Anisotropic Plasticity Model Considering the Dynamic Strain Ageing Effects

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Abstract. For the precise description of plastic deformation behaviours of metallic materials in various forming processes, the accuracy of the applied constitutive model is of essential importance. It is well known that the mechanical properties of commonly used constructional materials, such as steels, aluminium alloys, are affected by several factors, temperature, strain rate, and loading orientation. However, a constitutive model considering all these involved phenomena with high accuracy is still missing. In this study, a comprehensive experimental program is designed to investigate the effects of anisotropy and temperature on the mechanical properties of a high strength steel. The anisotropic flow behaviours of the investigated material are characterised by performing uniaxial tensile tests along three directions, namely the rolling direction, diagonal direction, and transverse direction. The thermal dependence of the mechanical properties, especially the flow stresses, is revealed by repeating uniaxial tensile tests along three directions over a wide range of temperatures, within which a special phenomenon called the dynamic strain ageing takes place. The mutual effects of the temperature and anisotropy on the plasticity are discussed. A phenomenological constitutive plasticity model is proposed to describe the anisotropic flow behaviours of the investigated material considering the complicated thermal effects over a wide range of temperatures.