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EFFECT OF GRAPHITE-PARTICLE MORPHOLOGY ON THERMOMECHANICAL PERFORMANCE OF COMPACTED GRAPHITE IRON: NUMERICAL MODELLING

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Excellent thermal behaviour and mechanical properties of cast irons result in a wide range of their applications. Compacted graphite iron (CGI) is an important type of cast irons and used in the automotive industry for cylinder heads and piston rings. As a metal matrix composite, the mechanical behaviour of CGI is significantly affected by its microstructure (size, distribution and volume fraction of graphite particles). Importantly, this cast iron contains not only nodular graphite particles but also vermicular ones and flakes. However, due to such a complex microstructure, the research into the effects of graphite morphology on thermomechanical performance and fracture mechanisms of CGI at high temperatures is still limited.

This problem was initially studied at Loughborough University with mechanical tests, microstructural analysis and two-dimensional numerical simulations [1, 2]. This work concentrates on the effects of a three-dimensional microstructure of CGI as well as relationship between graphite morphology and thermomechanical performance of CGI at micro scale under purely thermal loading.

Microstructural characterisation of CGI was performed using scanning electron microscopy while the results of statistical analysis for distribution of particles provided the geometric features for numerical simulations. Representative volume elements were generated in finite-element models with different morphology, orientations and sizes of graphite particles. The elastoplastic behaviours of the particles and the matrix were employed in numerical simulations. The graphite-matrix interface was considered to assess the fracture mechanism of CGI.

The obtained results including the microscopic fracture mechanism of CGI could provide a better understanding of the macroscopic behaviours of CGI for engineers. The experimental results were compared with the microstructural data and numerical simulations.

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