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FINITE ELEMENT SIMULATION OF THE MECHANICAL BEHAVIOUR OF WIRE ROPES, COMPARISON WITH ANALYTICAL MODELS AND EXPERIMENTAL TESTS

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1 Introduction

The mechanical analysis of a wire rope structure is made complex by contact-friction interactions taking place between elementary wires. Various approaches, based on different assumptions, have been proposed to assess stresses in wires within a rope subjected to different loadings. The presented work compares the results from two different methods to analyse the mechanical behaviour of wire ropes, with experimental results: an analytical model [1] and a finite element model based on the detection and modelling of frictional contacts between wires represented by means of a finite strain beam model [2].

2 Description of the models

The analytical model takes account wire by wire of the double helical wires on the basis of general thin rod theory developed by Love. Two different kinematics are proposed: based on the assumption that the friction between wires is ∞ [1] to model traction and torsion tests and based on the assumption that the friction between wires is 0 wires [3] to model bending tests.

The finite element model, based on an implicit solver, focuses on the modelling of contact-friction interactions taking place between wires of the rope, within a large displacement and finite strain framework.

3 Validations against experimental tests

Three different tests are modeled using each method: traction tests, torsion tests and bending tests. For each kind of tests, three different strands configurations have been used: Regular, Seale and Warrington (Figure 1).

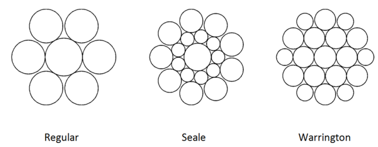
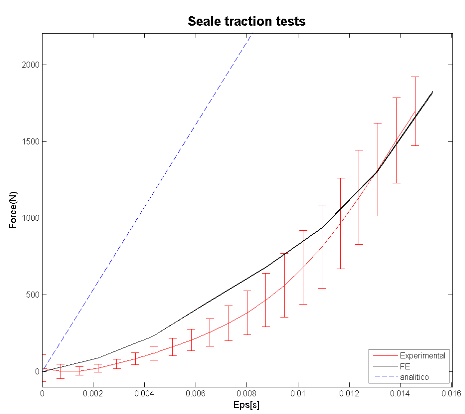
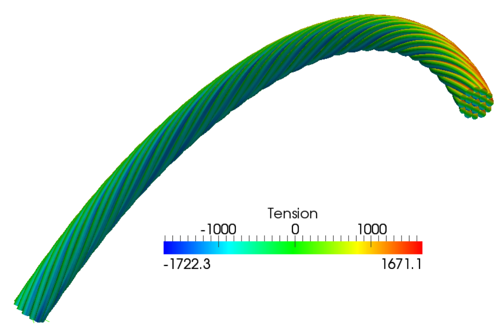


Figure 1: Strand configurations

Experimental tests have been carried out on three different machines: a INSTRON 4505 traction machine, a torsion machine developed by Ecole Centrale Paris and a bending machine fabricated by IKERLAN.

Results of traction tests shows good agreement with analytical and finite element model in traction and bending. Under torsion, as noted on a Seale strand plotted on the left figure below, finite element model can reproduce some experimental nonlinear effects that are not considered by the analytical model. On the right figure, the deformed configuration of a bended Warrington strand calculated by the finite element model is shown.





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