Isogeometric Analysis in LS-DYNA®

Attila P. Nagy[1], Stefan Hartman[2], and David J. Benson[1]
1. Dept. of Structural Engineering, UCSD, La Jolla, CA
2. DYNAmore, Stuttgart, Germany

Abstract

Two new areas of development of isogeometric analysis in LS-DYNA are presented. The first, which is currently available, is mass scaling. The second, which will be available sometime during the next year, is the development of efficient integration methods for trimmed NURBS, which will allow a much more direct connection between CAD and analysis in LS-DYNA. Industrial applications of both are presented.

Metal stamping is one of the most cost effective manufacturing methods for producing precision parts. Isogeometric analysis, which uses the same basis functions as the CAD programs used to design the shape of the part, is an attractive alternative to traditional finite element analysis for metal stamping. Mass scaling, and the underlying stable time step estimates, that are commonly used in metal stamping simulations are presented for isogeometric analysis.

Additionally, a numerical algorithm is proposed to construct efficient quadrature rules for trimmed isogeometric elements as part of the standard pre-processing step. The motivation is to overcome the proliferation of quadrature points observed in competing adaptive and tessellation-based integration approaches.

The constructed integration rule is considered to be optimal in the sense that the final quadrature points and weights satisfy the moment fitting equations with the trimmed domain up to a predefined tolerance. The resulting quadrature points are in the interior of the trimmed domain and positivity of the weights is preserved. The efficiency and accuracy of the scheme is assessed and compared to competing integration techniques. Selected problems of elastostatics and elasto-plastic dynamics are used to further demonstrate he validity of the approach.