Optimisation of Forming Processes

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Introduction

Cost saving and product improvement have always been important goals in the metal forming industry. To achieve these goals, metal forming processes need to be optimised. During the last decades, simulation software based on the Finite Element Method (FEM) has significantly contributed to designing feasible processes more easily. More recently, the possibility of coupling FEM to mathematical optimisation techniques is offering a very promising opportunity to design *optimal* metal forming processes instead of only *feasible* ones.

Goal

The goal of the project is to develop an optimisation strategy for industrial metal forming processes.

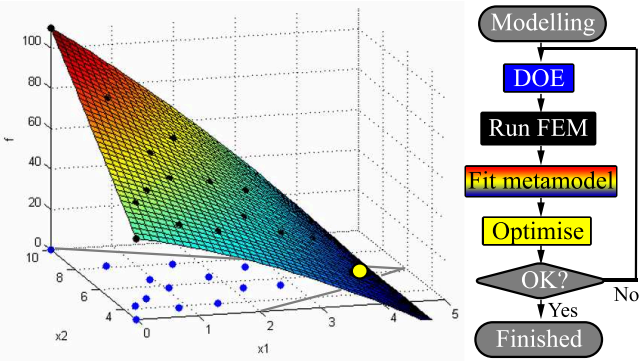

Figure 1 : Sequential Approximate Optimisation

Optimisation strategy

The developed optimisation strategy consists of three stages: modelling, screening and solving.

Modelling Brainstorming with industrial partners and structuring the results yielded a 7 step methodology for modelling optimisation problems in metal forming, i.e. defining objective function, constraints and design variables.

Screening A limited number of FEM simulations is run to determine the most important design variables and to reduce the size of the optimisation model.

Solving The final stage of the optimisation strategy is to solve the optimisation problem by a Sequential Approximate Optimisation (SAO) algorithm, which is presented in Figure 1.

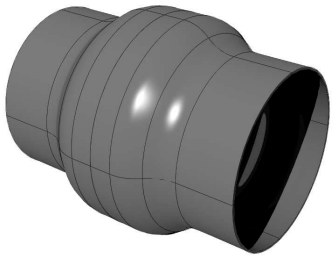

Figure 2 : Hydroforming application

Application

The optimisation strategy has been applied to the hydroforming process of the simple product presented in Figure 2. A 2D axisymmetric FE model has been made using the FEM code DiekA.

Modelling Applying the 7 step modelling methodology yields a 7 design variable optimisation problem. The objective function aims at achieving a constant wall thickness distribution throughout the final part.

Screening Using screening techniques, the optimisation model has been reduced to 5 design variables.

Solving The reduced optimisation problem has been solved by the SAO algorithm. Figure 3 presents that the wall thickness distribution of the optimised process is much closer to the perfect product than that obtained with several arbitrary process settings.

Conclusions

The hydroforming application demonstrates the potential of the developed strategy to optimise metal forming processes. Current work comprises its application to 4 industrial metal forming processes.

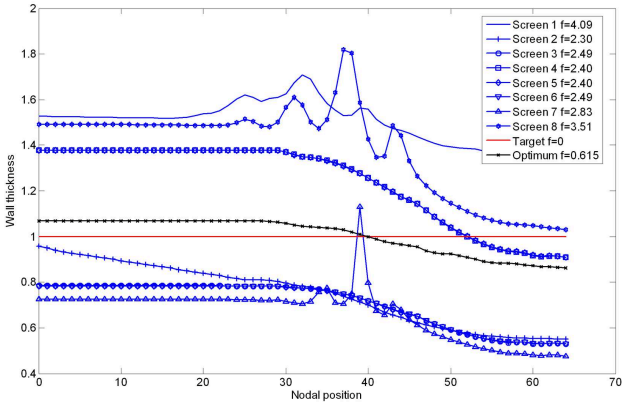

Figure 3 : Wall thickness distributions