Manufacturability of Hyperbolic Cups Using Single Point Incremental Forming Process

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ABSTRACT

Nowadays there is an increasingly demanding need for the development of agile manufacturing techniques that can easily be adaptable to a constant introduction of new products in the market. Incremental sheet forming is a new innovative and feasible solution for the rapid prototyping and the manufacturing of small batch sheet parts. The process is carried out at room temperature (cold forming).

Incremental sheet forming is a sheet metal forming technique where a sheet is formed into the final part by series of small incremental deformations. 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 geometry namely hyperbolic cups using 60-40 Brass alloy. 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.

The major SPIF process parameters, which influence the formability of hyperbolic cups of brass, were step size, coefficient of friction and tool radius. The reduction of thickness was highly influenced by the sheet thickness only. The optimal process variables could be any combination of trails 7, 8 and 9 for producing successful cups.

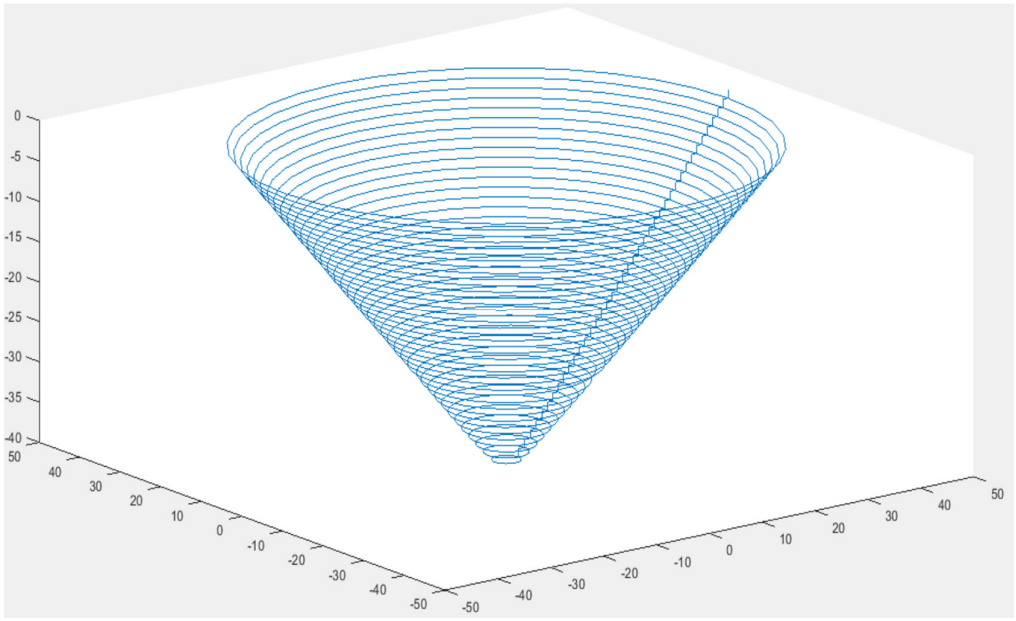

Figure 1: Tool path generation.

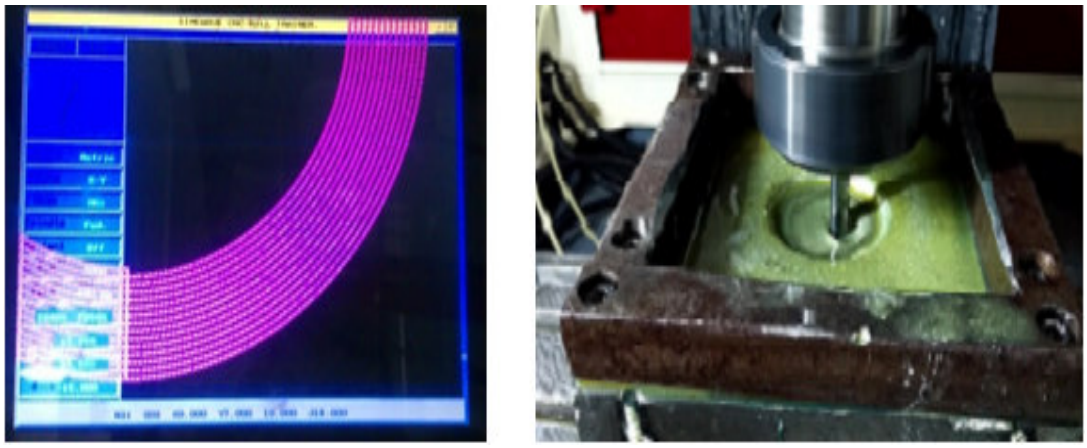

Figure 2: Forming of parabolic cup

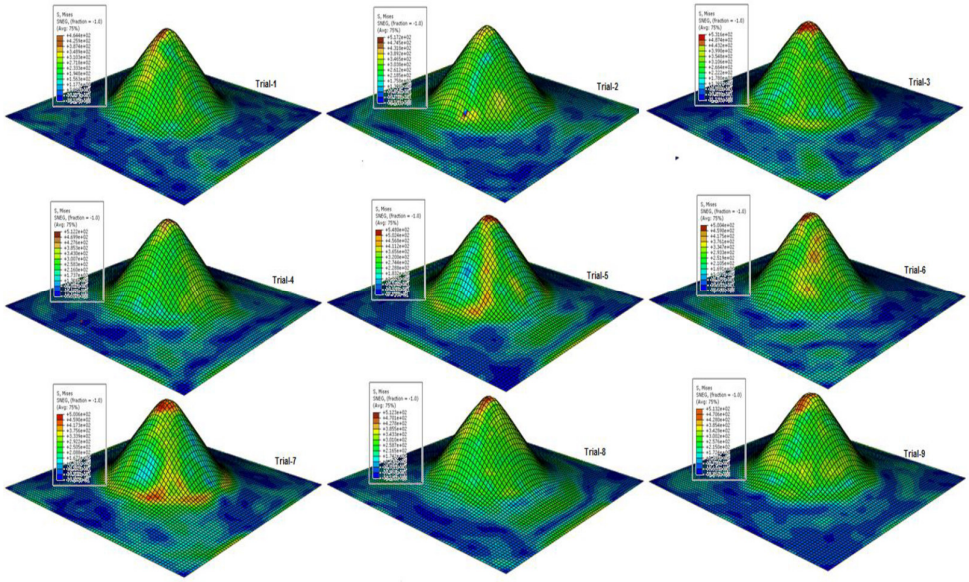

Figure 3: Raster images of von Mises stress in the cups.

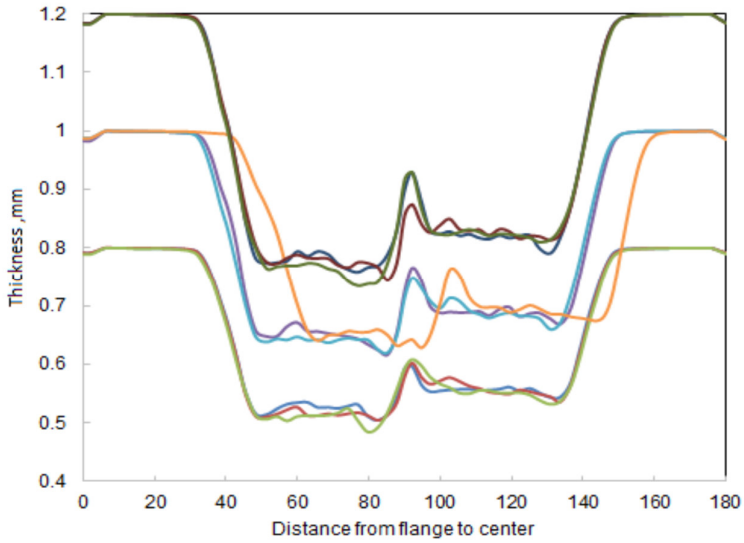

Figure 4: Location of thickness reduction in the deformed cup.

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