of resin and hardener mixture. The final layer in Balsawood was placed. The composite was applied a hydraulic pressure under 5 tonne and left for a day.

Results and discussion

Temperature resistance test

In temperature resistance test the B- G-B composite has shown more resistance than B-G-D-B composite. The glass fibre in B-G-B composite made it highly resistance to temperature.

The temperature of B-G-B composite has a combination of glass fibre which can withstand high temperature than depron.

- **Flexure Test**

  The composites are cut as per ASTM D790 standard dimensions. The test specimen geometry of B-G-B and B-G-D-B are 90*10*3 mm^3 and are 90*10* mm^3 respectively. In the results B-G-D-B composite as shown 12% more flexure strength than the other combination. Here Glass fibre and depron are played as strengthening materials. They provide good bonding strength, by adding of it increased the hardness value of both

Table 1: Flexure test results

Sample	Sample ID	Load(N)	Flexural strength (N/mm^2)
B-G-D-Bcomposite	S1	147	72.10
	S2	146.4	72.06
	S3	149.6	72.30
B-G-Bcomposite	S1	128.2	60.30
	S2	126	59.47
	S3	127.8	60.18

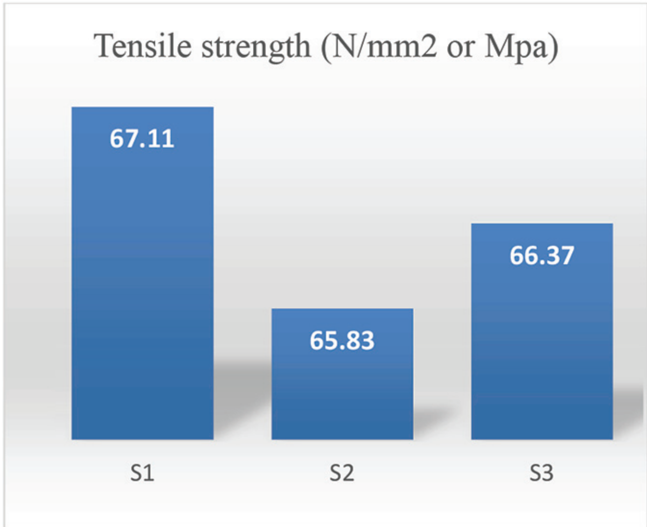

Figure 9: Graph of Tensile test results

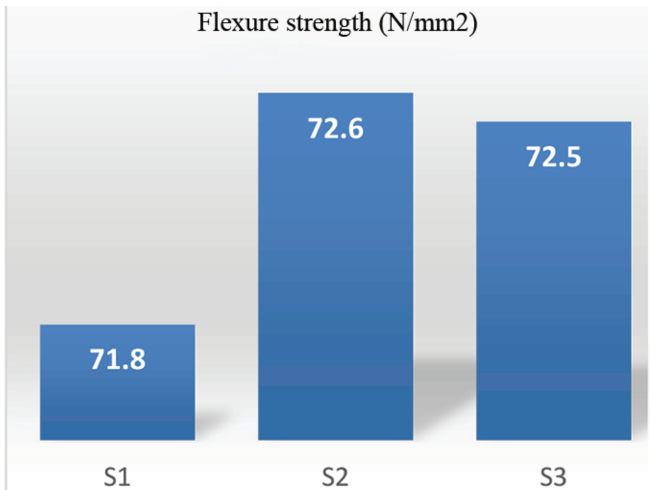

Figure 10: Flexure test results of different specimen of B-G-D-B composite

Table 2: Tensile Test Results

Sample	Sample ID	Load (Kg)	Elongation (mm)	Tensile strength (Mpa)
B-G-D-Bcomposite	S1	245	3.65	67.11
	S2	239.8	3.64	65.83
	S3	242.46	3.65	66.37
B-G-BComposite	S1	189.64	3.56	53.16
	S2	182.07	3.563	51.09
	S3	190.32	3.56	53.45

combination composite. Depron in B-G-D-B composite as given more added flexure strength. The bending of composite with depron hold the yield stress and higher strength.

- **Tensile test results**

  The tensile test is done by cutting the composite sample according to ASTM D638 standards. The specimen dimensions for B-G-B and B-G-D-B are 115*19*3 mm^3 and 115*19*4 mm^3 respectively. The ultimate tensile strength possessed by B-G-B and B-G-D-B composites is 52.560 and 66.430 N/mm^2 respectively. Both B-G-B and B-G-D-B composites shown greater improvement in tensile strength compared to plain balsawood. The addition of glass fibre and depron increased tensile strength tremendously by filling the band gap between cellulose fibres and lignin matrix. The B-G-D-B has 18% more tensile strength than B-G-B composite. Depron has added more tensile strength to B-G-D-B combination.

Conclusions

- Specimen with depron has shown 18% and 12% more ultimate tensile strength and flexure strength respectively.
- The both specimen withheld the safety factor temperature.
- Sample with depron can be used along with other floor pan materials in aircraft.
- Sample with B-G-B composite has more sufficient strength to be used for luggage compartment in aircrafts and as warehouse roof.

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