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A Generalisation of the Hill's Quadratic Yield Function for Planar Plastic Anisotropy to Consider Loading Direction

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Abstract

In this work, a new generalised quadratic yield function for plane stress analysis that is able to describe the plastic anisotropy of metals and also the asymmetric behaviour in tension-compression typical of the Hexagonal Closed-Pack (HCP) materials, is developed. The new yield function has a quadratic form in the stress tensor and it simultaneously predicts the r-values and directional flow stresses, which is shown to agree very well with experimental results. It also accurately describes the biaxial symmetric stress state which is fundamental for the accurate modelling of aluminium alloys. The new quadratic yield function represents the non-symmetric biaxial stress state by performing a linear interpolation from pure uniaxial loading to a biaxial symmetric stress state. The main advantages of this new yield function is that it can be used for the modelling of metals with any crystallographic structure (BCC, FCC or HCP), it only has five anisotropic coefficients and also that it is a simple quadratic yield criterion that is able to accurately reproduce the plastic anisotropy of metals whilst using an associated flow rule.