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

A. Mohammadpour*,†, V. G. Kouznetsova† and M.G.D Geers†

* Foundation NWO-I
Netherlands Organization for Scientific Research (NWO), 3502 GA Utrecht, Netherlands
E-mail: info-nwoi@nwo.nl, web page: http:// www.fom.nl /
† Eindhoven University of Technology (TU/e)
Department of Mechanical engineering, 5600 MB Eindhoven, Netherlands
Email: A.mohammadpour@tue.nl - Web page: http://www.tue.nl/

ABSTRACT

In this work, the micro-mechanical behaviour of Compacted Graphite Iron (CGI) is studied under thermo-mechanical loading representative of engine conditions. The micro-structure of the CGI is modelled as a network of connected graphite inclusions in pearlite matrix. The 3D EBSD data of CGI is used to construct the representative volume element (RVE) of the microstructure. Voxelized and level set representations of the micro-structures are compared. The level-set method is used 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 is considered based on closeness to the inclusion interface [2]. A thermo-visco-plastic model is developed to describe the matrix (pearlite) behaviour under thermo-mechanical loading and calibrate on the test on pearlitic steel. The RVE model is subjected to thermal cyclic load under mechanically constrained conditions. The results of the simulation are compared to the experimental data and showed good agreement. The results show that different RVE representations (i.e. voxel-based and level-set based) and mesh sizes provide different local behaviour while it has a negligible effect on averaged (macroscopic) field variables. The next step will involve the detailed study of microstructural failure mechanism in cast iron.

REFERENCES

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