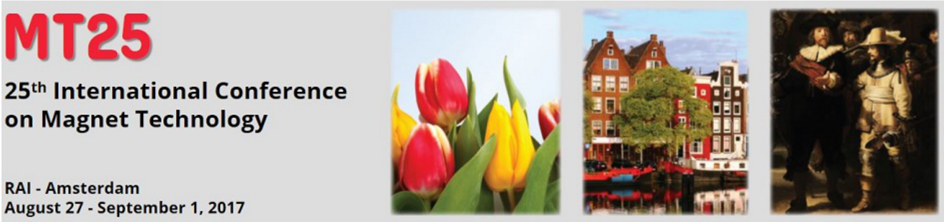


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# Optimization of structural performance of the toroidal field coil system of a tokamak

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One of the key systems of a fusion device is its magnet system producing high magnetic fields to confine plasma. The main component of the magnet system of a tokamak device consists of toroidal field (TF) coils, poloidal field (PF) coils and central solenoid (CS) coils. The shape of the TF coil has a big impact on its structural performance. When the shape is not mechanically optimized the unnecessary bending moments occur in the coil due to the electromagnetic forces acting in the coil plane. Many works on TF coils were conducted where so-called constant tension "bending free" shapes were derived using analytical expressions. The TF coils for many tokamaks like JET and ITER are designed as constant tension D-shaped ones. However, the previous studies regarded only the TF coil winding pack that was treated as a thin filament or a thin beam, thus neglecting the additional stiffness due to the winding finite dimensions, the external TF coil case and the outer intercoil structures. The impact of TFC case stiffness distribution as well as a coil shape on the in-plane bending of a coil winding is studied in this work. Based on the 2015 EU DEMO baseline design a finite element model of a constant tension "Princeton D"TF coil was developed. Electromagnetic and structural modeling of both the initial and the developed designs were conducted and the in-plane bending in the windings was analyzed. It was shown that a coil case can significantly change bending moment distribution in the coil. A parametric optimization procedure is presented which minimizes in-plane bending in a winding pack by changing the bending stiffness of the case. The way of utilizing this approach at the early design stage for real coils is discussed.

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