Formability of Martensitic Steel in Roll Forming of Variable Depth Profiles

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Aim:

The project aims at developing a test method to investigate forming limits in roll forming of martensitic steel. It also proposes a new method to extend the roll forming process to form variable depth sections.

Background:

Ultra-High Strength Steels (UHSS) have the potential to improve passenger safety and increases the strength to weight ratio of the automobile structures. However their high yield strength and low ductility makes forming of these steels difficult in conventional stamping processes. To form such high strength materials, hot stamping was introduced. This process is however very expensive due to additional heating setup involved. Previous studies have shown that roll forming is an alternative process that can be used for forming of UHSS. Therefore, UHSS such as martensitic steels, are of increasing interest for roll forming. But roll forming can be only used to form the profiles with constant cross section over length. In this study, the conventional roll forming will be extended to form variable depth components. The limitation of the process will be investigated in regard to fracture due to limited ductility of the martensitic steel.

Methodology:

Initially, the geometric deformation required to obtain a shape with variable depth (Figure 1) will be studied. This will allow the identification of compressive and tensile regions, responsible for the shape defects in variable depth profiles. Further, a process will be developed using finite element method to minimise shape defects. This will be done by introducing a suitable deformation method, using a new tooling, which allows to eliminate potential shape defects due to compressive deformation. The process will be used for forming UHSS, such as martensitic steels. Because of their limited ductility the limitation of the process will be investigated in regard to fracture. By studying the deformation involved in the variable depth roll forming, such as incremental bending, shear and unbending, a fracture model will be modified to estimate the fracture limits in non- proportional and reverse loading conditions. Also, the fracture strains in the plane strain condition will be compared with the existing notched tension tests and V-bending tests. This will allow the comparison of the fracture strains from both tests. Based on these results, the formability in roll forming will be predicted and later validated with experimental results. Further, using the new fracture model the variable depth roll forming process will be modified to enable forming of martensitic steel.

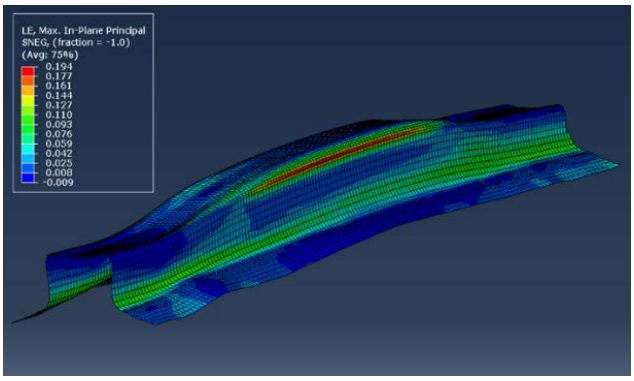

Figure 1 Variable depth component

Key findings to date:

- A variable depth geometry consists of compressive and tensile regions. Wrinkling can be significantly minimised by introducing shear deformation.
- In comparison to conventional tests, the results obtained from the V-bend test performed on the Erichsen machine can be used to accurately predict fracture in roll forming.
- The fracture model, calibrated with the bend tests performed on the Erichsen machine also gives accurate prediction in numerical simulations.

Future work:

- Estimating the fracture limits in unbending
- Modelling the fracture limit with non-proportional and reversible loading
- Experimental development of the variable depth forming process

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