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Numerical Simulation on Deformation Behaviour of Additively Manufactured AlSi10Mg Alloy

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Abstract : The deformation behaviour of additively manufactured AlSi10Mg alloy under low strains, high strain rates and elevated temperature conditions is essential to analyse and predict its response against dynamic loading such as impact and thermomechanical fatigue. The constitutive relation of Johnson-Cook is used to capture the strain rate sensitivity and thermal softening effect in AlSi10Mg alloy. Johnson-Cook failure model is widely used for exploring damage mechanics and predicting the fracture in many materials. In this present work, Johnson-Cook material and damage model parameters for additively manufactured AlSi10Mg alloy have been determined numerically from four types of uniaxial tensile test. Three different uniaxial tensile tests with dynamic strain rates (0.1, 1, 10, 50, and 100 s⁻¹) and elevated temperature tensile test with three different temperature conditions (450 K, 500 K and 550 K) were performed on 3D printed AlSi10Mg alloy in ABAQUS/Explicit. Hexahedral elements are used to discretize tensile specimens and fracture energy value of 43.6 kN/m was used for damage initiation. Levenberg Marquardt optimization method was used for the evaluation of Johnson-Cook model parameters. It was observed that additively manufactured AlSi10Mg alloy has shown relatively higher strain rate sensitivity and lower thermal stability as compared to the other Al alloys.

Keywords : ABAQUS, additive manufacturing, AlSi10Mg, Johnson-Cook model
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