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Mechanical and electromechanical behavior of REBCO coated conductors under combined tensile-bending deformation

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In the case of a REBCO superconducting coil, the coated conductors endure both tensile and bending strain. Therefore, the mechanical behavior of REBCO coated conductors and its effect on the critical current under combined tensile-bending deformation should be revealed. In this study a mixed-dimensional laminated composite finite element model (FEM) for REBCO conductor is developed for stress and strain analyses in the processes of fabricating and cooling, as well as tensile and bending test. The model includes all the major constituent layers of a typical REBCO conductor and is experimentally validated. First, the thermal residual stresses and strains accumulated during the fabrication and cooling processes are analyzed. Then, with the residual stresses and strains as initial stresses and strains, the mechanical behavior under tensile, bending and their combined strain state is studied. Lastly, a phenomenological critical current-strain model based on the Ekin power-law formula and the Weibull distribution function is combined with the FEM to predict the strain dependence of critical current under the combined tensile-bending deformation. The calculations show that a proper compressive pre-bending can improve the tensile strain tolerance of the conductors. While an exaggerated compressive pre-bending can reduce the initial critical current, even cause the irreversible degradation. It indicates that reasonable arrangement of bending and tensile strains is very important for the extremely high field operation of a superconducting coil.

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