FACILITATING THE INDUSTRIAL IMPLEMENTATION OF AN ADAPTIVE ISOGEOMETRIC CONTINUUM SHELL ELEMENT FOR LAMINATE ANALYSIS

Camiel Adams[1], Martin Fagerstrom[1], Joris J.C. Remmers[2], A. Vafeidis[3]
[1]Chalmers University of Technology
[2]University of Technology Eindhoven
[3]BETA CAE Systems

KEYWORDS –
Isogeometric analysis, Delamination, Adaptivity, Continuum shell formulation, NURBS

ABSTRACT
To accurately predict damage growth in large composite structures, it is required to have models that are both valid and computational efficient. In this respect, isogeometric continuum shell elements provide an interesting option. First of all, the higher order continuity achieved via isogeometric analysis yields an increased in-plane smoothness that enable the use of larger shell elements. In addition, the high in-plane continuity also leads to stress derivatives that are continuous across element edges, which allows an element-wise recovery procedure to enhance the out-of-plane stress predictions.

Furthermore, in an isogeometric continuum shell modelling framework it is rather straightforward to modify the through-thickness kinematics to incorporate weak and strong discontinuities. By introducing weak discontinuities at ply interfaces, the through-thickness strain discontinuities at these locations are explicitly accounted for. This enables a much better 3D strain and stress prediction, something which is key for a good estimation of the amount of intralaminar damage. By introducing strong discontinuities, the element is also capable to represent initiation and growth of one or several delamination cracks.

In the current contribution, we present a fully adaptive continuum shell element that allows for an update of the through-thickness kinematics at any required time instant during the simulation. A particular challenge for industrial implementation of this approach is the pre-processing stage. By using the so-called Bezier extraction technique, isogeometric elements can be implemented in a structural analysis code following a standard FE-scheme. However, in comparison to FE, additional geometry information is then required as output from the pre-processor (e.g. element-wise Bezier extraction operators). In the current collaboration, ANSA has therefore been augmented with the ability to provide the essential geometry information, thereby facilitating the first step of the adaptive shell element implementation in commercial FE-codes, ultimately making this modelling concept directly accessible for the industry.