Multi-scale modelling of failure in cast iron due to thermo-mechanical fatigue

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ABSTRACT

In this work, the micro-mechanical behaviour of Compacted Graphite Iron (CGI) is studied under thermo-mechanical loading representative of engine conditions. The 3D EBSD data of CGI is used to construct the representative volume element (RVE) of the microstructure. The voxel data is post-processed using the level-set method to define the surface contours [1]. The distance function from the surfaces is used as an input for adaptive mesh generation in which the optimality of the mesh size is considered based on the proximity to the inclusion interface [2]. A thermo-elastic-visco-plastic model is developed to describe the matrix (pearlite) behaviour under thermo-mechanical loading and calibrated on the tests on pearlitic steel. For the graphite, an anisotropic model is used in which the direction of the anisotropy is assumed in accordance with particle morphology, as indicated in the literature. An anisotropic bilinear damage cohesive model is used and implemented to simulate crack initiation at the matrix-graphite interface. The parameters of the cohesive model are selected in accordance with the observed theoretical and experimental findings for the graphite layers and graphite-pearlite interface. The RVE model is subjected to thermal cyclic loading under mechanically constrained conditions and the crack initiation at the interface is studied. Next, a continuum damage model combined with thermo-visco-plastic material model is implemented for material degradation and damage progression through the matrix.

REFERENCES

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