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Mon-Af-Po1.18-01 [58]: Advanced mechanical modeling of cyclically loaded cable-in-conduit conductors for fusion magnets

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The electrical performance degradation of Nb3Sn cables in the Cable-in-Conduit Conductors design has been well documented in literature. The Nb3Sn composite strands exhibit a critical current density that strongly depends on the strain state of the superconducting filaments. During the machine operation, the conductors are submitted to several electromagnetic and thermal cycles affecting the Nb3Sn mechanical state and consequently the capacity of the conductors to transport current. Different studies based on both a macroscopic and a microscopic approach have been performed so far to identify the mechanisms determining the conductors' behavior. Nevertheless, no theory permitting to predict the electrical performance of cyclically loaded conductors has been developed yet. Therefore, a solid electromechanical model able to tackle the analysis of CICC and other fusion cables when they undergo thousands of cyclic loadings would be very useful.
In this paper an advanced mechanical model to study the mechanical behavior of ITER TF CICC based on the new version of the MULTIFIL finite element code is presented. The thermal loadings simulations in MULTIFIL code have been upgraded to solve the non-homogenous strain distribution problem presented in a previous work. The model was adapted to take into account the Lorentz force cumulative effect of the other petals on the one under analysis. Moreover, new material constitutive laws have been implemented in the code.
An assessment of the electromagnetic behavior based on the mechanical analysis was also performed to make a preliminary comparison between the trend of the simulated results and the trend of the experimental ones obtained in the tests of the TFIO1 sample in the SULTAN facility.

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