In-Situ Cohesive Element Tailoring for Composites Delamination at Industrial Length Scales

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Abstract

Employing cohesive zone elements in the simulation of delamination in highly-loaded composite structures presents an incompatibility between the required length scales to accurately predict delamination (typically ~0.1 mm) and large element mesh sizes used for industrial components. A number of methodologies have been proposed to allow coarser meshes to be implemented in large-scale finite element models. Turon et al.(2007) [1] *modified the constitutive parameters of cohesive strength to artificially elongate the fracture process zone, whilst maintaining the correct energy dissipation. This produced admissible finite element size of almost 10 times coarser than by using the nominal cohesive strengths. However, such an approach can reduce the stiffness of the entire structure if employed everywhere in the model. A second approach proposed by Guiamatsia (2013)* [2] *via the use of enriched cohesive elements also produced coarse element sizes, however the overall CPU-time of the simulation is increased due to the cost of shape function enrichment.*

In this paper, a methodology is proposed which employs an in-situ damage-tracking and constitutive tailoring algorithm which considers only elements within the vicinity of the crack tip. Proof of concept has been achieved and verified against nominal cohesive zone strength models and analytical solutions for mode I, mode II, and mixed-mixed-mode conditions. With the improved model only the strengths of the required elements are reduced, thus maintaining overall stiffness.

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Keywords: *Delamination, Cohesive elements, Fracture*

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