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Manifestation of electromagnetic performance degradation of Nb3Sn cable-in-conduit conductor in the change of its mechanical structure

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Cable-in-conduit conductors (CICCs) are applied in the superconducting magnets designed for fusion reactors, because of their high-engineering current transmission capacity and large heat removal capabilities. In previous research, CICCs exposed varying degrees of performance degradation during electro-magnetic (EM) loading cycles. To prevent this kind of degradation, CICCs must be designed considering proper choices for the cable layout and the conductor geometry, depending on the operating conditions. In all cases, limiting of strand and cable movements and avoiding filament fracture inside the cable are necessary to exclude or at least diminish the degradation. But no matter how effective the structural improvement is, the nature of its mechanical composite properties determines that there is a critical structural collapse limit. The EM performance of the cable will show a relatively fast degradation after the Lorentz load reaches the structural collapse limit. To investigate this, sections of CICCs are tested with EM loading cycles in SULTAN, and sections with similar layout are tested by method of hydraulic cryo-mechanical pressing cycles. The test plan and loads of the two groups are corresponding. By comparison of the EM and the cryo-mechanical press test results, the relatively fast degradation of cable's EM performance can mostly be reproduced by the changes in its mechanical properties during the transverse mechanical loading test. This potential relationship has a high reference value for the design of future conductors and the preliminary evaluation of electromagnetic cycles.

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