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Combined Experimental and Numerical Study on the Hardening Behaviour of Q&P-Processed Steels

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This contribution deals with a combined experimental and numerical study on the hardening behaviour of low alloy (high strength) Q&P steel with different heat treatment strategies. One material is conventionally treated by quenching and tempering. Beyond that, two different quenching and partitioning treatments are regarded.

The experimental investigation includes (i) uniaxial tension tests at small strains to evaluate the Young's modulus, (ii) uniaxial tension tests up to different predefined strain levels (i.e. differently plastically deformed specimen), and (iii) compression tests on virgin and plastically deformed test specimens. To this end, compression test specimens were cut from virgin and plastically deformed tension test specimen.

Next, a phenomenological model of large strain viscoplasticity is applied to simulate the material behaviour of the different steels. It includes a von Mises yield function, viscoplastic yielding of Perzyna type, as well as multiple isotropic and kinematic hardening mechanisms. The model is adapted to the tension/compression data of the different steels by a combined manual/automatic identification approach. Finally, the identified material models are applied within finite element (FE) simulations of the tension/compression tests. Since different FE models have to be employed for each loading case, a procedure is applied to pass the values of plastic variables among the FE models.

Finally, the hardening behaviour of the different steels and the applicability of the material model in its current form are discussed.