Influence of the residual stresses in reshaping operations of large aeronautical parts

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ABSTRACT

In the aeronautical industry, large monolithic structures are made by aluminum forgings. These structural components present residual stresses (RS) as a consequence of the non-uniform plastic strains generated during previous manufacturing steps [1, 2]. When the parts concerned are machined in order to obtain the final geometry, important distortions that are out of the geometrical tolerances arise and an extra operation called "reshaping" is needed before being put into service. This step is highly manual, depends exclusively on the worker's skills and contributes to increment the manufacturing cost.

The final goal of this work is to develop a Reduced Order Model (ROM) for the reshaping operation. However, as a first step, the following question has arisen: What is the influence of residual stresses for reshaping? The order of magnitude of RS reported in literature is ± 30 MPa [3] and it is expected that straightening operations will modify the previous stress field. To study this phenomenon an L shape beam is defined and the four points bending is selected to be one of the most used straightening techniques. The main idea is to induce a localized plastic strain in the out-of-tolerance zone with an extra displacement to take into account the spring back effect. To perform this study two cases are compared, one distorted element with RS and one distorted geometry free of RS. The selected material for this analysis is an AA7010.

In this work, the different steps required to obtain the RS and its associated distorted geometry will be explained together with the associated technological challenges from the simulation point of view. The result of this study will provide a route to follow for developing the desired ROM.

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