NUMERICAL AND EXPERIMENTAL STUDY ON COMPOSITE STRUCTURES UNDER A CRUSHING LOAD

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Motivation:

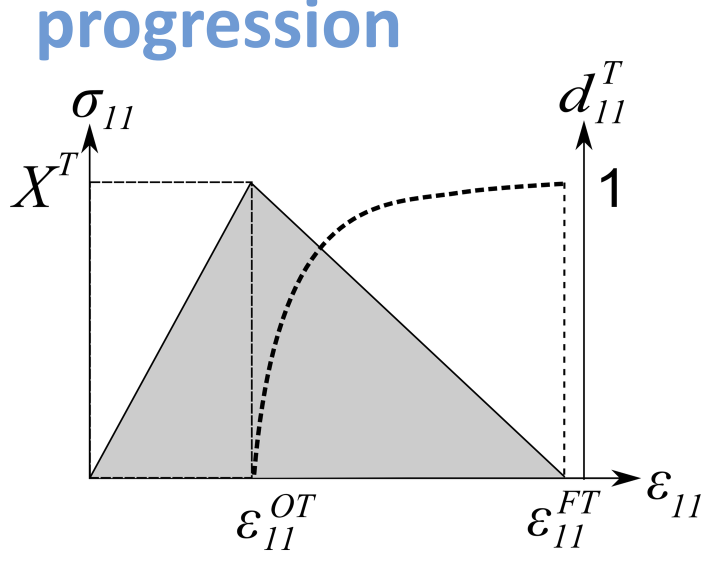
Crashworthiness of aerostructures is one of the most important factors in their design. Energy absorbing structures within the airframe can contribute substantially to crash protection. The multitude of damage mechanisms of composite structures increase energy absorption capability while making analysis significantly more difficult than those of traditional metallic structures. Currently, the design process of composite structures is heavily dependent on expensive and time consuming physical testing, which can be reduced by the use of validated virtual testing capability.

Achievements:

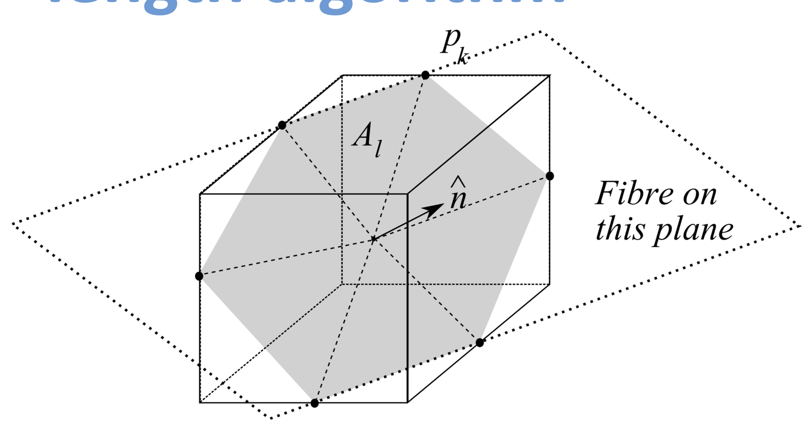
1. A detailed predictive intralaminar damage model for the analysis of composite laminate structures under a crushing load was developed and validated.
2. This intralaminar damage model was implemented for Abaqus/ Explicit via a VUMAT subroutine.
3. Experimental tests were conducted to obtain detailed data on crush behaviour of a composite energy absorbing structure.
4. Validation against a range of experimental tests was performed. Good match was achieved for all test cases.

Comprehensive intralaminar damage model:

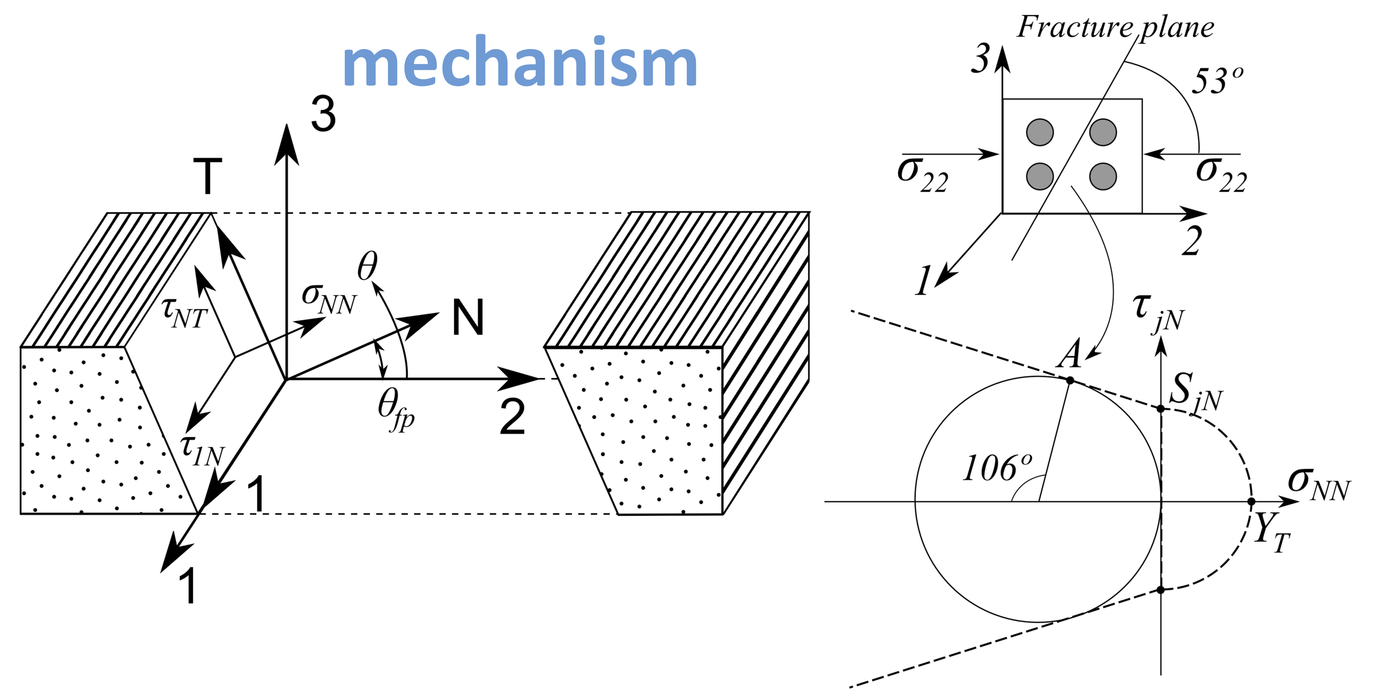
Energy-based damage progression

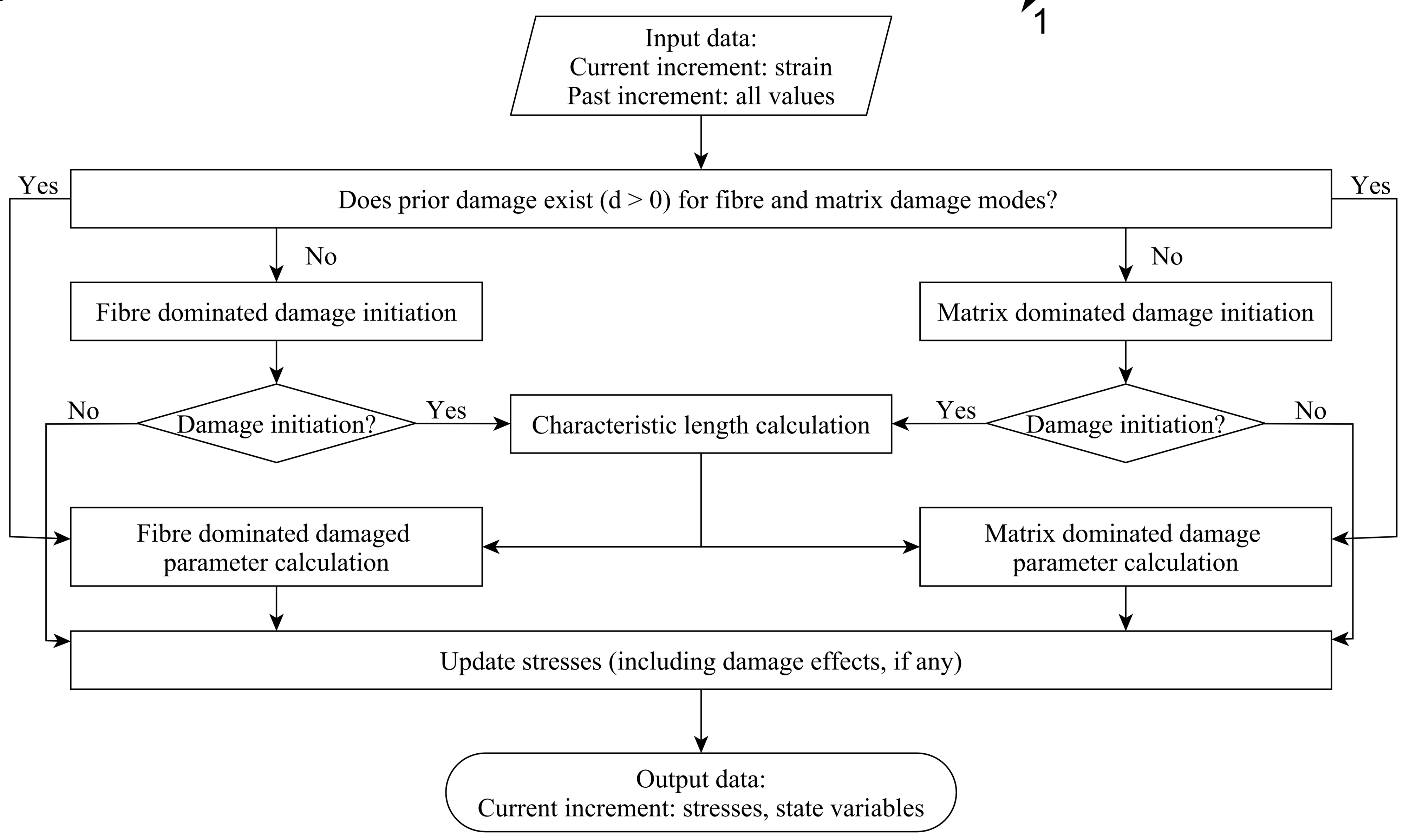


Robust characteristic length algorithm

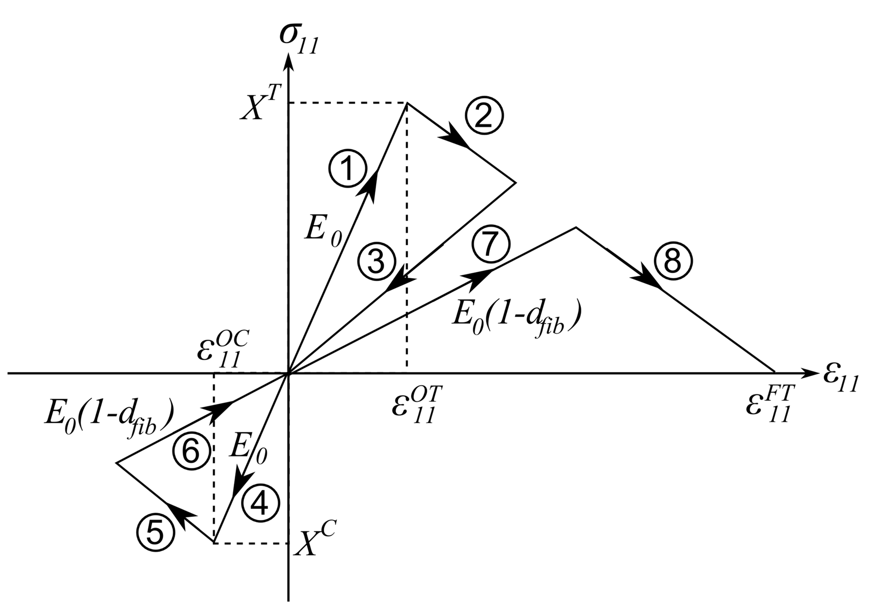


Unified matrix damage mechanism

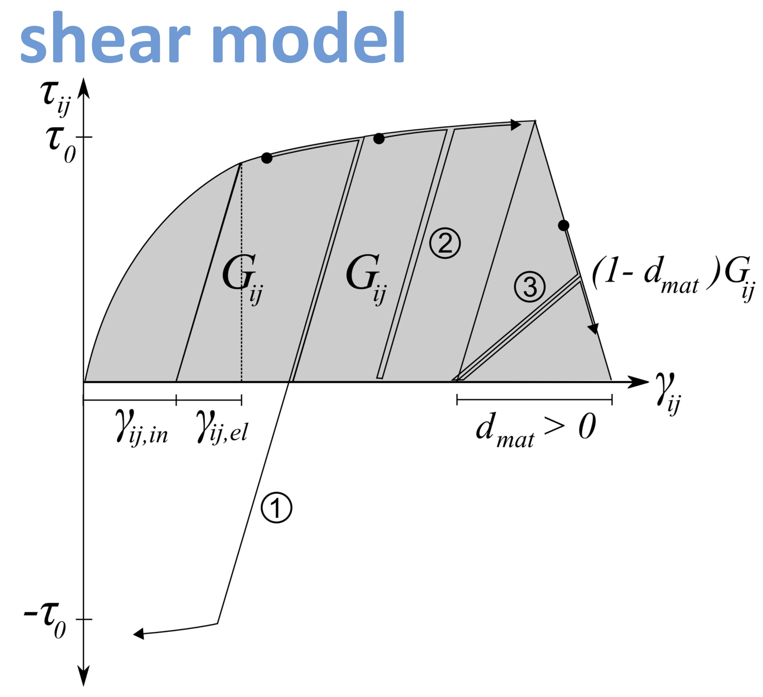




Damage interaction, load-history effects

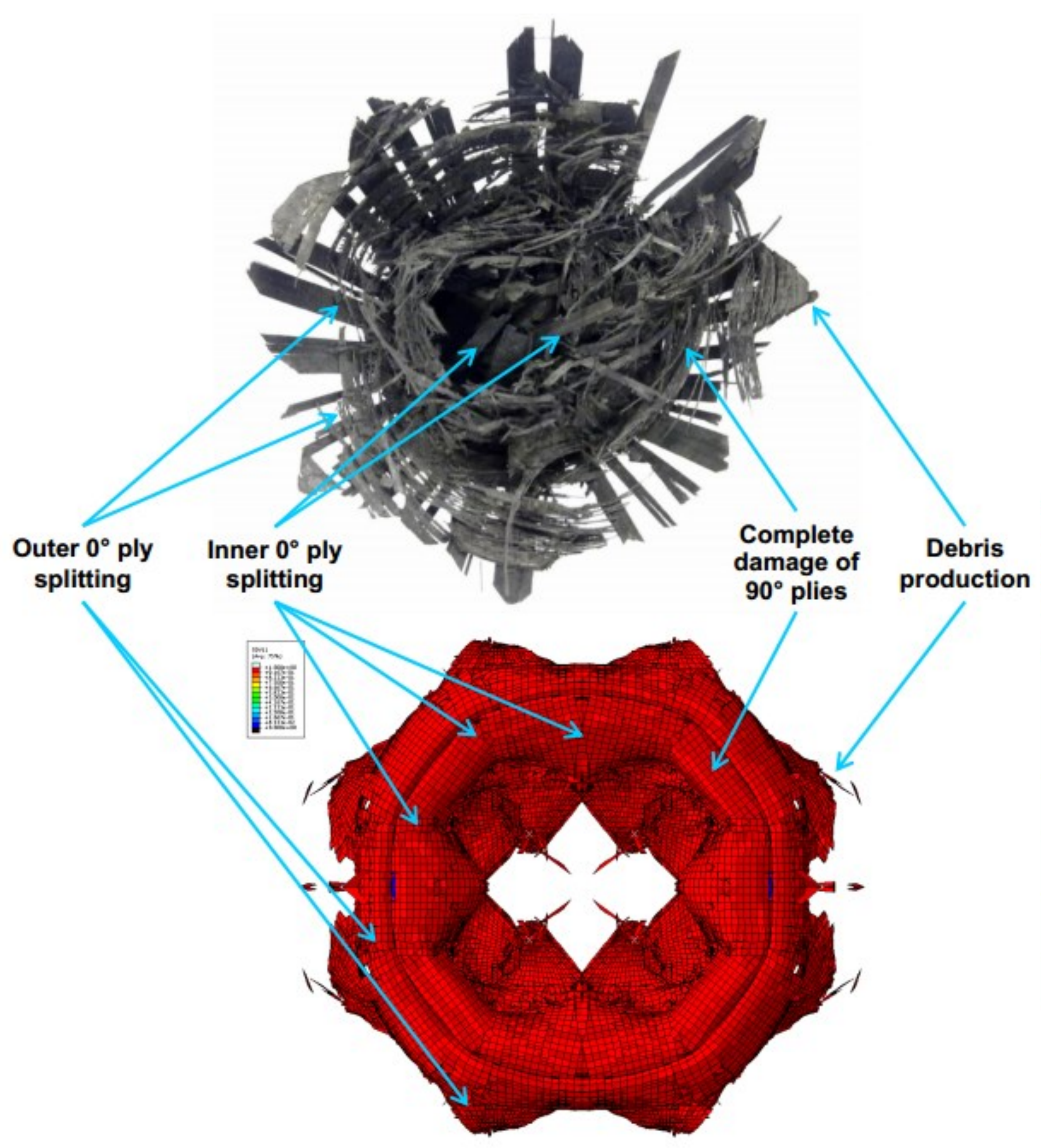


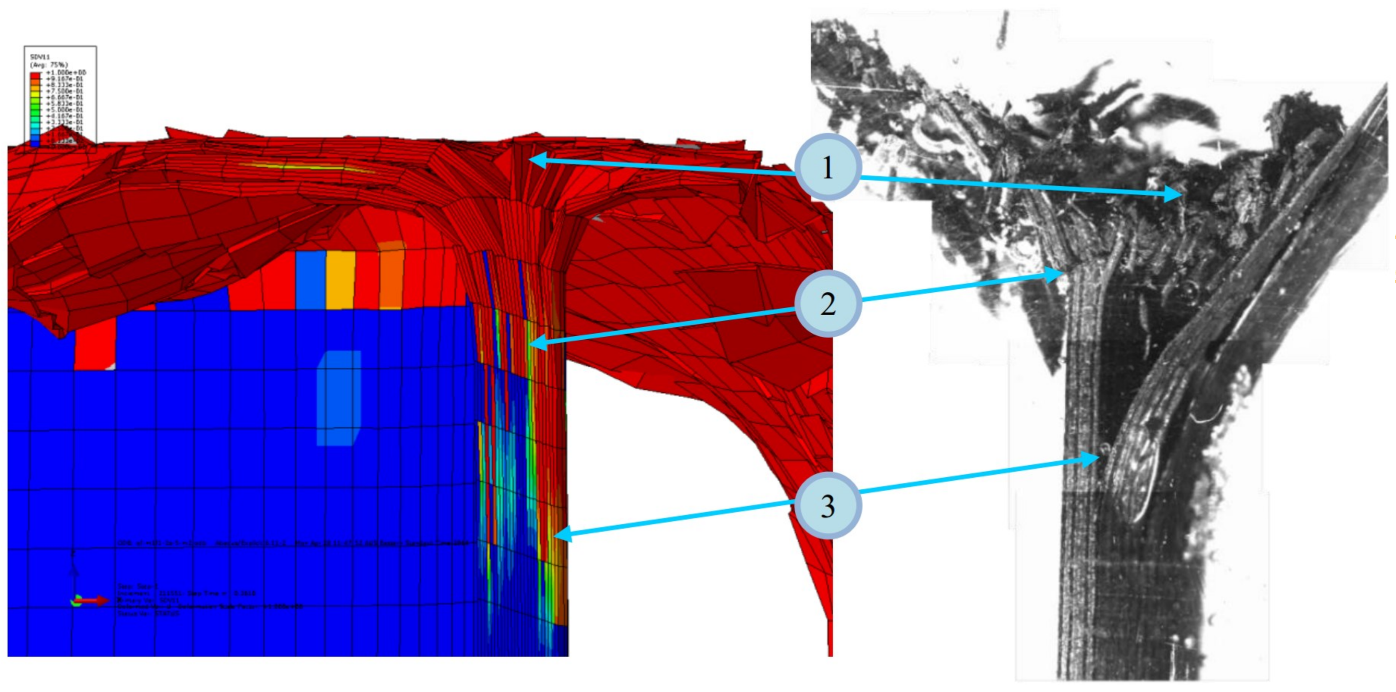
Nonlinear and inelastic shear model

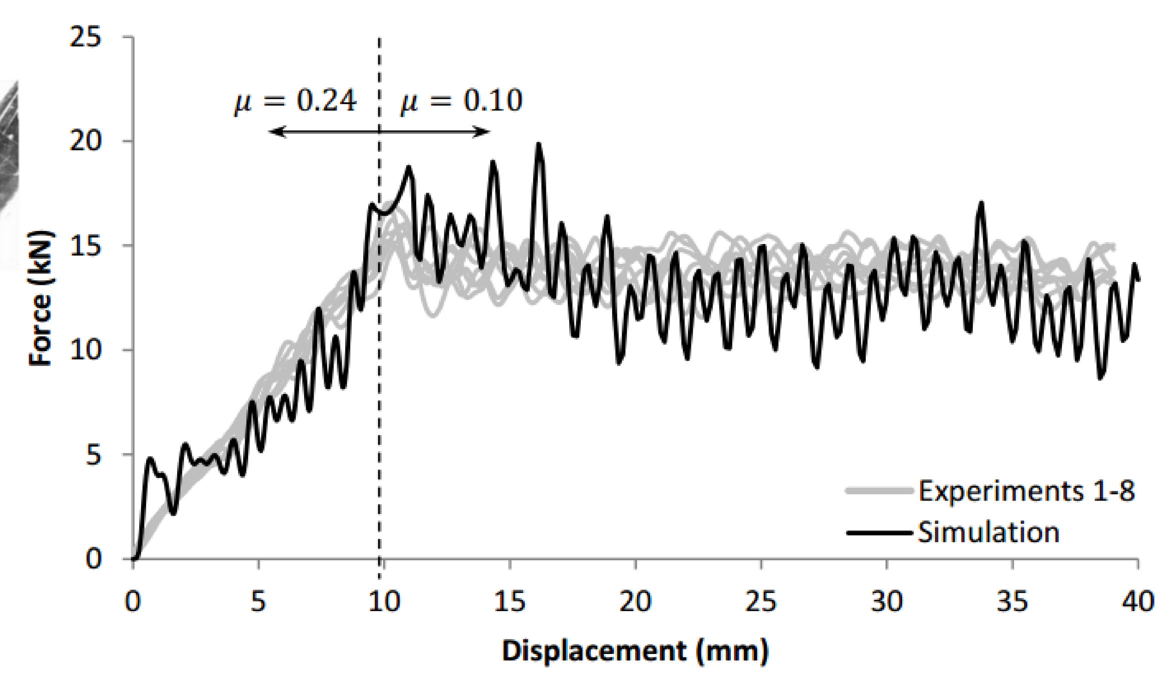


Validation against experimental data:

Close agreement was achieved between simulated results and experimental observations. The damage morphology and resulting deformation was well captured. The This was achieved using only physically measurable material properties. Hence demonstrating the suitability of the material model for use in virtual testing applications to reduce reliance on physical testing of energy absorbing components.







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