Locking-free space curved beam element based on mixed displacement/strain formulation

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ABSTRACT

In numerical analysis, formulation of curved structural elements is a challenge due to the so-called locking phenomena. Locking occurs as spurious strain caused by inability of an element to properly evaluate membrane, shear and bending stiffness. The structure becomes too stiff making displacements significantly smaller than in real structure. A wide range of methods have been proposed to overcome this locking phenomena. Some among them are: reduced/selective integration, strain method, anisoparametric interpolations, hybrid or mixed formulations etc. In this paper, mixed formulation (hybrid displacement/strain formulation) based on Isogometric analysis (IGA) is presented. The basic idea of IGA is to directly use functions which describe geometry (in this case Non-uniform rational B-Spline, or NURBS) as the interpolation functions for the unknown fields of interest (displacement and strain).

This paper primary focuses on the isogeometric approach for static and dynamic analysis of thin curved beams by using mixed formulation. Results are compared with analytical solutions and with conventional displacement based formulation. MATLAB code is developed for isogeometric analysis of both mixed and displacement based formulation.

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