Isogeometric Methods in Structural Analysis

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ABSTRACT

Structural mechanics is a field where isogeometric analysis has had an especially high impact, with several novel formulations having been developed over the recent years. Besides the generally superior approximation properties compared to standard finite element analysis, one may identify the high continuity of the underlying shape functions as well as the exact geometry representation as the main reasons for the success of IGA in structural analysis. The exact geometry description is crucial for curved structural elements which are very geometry-sensitive, such as shells and spatial beams, while the high continuity allows the formulation of novel and highly efficient structural formulations, which are not possible with C^0 finite elements. A prominent example is Kirchhoff-Love plate and shell formulations, which naturally require C^1 continuity for the bending terms. While this requirement has been a major obstacle for efficient element formulations in classical FEA, isogeometric analysis has created a real revival of such formulations. But also in the context of Reissner-Mindlin models, the high continuity in IGA allows for innovative formulations, which avoid the classical locking phenomena ab initio.

In this talk, we first present isogeometric Kirchhoff-Love shell formulations [1, 2] and their application to various problems including biomechanics, marine applications, fluid-structure interaction, and shape optimization. Secondly, we show a novel Reissner-Mindlin plate formulation [3], which exploits the continuity properties of IGA for avoiding shear locking ab initio. Finally, we show isogeometric collocation formulations for structural analysis [4, 5], a very novel approach to combine the high accuracy of IGA with the computational efficiency of low-order integration schemes.

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