Axial and transverse stress–strain characterization of the EU dipole high current density RRP Nb3Sn strand

A Nijhuis

Faculty of Science and Technology, Low Temperature Division, University of Twente, PO Box 217, 7500 AE Enschede, The Netherlands
E-mail: a.nijhuis@tnw.utwente.nl

Abstract
We have measured the critical current (Ic) of an OST high current density Nb3Sn RRP strand subjected to spatial periodic bending, periodic contact stress and uniaxial strain. The strand is destined for the cable-in-conduit conductors (CICC) of the European dipole (EDIPO) 12.5 T superconducting magnet test facility. The spatial periodic bending was applied, using bending wavelengths from 5 to 10 mm with a peak bending strain of 1.5% and the periodic contact stress with a stress level exceeding 250 MPa. For the uniaxial strain characterization, the VI characteristics were measured with an applied axial strain from −0.9% to +0.3%, magnetic field from 6 to 14 T, temperature from 4.2 to 10 K and currents up to almost 900 A. In addition the axial stiffness was determined by a tensile axial stress–strain test. The characterization of the strand is essential for understanding the behaviour of the strand under mainly axial thermal stress variation during cool down and transverse electromagnetic forces during charging, which is essential for the design of the CICC for the dipole magnet. The strand appears to be fully reversible in the compressive regime during the axial strain testing, while in the tensile regime, the behaviour is already irreversibly degraded when reaching the maximum in the critical current versus strain characteristic. In particular for CICC design, the tensile intrinsic axial strain in the filamentary region should stay well below zero (only compressive) and the contact stress sufficiently below 50 MPa. These requirements are feasible, in particular for a CICC design with steel conduit which would provide sufficient thermal compression, a sufficiently low void fraction and a cabling pattern that limits the peak bending strain during transverse load to about 0.3%. This is substantiated with transverse load modeling and experimental SULTAN results.