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Bending strain sensitivity of critical current in REBCO CC windings with different pitches on a large diameter former under static fatigue condition at 77 K

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High-temperature superconducting (RE)Ba₂Cu₃O_{7-x} (REBCO) coated conductor (CC) tapes are known for their capacity to tolerate high tensile stress under applied uniaxial tension, typically in the range of 600-700 MPa at 77 K, while mediocre level under pure bending (a.k.a., easy bending). Once utilized in coil, however, there is a limit to the value of the allowed strain/stress before degradation of the critical current (I_c) occurs, which is mainly attributed to the combined twisting and axial tension. These strains or stresses will affect considerably the irreversible strain limits of I_c due to added strain along the CC tape's edgewise direction (a.k.a., hard bending strain) even under static loading. With such conditions, degradation of the REBCO coil performance can be expected. So far, the systematic investigations of the mechanism for such I_c degradation in REBCO coil have not been clearly considered, therefore the current study aims to investigate the fundamentals of such degradation. Here, the linear superposition of strains induced in different modes such as pure tensile, easy and hard bendings, etc., are tackled analytically and experimentally. The I_c degradation behaviors of IBAD/REBCO CC tapes in windings with different pitches on a large diameter former are examined at 77 K and self-field, using a modified static fatigue tester designed for coil testing. The coil bend strain parameters, such as the radius of curvature, pitch between turns, etc., are analyzed. Through the linear superposition of strains induced in the REBCO coil, the appropriate approach to effectively suppress the I_c degradation while under static loading was suggested, and the static fatigue endurance were also determined.

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