Modeling combined necking cracking phenomena using different modeling techniques

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Ductile fracture of metals is characterized by the formation of highly localized zones of intense straining which ultimately leads to the onset of fracture and failure. Presence of two interacting localization phenomena, necking and cracking in ductile fracture is observed in different experiments performed on thin metal sheets under different loading conditions [2]. This contribution aims to model the interaction of necking and cracking phenomena using different modeling techniques. While incorporating necking and cracking phenomena into a failure model, attention will be given to the local deformation and stress state in a neck or ahead of a crack tip, and also the global behavior such as boundary conditions and force displacement behavior. The first modeling technique that is incorporated to simulate necking cracking interaction uses a continuum approach to model necking followed by XFEM integrated into a geometrically nonlinear discontinuous solid-like shell element [1] to simulate fracture and ultimately failure. Although this technique is helpful to model details of necking deformation (both in-plane and out-of-plane), the model suffers from mesh dependent behavior while modeling necking phenomena. The second modeling technique in this contribution uses a discontinuous approach for both localization phenomena. The transition of a neck to a crack is governed by a fracture initiation model and different segments of the traction separation law. This technique is advantageous for reproducing the global force-displacement behavior and reducing mesh dependence. The traction separation law that governs the failure process zone after initiation of XFEM plays a significant role in the failure modeling. The effect of different parameters and shapes of traction separation laws in simulation of interaction of necking and cracking phenomena using both modelling techniques is thoroughly investigated in this contribution.

References

[1] A. Ahmed, F. P. Van der Meer and L. J. Sluys, A geometrically nonlinear discontinuous solid-like shell element (DSLS) for thin shell structures, Computer Methods in Applied Mechanics and Engineering 201 (2012) 191–207.

[2] K. Chung, H. Kim and C. Lee, Forming limit criterion for ductile anisotropic sheets as a material property and its deformation path insensitivity. Part I: Deformation path insensitive formula based on theoretical models, International Journal of Plasticity 58 (2014) 3–34.