Impact of shape uncertainties in structural response of Isogeometric Kirchhoff-Love shells

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ABSTRACT

The recently developed Isogeometric Analysis (IGA) technology enables the accurate representation of geometrically very complex structures compared to traditional methods such as the Finite Element Method (FEM). Especially for shell structures, the high continuity of the IGA design shape functions can lead to formulations capable of efficiently capturing higher-order phenomena. However, in the presence of uncertainties IGA has not yet been exploited and its performance over the FEM has not been systematically studied. To this end, we propose a novel methodology to account for shape uncertainty in the framework of modelling shell structures with IGA. More specifically, an IGA-based Karhunen-Loeve representation of the random field of the initial geometric imperfections is proposed. This process is applied to the parameter space of the NURBS shell, thus utilizing the mapping of a complex geometry to a simple rectangular domain. Karhunen-Loeve expansion [1] is then evaluated at Greville abscissas as an estimation of the parametric positions of the Control Points and through a projection applied to the geometry, taking advantage of the local support property of the shape functions used. In stochastic FEM formulation of shell structures, the discretization of the random field depends on the finite element mesh. However, the IGA formulation allows for a "mesh-free" discretization of the random field which enhances the performance of the method [2][3]. Finally, a comparison of the proposed methodology with its FEM counterpart is performed in terms of accuracy and computational cost.

REFERENCES

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