CHAPTER 7

CONCLUSION

The following conclusions are drawn from the experimental and analytical studies on axi-symmetric deep drawing of sheet blank.

1. The rigid-plastic Finite Element Analysis permits use of larger steps in simulation though for each step the non-linear problem has to be solved iteratively. With a reasonable compromise in the numerical efficiency, better results are ensured in the simulation.

2. The process simulation permits the tracing of actual deformation path.

3. In the rigid-plastic formulation, it is possible to start the analysis from the stress-free state.

4. The rigid-plastic formulation is in good agreement with the experimental results over the flange portion of the cup for the thickness strain.

5. It can be concluded that the rigid plastic formulation in Finite Element can treat the deep drawing problems with efficiency and reasonable accuracy.
6. The numerical simulation can be applied to problems of relatively complex geometries taking into account realistic friction conditions and provides a detailed picture of strain distribution.

7. The percentage deformation obtainable in drawing with the flat bottom punch is always greater than with hemispherical punch for otherwise identical conditions.

8. The lesser radial strain in the outer elements indicate the thickening at the flange.

9. The higher friction coefficient will create non-uniform metal flow resulting the failure.

10. The increase in blank holding force increases the thickness strain.

7.1 SUGGESTIONS FOR FUTURE WORK

This analysis could be of use to designers to find out different try out solutions before optimizing the tooling for deep drawing operations. In the present analysis four noded rectangular elements with constant friction conditions at punch sheet and blank holder-sheet interface are used.

The number of elements in the element formulation with different friction conditions at punch and blank holder may be taken into account in the analysis.
The blank holding force is maintained constant during the process simulation as well as experimental work. The blank holding force can be varied to determine the region of safe blank holding force which will avoid wrinkling.

Many of the hand books on die design provide generally the empirical rule for the draw radius, punch profile radius and clearance. These parameters can be used with greater accuracy in the analytical simulation to optimising the tooling.

The effect of tooling temperature on the formability of metal has a significant influence on the quality of the drawn parts. Studies can be made to determine the formability with punch temperature variation.

Localised heating of the sheet metal is observed in the deformation process and the die metal friction. Investigation can be made to determine the effect of tooling temperature on the drawability of the material.