DISPUTATION
Ämnesområde: Materialmekanik/Material Mechanics
Opponent: Professor J Huetink, University of Twente, Nederländerna
Ordförande: Professor Lars-Erik Lindgren, Luleå tekniska universitet
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Experimental and computational investigation of the roll forming process

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Abstract

One of the first questions to consider when designing a new roll forming line is the number of forming steps required to produce a profile. The number depends on material properties, the cross-section geometry and tolerance requirements, but the tool designer also wants to minimize the number of forming steps in order to reduce the investment costs for the customer. There are several computer aided engineering systems on the market that can assist the tool designing process. These include more or less simple formulas to predict deformation during forming as well as the number of forming steps. In recent years it has also become possible to use finite element analysis for the design of roll forming processes.

The objective of the work presented in this thesis was to answer the following question: *How should the roll forming process be designed for complex geometries and/or high strength steels?*

The work approach included both literature studies as well as experimental and modelling work. The experimental part gave direct insight into the process and was also used to develop and validate models of the process. Starting with simple geometries and standard steels the work progressed to more complex profiles of variable depth and width, made of high strength steels. The results obtained are published in seven papers appended to this thesis.

In the first study (see paper 1) a finite element model for investigating the roll forming of a U-channel was built. It was used to investigate the effect on longitudinal peak membrane strain and deformation length when yield strength increases, see paper 2 and 3. The simulations showed that the peak strain decreases whereas the deformation length increases when the yield strength increases. The studies described in paper 4 and 5 measured roll load, roll torque, springback and strain history during the U-profile forming process. The measurement results were used to validate the finite element model in paper 1. The results presented in paper 6 shows that the formability of stainless steel (e.g. AISI 301), that in the cold rolled condition has a large martensite fraction, can be substantially increased by heating the bending zone. The heated area will then become austenitic and ductile before the roll forming. Thanks to the phenomenon of strain induced martensite formation, the steel will regain the martensite content and its strength during the subsequent plastic straining. Finally, a new tooling concept for profiles with variable cross-sections is presented in paper 7.

The overall conclusions of the present work are that today, it is possible to successfully develop profiles of complex geometries (3D roll forming) in high strength steels and that finite element simulation can be a useful tool in the design of the roll forming process.