Steady State Formulation for Rolling Bodies using Higher Order NURBS

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ABSTRACT

The lately increase of the application of Isogeometric Analysis (IGA) in a large variety of fields has shown many of the advantages of this approach over traditional Finite Element Analysis (FEA). In this contribution, rolling bodies are analyzed at steady state conditions. This is a common practice in FEA for the study of rollers, wheels and especially car tires. However, an important issue to overcome is the discretization of the geometry, which is usually approximated using linear basis functions. It is at this point that IGA stands as an ideal alternative, with the use of higher order NURBS for the exact geometrical definition with fewer degrees of freedom. Moreover, the continuity across element boundaries is taken into account for the calculation of inertial effects, where higher order gradients can be derived with ease. This leads to a consistent implementation and linearization of inertial forces within and Arbitrary Lagrangian Eulerian (ALE) formulation, where the inertial term in the balance of linear momentum is analyzed in detail. This approach is compared to a common FEA implementation. Numerical examples using hyperelastic materials in a finite strain framework are presented for comparison and verification. Special attention is given to the computation of inertial forces. Furthermore, a convergence study is carried out, where the different possibilities of mesh refinement for an axisymmetrical 3D model are analyzed. Finally, important remarks on this implementation, conclusion and possible future research directions are discussed.