Finite Element Analysis of Single Point Incremental Forming Process of Parabolic Cups

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ABSTRACT

The slow shift of manufacturing industry from mass production to batch production needed a new sheet forming technique. In search for new manufacturing process, Single Point Incremental Forming (SPIF) emerged to be one of the useful processes for forming complicated shapes. This is a flexible forming process which eliminates the die, punch and errors due to them. It is widely used for batch production of different shapes which has applications in diverse fields like automobile, aerospace, medical industry, packaging industry etc.

The equipment requirement of SPIF process is very simple, which includes; standard 3-axis CNC machine, a rotating spherical or hemispherical tool and a clamping setup. The SPIF is a sheet metal forming technique where a sheet is deformed locally. The forming of sheet due to a series of local deformation increases the formability of the sheet, when compared to conventional sheet forming process.

The present work was to study the formability of parabolic cup on AA6082 sheet using SPIF process. The investigation was to optimize the process parameters such as sheet thickness, step depth, coefficient of friction and tool radius. The design of experiments was carried out using Taguchi technique. The single point incremental forming was implemented using the finite element analysis software code namely ABAQUS version 6.14.

Using ANOVA it is found that, sheet thickness and step depth are the most influencing parameters of the formability. The optimal process parameters could be sheet thickness of 1.5 mm, step depth of 0.5 mm, tool radius of 4.0 mm and coefficient of friction of 0.10.

For validating the results of simulation, a parabolic cup was drawn on AA6082 sheet using SPIF process on a CNC machine. The deformed patterns of grid on formed cups from experimentation were similar to that of deformed pattern of mesh in simulated cups from FEA. The experimental strains of the formed cups were within the forming limits, as there was no fracture observed.

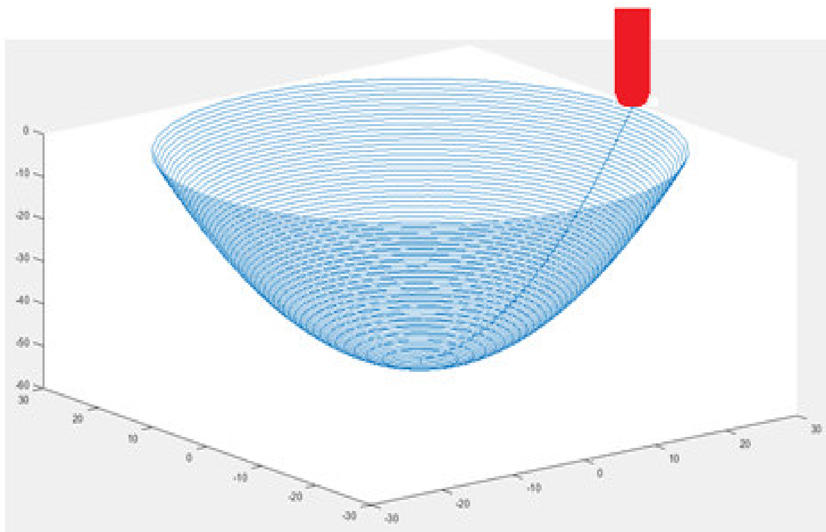

Figure 1: Tool path for parabolic cup

Figure 2: Forming of parabolic cup

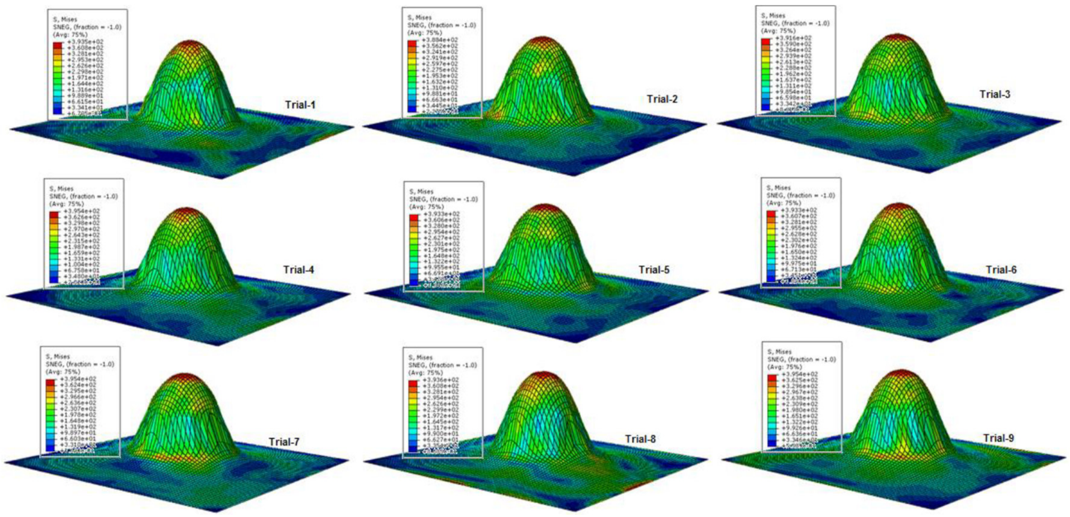

Figure 3: Raster images of von Mises stress in the cups.

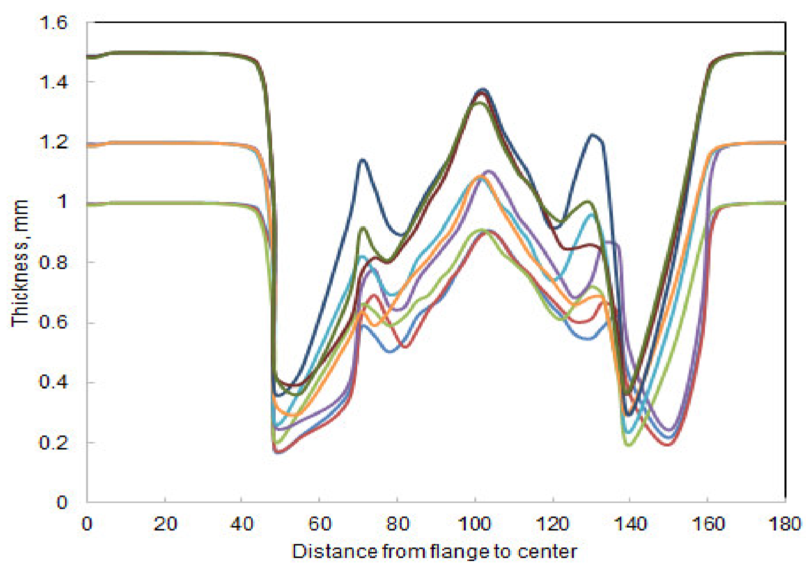

Figure 4: Location of thickness reduction in the deformed cup.

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