The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Modeling the Effective Inelastic Behavior of Multi-Wire Cables Under Mechanical Load Using Finite Elements

Muhannad Hawwash[1], Vanessa Dörlich[1], Joachim Linn[1], Roger Keller[2] and Ralf Müller[3]

[1] Fraunhofer Institute for Industrial Mathematics ITWM, Fraunhofer Platz 1, D-67663 Kaiserslautern, Germany, [muhannad.hawwash, vanessa.doerlich, joachim.linn]@itwm.fraunhofer.de
[2] Burckhardt Compression AG, Franz Burckhardt Strasse 5, 8404 Winterthur, Switzerland, roger.keller@burckhardtcompression.com
[3] Technical University of Darmstadt, Franziska-Braun-Straße 7, 64287 Darmstadt, ralf.mueller@mechanik.tu-darmstadt.de

Key Words: *Multi-wire cables, Nonlinear beam, Frictional wire contact, Bending, Torsion.*

In the development and manufacturing process of modern cars, cables and hoses are important system components. In automotive industry, virtual assembly planning and digital validation of system layouts require a fast and physically correct simulation of the mechanical behavior of cables and hoses. In this work, we present a modeling approach using a finite element (FE) model [1] for cables, which can be used to investigate the effective inelastic constitutive behavior of multi-wire cables.
Experimental results on a simple cable specimen show that the effective mechanical response of cables is usually strongly nonlinear and inelastic [2]. Presumably, the observed behavior is caused by a superposition of inelastic phenomena such as material and structural effects on the level of individual constituents (e.g. contact and friction). Cable models using finite elements on the level of wires provide an approach to investigate such effects and their interplay. In this work, we use a commercial FEM tool [3] to simulate virtual bending and torsion experiments on multi-wire cables.
Cables undergo large spatial deformations in applications. Therefore, we model the wires using finite beam elements with quadratic shape functions. In addition, contact between wires occurs and is taken into account. In order to investigate the influence of friction on the effective mechanical response of the cable, we perform simulations without and with friction. This modeling approach can furthermore be used to investigate the influence of structural parameters, such as the lay angles of the helix wires, on the effective behavior of the simplified cable model. The modeling approach presented in this work allows for versatile and detailed investigations of the effective mechanical response of multi-wire cables. The simulation results will be compared to experimental results aiming at an improvement of the understanding of the different inelastic material and structural effects occurring in these experiments performed on cables.

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