Abstract

This thesis investigates the blast response of cellular sandwich structures, including those with Dyneema face sheets and encapsulation, subjected to near-field air and buried landmine conditions. Experimental setups used a metallic leg surrogate, with an explosive charge positioned at a 150 mm stand-off for free-air blasts and buried at 25 mm beneath the soil surface for anti-personnel mine (APM) conditions. Various configurations of aluminium (Al) foam, Al honeycomb, and ceramic honeycomb were tested to evaluate the influence of core material, core thickness, core sequence, and encapsulation on force transmission, energy absorption and structural response.

A high-fidelity finite element (FE) model, developed using the Multi-Material Arbitrary Lagrangian-Eulerian (MM-ALE) method, was rigorously validated against experimental results. This validation demonstrated a close correlation, with deviations typically within 7-10%, in predicting transmitted forces, observed deformation patterns, and failure mechanisms. Following validation, parametric studies were conducted to explore additional configurations, particularly those involving Al foam with varying densities.

The results highlight the critical role of material arrangements, including the significant enhancement provided by encapsulation in blast mitigation. A hybrid encapsulated Al foam and ceramic honeycomb configuration achieved up to a 72% reduction in transmitted force against buried mine blasts compared to baseline conditions, where no sandwich structure was used. Other configurations also demonstrated substantial attenuation, including up to 42% for Al foam and Al honeycomb double-layered sandwich structures, and up to 67% for encapsulated triple-layered structures in 150 mm stand-off free-air blasts. This work describes a robust experimental-numerical framework and contributes insights for developing effective protective systems in mine-threat environments.