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Experimental Investigation of Balsa wood, Depron and Glass fiber Composite material for UAVs application.

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Rockwell Hardness,
Temperature Resistance

Abstract

Composite materials are the combination of fiber and matrix materials of different constituents, the mixture of these two composition makes this useful for the UAV's applications. Due to small and less strengthen parts in UAV's, Composite materials fulfilled the requirement for making high strength to weight ratio Components. The present study focus on experimenting materials like Balsa wood, Depron and Glass Fiber for investigating their physical and mechanical properties liken Strength to Weight ratio, resistance to buckling, tensile strength, Inflammable, Thermal gradient, Noise and Vibrations, Resistant against deteriorative fuels and chemicals, Corrosion and oxidation is of shape ability, Fastening and joining, Fatigue and Endurance limit. The specimens were prepared and tested according to ASTM standard. The results shows that Depron-Glass fiber-Balsa wood showed 6 time greater tensile strength and 66% harder than plain balsa wood. Depron-Glass fiber-Balsa wood showed 34% times greater flexural strength than plain balsa wood.

1. Introduction

A material which is made up of two or more different materials with different properties combined to make a new material which has higher physical properties compared to the physical properties of the raw materials is called Composite material.

Composite as a technical material

Using modern techniques and equipment it is quite difficult to obtain high material characteristics, performance, durability, and reliability in materials such as metals and its alloys. Composites are widely used in fields such as rocketry, aviation, automotive, chemical industries, and electrical constructions. Composite material is made up of matrix with a reinforcement. And secondary phase is reinforcement which has further classification.

Composite materials are usually classified by the type of reinforcement they use, this reinforcement in embedded into a matrix that holds it together. The reinforcement is used to strengthen the composite. The composite properties are best in the direction of the fibers. Perpendicular or transverse to the fibers, the matrix properties dominate because load must be transformed by the matrix every fiber diameter.

The different types of matrix materials used in Composites are: -

Metal matrix: - A matrix combines the particles of the reinforcement to protect them from external influences, matrix transfers the load to the reinforced phase, a good bond strength is required for reinforcing material, A low weight is included in the requirements of the matrix.

Polymer matrix: polymer matrix is the most common type in production, they have low weight, high strength, are corrosion resistant, surface treatment not required, and have low thermal conductivity compared to metal matrix.

Ceramic and glass matrix: - it is a heterogeneous material made up of crystalline substance of various compositions, they usually have good chemical resistance, low thermal conductivity, high melting point, high hardness and compression strength and are non-conductive. Glass is an amorphous subst5ance which is formed by crystallization, the properties of glass and ceramics are almost same.

The reinforcement: **-** reinforcement transfers the external load, it has high strength and modulus of elasticity, and a small deformation. Tensile behavior of the composite is shown by the shape, concentration, and orientation, the shape of the particles is considered to be cylindrical or spherical, the size and distribution is determined by the texture of the reinforcement.

2. Literature Survey

Strait at el performed an impact test on composite laminates with varying stack sequence, the test proved that stacking sequence has a big effect on the impact resistance **[1]**. **Wu and Chang** understood the displacement stress, strain distribution along the thickness of laminate under impact force [2]. **Choi** and **Chang** made a model so that he can understand the impact of low velocity point damages in graphite/epoxy laminated composite, existence of impact velocity threshold for laminated composite was concluded [3]. **Dost et al** founded significant effect of laminate stacking on compression after results. **Caprine et al** carried tests on carbon/epoxy laminates with different thickness for low velocity impact. They also tested for delamination points where load was applied and energies were absorbed [4] [5]. **Caprino** and **Lopresto** tested for the residual strengths. Results obtained were predictable and good when compared with experimental data. Although, what was not predictable was the internal damage [6]. **Luo et al** had an approach for the evaluation of the impact damage initiation and strength for matrix cracking propagation. Through this approach, the characteristics of impact damage became predictable. As a result of both, simulation and experimentation, a small zone of matrix failure was discovered at the center of impact area [7]. **Sadasivam** and **Mallick** studies effects of material and geometric parameter on mechanical response of graphite-epoxy composite laminate was observed [8]. **Aslan et al** experimented to numerically understand the effects of projectile velocity, thickness, and in-plane dimensions of target, and projectile mass on the response of laminated composure plates under low velocity impact [9]. **Hosur et al** experimented with four different combinations for the low velocity impact response. It was proved that the hybrid composites have better load carrying capacity than that of the carbon epoxy laminates [10]. **Saez et al** conducted an experiment to investigate the damage tolerance of thin carbon/epoxy laminates [11]. **Hossenzadeh et al** conducted an experiment with four different fiber reinforced composite plates.

The outcome was that the carbon fiber reinforced composite plate has the best structural behavior under low velocity impact

Problem formulation

1. Many studies focus on virgin materials only, specifically on depron and balsa wood.
2. The study focuses on the effect of orientation on different fiber materials**.**

Objectives

The objective of current study is as follows: -
1. comparative study of different composite compositions (balsa wood-glass fiber, depron-balsa wood and depron-glass fiber-fiber glass)
2. To estimate the mechanical properties of different composition structure.

3. Experimentation

Aim: to fabricate composite material combining the depron, glass fiber and balsa wood strips to form three different combinations of composite material. Different combinations of the above materials are to be tested and analyzed.

The scope of the project is high strength to weight ratio and cost efficient.

Concept of operation:

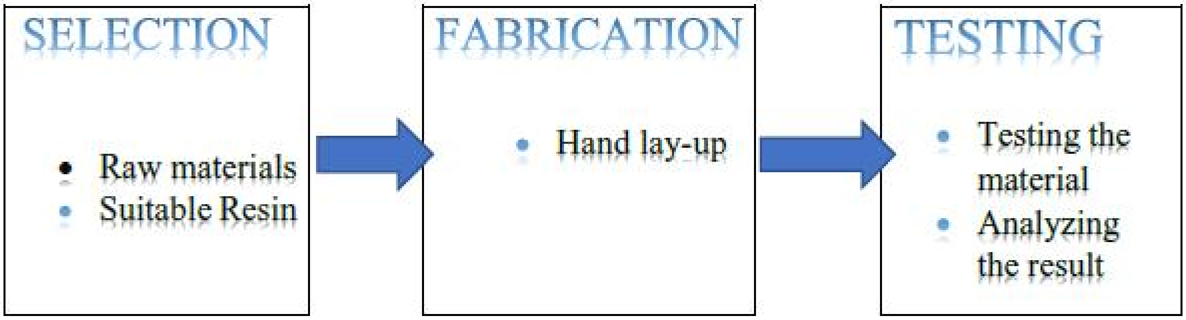

Fig. 1.1 Process Chart

Raw materials used for the making of composite materials are:

- Balsawood
- Depron
- Glass fiber
- Epoxy resin (L 12 resin and K 6 hardener)

In the fabrication process Hand lay-up layers of resin and reinforcement are manually applied to an open mold to build the laminated composite structure.

Preparation of depron, balsa wood and fiber glass composite: initially Balsa wood, depron and glass fiber were cut into desired measurements, and the resin, hardener and catalyst were mixed in 10:01 ratio (i.e. 10ml of resin mixed with 1ml of hardener with 2ml of catalyst).

4. Testing and Results

Temperature resistant test

Temperature resistant is conducted for all three combinations that is Balsawood-depron combination, Balsawood-Glass fiber combination, and Depron-Balsawood-Glass Fiber combinations, the test was done using a furnace to know the heat resistance of the following composite combinations.

Table 1.1 Temperature resistant test result

Material	Temperature	Observation
Balsawood-Glass Fiber composite	Up to 200-degree Celsius	No sign of blisters or pores found
Balsawood-Depron-Glass Fiber composite	Up to 150-degree Celsius	No sign of blisters or pores found
Balsawood-Depron composite	Up to 150-degree Celsius	No sign of blisters or pores found

Fig. 1.2 Temperature Resistant Test

2. Rockwell hardness test

This test was done using a Rockwell Hardness testing machine for all the three test samples to determine the hardness of the following composite combinations. In this test three different loads of 60KN, 100KN, and 150KN were used.

Table 1.2 Rockwell Hardness Testing Results

Material	Load	Tensile strength
Balsawood-depron composite	60KN 100KN 150KN	43 41 48
Balsawood-depron-glass fiber composite	60KN 100KN 150KN	63 66 64
Balsawood-fiber fiber composite	60KN 100KN 150KN	52 51 49

Fig. 1.3 Specimen after Hardness Testing using Rockwell Hardness Tester

3. Fire Retardant Test

Fire retardant test is a testing of various thermos plastic thermosetting and coating materials that resist the spread of fire, there are number of methods for evaluating fire retardancy that is, UL-94V method, cone calorimetry, and limited oxygen index method.

Table 1.3 Fire Retardant test results

Material	Time taken
Balsawood-depron composite	9 seconds
Balsawood-glass fiber composite	7 seconds
Balsawood-glass fiber-depron composite	12 seconds

Fig. 1.4 Specimen after Fire Retardant Test

5. Conclusion

Materials are most important in construction of any aircrafts. It should meet the necessary requirement to satisfy the needs of the application of the aircrafts. Any problem in material would lead to major accidents. Composite materials combine the property of two or more material. Hence it is preferred amongst other materials. This project aimed at fabricating a composite for UAVs, which plays a vital role in UAV construction. The three composites Balsawood-Depron, Balsawood-Glass Fiber-Depron, Balsawood-Glass Fiber composite was fabricated and tested. Amongst these three combinations of composites, by the performing three major tests it is recorded that the combination of three materials that is Balsawood-Glass Fiber-Depron composite is preferred compared to the other two combinations of composites as it has higher Hardness, more Flexible. The composite made of Depron and Balsawood that is Balsawood-Depron composite is not at all preferred as it showed least Hardness than other two composite materials. When compared to the individual properties of the Balsawood, the fabricated material Balsawood-Glass Fiber-Depron composite has better properties such as heat resistant, hardness. Quantitative conclusions are as follows.

Depron-Glass Fiber-Balsa wood showed 6 time harder than plain balsawood.
Depron-Glass Fiber-Balsa wood showed 66% more heat resistant than plain balsawood.
Depron-Glass Fiber-Balsa wood showed 20% more fire retardant than plain balsa wood.

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