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Structural optimization methodology of the 2-D inner-leg cross-section for the Toroidal Field Coils of fusion reactors

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A novel methodology is proposed for the structural optimization of the inner-leg cross-section of Toroidal Field (TF) coils of DEMO fusion reactor to achieve significant improvements in the structural response of the component. The original Winding Pack (WP) configuration, used as starting point of the optimization process, despite being compliant in terms of the electro-magnetic behavior, causes the entire component cross-section to be far beyond structural limits, because of intensive peak stress concentrations. Moreover, a standard optimization approach, aimed to lower these stress peaks, is nearly impossible, even on modern computer platforms, because of the expensive computational cost of each single Finite Elements analyses, resulting in unaffordable optimization times. Within this frame, in this work, borrowing numerical concepts and techniques from the aerospace industry, the mentioned prohibitive optimization problem is made computationally solvable, in reasonable optimization times.

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