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MULTISCALE ANALYSIS OF THE HIERARCHICAL STRUCTURE OF A STRAND BUNDLE

***Marek J. Lefik[1], Daniela P. Boso[2] and Bernhard A. Schrefler[2]**

[1] Chair of Geotechnical Engineering and Engineering Structures
Technical University of Łódz, Al.Politechniki 6, 93-590 Lodz, Poland
emlefik@ck-sg.p.lodz.pl

[2] Dipartimento di Costruzioni e Trasporti
Università di Padova, Via Marzolo 9
35131 Padova, Italy
boso@dic.unipd.it
bas@dic.unipd.it

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ABSTRACT

During the last decade an extensive Research and Development (R&D) program has been performed to demonstrate the feasibility of the magnet system of the future International Thermonuclear Experimental Reactor (ITER) [1], [2]. The major elements of this program have been the construction and test of real scale coils (the Central Solenoid Model Coil CSMC [3], and the Toroidal Field Model Coil TFMC [4]) as well as solenoid prototypes (the various Insert Coils [5], [6], [7]). In addition a series of tests is being completed on short samples, i.e. 2-3 m long straight segments of superconducting (SC) cables.

The testing of the model coils has provided valuable information to finalize the design of the ITER magnetic system. However the behaviour of Nb3Sn based cables was not as good as expected on the basis of the characteristics evaluated for the uncabled strands [4], [8].

This degradation in Nb3Sn performance is due to various factors, among which the strain state of the filaments due to bending and contact phenomena inside the cable. Therefore the conductor degradation seems to be linked to the loads on the strands within the cable, and the extent to which the wires are supported by each other, i.e. the cabling pattern.

The objective of this work is to develop some finite element models, to analyze the influence of the twist pitches on the overall transverse stiffness of a petal. Non-linear behaviour of the material and contact phenomena occurring inside the strand bundle will be taken into consideration. The possibility of using the numerical results to train a suitable developed Artificial Neural Network is also discussed.

The motivation of this analysis consists in searching for patterns that offer a significant improvement in transverse stiffness compared to the reference, assuming that a higher stiffness will reduce strand bending and filament breakage.

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