Modelling strategies for residual stress analysis of a hybrid rolling process

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ABSTRACT

The focus of this paper is a hybrid cold rolling process that can be used to form mechanical joints between an axle and a secondary component like a drive gear. The process variant investigated here is an incremental flexible rolling process with kinematic forming of the geometry [1] which also includes some aspects of deep rolling surface treatments. The final workpiece geometry is not only determined by the roll geometry as in most profile rolling processes, but is also influenced by the work roll path [2]. Two sets of actively driven work rolls are used in a transverse and axial rolling process to selectively reduce the diameter of a cylindrical workpiece. Simultaneously, the excess material is pushed in axial direction, thereby forming the mechanical joint. The resulting circumferential groves are natural weak points of the workpiece and can become critical under cyclic loads.

This disadvantage can be at least partially compensated by selectively inducing residual compressive stress and utilizing the material's strain hardening during the cold rolling process to improve the fatigue strength under cyclic loads [3]. The authors propose a simplified semi-analytical model to quickly analyze a number of process parameters like axial and radial roll feed regarding their influence on the resulting residual stress profile. The semi-analytical model is using the elementary theory of plasticity for axisymmetric cases. The modelling is verified using virtual experiments carried out via finite element analysis using LS-Dyna. The numerical model uses a 2 ½ D axis-symmetric approach with an implicit solver. Additionally, selected parameters are also tested in real experiments on a Profiroll 2-PR-15e skew rolling machine on specimen from 42CrMo4. All types of results will be shown and discussed in the paper.

REFERENCES

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