Multiscale modelling of composite laminates using meshless methods

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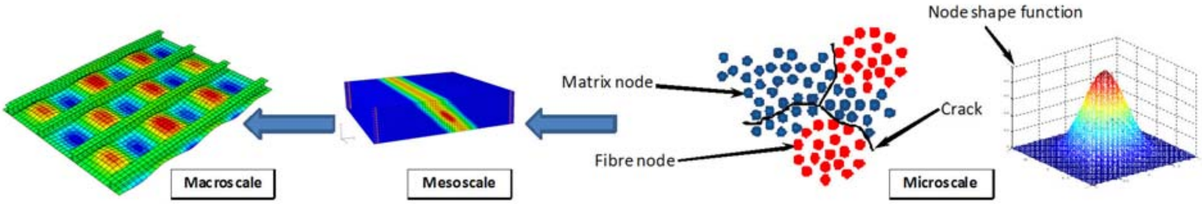
Background

Advanced carbon-fibre composite materials account for a significant portion of the primary structure on the latest generation of passenger aircraft. Despite their increased use, the full potential of this material has yet to be fully exploited. One of the main reasons for this is the difficulty in predicting the complex damage initiation and progression of damage in these structures, leading to highly conservative designs. The finite element method has been widely adopted for the modelling of in-plane damage and delamination (cracking), with some success. Nonetheless, there are still problems with mesh-size dependency, mesh distortion when mesh adaptivity is required and numerical stability.

Proposed Research

A number of these problems are mitigated using a meshless approach whereby node connectivity, leading to the formation of elements, is removed. In essence, the structural domain is represented by a 'cloud' of nodes, each with an associated weighted shape function. Various meshless methods have been proposed and the strategy that will be adopted for this research is based on the Element-Free Galerkin (EFG) method first. A mutliscale approach will be adopted whereby a damage modelling capability, using EFG, is developed at the microscale level and the resulting constitutive behaviour utlised by finite element models of the structure at the meso- and macroscale level. The development of a robust meshless-based tool for composite damage modelling would represent a major step forward towards the effective and reliable virtual testing of composite aerostructures.



Multiscale modelling using meshless and finite element methods.