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Bending of CORC cables, Experiments and Modeling

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The CORC cable is composed of several layers of helically wound HTS tapes on a round core with the winding direction reversed in each successive layer. The cable is flexible but the flexibility is limited by the critical strain value when causing breakage of the HTS layer. The cables for magnets in fusion reactors experience large mechanical and electromagnetic loads arising from cabled conductor and coil manufacturing to cooling and operation of the magnet. In order to optimise the manufacture and operating conditions, the mechanical behaviour of CORC cable must be understood for different relevant loading conditions. The complex configuration with many contact interactions between tapes and the non-linear behaviour of the materials during the production and operation conditions requires the use of finite element (FE) modelling. The FE modelling will allow an accurate calculation of the stress-strain state of the cable components under various loads and importantly; avoiding large-scale and expensive experimental optimisation studies. This work presents the results of experimental tests and detailed FE modelling of the 3D stress-strain state in a CORC cable under bending load, taking the temperature dependence and the elastic-plastic properties of the individual tape materials into account, 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 individual tape performance becomes irreversibly degraded. The FE model appears to describe the bending test of the CORC cable adequately and thus can be used to study other types of loads, parametric research of dependent variables and optimisation of the CORC cable design.

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