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A high-order finite element formulation for nonlinear computation of cables

André Hildebrandt[*1], Prateek Sharma[2], Stefan Diebels[2] and Alexander Düster[1]

[1] Hamburg University of Technology (TUHH),
Am Schwarzenberg Campus 4 c, 21073 Hamburg,
e-mail: andre.hildebrandt@tuhh.de, web page: https://www2.tuhh.de/skf/
[2] Applied Mechanics (LTM)
Saarland University (UdS)
Campus A4.2, 66123 Saarbrücken, Germany
web page: http://www.ltm.uni-saarland.de

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Cables are slender and long structures that are used in many areas of our daily life as well as in numerous industrial applications. With the growing electrification, the increasing digitalisation and automation of (industrial) processes, the demands and requirements with regard to cables are becoming more and more important. Cables can serve as structural elements (e.g. in bridges and ski lifts), electrical conductors to transmit energy or signals, or feed lines in maritime applications to name only a few examples.
It is our aim to advance and study the numerical simulation of cables, given their complex and challenging structure: several layers of different materials like metallic wires, dielectric layers, polymer insulations, or conducting sheaths among various other types of materials are used. Throughout their lifetime cycle, cables can be exposed to various loading situations like tension, torsion, bending or contact deformations, which can lead to large local deformations. Also, geometrical aspects like reordering of the inner parts and friction between the parts must be considered, posing a serious challenge to numerical simulations.

In our approach, high-order hexahedral elements with an anisotropic ansatz space [2] are used to model the cables as slender structures. The geometric characteristics of the slender structure facilitate the choice of an advantageous and efficient ansatz for each loading situation. The complex inner structure is approximated by a single material that is anisotropic in both the elastic and elastoplastic regime [1]. Thereby, the elastoplasticity covers the inelastic phenomena arising from the contact of the inner parts. Several numerical examples are presented and compared to experimental results for tension, torsion, and bending. Eventually, the possibilities and limits of the approach are shown and discussed.

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