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ABSTRACT

Simulation-Based Analysis of Blast Wave Absorption by Hybrid Metal Foams

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Cellular structures have a wide range of applications across various fields, including lightweight construction, automotive engineering, medicine, and aerospace. Among these structures, metal foams stand out due to their unique properties and versatility.

This study explores the ability of hybrid metal foams (HMF) to absorb blast waves, employing both simulation and experimental methods to evaluate their effectiveness. The study specifically examines the energy absorption characteristics of nickel-polyurethane HMF. Using theoretical principles as a foundation, simulations were conducted in Abaqus/CAE to model the behavior of these materials under dynamic loading conditions. Different sandwich constructions were simulated, each incorporating four distinct types of HMF parameters as absorber structures. Based on these simulations, the most promising configurations were selected for experimental testing to validate their effectiveness.

The analysis revealed that the optimal configuration consists of a sandwich structure with an upper layer of 20 mm thick HMF, featuring a pore density of 10 PPI and a 200 μm nickel coating. This layer is complemented by a lower layer of 40 mm thick, softer foam, coated with 50 μm of nickel to enhance its absorption properties. Each foam core is enclosed and separated by a 2 mm thick steel sheet. This specific arrangement demonstrated superior energy absorption capabilities, effectively damping the impact of detonation waves. The findings were further confirmed through experimental validation, reinforcing the potential of HMF in applications requiring high-performance energy absorption.

Overall, this research contributes to a deeper understanding of HMF and their application as energy absorbers in various engineering fields. The results emphasize the significance of load spreaders between foam sections and structural design optimization in maximizing energy absorption and distribution. These insights pave the way for future advancements in lightweight construction and impact protection technologies.