ABSTRACT

The application of computer aided analysis in sheet metal forming processes is particularly important in view of the large number of variables that are influencing the processes and high cost of tooling and material that are at stake. The recent advances in the area of high speed computing and the development of more reliable and flexible numerical techniques offer economic solution to many sheet metal working problems where a large number of process variables are involved. However, the capability to analyse more practical problems has been developed only recently. The current approach is the use of Finite Element Method which simulates in discrete steps, the manner in which the component is formed.

A finite element program code is developed for the numerical simulation of axisymmetric deep drawing process. A rigid plastic material model with the formulation on variational principle is used in the algorithm. The penalty function approach with a geometric and material non-linearity was also considered. Four-noded, two-dimensional iso-parametric elements are used in this modelling. The programme simulates the deep drawing process considering contact friction at tool-sheet interface.

Two frontal configurations for the punch namely, hemispherical and flat profiles have been used in studying the effect of parametric variation on typical materials like Aluminium (1100-O), Deep draw quality steel (C 20) and Stainless steel (304 grade). The surface strain distributions under different punch travel are analysed.

The theoretical results are validated with experimental study using identical parameters. Suitable toolings were designed and fabricated. Deep drawing operations
were performed on homogeneous blanks of the above mentioned materials, with the two types of punches. A common draw ratio was used in all the experimental studies.

The study indicates that the rigid plastic material model fits well with the experimental values for thickness strain in the flange portion of the cup. Experimental studies on Stainless Steel, deep draw quality steel and Aluminium have shown that the surface thickness strain and circumferential strain have good agreement in the flange portion of the cup. The study also reveals that lesser strain values are observed in the outer elements indicating flange thickening. The friction coefficient also plays an important role in metal flow.