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Development of a Dynamic Failure Model for Polymeric Adhesives

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ABSTRACT

One method to improve armor performance of land vehicles under ballistic impact is to better design the adhesive layer used to bond the ceramic tiles to the metal/composite backing layer. This presentation will explore the development of a finite element model to simulate failure of polymeric adhesives used in these systems. The adhesive layer plays a critical role in controlling wave propagation that leads to damage accumulation within the armor structure during impact. Modelling the dynamic failure of the adhesive layer is performed using the cohesive zone modelling (CZM) approach in the explicit nonlinear finite element software, LS-DYNA®. Specifically, the trilinear traction separation law is implemented in cohesive elements. The CZM approach is an energy-based method combining fracture mechanics with stress-based criteria to predict the initiation and direction of crack growth. The model is validated using force-displacement curves of the double cantilever beam (DCB) and end-notched flexure (ENF) tests for the polyurethane adhesive, SikaForce™6 7752-L60. These tests determine the tensile and shear critical energy release rates of the adhesive layer, respectively. The validation process considers the variability in material properties used in these experiments. After validation, the adhesive model is implemented into a full-scale numerical model of the add-on armor system that also comprises of ceramics and steels. Overall, this study aims at providing novel insights in the modelling of adhesives using CZM for applications in armor systems. This work was in collaboration with Defence Scientist Geneviève Toussaint of Defence Research and Development Canada through NSERC CRD-DND project DNDPJ 531130-18.

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