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P4.119 Enhancements in the structural integrity assessment of plasma facing components

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The preferred design of the ITER divertor target component is the monoblock, comprising a tungsten armour block through which passes a CuCrZr cooling pipe joined to the tungsten via a copper interlayer. This construction currently looks to be one of the favoured designs for DEMO. Ideally this structure can be assessed for structural integrity by finite element (FE) analysis using the ITER structural design code (SDC-IC). However, the multiple materials used in monoblock construction introduces many factors causing difficulties in the application of SDC-IC. The factors include residual stress, dissimilar material joints, the interaction of pipe and interlayer plasticity, the effects of irradiation hardening and the possibility of tungsten recrystallization. This presentation discusses some of the FE simulation methodologies that can be employed to overcome these issues. The effects of residual stress (caused be the differential contraction during manufacture) can be included in the stress assessment by using elasto-plastic methods and a simulation step representing the manufacturing cycle. The effects of dissimilar joints (which create singularities) can be avoided by modified joint design or hot spot methods. Irradiation hardening effects can be simulated directly by applying modified material stress/strain characteristics within an elasto-plastic simulation. The ratchetting effects of pipe/interlayer plasticity interaction can be addressed by separating material ratchetting from structural ratcheting, and the effects of tungsten recrystallization can be included by modification of modelled material characteristics and the assessment of plastic strain above and below the materials DBTT. Using these methodologies, analysis results can be assessed against the current list of SDC-IC failure mechanisms, allowing an improved assessment of structural integrity to be made. These methodologies form part of a divertor component design plastic analysis procedure being developed for EUROfusion. It is intended that they can be applied in the analysis of all types of multi-material plasma facing components.

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