MECHANICAL CHARACTERIZATION OF PLA, PLAF & FLYASH BIOCOMPOSITES FOR AIR INTAKE DUCT OF AN TRAINER AIRCRAFT

Project Reference No.: *48S_BE_4534*

College : Proudhadevaraya Institute of Technology,Hospete,Bellary
Branch : Department of Mechanical Engineering
Guide(s) : Prof. Poornima K
Dr. Madeva Nagaral
Student(s) : Mr. Mallikarjuna O M
Mr. Rahul K
Mr. Zaheer ahmed khan P
Mr. N Y Sriyellappa

Keywords:

Mechanical characterization, Hardness & Tensile test of Specimen

Introduction: Bio Composite

Composites are materials made from two or more distinct constituents, combined to achieve superior properties compared to the individual components. These materials are extensively used in aerospace, automotive, and construction industries due to their lightweight, high strength, and corrosion resistance. A significant advancement in this field is the development of bio-composites, which incorporate renewable, biodegradable materials and offer eco-friendly alternatives to conventional composites.

Bio-composites consist of a natural fiber reinforcement and a biodegradable polymer matrix. In this study, Acid (PLA) is used as the matrix due to its biodegradability and compatibility with natural fibers. Pineapple Leaf Fiber (PALF), known for its high strength-to-weight ratio, and Fly Ash, a byproduct from coal combustion, are selected as reinforcements. The integration of these materials not only improves mechanical properties but also supports sustainability by utilizing agricultural and industrial waste.

The composite specimens are fabricated using the hand lay-up process followed by compression molding, with different weight proportions of fly ash (0%, 5%, 10%, and 15%) while keeping PALF constant at 30%. Mechanical tests such as tensile and flexural strength are conducted to evaluate the performance of the composites. Results indicate that composites with higher fly ash content exhibit improved strength and stiffness, making them suitable for applications like air intake systems in aerospace, where strength, durability, and weight reduction are crucial.

This project demonstrates that PLA-PALF-Fly Ash bio-composites are promising candidates for lightweight and sustainable engineering applications, aligning with the goals of reducing environmental impact while maintaining high performance.

Figure 1: Bio composite specimens (PLA,Flyash & Pineapple leaf fibers)

Objectives:

- To design and fabricate a sustainable bio-composite using PLA, pineapple leaf fiber (PALF), and fly ash.
- To develop a lightweight, cost-effective material suitable for aerospace applications
- To evaluate mechanical properties through tensile and flexural testing.

- To assess the composite's potential for use in eco-friendly and high-performance engineering applications.

Methodology:

1. Material Selection: PLA, PALF, and fly ash were selected for their sustainability, mechanical strength, and cost-effectiveness.

2. PLA: A biodegradable polyester from renewable sources, offering good biocompatibility and processability.

3. PALF: Natural fiber with high strength-to-weight ratio, renewable and biodegradable.

4. Fly Ash: Industrial by product used as a filler to improve composite strength.

5. Fiber Pre-treatment: PALF was cleaned, dried, and possibly surface-treated for better PLA adhesion.

6. Processing: Materials were compounded and extruded using twin-screw extrusion.

7. Molding: Final shapes formed using injection or compression molding.

8. Testing: Tensile and flexural properties tested per ASTM standards using UTM and flexural testing machines.

Result and Conclusion:

In conclusion,

1.PLA-PALF-fly ash bio composites showed improved mechanical properties with up to 15% fly ash addition.

2. Tensile strength, flexural strength, and stiffness increased with optimal fly ash content.

3. The bio composites demonstrated potential for aerospace applications, particularly in air intake ducts.

4. Natural fibers like PALF and industrial by-products like fly ash can enhance bio composite performance.

5. The sustainable material selection and eco-friendly fabrication processes reduced environmental impact.

6. The study highlights the potential of PLA-PALF-fly ash bio composites as a sustainable alternative for lightweight, high-performance components.

7. Future research directions include optimizing component proportions, advanced fiber treatments, and hybrid composites.

8. Recyclability and lifecycle assessments are essential for validating long-term industrial feasibility.

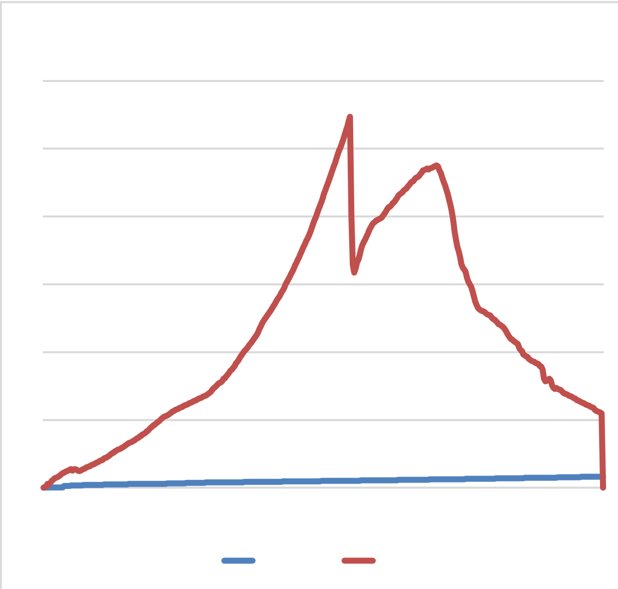


Fig 2 :It represents the displacement vs load graph for 0% flyash of Tensile test

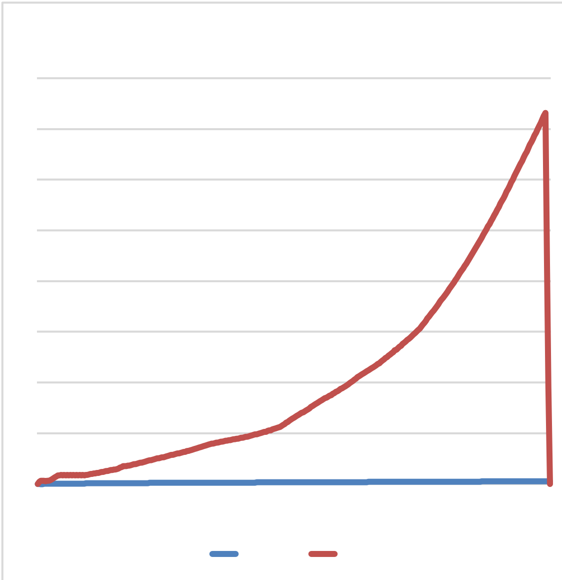
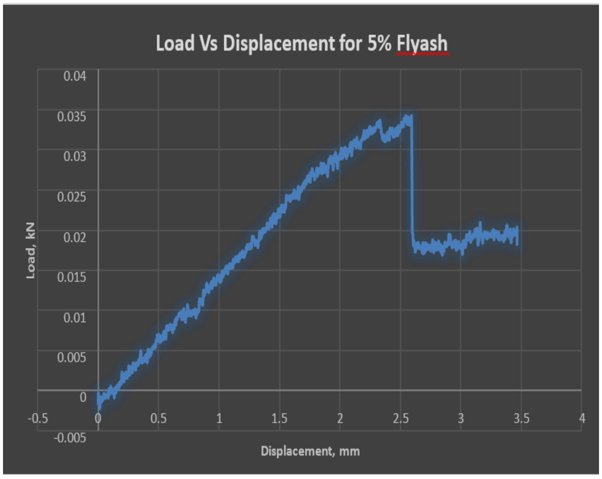


Fig 3 : It represents the displacement vs load graph for 15% flyash of Tensile test



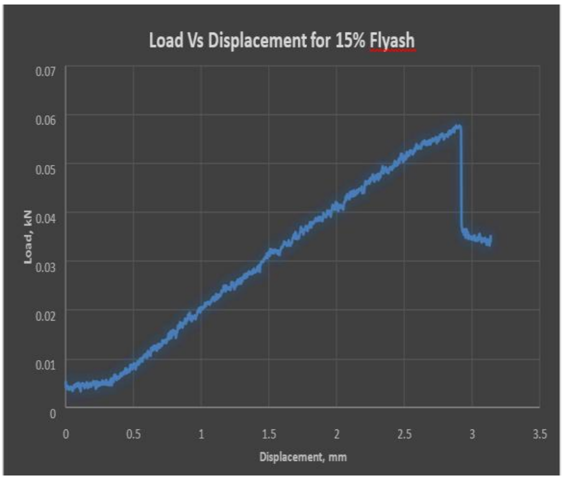


Fig 4 : It represents the load vs displacement graph for 0% flyash

Fig 5 : It represents the load vs displacement graph for 15% flyash

Future Scope:

The future scope of this project includes:

1. Development of PLA-PALF-fly ash biocomposites for aerospace applications.

2. Characterization of material properties.

3. Investigation of mechanical performance (tensile strength, flexural strength, stiffness).

4. Optimization of fly ash content (up to 15%).

5. Sustainable material selection and eco-friendly fabrication processes.

6. Lightweight, durable, and cost-effective alternative to conventional materials.

7. Reduced environmental impact.

8. Potential application in air intake ducts of trainer aircraft.

9. Alignment with previous research on natural fibers and fiber-matrix optimization.

10. Future scope for optimizing component proportions and exploring hybrid composites.