Simulation of Crack Propagation using Damage-Driven Fission Adaptivity Coupled with Element Erosion or Node Splitting

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Summary:

A novel method for simulation of crack propagation has been developed in LS-DYNA. The method combines damage-driven fission adaptivity and element erosion or node splitting to simulate crack propagation in the finite element mesh. A damage model is used to describe the evolution of material damage with plastic straining and fracture is assumed to occur at a critical value of the damage parameter. Coupled or uncoupled damage models may be used. Mesh refinement by fission adaptivity [1] occurs at user-defined damage levels, and further the user defines the maximum number of subdivisions. If element erosion is adopted, this happens when the critical damage level is reached within the element. When node splitting is used, multiple nodes are generated for the sibling elements and nodal values of damage are estimated. As the critical damage value is reached in a multiple node, selected bonds are released to allow for a crack to develop. The direction of the crack propagation is determined based on damage values in neighbour nodes. The method has been developed for 2D continuum elements, axisymmetric elements and shell elements.

Applications of the method are shown for two cases: I) tearing of cast aluminium thin-walled profiles discretized with plane-stress elements and II) plugging of steel plates modelled with axisymmetric elements. For each case simulations with element erosion and node splitting are carried out and the results compared with experimental data.

[1] Belytschko, T., Wong, B.L., Plaskacz, E.J. Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Computers and Structures 33 (1989) 1307-1323.