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BEND-OVER-SHEAVE OF SYNTHETIC BRAIDED ROPES: APPROACH TO INTERNAL MECHANISMS THROUGH FINITE ELEMENT SIMULATION

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Contact-friction interactions taking place between internal components of synthetic braided ropes when passing over a sheave are suspected to cause damage and to limit their lifetime. A modelling approach based on a finite element simulation at the microscopic scale of these interactions is proposed in order to highlight internal mechanisms responsible for this occurence of damage and to assess stresses within components of the braid [1].

Elementary filaments making up the braided ropes considered in this study are arranged into three successive levels: they are first assembled into yarns, which are twisted to form strands, which are eventually braided together. As the number of filaments is too high (a few tens of thousand), the proposed modelling starts at the level of yarns and considers ropes made of 84 elementary yarns assembled into 12 strands.

The simulation is based on the determination of the mechanical equilibrium of an assembly of elastic fibers developing contact-friction interactions, using an implicit solver, within a quasi-static framework [2].

The first task is devoted to the simulation of the determination of the unknown initial configuration of the braid, through a special procedure of gradual separation of initially interpenetrated yarns. The obtained configuration (Fig. 1) is validated by simulating a tensile test and comparing results with experimental data.

A bend-over-sheave test is then simulated, taking into account frictional contact interactions between yarns of the braid and a sheave modelled as a rigid surface (Fig. 2). As a validation, the work dissipated by friction over a cycle of bending is compared with experimental measures obtained from a similar test. Results from simulation demonstrate a wide distribution of stresses within yarns (Fig. 3) caused by friction generated between

yarns. Strongest effects are shown to take place both at the entrance and at the exit of the sheave.

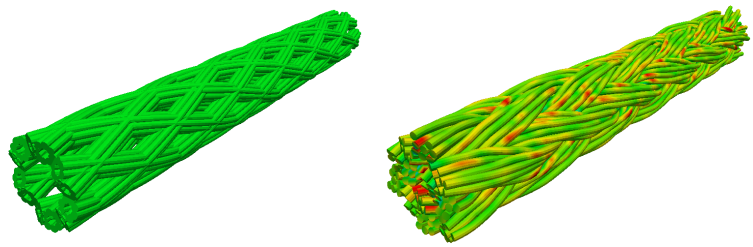

Figure 1: Determination of the initial configuration of the rope through a procedure of gradual separation

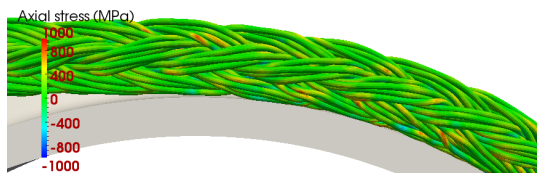

Figure 2: Detail of a braided rope bent over a sheave

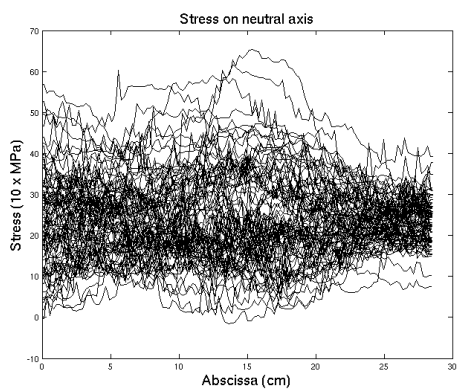

Figure 3: Axial stresses in the different yarns of the rope bent over a sheave

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