INTEGRATION OF XFEM FOR SOLID ELEMENTS INTO MATLAB: MODELING OF FOAM FAILURE

J.H.A. Schipperen
TNO, Van Mourik Broekmanweg 4, 2628XE, Delft, The Netherlands, Ingrid.Schipperen@tno.nl

B. Atli-Veltin
TNO, Van Mourik Broekmanweg 4, 2628XE, Delft, The Netherlands, Bilim.Atli@tno.nl

L.O. Voormeeren
TNO, Van Mourik Broekmanweg 4, 2628XE, Delft, The Netherlands, lars.voormeeren@tno.nl

The structural dynamics department of TNO aims at the accurate analysis, pre and post failure, of large structures subjected to out of plane dynamic loading, particularly structures with foams. These foams are often used as core material in sandwich structures. Failure behavior of foams on larger scales, therefore needs to be explored and implemented into available finite element software. In simulations of large structures, such as vessels, use of large elements is preferable in order to reduce computational costs, without compromising the accuracy of the failure prediction. The desired requirements of a technique suitable to analyze a whole vessel can be listed as following:

- In tension the model behaves elastically followed by damage. The plastic component in the tension behavior is considered minor.
- In compression the model behaves elastic or elasto-plastic, without damage accumulation in the strain range of interest.
- The elastic behavior is assumed to be isotropic, but the formulation is open to anisotropy.
- Applicable in large elements without predefined damage orientation
- Applicable in both implicit and explicit FE analyses due to the dynamic characteristics of the loading.

An implementation of damage initiation and propagation in foams using XFEM techniques in solid elements can meet the requirements above, without the need of predefined damage paths or remeshing. In XFEM, in addition to the regular shape functions, a discontinuous Heaviside jump function is used for the elements containing cracks and asymptotic functions are used for elements containing crack tip. An implementation in an explicit FE analyses tool would be necessary. Currently, implementation of XFEM in LS-Dyna is limited to 2D elements. For a more practical industrial applications, 3D geometries have to be considered. Our efforts will focus on use of XFEM with 3D solid elements, with the application to brittle cracking in foams.

The presentation will discuss the implementation of XFEM with solid elements into implicit and explicit FE analyses. The implementation is done in Matlab for testing purposes. A full implementation in a commercial code such as LS-DYNA will be a next step in the process. The investigation will focus on the crack propagation of foams. Test case results will be provided, with validation against an experimental study.