A Model to Study Plastic Deformation in Nb_3Sn Wires

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Abstract - An important part of superconducting accelerator magnet work is the conductor. To produce magnetic fields larger than 10 T, brittle A15 conductors are typically used. The original round wire, in the form of a composite of Copper (Cu), Niobium (Nb) and Tin (Sn), is assembled into a so-called Rutherford-type cable, which is used to wind the magnet. The magnet is then subjected to a high temperature heat treatment to produce the chemical reactions that make the material superconducting. At this stage the superconductor is brittle and its superconducting properties sensitive to strain. This work is based on the development of a 2D finite element model, which simulates the mechanical behavior of Nb-Sn composite wires under deformation before heat treatment. First the composite was modeled in detail and its behavior analyzed under flat rolling using Finite Element Analysis (FEM). To identify a critical criterion, the strain results of the model were compared with those measured experimentally on cross sections of the deformed composite. Then the model was applied to a number of different wire architectures.

Index Terms - Nb_3Sn wires, Restacked-Rod Process, Finite Element Model analysis, Principal strain, Plastic work.

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