Fundamental Evaluations of Transverse Load Effects of Nb_3Sn Strands Using Finite Element Analysis

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Abstract - The performances of large superconducting Cable-In-Conduit Conductors (CICC) are affected by various mechanical effects caused by thermal contractions during cooldown and the inherent interaction of current and field during operations. Recent large CICC cables and magnets such as ITER conductors have shown significant unexpected degradations. In this paper the transverse load effect caused by the Lorentz load is studied for a single strand and a 3-strand cable, basic elements of a CICC. 2D finite element models of Nb_3Sn single strand and 3-strand cable are developed to study the deformation and contact pressure of individual strand under external transverse loads. The strain and stress distributions of each strand inside a triplet are investigated considering the different positions of a strand in a triplet to simulate a twisted cable. The numerical results, combined with the single-strand experimental results and theory of contact mechanics, are applied to estimate the performance of a twisted 3-strand cable. The behavior of the 3-strand configuration obtained using finite element analysis (FEA) is discussed and compared to experimental results and existing models of the effect of contact pressures on the performance of superconducting cables.

Index Terms - FEA, Nb_3Sn strands, transverse load, CICC

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