Thermo-mechanical response of 9Cr-1Mo-V-Nb (P91) steel under multi-axial loading: Experiments and numerical modelling

Virtual prototyping tools of processes and systems in the domain of sheet metal working is nowadays a real prospect for industrial users to provide accurate predictions of the part geometrical features and post-forming characteristics (e.g. residual stresses) and possible defects and failures based on the chosen process parameters. Thanks to these predictions, critical decisions in process design are taken which strongly affect the technical and economical success of the process such as the selection of the proper process chain, the tool and equipment design, the process design with respect to the product service life characteristics. However, to make the numerical simulation tools reliable and versatile for efficiently and accurately predicting the events and phenomena that materials, processes and products are subjected to, useful and efficient models and tests able to evaluate the different aspects of the material response to deformation are among the most critical prerequisites.

The main objective of this project is to introduce a thermo-mechanical testing strategy and conduct a series of uniaxial, cruciform quasi-static biaxial as well as proportional/non-proportional cruciform biaxial cyclic tests and replicate experimental observations of 9Cr-1Mo-V-Nb (P91) steel flow behaviour by developing phenomenological constitutive models. In doing so, behaviour of P91 sheet metal in a biaxial stress space is represented by providing: (i) a yield criterion, correlating the stress components when the yielding occurs; (ii) a flow rule, connecting the components of the strain-rate and stress; (iii) a hardening rule, describing the evolution of the initial yield locus.

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