

ISOGEOMETRIC SIMULATION OF BRITTLE FRACTURE IN SHELLS USING A PHASE-FIELD APPROACH AND LR-NURBS-BASED ADAPTIVE REFINEMENT

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We present an approach in which we employ a rotation-free isogeometric thin shell formulation, which is coupled with a phase-field description of brittle fracture. The phase-field formulation is based on a tension-compression split of the elastic energy [1], which requires additional considerations in structural models which are subjected to bending, like plates and shells [2]. The phase-field approach demands a fine mesh around the crack, resulting in an increase of the computational costs of the simulations performed in the traditional NURBS-based IGA framework, in which only global refinement of the mesh is allowed. To overcome this limitation, Locally Refined (LR) NURBS [3] are adopted as basis functions. The local refinement of the mesh is performed adaptively, using the phase-field as refinement indicator. Thanks to the adaptivity of the refinement, the analyses are extremely flexible and capable of simulating situations in which the crack path is unknown a priori.

REFERENCES

- [1] C. Miehe, M. Hofacker and F. Welschinger, A phase field model for rate-independent crack propagation: Robust algorithmic implementation based on operator splits. *Comput. Methods Appl. Mech. Eng.*, Vol. **199**, pp. 2765–2778, 2010.
- [2] J. Kiendl, M. Ambati, L. De Lorenzis, H. Gomez and A. Reali, Phase-field description of brittle fracture in plates and shells. *Comput. Methods Appl. Mech. Eng.*, Vol. **312**, pp. 374–394, 2016.
- [3] K. A. Johannessen, T. Kvamsdal, and T. Dokken, Isogeometric analysis using LR B-splines. *Comput. Methods Appl. Mech. Eng.*, Vol. **269**, pp. 471–514, 2014.