8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

FINITE ELEMENT SIMULATION OF FORMING AND MECHANICAL LOADING OF CIC CONDUCTORS FOR THE OPTIMIZATION OF THEIR SUPERCONDUCTING PROPERTIES

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Key Words : *CIC conductors, finite element simulation, contact-friction, forming, magnetic loading.*

ABSTRACT

Cable-in-conduit (CIC) Nb3Sn conductors used for ITER are made as assemblies of multi stage twisted strands. It is known that the superconducting properties of such conductors depend highly on the mechanical loading they undergo, and particularly on the local strains individual strands are submitted to.

The goal of the approach presented here is to simulate the mechanical behaviour of CIC conductors in order to quantify local strains and stresses in individual strands. To this aim, it is necessary to take into account each strand constituting the global conductor, and especially to model contact-friction interactions taking place between these strands.

The finite element code Multifil [1], dedicated to the simulation of entangled media, has been adapted to handle problems specific to these conductors. Since the initial geometry of strands in the conductor cannot be known a priori, the first task assigned to the modelling is to simulate the forming of the conductor, starting from a theoretical configuration, then compacting the assembly of strands by means of rigid tools until the desired shape with the proper void fraction is reached . In a second step, various successive loadings are applied to the conductor to simulate respectively the effects of the cool down and of the Lorentz force generated under a magnetic field. As results, the software provides with a comprehensive description of strains and stresses in all strands, due to the combination of the different loadings applied after the forming process.

The effectiveness of non linear models and algorithms implemented in the code allows to simulate the behaviour of conductors made of a few hundred strands. Descriptions of these models and particularly of the modelling of the boundary conditions and of the various loading cases will be introduced in the presentation. Results of numerical simulations performed on ITER conductors will also be shown.

REFERENCES

[1] D. Durville. “Numerical simulation of entangled materials mechanical properties”. *Journal of Materials Science*, Vol. **40**, n° 22, pp. 5941-5948, 2005.