

Assessment of Failure Modeling with Thinning Strain Criterion

Ching-Shan Cheng

GM R&D Center
30500 Mound Rd., M/C 480-106-256
Warren, Michigan 48090
ching-shan.cheng@gm.com

While the components in general are designed not to fail before the end of their life cycle, failure prediction will help to reduce the number of physical tests, the time needed for the design and development cycle and eventually achieve the optimized design while meeting the requirements. Unfortunately, due to the highly localized nature of crack formation, it has been a challenge to the engineering community to predict the crack initiation and propagation. Although there are numerical methods proposed by researchers, they are either somewhat computational expensive or still under development.

Element deletion based on various failure criteria has been implemented in commercial finite element analysis packages, e.g. LS-DYNA. The fundamental problem with the element deletion method for failure modeling is that conservation of mass and energy is not satisfied. Also, because elements are removed from the model, the contact conditions between the newly created crack surfaces following the crack growth are not the same as in reality. It can be seen as a phenomenological model and will not be able to provide accurate stress strain information around the crack. However, it could provide an engineering approximation for failure modeling if the appropriate element deletion criterion is utilized. In the present work, the thinning strain failure criterion is investigated. Simulations of different tests using element deletion with the thinning strain at failure show better correlation with the experimental results than the other material models examined.

References

- [1] J. R. Yeh, T. L. Summe and D. C. Seksaria, "The Development of an Aluminum Failure Model for Crashworthiness Design," *Crashworthiness, Occupant Protection and Biomechanics in Transportation Systems*, American Society of Mechanical Engineers, AMD-Vol. 237/BED-Vol. 45, pp. 97-105, 1999.
- [2] LS-DYNA User's Manual, Version 960, March, 2001.
- [3] C.S. Cheng and K. A. Strom, "Dynamic Material Characterization for Multi-layer High Density Polyethylene Material," to appear in Society of Experimental Mechanics 2003 Annual Conference.
- [4] Mayer, R. R., Chen, W. and Sachdev, A. K., Crashworthiness Performance of Mass-Efficient Extruded Structures, Proceedings of 2002 ASME International Congress & Exposition, Nov. 2002.