Geometric nonlinear analysis of cable structures using isogeometric cable elements

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ABSTRACT

The isogeometric analysis method (IGA) is developed by Hughes et al. [1] to overcome discrepancy between computer aided design and structural analysis using traditional finite element method (FEM). Compared with FEM, IGA uses a different mathematical description of the geometry which enables it to preserve the exact geometry which is especially important for complex structures such as cable structure. Furthermore IGA provides a flexible way to make refinement and degree elevation.

When analysing the cable structures large displacements appear which corresponds to geometric nonlinearity. Therefore incremental decomposition approach is used to solve nonlinear system of equations. In this paper total and update Lagrangian formulations, [2], are applied and compared.

Implementation of nonlinear analysis of cable structures is based on GeoPDE package [3]. Several functions from the package are adopted while also several new functions are written to apply total and update Lagrangian formulations.

The accuracy and efficiency of proposed algorithms are verified on two cable structures which are loaded with self-weight and concentrated force. The *h* and *k* refinement strategies are carried out to examine its influence to convergence and accuracy. The obtained results are compared with results given by other authors who have used different approaches [4].

By comparing the obtained results the effectiveness of IGA is confirmed because the results are the same or even more precise. IGA provides accurate results when using the lowest degree of the polynomial, however in that case it is necessary to apply greater number of elements. By increasing the degree of polynomial the necessity for the large number of elements decreases and precise results are achieved by using only few elements. The difference and convergence speed between the two formulations is not considerable.

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