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Transverse, axial and torsional strain tests on REBCO tapes as a basis for CORC modeling

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For high current REBCO superconductors in high magnet fields with currents in the order of 50 kA, single coated conductors must be assembled in a cable. The geometry of such a cable is mostly such that combined torsion, axial and transverse loading states are anticipated in the tapes and tape joints. A set of experimental setups as well as a convenient and accurate method of stress-strain state modeling based on Finite Element Method (FEM) has been developed. Systematic measurements on single REBCO tapes are carried out combining axial tension and torsion as well as transverse loading. Then the behavior of a single tape subjected to the various applied loads is simulated in the model. This paper presents the results of experimental tests and detailed FE modeling of the 3D stress-strain state in a single REBCO tape under different loads, taking into account the temperature dependence and the elastic-plastic properties of the tape materials, starting from the initial tape processing conditions during its manufacture up to magnet operating conditions. Furthermore a comparison of the simulations with experiments is presented with special attention for the critical force, the threshold where the tape performance becomes irreversibly degraded. We verified the influence of tape surface profile non-uniformity and copper stabilizer thickness on the critical force. The FE models appear to describe the tape experiments adequately and can thus be used as a solid basis for optimization of various cabling concepts.

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