Explicit dynamics simulation of blade cutting of layered shells

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The numerical simulation of blade cutting of thin layered shell is a challenging task, involving complex phenomena, such as large deformations, nonlinear material behaviour, contact, crack propagation, delamination. In particular, three small geometrical scales need be resolved: the scale of layer thicknesses, the scale of blade radius of curvature, the scale of fracture and delamination process zones.

In view of the problem nonlinearity, an explicit dynamics formulation with solid-shell elements is adopted to avoid convergence problems. A selective mass scaling approach [1,2] is used to enlarge the critical time step size, dictated by the layers thickness.

Crack propagation is modelled by inserting cohesive interfaces between adjacent elements placed along the prescribed blade trajectory. The problem of the interaction between the sharp blade and the cohesive process zone is addressed by using the so called “directional cohesive elements” proposed in [3].

Depending on the type of material and on the layer thickness, the problem may be characterized by very small process zone sizes. Techniques for the reduction of spurious oscillations in the presence of coarse discretization and for the improvement of overall accuracy are investigated.

Numerical applications to engineering problems are used to assess the effectiveness of the proposed simulation approach.

References

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