Influence of Process Parameters of Single Point Incremental Forming for Different Cup Shapes from AA1100-H18 Using FEA and Validation through Experimentation

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ABSTRACT

In incremental sheet forming process, sheet is deformed into desired shape by a rigid spherical tool without dies. The process is carried out on a CNC machine. For a given shape of the product tool path is controlled by a part program. In recent years many researchers focused on study of deformation mechanism in single point incremental forming process (SPIF) through analytical and numerical models. Most of the numerical studies in incremental forming concentrated on prediction of formability and thinning. Using finite element methods, forming limit diagrams (FLD) were predicted for several materials such as AA1050 alloy, AA1070 alloy, AA1080 alloy, AA1100 alloy, AA2014 alloy, AA2017 alloy, AA2024 alloy, AA2219 alloy, AA2618 alloy, AA3003 alloy, AA5052 alloy, AA5039 alloy, Ti-Al-4V alloy, EDD steel and gas cylinder steel.

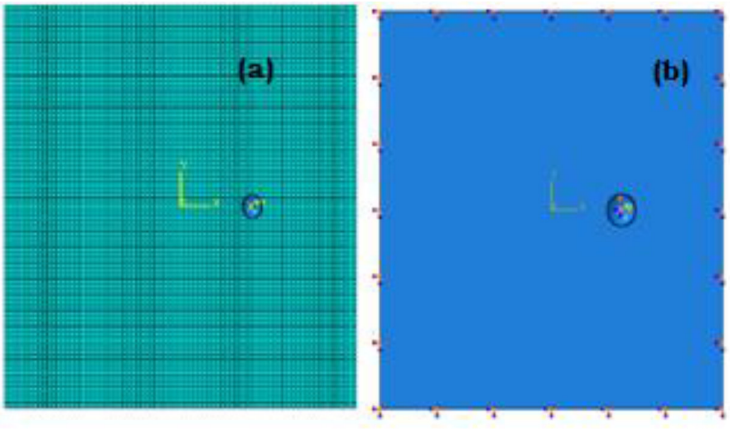

Figure 1: Finite element modeling: (a) mesh generation and (b) boundary conditions.

In the present work elastic-plastic scheme based on the incremental theory of plasticity was employed to simulate SPIF process instead of the conventional flow theory of plasticity minimize the computational time. The present work was to study the formability of pyramidal and conical of AA1100 alloy using SPIF. For this purpose the design of experiments was executed as per Taguchi technique. The process parameters of SPIF were sheet thickness, step depth, tool radius and coefficient of friction.

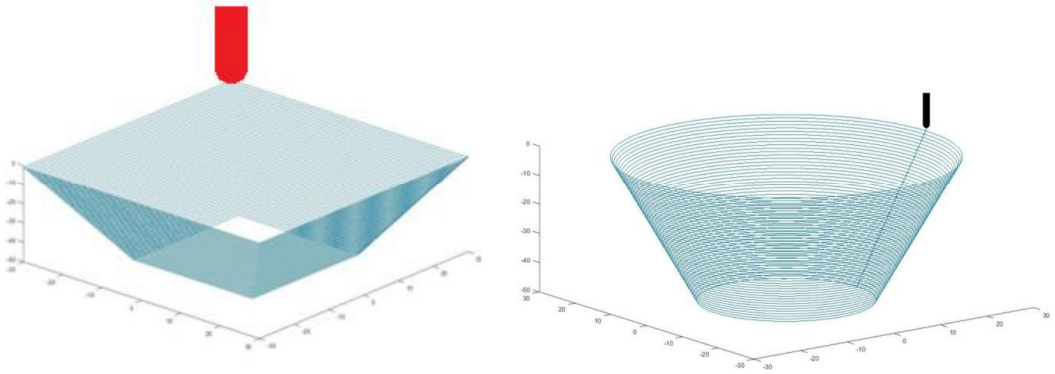

Figure 2: Tool path generation.

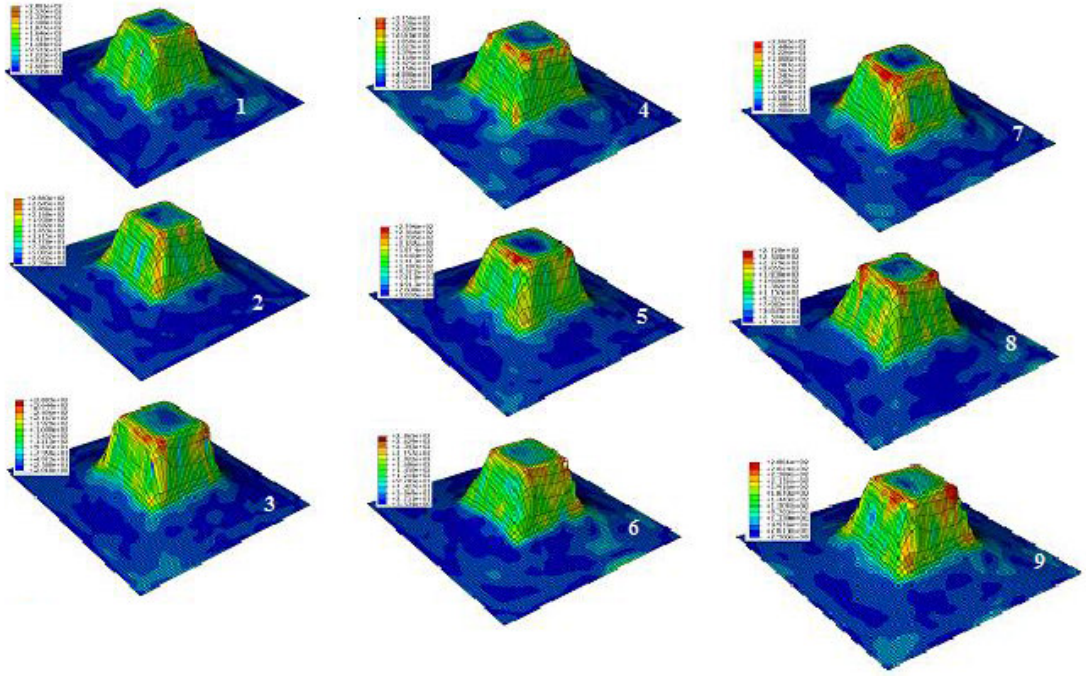

Figure 3: Raster images of von Mises stress in the pyramidal cups.

The major SPIF process parameters which influence the formability of truncated pyramidal and conical cups of AA1100-H18 alloy were sheet thickness and step depth of incremental forming process. The strain rate developed during the incremental forming of conical cups was within the limits of superplasticity.

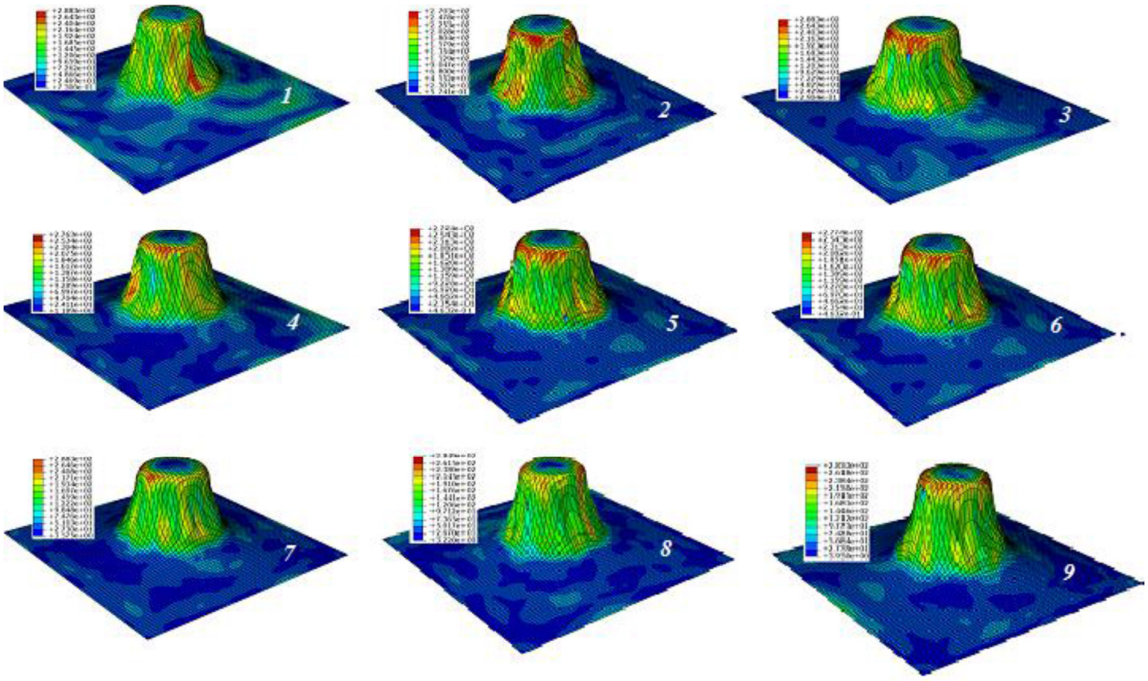

Figure 4: Raster images of von Mises stress in the conical cups.

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