Residual stresses in multi-pass cold drawn high-strength steel wires

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SUMMARY. Cold drawing is employed to fabricate wire and rods, which are mainly used as structural reinforcements in prestressed concrete structures, in tyres, but also as cables in deepes mines shafts and off-shore petroleum production. As a consequence of the drawing process, a residual stress profile is developed [Atienza et al., 2005b] [Atienza et al., 2005a]. The drawing process is complex, and there are many parameters that determine the deformation and therefore the final state of residual stresses [Overstam, 2006]. Some studies [Elices et al., 2004] [Atienza and Elices, 2003] have demonstrated the influence of residual stresses on the stress relaxation losses and on the ductility in steel wires. In prestressed concrete structures, stress relaxation losses in steel cables are very important, and design codes place both limits on the initial prestress load and recommendations for keeping these losses within safe margins. Wire manufacturers know the harmful effects of residual stresses, and try to reduce their influence by thermo-mechanical treatments [6] after drawing. These treatments are often empirical, because of the difficulty to model these processes. It is desirable for the industry to find an efficient way to study the influence of the drawing process and heat treatment variables on residual stresses. Hence, it would be advantageous to predict the distribution of residual stresses generated by cold-drawing and by the subsequent heat treatment. This paper presents a study on the multi-pass drawing of a wire of high-strength steel by means of the finite element method (FEM), and on the effects of the thermo-mechanical treatments on the residual stresses in the wire. A FEM model of the drawing process and of the heat treatment is presented. The results show that the post-drawing treatment is very successful in reducing the residual stresses produced by the drawing, suggesting that the FEM method could be used to design and optimize this specific industrial process.

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