Investigating High-Velocity Impact Response of GFRP-Faced Aluminium Honeycomb Sandwich Panels

Abstract

This research aims to investigate the high-speed impact behaviour of aluminium honeycomb sandwich panels with glass fibre reinforced polymer (GFRP) composite face sheets. With increasing demands for lightweight yet impact resistant materials in the aerospace, automotive, and defence sectors, understanding the energy absorption, damage mechanisms, and failure modes of such hybrid structures is critical. The study will involve experimental testing using gas-gun or projectile-based setups, finite element modelling (FEM), and comparative analysis to evaluate the structural integrity and energy dissipation characteristics under varying impact conditions.

1. Introduction

Sandwich panels with composite face sheets and metallic cores offer high strength-to-weight ratios and are increasingly used in applications requiring both structural efficiency and impact resistance. Aluminium honeycomb cores provide excellent energy absorption, while GFRP face sheets add stiffness and durability. However, the high-speed impact behaviour of these hybrid systems is not yet fully understood, especially under varying projectile energies and core configurations.

2. Objectives

- To analyse the effect of projectile velocity on damage patterns and energy absorption.
- To evaluate the role of core geometry and thickness in impact resistance.
- To model the high-speed impact event using finite element software (e.g., ANSYS, LS-DYNA).
- To compare experimental results with numerical predictions for validation and optimization.

3. Methodology

- **Material Selection:** Aluminium honeycomb cores and GFRP face sheets with defined mechanical properties.
- **Sample Fabrication:** Panels will be fabricated with standardized dimensions and various core thicknesses.
- **Impact Testing:** High-velocity impact tests using a gas-gun setup with instrumented projectile.
- **Data Acquisition:** High-speed imaging and sensors to capture real-time deformation, penetration, and delamination.
- **Numerical Simulation:** FEM modelling for stress distribution and failure analysis.
- **Analysis:** Energy absorption, deformation of the back face, and residual strength will be evaluated.

4. Expected Outcomes

- A better understanding of energy absorption mechanisms in composite-metal sandwich panels.
- Identification of critical parameters that influence high-speed impact performance.
- Validated numerical model for design prediction.
- Recommendations for optimizing panel design for high-impact applications.

5. Literature Review (Summary)

Previous studies have shown the efficiency of honeycomb structures in impact mitigation; however, the synergy between aluminium cores and GFRP faces under high-strain rate conditions remains under explored. The current literature lacks comprehensive data on the influence of face sheet properties, impact angle, and boundary conditions.

6. Timeline

Phase	Duration	Activity
1	Month 1–2	Literature review & material procurement
2	Month 3–5	Panel fabrication & experimental setup
3	Month 6–8	Impact testing & data acquisition
4	Month 9–10	Numerical modelling & simulation
5	Month 11–12	Analysis, validation & report writing

7. Significance

The findings will contribute to the design of lightweight, impact-resistant structural components suitable for critical applications, enhancing safety and material efficiency in high-performance engineering systems.