Formability Analysis of Elliptical Cups Fabricated by Single Point Incremental Forming Process Using FEM

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ABSTRACT

New trends in sheet metal forming are emerging rapidly and different processes have been developed and used to accomplish the required goals of flexibility and reduction of cost in production. One of the innovative process in sheet metal forming process is the Incremental sheet forming process(SPIF) for small batch production and rapid prototyping. This is a flexible forming process which eliminates the die, punch and errors due to them.

In this Incremental sheet metal forming process the final shape of the component is obtained by the CNC relative moments of the simple forming tool which deforms the clamped blank into the desired shape. It is a relative new sheet forming process which offers the possibility of forming complex parts without dedicated dies using only a single point tool and a standard 3-axis CNC machine. This process reflects good surface finish, product consistency, complex shapes, reduces material wastage, cost efficient.

This project discusses about the finite element modelling of single point incremental sheet forming process by considering Elliptical geometry using Stainless Steel 304. ABAQUS 6.14 software code was used for finite element analysis. Four process parameters, sheet thickness, step depth, tool radius and coefficient of friction were taken at three different levels. Design of experiments was carried out as per Taguchi technique using L9 orthogonal array. ANOVA was performed on the results of Taguchi trails to know the significance of each process parameter and their influence on formability of cups. Experiments were carried on CNC machine and FEA results were validated with experimental results.

For the obtained FEA results ANOVA is carried out to understand the effect of process parameters on the forming of the elliptical cup on Stainless Steel 304 sheet. The major SPIF process variables, which could influence the formability of elliptical cups of 304 stainless steel, were sheet thickness, step depth and tool radius. The optimal process variables were sheet thickness of 1.0 mm, step depth of 0.5 mm, tool radius of 5.0 mm and coefficient of friction of 0.20.

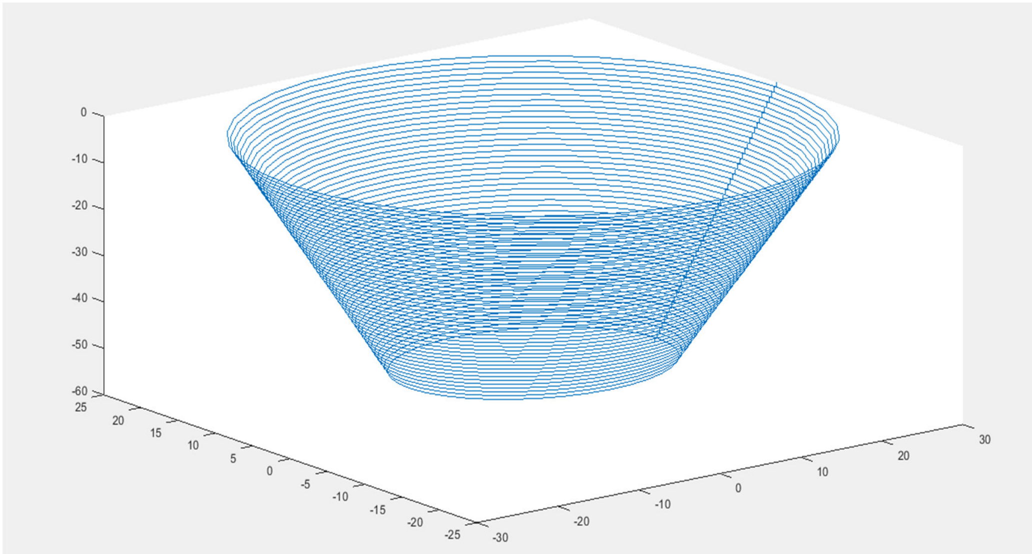

Figure 1: Tool path generation.

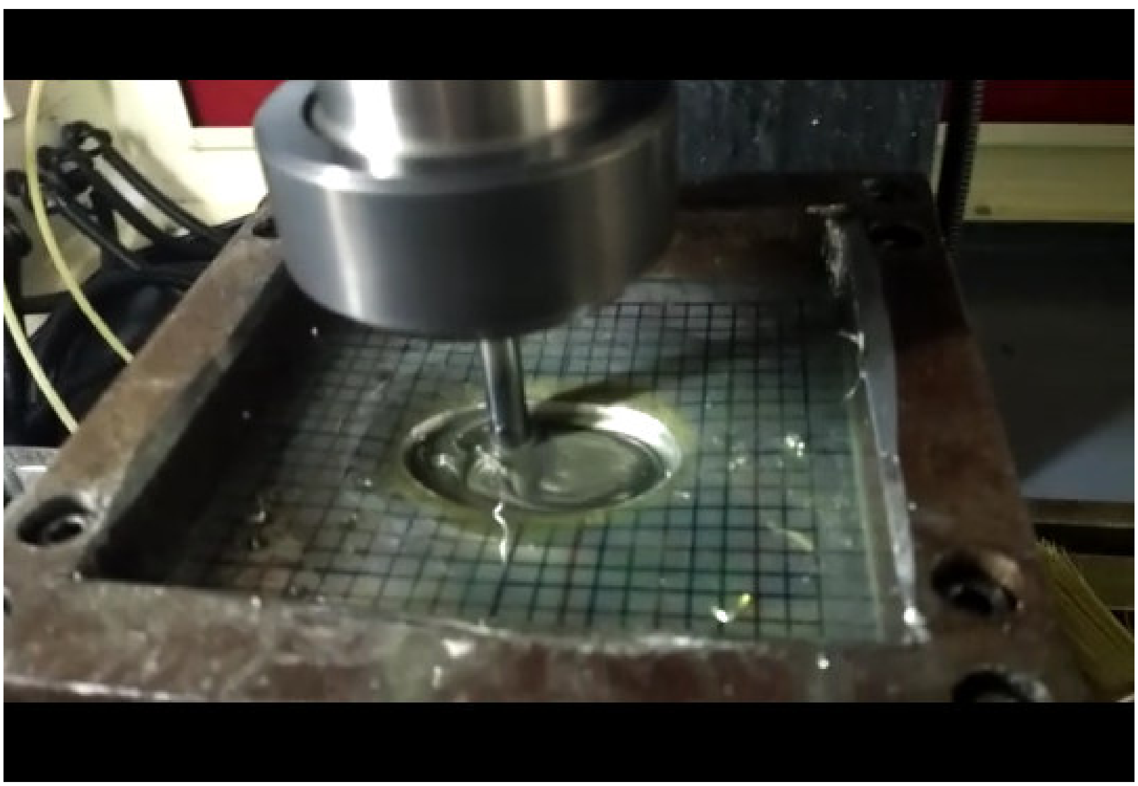

Figure 2: Forming of elliptical cup

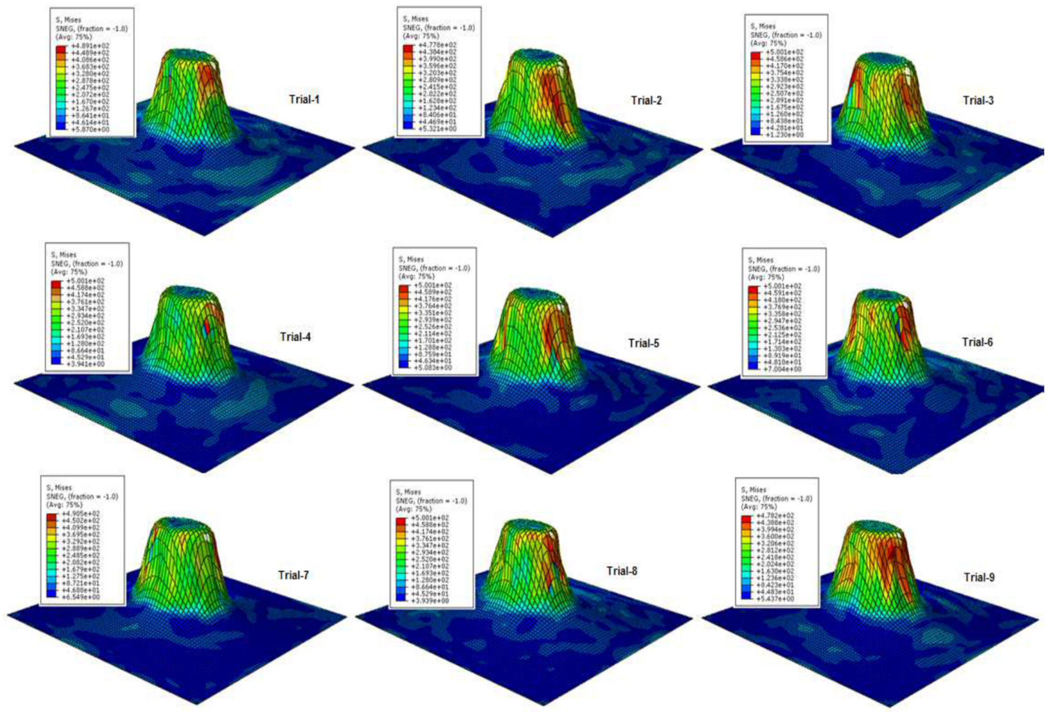

Figure 3: Raster images of von Mises stress in the cups.

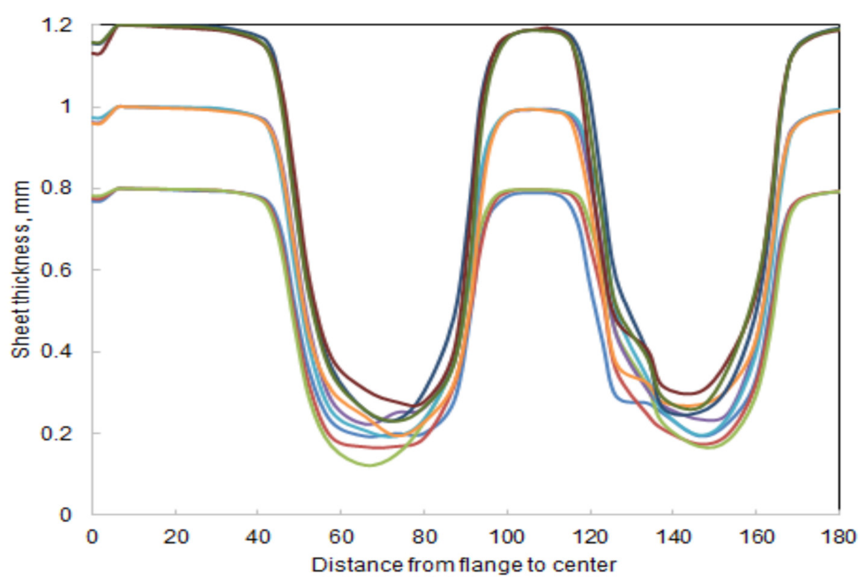

Figure 4: Location of thickness reduction in the deformed cup.

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