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Development of a System-Scale Armor Model for Vehicles

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ABSTRACT

This presentation explores the simulation and assembly (e.g., geometry, mesh, and contacts) of a system-scale multi-material armor model used as protection systems in land vehicles. The geometry consists of alumina hexagonal tiles sandwiched between a front polycarbonate layer and a carbon fiber backing, and bonded using a polyurethane adhesive interlayer. The sandwiched structure is bolted to a steel backing which represents the hull of the vehicle. The development of the proposed geometry is automated using Ansys SpaceClaim coupled with Python scripting and considers: (1) manufacturing defects of the parts (e.g., tolerancing errors of the ceramic tiles, adhesive seepage between the tiles, trapped air bubbles within the adhesive, and structural defects) and (2) variation in the material properties. High-velocity long rod impact simulations are performed using LS-DYNA® V11.1 where the model is validated using depth-of-penetration plots, fracture plots of the damage accumulation and propagation, and projectile erosion values of long rod experiments. Here, deep learning is used to guide optimum configurations of the armor geometry to provide the best overall impact performance depending on the level of threat. Overall, this study provides novel insights into the governing processes that influence impact performance, and, in turn, can inform on design of improved systems. This study includes assessing the effect of realistic manufacturing conditions (by considering component defects and material variability) on the armor performance. This work was conducted 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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