Reshaping of Large aeronautical structural parts: A simulation approach based on Reduced Order Modeling

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Keywords: Distortion, Residual Stresses, Reshaping, Reduced Order Modeling

ABSTRACT

Large aeronautical structural parts present important distortions after machining. This problem is caused by the presence of residual stresses, which are developed during previous manufacturing steps (quenching). Before being put into service, distortions are removed manually by mechanical methods. This operation is called reshaping and exclusively depends on the skills of a well-trained and experienced operator. Moreover, this procedure is time consuming and nowadays, it is only based on a trial and error approach. Therefore, there is a need at industrial level to solve this problem with the support of numerical simulation tools [1].

A T-shaped beam made of aluminum AA7010 is proposed as a test case and a four-point bending is selected as reshaping operation. Distortion is generated numerically, following the procedure described in [2]. Reshaping can be considered as an optimization problem, in which the goal is to find the stroke that minimizes distortion for a given technological setup (i.e. support rollers positioning). Both mechanical state (i.e. residual stresses) and mechanical properties are likely to vary from one part to part. Reduced Order Models have been proven to be very effective in optimization problems such as the one described here [3]. In particular, the Sparse Subspace Learning (SSL) [4] exploits the sparsity of the solution with respect to the parameters in order to build a parametric solution in a non-intrusive manner, from the computation of only few wisely chosen snapshots. This method will be applied to the test case with the aim to compare the response of both models in terms of initial distortion, distortion evolution during reshaping, remaining residual stresses and computational time. The present study will allow setting the first technological brick to simulate reshaping under a Reduced Order Modeling framework.

ACKNOWLEGDMENTS

This project is part of the Marie Skłodowska-Curie ITN-ETN AdMoRe funded by the European Union Horizon 2020 research and innovation program with grant number 675919.

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