Springback: Influence of an Accurate Trimming on Springback

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Introduction

In automotive industry, sheet metal parts are created by a sequence of manufacturing processes, comprising blanking, deep drawing, trimming, flanging and hemming operations. Each of these operations introduces a certain amount of shape change upon unloading – springback, which is not accounted for at the stage of tooling design. Therefore, an expensive experimental trial and error process has to be performed to determine the tool design that will lead to the dimensionally accurate product.

Objective

The substitution of such experimental process by a less costly numerical one offers a good alternative. The stress state driving the springback has to be predicted numerically as accurately as possible after each of the mentioned-above forming operations, to be taken into account during the tool manufacturing. The process discussed is the trimming operation.

Figure 1: Stages of numerical simulation.

Methods

The numerical procedure followed for a sequence of simulations is outlined in Fig. 1. Due to the complexity of the trimming, in addition to the geometric mesh adaptation to the trimline, two techniques of taking into account the stress state change due to cutting are developed.

1 Data Remap After adapting the mesh to the trim-line, the shape and size of the distorted elements of the plate model is improved by the node centering method.

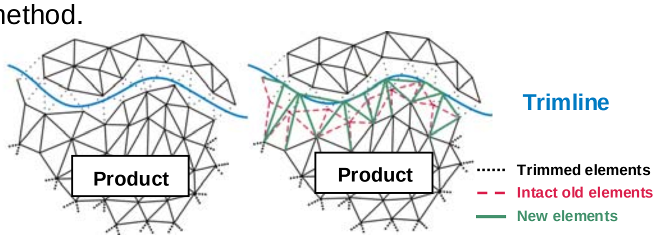

Figure 2: Mesh manipulation.

At this point, the accuracy of the numerical springback prediction depends on the accurate interpolation of the data known in the integration points (IP) of the untrimmed mesh to the IP's of the newly formed elements.

2 Cutting stress Transfer The second technique concerns the stresses introduced by the cutting operation itself. Crystal, the in-house FE code of Philips BV, was used to model the 2D cutting (Fig. 3a). Then the data from the 2D cutting simulation is transferred to the plate model using the coordinates *d* and *h* (see Fig. 3b). In this way the cutting stress state is accounted for in the plate model.

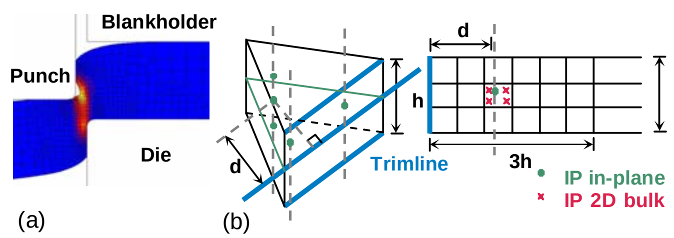

Figure 3: 2D data manipulation.

Results and Conclusions

Fig. 4 shows the lateral deflection of the flange of the rectangular product after trimming (initial plate thickness: 1mm). Three simulations are performed, i.e. one without any of the discussed techniques (mesh adaptation), one with data remap only and one with both data remap and cutting stress transfer. The results show that the influence of the cutting stress transfer is much larger than the data remap. Nevertheless, the influence of taking into account all discussed techniques stays within plate thickness.

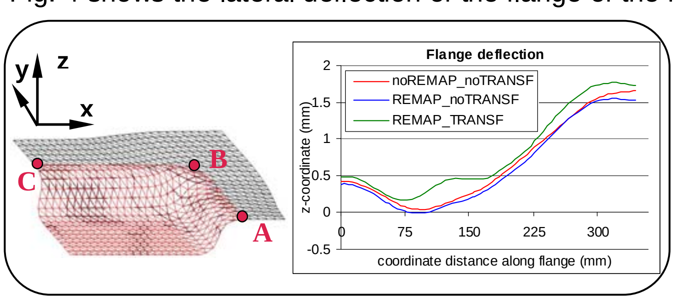

Figure 4: Deflection of the flange.

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