3D Numerical Analyses of SPIF performed on tailored sheets to control the sheet thinning

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Abstract. Nowadays, single point incremental forming (SPIF) is a widely studied process and a lot is known about advantages and drawbacks arising from its use in sheet manufacturing [1]. Not homogeneous material thinning along the formed walls is one of the process limitations. If this were reduced, the product quality would benefit with a possible increment of its industrial applications. Furthermore, products in service must resist not homogeneous loads. Therefore, a customized thickness distribution could be useful for a stress homogenization allowing, at the same time, the part weight reduction. The thinning of the sheet in SPIF can be altered using tailored blanks, whose resistance can be modified, appropriately, by changing their thickness by additive, subtractive or forming techniques or by heat treatments, which can affect their microstructures, locally.

Implicit 3D numerical simulations, performed by Abaqus, have been used to highlight the effects of the proposed idea. Specifically, sheets with weakened zones have been modelled (See Fig. 1 a)) and SPIF for different working conditions, i.e. step depth, wall angle and material properties have been run. The tailored sheets have been designed introducing pockets with different size, depth or position on the blank surface (See Fig. 2 a)). A benchmark shape, i.e. a frustum of cone, was the manufactured shape [2].

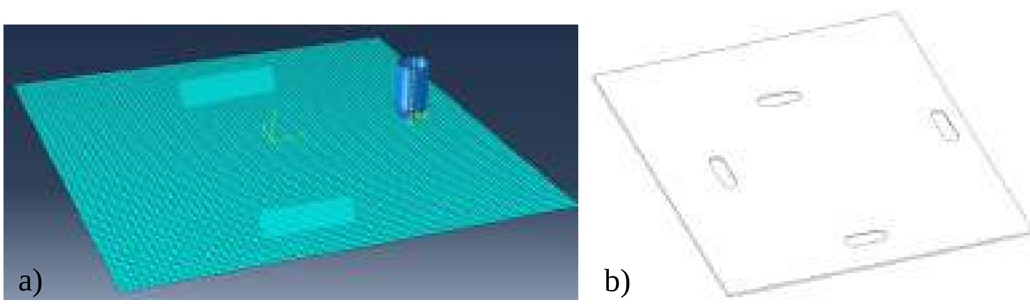

Figure 1. a) The FE model and b) weakening pockets placed in different positions on the sheet surface.

The numerical results proved that the thickness distribution along the formed wall, typically of SPIF [3], can be altered if the process is performed on a sheet with a not homogeneous strength. Pockets placed, even far from the working area, can affect the sheet formability. This consequence can be exploited to avoid localized thinning or to concentrate the deformation in an area, which will be trimmed out or that will be underload in service. The obtained results have to be confirmed for more complex shapes, using also experimental validations, to assess the relevance of this procedure in the improvement of components made by SPIF.

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