Modeling of grey cast irons by crystal plasticity approach based on classical and micromorphic plasticity

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ABSTRACT

Cast iron is a complex natural composite consisting of grains of iron and carbon-iron alloys and inclusions of pure graphite. The study of the micromechanical performance of materials with such complex microstructure is especially important for explaining their macrostructural behavior, such as fracture and fatigue. For this purpose, a numerical modeling approach based on the crystal plasticity theory [5, 3, 1] is used in the current contribution .

In addition to the classical plasticity model, a reduced micromorphic crystal plasticity model [2, 4] is utilized to address scale dependencies while treating the cast iron as a composite material with full field modeling. The model is coupled to a cohesive zone-like treatment of damage to address the evolution of cracks arising from plastic slip during cyclic loading. The tension-compression asymmetry prevalent in cast irons is included and its sources addressed, including a smeared contact approach for closure of cracks formed under the tensile stages of loading. Altogether, the investigations and implementations are aimed at proper multiscale modeling of the wear, fracture, and fatigue processes in cast irons as well as cast processes. The experimental observations are addressed in order to validate the numerical results.

Keywords: cast iron, crystal plasticity, micromorphic plasticity, micromechanics

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