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ON THE PLASTIC SPIN IN AN ISOTROPIC SMALL DEFORMATION GRADIENT PLASTICITY THEORY

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Classical plasticity models are scale independent and thus cannot capture any size effect. To resolve this limitation, higher order crystal plasticity theories account for the incompatible deformation in each slip system, hence capturing the size effects induced by the grain boundaries, as well as the non-uniform structural deformation. However, it is computationally expensive to adopt such a high resolution model for a large structural problem. In this contribution, we focus our attention on the isotropic gradient plasticity theory in [1] which accounts for the plastic spin, hence departing from most isotropic theories in literature. To elucidate on the role of the plastic spin, we compare and contrast three analogous higher order theories – a crystal plasticity model in [2] which we take as a reference, the isotropic model with plastic spin [1], as well as an isotropic model neglecting the plastic spin [3]. Through a constrained shear problem, it is shown analytically that the plastic spin enables the isotropic model to capture the essential features of a crystal plasticity model with multiple slip systems. The numerical framework for the isotropic model is next presented, and the plastic spin effect further demonstrated with a composite cell example. The findings illustrate that the isotropic model with plastic spin can be adopted at the sub-granular scale – if multiple slip systems are assumed to be present within each grain – hence capturing the direct influence of grain boundaries in a computationally efficient manner by neglecting the crystallographic influence.

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