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Comparison between the Phantom Node and Extended Finite Element Methods for Composite Laminates

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A phantom node method for the computational modeling of weak and strong discontinuities in composite laminates is presented.
By introducing additional degrees of freedom, a discontinuous element is considered as a superposition of two independent continuous elements. Only standard shape functions are used and elemental locality is preserved in a purely displacement based finite element (FE) setting.
A cohesive zone concept is applied along the discontinuity surface to incorporate nonlinear fracture. The method is equivalent to the widely used extended finite element method (X-FEM) and has been implemented into the commercial FE software Abaqus as a user-defined subroutine. A numerical analysis of damage mechanisms in composite laminates investigates the performance of the phantom node method compared to X-FEM with special focus on the ability to account for multiple damage evolution and their coupling.

Keywords: Phantom node method, Extended finite element method, Cohesive zone model, composite laminates, Abaqus