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Investigation of the effect of porosity on the high cycle fatigue behaviour of cast Al-Si alloy by X-ray micro-tomography

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Abstract

Porosity generated by the casting process has a detrimental effect on the high cycle fatigue strength of cast aluminium alloys. The current study presents an investigation using the non-destructive X-ray micro-tomography technique of the effect of the size and the population of casting pores on the fatigue strength of the AlSi7Mg0.3 alloy. This alloy was obtained by the lost foam casting process, which leads to a "high" volume fraction of porosity. Observations by micro-tomography, realized on specimens containing fatigue cracks, highlight an important role of the pore distance to the specimen surface in addition to the pore size. In the second part, the local mechanical response around real 3D pores is investigated thanks to finite element models using an elasto-plastic material behaviour law for the aluminium matrix. A critical volume approach based on the Dang Van criterion to predict the fatigue limit is introduced and shows good agreement with the experimental data. The effect of the pore geometry on the Dang Van equivalent stress distribution around individual pores is also investigated.

Keywords: cast aluminium alloy, fatigue, tomography, porosity, finite element simulation

Nomenclature

β macroscopic torsional fatigue strength for R=-1 [MPa]

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