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Numerical Assessment of OFHC Cu Creep in the Demonstration Fusion Power Reactor (DEMO) Divertor Monoblock

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One of the technological challenges associated with a power plant-scale fusion reactor is heat exhaust, namely, removal of large amount of heat generated by particle bombardment (and nuclear heating). It is divertor targets that are in charge of heat exhaust. The targets must withstand high heat fluxes, neutron irradiation and cyclic variation of thermal stresses. Such combined loads can lead to inelastic deformation, damage and eventually failure after long-term operations. Interaction of plastic fatigue, creep and nuclear swelling is thought to be a driving mechanism of damage. Present contribution presents a FEM-based computational study to investigate creep/swelling behaviour of a typical divertor target component, namely ITER-like tungsten monoblock, under reactor-relevant operation conditions. The aim is to assess the impact of creep on the stress states and the structural integrity of the monoblock-type target. To this end, an experimentally calibrated time-hardening model was adopted to simulate the primary and secondary creep in the Cu interlayer. Swelling was considered for the tungsten armor blocks. The main results indicate that creep in the copper interlayer is primarily activated during transient plasma phases. However, the accumulated strain remains limited and stabilizes over successive cycles. Consequently, its effect on stress distribution and pipe fracture behavior is negligible.

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