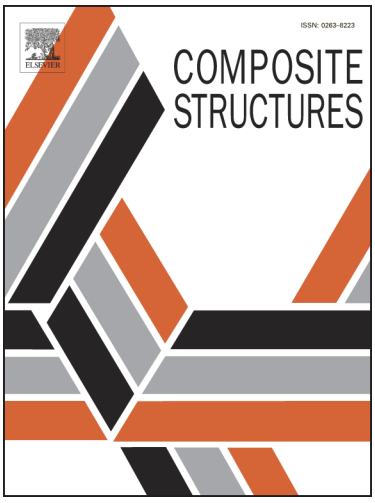

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On a multi-scale finite element model for evaluating ballistic performance of multi-ply woven fabrics

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Abstract: In this study, an improved multi-scale finite element model of woven fabric was developed for evaluating ballistic responses of multi-ply woven fabrics. The improved multi-scale model was composed of a meso- and a macro-scale model that were coupled through node-sharing at the interface to improve wave propagation responses. To evaluate the accuracy and efficiency of the multi-scale model, a full meso-scale model was also created, and both numerical models were validated using experimental data. The multi-scale model was found to have good accuracy and computational efficiency compared to the full meso-scale model and thus used in the evaluation of ballistic responses of multi-ply woven fabrics. Further, multi-ply woven fabrics were also created using the multi-scale model, and they were validated against experimental data. Thereafter model validations, the three-, five-, seven-, and ten-ply fabrics were created using the improved multi-scale model to investigate ballistic performance of the multi-ply dry Kevlar woven fabrics. The ballistic limit velocities of each target were first determined, followed by the ballistic impact responses, energy transitions, displacements, and damage patterns of the four multi-ply at the impact of V_{100} ballistic limit were discussed in detail.

Keywords: Meso-scale; Multi-scale; Multi-ply; Finite element; Kevlar; Ballistic

1. Introduction

Flexible woven fabrics are broadly utilized to provide ballistic protections in security applications such as soft body armor equipment or protective layering of military vehicles for their high strength-to-weight ratios and good flexibility. By nature of their compositions, woven