Fatigue Behaviour and Life Prediction of Cold-Formed High Strength Steel.

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Abstract. Nowadays, HSS grades serve as multipurpose materials since they combine several advanced mechanical properties such as an excellent specific strength and enhanced fatigue performance. In recent years the implementation of HSS for various mobile application and lifting equipment has increased significantly. The design and performance of these applications can be optimized by using high strength steel components, in thinner, more compact configurations. As service loads are typically cyclic in nature, the fatigue behavior is a major concern for the final design. Furthermore, HSS components often require a closed cross-section achieved by a secondary forming process, inducing a significant amount of strain hardening and residual plastic strain in the deformed area which affects the fatigue properties compared to the undeformed base material. In this study, a new benchmark specimen and a set of modular tools have been designed for plain strain bending to derive a fatigue sample that considers residual stresses caused by forming. Force-controlled tensile fatigue tests have been performed for five different load levels with three repetitions each. By means of numerical and experimental techniques, the fatigue behavior of a cold-formed high strength steel S500MC is predicted and assessed. The present study is concerned with setting up a general framework for modelling and fatigue testing of bent samples where the crack growth is monitored at consecutive intervals of the expected fatigue life. Therefore, a full SN-curve has been developed for the abovementioned material. In addition, a predictive finite element model has been created capable of assessing the fatigue life based on 3D stress-strain methods. The model, developed in Abaqus/Standard, consists of a quasi-static bending process followed by static fatigue loading. Finally, a few common as well as more complex multi axial fatigue criteria are used to assess the expected total life and compare theoretical findings with experimental observations.