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Finite element analysis of strain distribution of REBCO coated conductors subjected to bending conditions experienced in high-field magnet applications

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A finite element method was developed to investigate the strain distribution of REBCO coated conductors under bending conditions relevant to high-field accelerator magnets. Due to their high current and high field capabilities, REBCO tapes are promising conductors for high field magnet applications. During magnet fabrication, REBCO tapes bend around a former. Because of the asymmetric architecture of the tape, the REBCO layer does not lie on the neutral plane and will experience strain during bending. The brittle characteristic of the superconducting layer requires the investigation of the generated strain distribution to avoid overstrains and damages of the tapes. In this work, the effect of bending on the strain distribution of a tape was analyzed using 3D numerical simulations. Various bending configurations relevant to high-field magnet applications were analyzed, including canted-cosθ (CCT) dipole and quadrupole. For both configurations, strain results were presented as function of the winding tilt angle and mandrel diameter. In addition, the strain generated by bending in the coil ends of a possible configuration presented by CEA Saclay was investigated. To validate the developed finite element model, we compared the calculated strain to the measurement based on the strain gauges mounted on the tape surface subjected to various bending modes. The results are used to identify possible design solutions to apply REBCO tapes in accelerator magnets.

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