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Fri-Af-Po.07-04: A Structural Calculation Method for Pulsed High-field Magnets Considering the Deviation of Axial Strain

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Solenoidal high-field pulsed magnets typically employ layered reinforcement techniques to mitigate the substantial Lorentz forces acting on the conductors. The thickness of each reinforcement layer must be optimized through stress analysis to achieve a uniform and reasonable stress distribution. Although commercial finite element analysis (FEA) software can accurately calculate the stresses within magnets, it presents challenges such as complex modeling processes, slow computation speed, and poor convergence, which require researchers to invest considerable time during the early stages of magnet design. In contrast, the specialized pulsed magnet design software PMDS offers faster computation. However, the PMDS model assumes a constant axial strain in the mid-plane of the magnet, simplifying the calculations but introducing errors. In reality, due to the non-uniform axial Lorentz forces and the characteristics of the contact interface between conductors and reinforcement layers, the axial strain in the mid-plane varies along the radial direction. In this paper, an improved mechanical model for stress analysis of solenoidal pulsed magnets is proposed, which accounts for the radial variation of axial strain and its influence on stress distribution. By introducing a parabolic distribution for the axial strain, a complete one-dimensional finite element calculation theory and method is established. Compared to the classical generalized plane strain analysis, the improved model significantly enhances the accuracy of stress predictions. The results obtained from the proposed model are validated through comparison with commercial FEA software. This improved model achieves both high efficiency and high accuracy, making it a valuable tool for optimizing high-field solenoidal pulsed magnets and exploring the potential for achieving higher magnetic fields.

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