

Numerical study of impact and blast performance of nacre-like aluminium composites

E.A. Flores-Johnson¹, *Luming Shen¹, Irene Guiamatsia¹, and Giang D. Nguyen²

¹School of Civil Engineering, The University of Sydney, NSW 2006, Australia.

²School of Civil, Environmental and Mining Engineering, The University of Adelaide, SA 5005, Australia

*Presenting and Corresponding author: Luming.Shen@sydney.edu.au

Abstract

The ever increasing demand for energy-absorbing lightweight and high strength materials for impact and blast applications in automotive, aeronautical and defence industry is posing a great challenge for innovative design and manufacturing to address the competing properties of light weight on one hand, and impact and shock mitigation on the other hand. Nacre, commonly known as the mother-of-pearl, is a biological material that exhibits outstanding mechanical properties due to its brick-wall patterned hierarchical structure that spans from nano- to macro-scales. Inspired by the hierarchical structure of nacre, an aluminium alloy (AA) 7075 based composite featuring layer waviness and cohesive interface is being developed and studied numerically as high velocity impact and blast resistant material. To investigate their ballistic and blast performance, a numerical study of the proposed nacre-like composites made of 1.1-mm thick AA 7075 plates bonded with toughened epoxy resin is performed using Abaqus/Explicit. In the simulations, the Johnson-Cook material model is used together with the Johnson-Cook fracture criterion to simulate the constitutive response of the AA 7075 plates. The epoxy material is modelled using a user-defined interface cohesive element that properly takes into account both strength and toughness enhancements under compression. A significant performance improvement is observed for the proposed nacre-like Al composites plate as compared to the same thickness bulk Al plate, which can be explained by the hierarchical structure facilitating both localized energy absorption (by deformation of the plate) and more globalized energy absorption (by inter-layered delamination and friction) under both impact and blast loading.

Keywords: Hierarchical Structure, Blast, Impact, Bio-Inspired, Cohesive Element, Finite Element Method.