Elastoplastic Behavior of S66286 and S13800 Alloys Used to Make Hemispherical Cups

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ABSTRACT

The objective of the current project work was to establish plastic behavior of S66286 and S13800 alloys to manufacture hemispherical cups. The design procedure for the finite element analysis was carried out as per Taguchi's techniques using ABAQUS software code. The tool radius of incremental deep drawing was the critical process parameter influencing the effective stress induced during the formation of hemispherical cups. Von Mises stresses induced in the cups are within the limit of ultimate strength of S66286 and S13800. The sheet thickness and step depth had influenced the reduction of sheet thickness during the cup formation. Single point incremental sheet forming operation is sheet metal forming operation, in which simple fixed sheet is incrementally deformed into a desirable shape by hemispherical or ball nose tool whose trajectory is numerically controlled. This process offers the possibility of complex parts without dedicated die using a single point forming tool and a CNC machining center. It is a new innovative and feasible solution for small batch sheet parts.

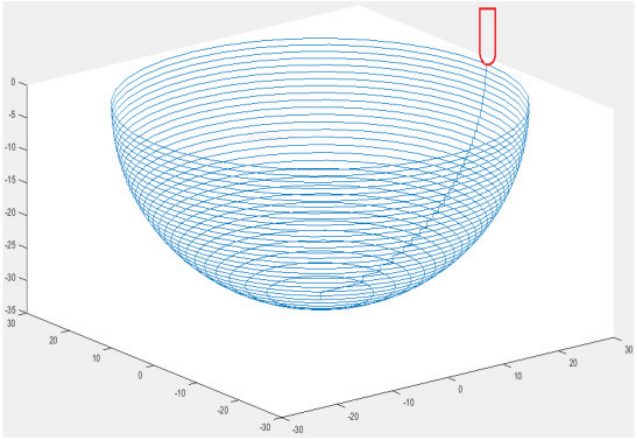

Figure 1: Tool path generation.

The present project work was carried out in two phases. Initial phase is numerical simulation of physical process with fine element analysis and final phase analysis of results for understanding its formability. The finite element analysis was carried out using ABAQUS 6.14 software code.

Experiments were designed using the Taguchi technique and ANOVA method was employed to establish the influence of process parameters: step depth, feed rate, sheet thickness and coefficient of friction on the stresses and strains developed in the sheet and to find significant process parameters affecting the formability. Thickness variation along the wall and flanges of cups and forming limit diagram were presented for the all the cups.

The major SPIF process parameters which influence the formability of hemispherical cups were coefficient of friction and step depth of incremental forming process. The majority of thickness reduction takes place in the middle part of the wall of the cup but not in the flange or bottom part of walls of the cup. Stresses induced are lower than the ultimate tensile strength of the material.

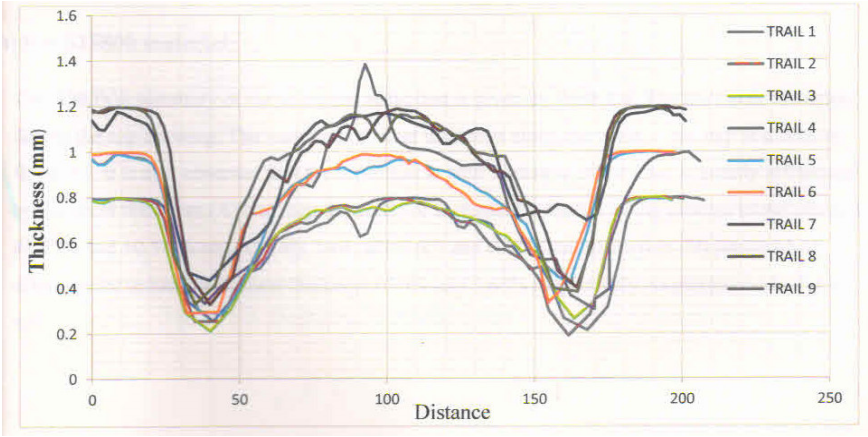

Figure 1: Thickness reduction along a path for S66286 material.

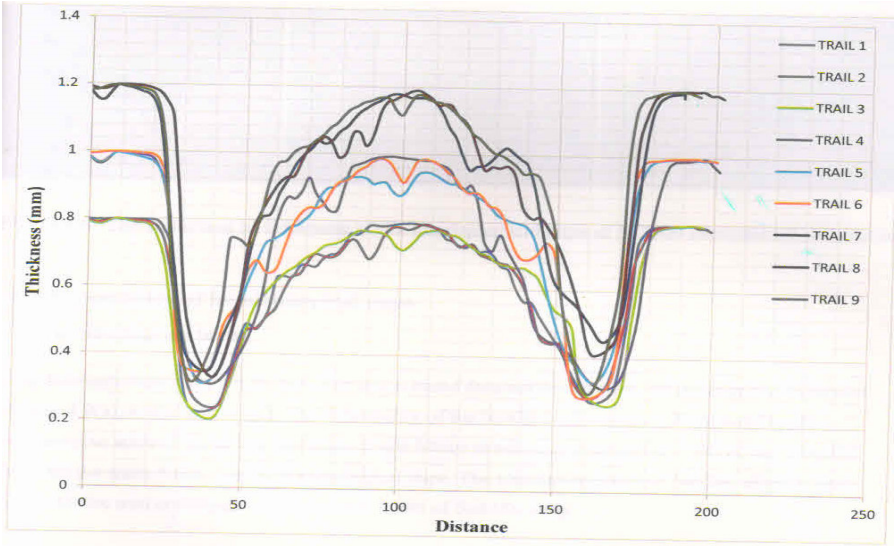

Figure 2: Figure 1: Thickness reduction along a path for S13800 material..

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