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Compare the FEA analysis of Elliptic Cups using Simple die and Conical die

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Abstract— **Deep drawing is one of the important sheet metal operation which is mainly used in automobile and aircraft industry. Obtaining a defect free final product with desired physical and mechanical properties is very important any manufacturing industry. The quality of deep drawn component depends on various geometric parameters, physical properties and process parameters. Formability is one of the important properties which influence the quality of deep drawn component. In this present study, simulation of deep drawing process can be carried out using FEM tool. Conical die and simple die are simulated and both the results are compared which shows lower stress distribution and %thinning in conical die as compared to simple die forming process.**

Keywords—Deep drawing, conical die simple die and % thinning

I. INTRODUCTION

Deep drawing process is a sheet metal forming process where a punch is utilized to force a flat sheet metal to flow into the gap between the punch and die surfaces. As a result, the sheet metal or blank will deformed into desired shape like cylindrical, conic, or boxed-shaped part and also complex parts which normally require redrawing processes by using progressive dies. Deep drawing is a popular selection due to its rapid press cycle times. Its capability of producing complicated shaped and geometries with low labors requirement is also an advantage in manufacturing industries. A few examples of deep drawing applications that is widely use nowadays include beverage cans, automotive bodies, aircraft panels and sinks.

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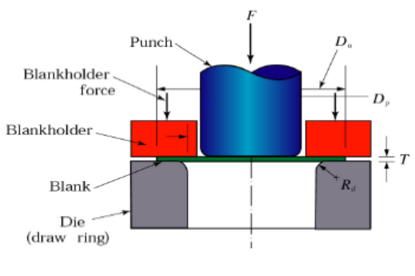

Fig:-1 Deep drawing process

Sheet metal forming process is used for both serial and mass production. Their characteristics are high productivity, highly efficient use for material, easy servicing machines, the ability to employ workers with relatively less basic skills and other advantageous economic aspects. Part that made from sheet metal has many attractive qualities: Good accuracy of dimension, adequate strength, light weight and a broad range of possible dimensions.

Deep drawing is a sheet metal forming process in which a metal blank radially drawn in to a forming die by the mechanical action of punch.

II. LITERATURE REVIEW

R. Narayanasamy, R.Sowerby was develop cylindrical cup through a Tractrix die using flat-bottomed and hemi-spherically ended punches. In this investigation cold rolled commercially pure aluminium and copper blanks of different diameter are drawn through tractrix die under dry lubrication condition. After the experimental results, they conclude that if initial blank diameter increase than wrinkling decrease. The percentage deformation obtainable in drawing with flat-bottomed punch is always greater than that with hemi spherically ended punch.[1]

D.H. PARK et al was studied of improvement of formability for elliptical deep drawing process. They formulate a concrete report on the non-axis symmetric shape. To obtain the optimal products in the deep drawing process, elliptical deep drawing test were carried out with several corner radii of punch and die. In this study, the optimal corner radii of punch and die in the deep drawing process with non-axisymmetric blank shape are obtained for the experimental work, they used a electro-galvanized sheet steel SECE with thickness 1.6 mm. Deep drawing processes were carried out on different corner radius in a 300 t mechanical press.[2]

Dong Hwan Park et al was investigated a effect of blank shape using three kinds of blank shape. They measured punch load distribution according to different profile raddi of punch and die and observed non-axisymetric formability for different punch load. They also observed friction test condition of three different types, non-lubrication, and full-lubrication and film lubrication. In this paper, they conclude that better result carried out when applied film lubrication to the non-axisymetric product as compared to full lubrication. They also see the maximum punch load of the elliptic blank shape [3].

Dong Hwan Park was examined a effect of punch load for elliptical deep drawing product of automotive part. They investigate three kinds of blank shapes and scribed circle test on three deformation mode. The punch load distribution for elliptical forming process were measured under different conditions of profile radii of punch & die and experiments was carried out for clarified the influence of punch-load distribution. Tensile test were carried out of blank 1.6 mm. Different design of blank are used for experiment. They also observed a resulting deformation from formation of a sheet metal work piece measured by using scribed circle test [4].

G. Palumbo et al was investigating the deep drawing process of mg alloy sheet in warm conditions. A experimental activity on the WDD process of mg alloy sheet was performed at IMR using a set of circular section tools in which thickness taken as 0.6mm. The WDD tests were performed using contact punch speed 10 mm/min and different temperature level including 120 to 170 [5].

T.S.YANG was focus on the deep drawing process of magnesium alloy sheet. They used a FEM software DEFORM -3D to investigate the material flow character during the elliptic cup deep drawing of magnesium alloy sheet at elevated temperatures. In this study, they investigate the effective stress and forming load under various parameter conditions such as profile radius of die, clearance between die cavity and punch , the blank holding force and working temperature during the elliptic cup deep drawing process. Magnesium AZ31 alloy sheet used for experiment [6].

M.A HASSAN Et Al was introduce a new process for increasing the drawability of square cups. In this techniques, flat-headed square are used to punch a circular blank through conical die through square aperture without using draw beads or blank holder. The set up is built up accordingly with half-cone 18̊. Brass-alloy and pure aluminum sheets are used for experiment. The effect of blank thickness and orientation of blank rolling direction to the punch side on the LDR and punch load are experimentally investigated and show a FEA result to good agreement with experiment result. After the result they conclude that , a brass square cup with LDR of 2.92 and aluminum square cups with LDR 2.74 successfully achieved by this technique. And shown that half cone angle18̊. Best drawability and drawing sheets are most convenient for thickness of 2-3 mm [7].

ABDULLAH A.DHAIBAN et al[14] was introduce a new technique for deep drawing of elliptic cups through a conical die without blank holder or draw beads. In this technique an elliptic-cup is produced by pushing a circular blank using flat-headed elliptic punch through a conical die with an elliptic aperture in a single stroke. FE-Package ansys is used built up a 3D-parametric model. A die with half-cone angle, of is a best drawability for this new technique. Experiments are conducted on blanks of brass with initial thicknesses at different clearance ratios(c/t). The effect of blank thickness and clearance ratio on different parameter such as limiting drawing ratio, drawing load and thickness strain were numerically and experimentally investigates and shows a FEA result to good agreement with experiment result. After the result. They conclude that the half cone angle and die – aperture length of 3 mm has best for a new technique. Elliptic cup with an LDR ratio up to 2.28 was successfully achieved. And this is more convenient for thickness between 1.9 to 3 mm [8].

Swadesh Kumar Singh et al was investigation effect of ironing behaviour on the characteristic of product like thickness distribution with respect to temperature was studied. They use a finite element code LS-DYNA to predict stress distribution on the drawn cups. The simulation they use a blank were heated to a required temperature of 200, 400c. After the simulation they observed that quality of cups depends upon both temperature and percentage deformation of wall thickness. Decrease number of stages achieved by increase temperature [9].

M. Ghosha, A. Meraux et al was investigating the behaviour of two Al-Mg-Si alloys at room temperature and 250 and compares both deep-drawing processes. The effect of different parameter like ram speed, drawing ratio, holding time and temperature was investigate. Aluminium alloys EN AW-6061 and EN AW-6016 in form of rolled sheets were used for present investigation. After result they conclude that number of ear remain unchanged with increasing temperature but reduce amplitude of ears. Increase a ear height with reduction of friction force [10].

Suresh kurra et al was focuses on the formability and thickness distribution in incremental sheet forming of extra-deep drawing steel [EDD]. In this study, A continuously varying wall angle conical frustum (VWACF) was used to predict the maximum wall angle to minimize the number of experiment. VMACF is generated using circular, parabolic, elliptical, and exponential generatrices. They also computed thickness distribution with theoretically based on sine law and also using FA-code LS-DYNA. For experimental study, Bridgeport Harding 3-axis CNC milling machine was used. After the result they conclude that, thickness distribution obtained from numerical simulations was found to be more accurate than theoretical mode and limiting wall angle and allowable thinning w.ere found to be 75.27 and 0.252mm respectively [11].

Anand s. Chale and Dr. Wankhede L.N were examined the influence of temperature of blank, on deep drawing process. Simulation was carried out on the Altair hyperform and RADIOSS simulation tool. The optimum value of temperature is predicted to get maximum LDR considering iso-thermal condition. In this study models created using CATIA V-5. After that model was imported in HYPERFORM in which punch, binder, die was meshed by R-mesh and blank was meshed by B-mesh. After the result, they found that LDR is increased with respect to temperature. By warm forming achieve LDR up-to 2 without any fracture and the amount of blank holding pressure required is reduced at higher temperature than deep drawing at normal temperature thinning percentage is also increased in deep drawing at 300 temperatures [12].

Deep drawing is one of the important sheet metal operation which is in automobile and aircraft industry. Obtaining a defect free final product with desired physical and mechanical properties is very important in any manufacturing industry. Further such defects can also be minimized by using conical die which defers from conventional drawing process. By varying different parameter such as thickness, temperature, BHF, corner radii of punch and die, aspect ratio, etc can be minimized such defects.

III. MODELING AND SIMULATION

Modeling was done with cre-o and analysis was carried out using HYPERFORM, a commercially available explicit FEA code. For the simulation cuzn33 is used. Physical parameters of component and material properties are given below.

A. *Physical parameters of component*

Table:-1 [8]

1.	Half cone angle	18°
2.	Die diameter (mm)	60
3.	Radius of the punch (mm)	5
4.	Sheet thickness (mm)	1,1.5,2,2.5
5.	Punch Speed (mm/sec)	69
6	Blank Diameter (mm)	92

B. *MATERIAL PROPERTIES OF CUZN33*

Table:-2 [8]

Poisson's ratio	0.35
Density (Kg/mm3)	7.8 x 10 -6
Young's Modulus (GPa)	100
Yield strength (MPa)	132.5
work hardening co efficient	713.4
strength of coefficient	0.40

1) CRE-O model of simple and conical die

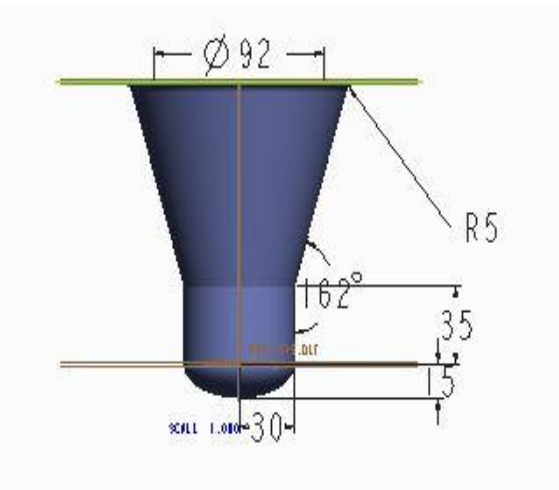

Fig:-2 Conical die

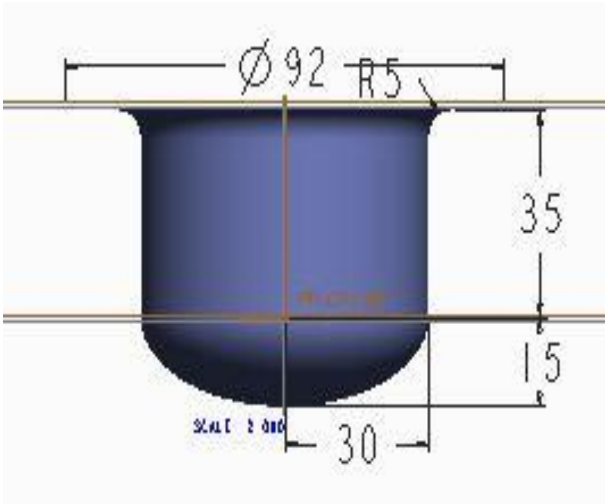

Fig:-3 Simple die

2) Finite element simulation

FEA was carried out using HYPERFORM, a commercially available explicit FEA code. First, Model of Die and blank is creating using cre-o software. The rigid component such as Punch, Binder, and Die is meshed by R-mesh. Blank was fine meshed using B-mesh. Meshed model is shown in fig.4 and Fig.5

Table:-3

component	Types of mesh	Size of mesh
punch Binder Die	R-mesh	7.0 mm
blank	B-mesh	3.0mm (1039elements)

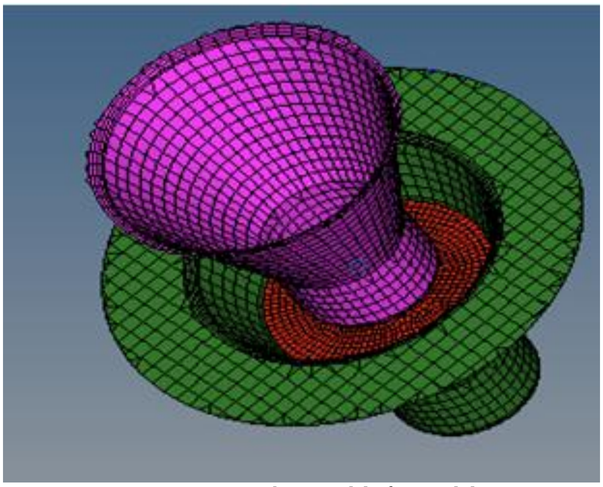

Fig:-4 Meshing model of conical die

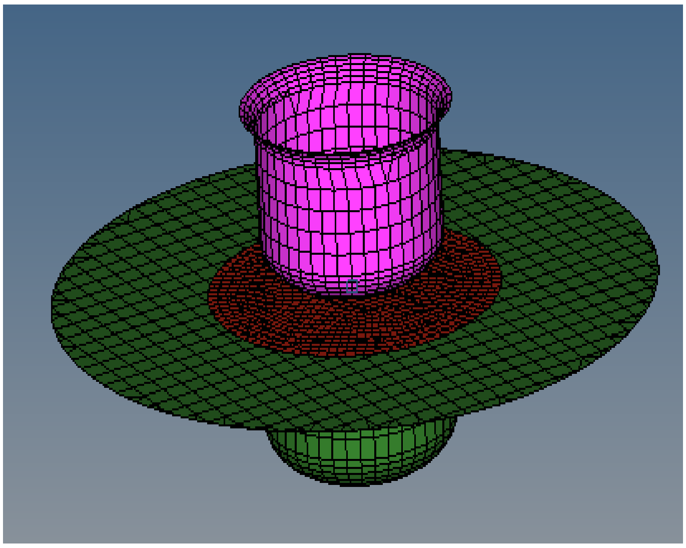

Fig:-5 Meshing model of simple die

IV. RESULTS AND ANALYSIS

Simulation is carried out for different thickness of the blank such as 1.5mm, 2.0mm, 2.5mm and 3.0mm for both simple and conical die process. After the Change thickness of blank, compare the results of simple die and conical die and check %thinning and stress on both.

A. comparison of %thinning on cups using simple and conical die with different blank thickness

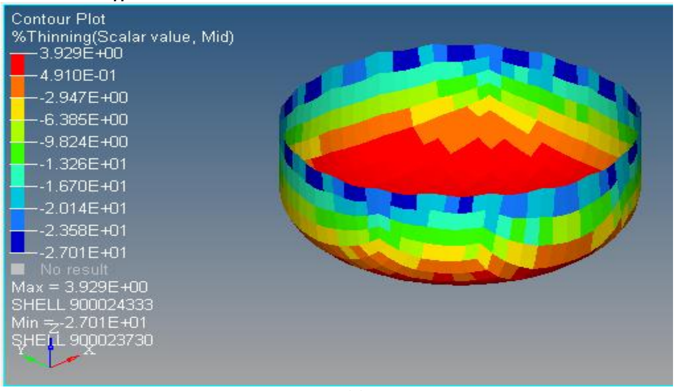

Fig:- (a)

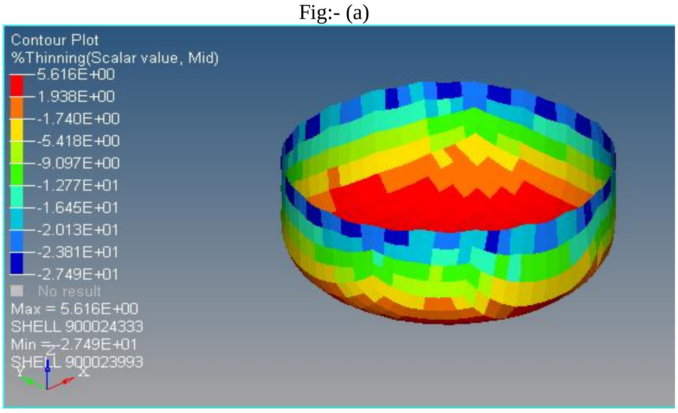

Fig:- (b)

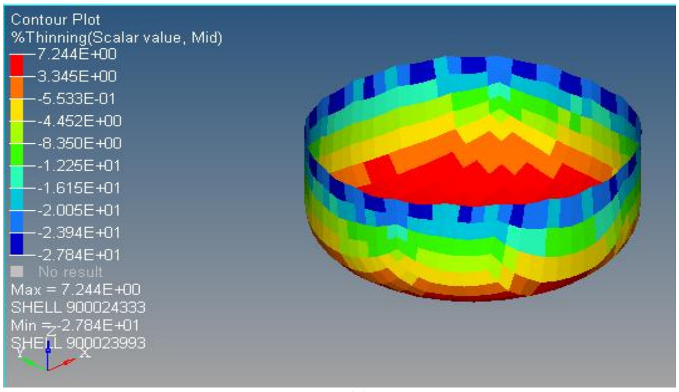

Fig:- (c)

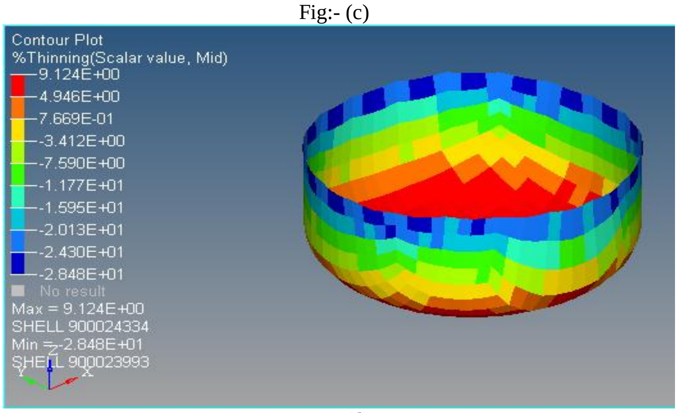

Fig:- (d)

%thinning on cups using conical die with different blank thickness (a) 1.5mm (b) 2.0mm (c) 2.5mm (d) 3.0mm

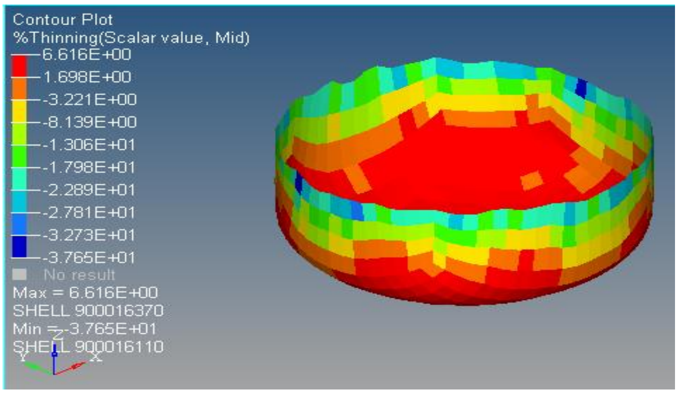

Fig:- (a)

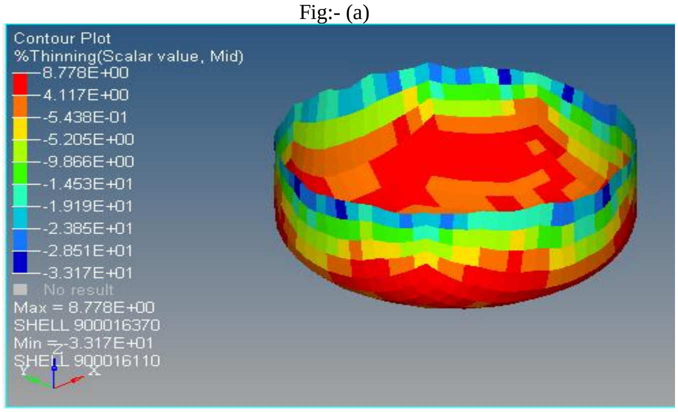

Fig:- (b)

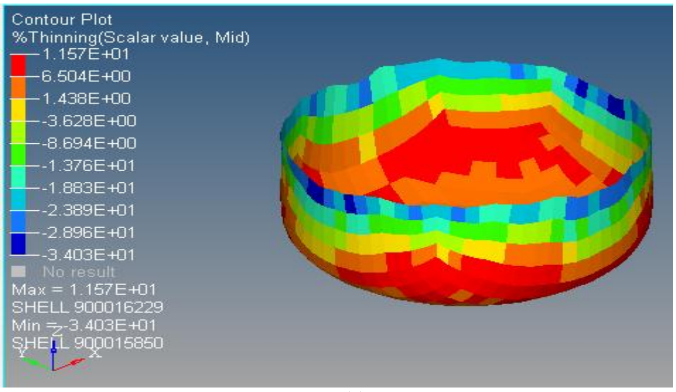

Fig:- (c)

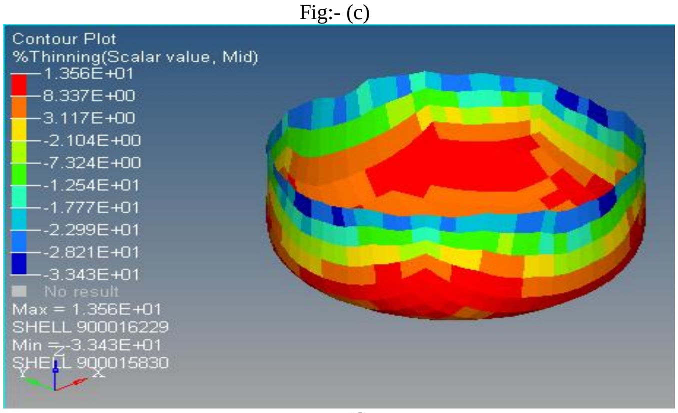

Fig:- (d)

%thinning on cups using simple die with different blank thickness (a) 1.5mm (b) 2.0mm (c) 2.5mm (d) 3.0mm

B. comparison of the maximum %thinning on cups using both die

The results of maximum %thinning suggests that the conical die forming process gives less thinning as compared to simple die forming.

Table:-3

THIKNESS OF THE BLANK	CONICAL DIE	SIMPLE DIE
1.5 mm	3.929%	6.616%
2.0 mm	5.616%	8.778%
2.5 mm	7.244%	11.67%
3.0mm	9.124%	13.56%

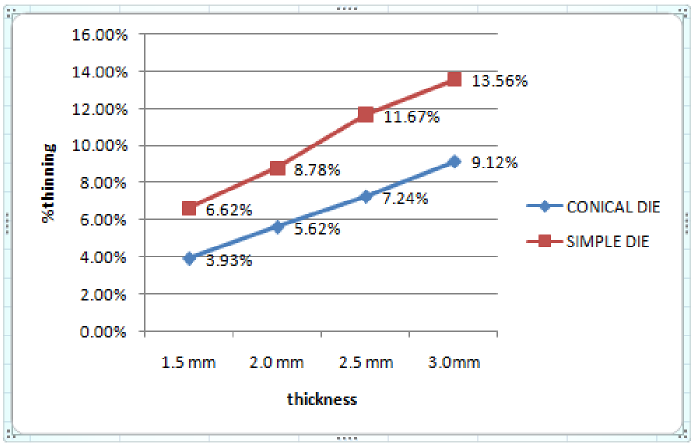

Fig:-6 graphical representation

C. comparison of Stress distribution on cups using simple and conical die with 2.0mm blank thickness

Stress distribution on cups using simple and conical die with 2.0mm blank thickness are shown in below fig.7 & fig.8. This shows higher stress distribution in simple die forming as compared to conical die forming.

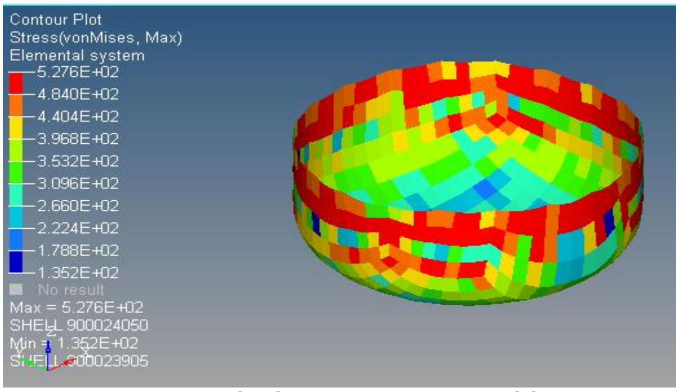

Fig:- 7 stress distribution on cups using conical die

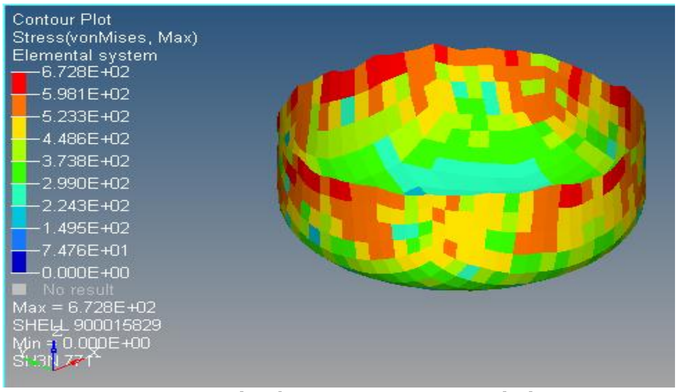

Fig:- 8 stress distribution on cups using simple die

CONCLUSION

In this study, deep drawing process is introduced for producing elliptic cups using a simple tooling set without blank holder or draw beads in a single-acting stroke using simple die and conical die. The CAD model was created in CRE-O and FEA is carried out using HYPERFORM. Based on these results, the %thinning and stress distribution on elliptic cups using conical die is less as compared to simple die. So for given specific case, conical die gives is better finished product as compared to a simple die.

REFERENCES

1. R. Narayanasamy, R. Sowerby, "Wrinkling behaviour of cold-rolled sheet metals when drawing through a tractrix die," Journal of materials processing technology 49 (1995) 199-211
2. D.H.Park, S.S.Kang, S.B.Park, "A study on the improvement of formability for elliptical deep drawing processes," Journal of materials processing technology 113 (2001) 662-665
3. Dong Hwan Park, Young Min Huh, Sung Soo Kang, "Study on punch load of non-axisymmetric deep drawing product according to blank shape," Journal of Materials Processing Technology 130–131 (2002) 89–94
4. Dong Hwan park, Prasad K.D.V. Yarlagadda , "Effect of punch load for elliptical deep drawing product of automotive parts," Int J Adv Manuf Technol (2008) 35:814–820
5. G. Palumbo , D. Sorgente , L. Tricarico a, S.H. Zhang, W.T. Zheng, "Numerical and Experimental analysis of the warm deep drawing process for Mg alloys," VOLUME 14 ISSUE 1-2 January-February 2006
6. T. S. Yang, "Finite element analysis of elliptic cup deep drawing of magnesium alloy sheet," VOLUME 27 ISSUE 2 April 2008
7. L.M.A Hezam, M.A. Hassan, I. M. Hassab-Allah,EI- Sebaie, "Development of a new process for producing deep square cups through conical dies," International Journal of Machine Tools & Manufacture 49 (2009) 773–7
8. Abdullah A. Dhaiban, M. Emad S. Soliman, M.G.EI-Sebaie, "Finite element modelling and experimental results of brass elliptic cups using a New deep drawing process through conical dies," Journal of Materials Processing Technology 214 (2014) 828– 838
9. Swadesh Kumar Singh, Vinay Kumar, Amit Kumar Gupta, Paresi Prudvi Reddy, "Finite element simulation of ironing process under warm Conditions" j mater res technol.2014;3(1):71–78
10. M. Ghosha, A. Miroux R.J. Werkhoven, P.J. Bolt, L.A.I. Kestens, "Warm deep-drawing and post drawing analysis of two Al–Mg–Si alloys,"
11. Suresh kurra,Srinivasa Prakash Regalla, "Experimental and numerical studies on formability of extra-deep drawing steel in incremental sheet metal forming," j mater res technol.2014;**3(2)**:158–171
12. Anand S. Ghale, Dr. Wankhade L. N, "Study of effect of temperature on Limiting Draw Ratio of Deep Drawing process using HyperForm," Alter technology conference,2013