Contact Mechanics Model for Transverse Load Effects on Superconducting Strands in Cable-in-Conduit Conductors

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Abstract - A new model based on contact mechanics concepts has been developed to analyze and quantitatively evaluate mechanical transverse load effects on superconducting strands in a cable-in-conduit-conductor (CICC). It has been used to determine the number of contact points and the effective contact pressures among the strands in a cable. The new model has been confirmed by experimental measurements and it is used to explain mechanical transverse load effects on the critical current degradation of sub-sized cable samples. The transverse load degradations of the critical currents of a large CICC cable can be evaluated based on experimental critical-current degradation data of a 3-strand cable as a function of the effective contact pressure. The model predicts the critical current degradations of cables like an ITER full size conductor as high as 20% caused solely by the transverse Lorentz load effect. Parametric studies performed with this model indicate that the initial degradation could be reduced by shortening the twist pitch length of the initial stages of a full-size cable or by mechanically supporting the last stage bundles of the cable. This analysis shows that the transverse Lorentz load effect, which is inherent in the CICC design, contributes a significant fraction of the degradation of a large Nb_3Sn superconducting cable.

Keywords - Contact mechanics, Cable-In-Conduit-Conductors (CICC), critical current, transverse stress, Nb3Sn, superconducting cable.

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