M. Tech Thesis January 2017
Department of Mechanical Engineering, JNTUH College of Engineering,
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Numerical Analysis of Single Point Incremental Forming Process Used for Manufacturing of Hemispherical Cups

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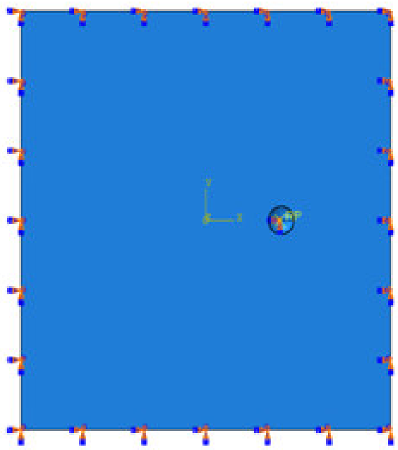
ABSTRACT

New innovative and feasible sheet metal forming techniques that can provide good quality product with less manufacturing time, less set up cost and more flexible to any part complexity are in very demand nowadays. Therefore, incremental sheet forming (ISF) is a new technology to takes part in solving many problems from conventional sheet forming process in terms of more flexibility, inexpensive, short production time, suitable for small batches and especially rapid prototype production.

This is a flexible forming process which eliminates the die, punch and errors due to them. The process is easily done on CNC machining centers with a rotating forming tool which moves along predefined trajectories that corresponds to the contour of the desired geometry. It is widely used for mass production of cup and different shapes in automobile, aerospace and packaging industries.

This project discusses about the finite element analysis of single point incremental sheet forming (SPIF) process to form hemispherical cups using Phosphorous bronze 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 hemispherical cup. Experiments were carried on CNC machine and FEA results were validated with experimental results.

The major SPIF process parameter which influences the formability of hemispherical cup was sheet thickness. The strains obtained through experimentation were within the limit of the formability curve.



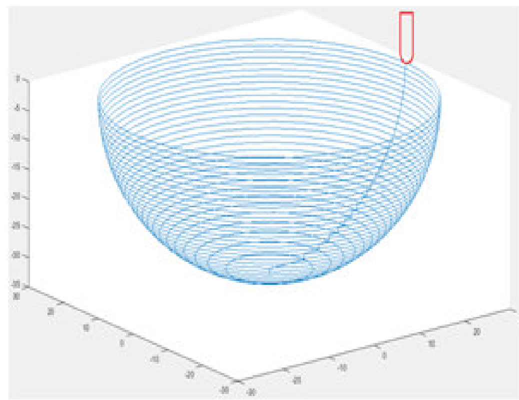
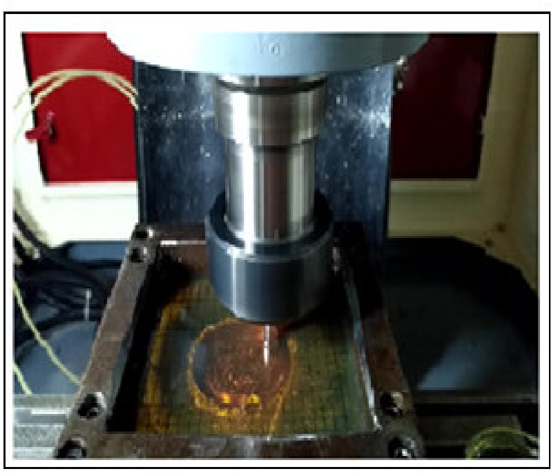


Figure 1: Tool path generation.



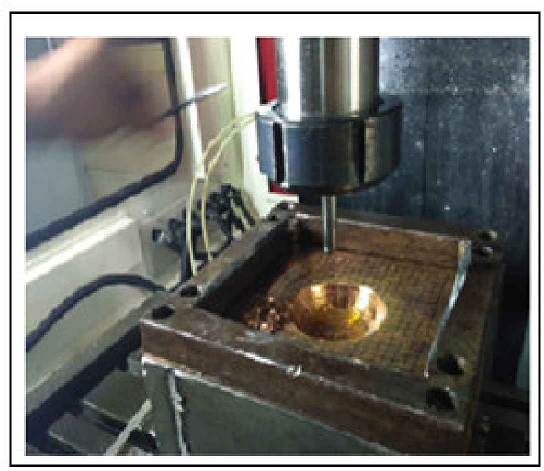


Figure 2: Forming of parabolic cup

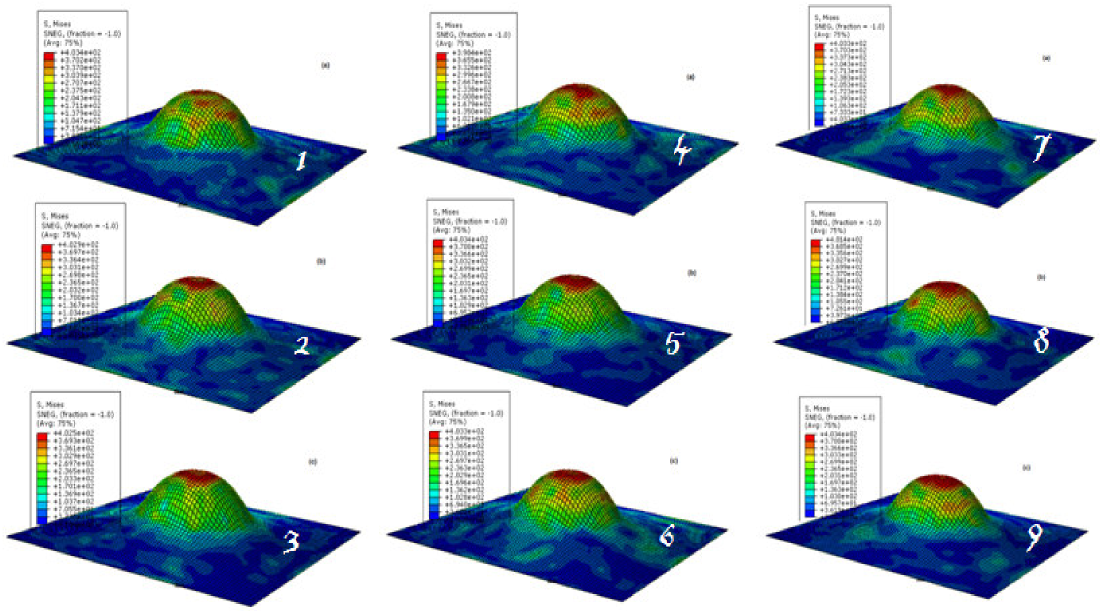


Figure 3: Raster images of von Mises stress in the cups.

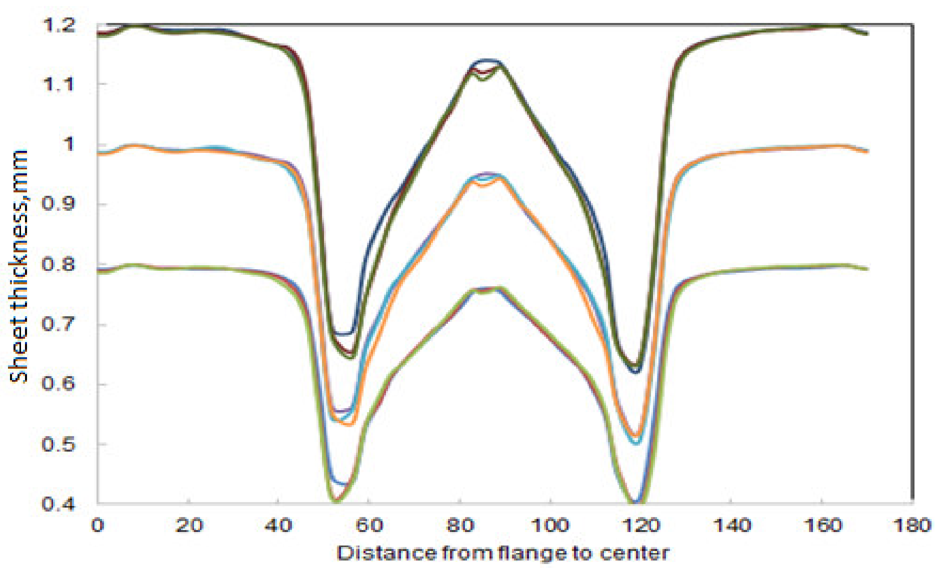


Figure 4: Location of thickness reduction in the deformed cup.

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