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Fracture assessment of DEMO divertor components by submodeling approach

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This study addresses, within the framework of fracture mechanics, the structural analysis of the DEMO divertor - a key component in fusion reactors - subjected to particularly severe loading conditions.
A global model of the divertor was developed using Finite Element Method (FEM) analysis, including all structural subcomponents. Thermal and Internal pressure load cases were considered. The FEM analysis enabled the identification of critical areas prone to stress concentration.
Based on the global results, a submodeling technique was applied to analyze locally critical components with higher resolution. On these sub-models, a Linear Elastic Fracture Mechanics (LEFM) analysis was performed using the FRANC3D software. Static semi-elliptical cracks were introduced in various configurations, and the Stress Intensity Factor was evaluated to assess their criticality.
Subsequently, an incremental crack growth analysis was conducted to simulate crack propagation based on the local stress field, also accounting for directional variations.
Finally, a Lifetime Analysis was carried out using Paris' law, estimating the remaining fatigue life of components under the given loading conditions and in the presence of cracks at the identified critical points.
The entire procedure was repeated for each subcomponent and loading condition, resulting in a broad and detailed understanding of the fracture response of the system. This approach provides crucial insights for the design, inspection, and long-term maintenance of the divertor.

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