ISSN: 2454-9940

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

E-Mail :
editor.ijasem@gmail.com
editor@ijasem.org

www.ijasem.org

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN:2454-9940
www.ijsem.org
Vol 14, Issue 3 Agu 2023

NUMERICAL ANALYSIS OF DEEP DRAWING PROCESS BY VARYING PROCESS PARAMETERS

A.Ranjith Kumar, Dr.CH.Radhika, N. Sudheer Kumar
Assistant Professor(C),
Department of Mechanical Engineering,
KUCE&T, KU Campus

ABSTRACT

This investigation is to carry out to know the effect of different process parameters in the deep drawing process, by finding out the strain, stress, along with the cup and the drawing force required for different anisotropic materials, by designing a nd fabricating the deep drawing tools by conducting experiments and simulations to compare the results.

INTRODUCTION

Forming is a process in which force is applied on metal to modify its shape and geometry instead of removing of material. The applied force stresses the metal beyond its yield strength, causing the material to plastically deform, but not to fail. The stresses induced during the process are greater than yield strength, but less than fracture strength, of the material.
The type of loading may be tensile, compressive, bending or combination of these. This is very economical process as the desired shape, size and surface finish can be obtained withoutany significant loss of material.
Sheet metal forming is one of the most widely used manufacturing processes for the fabrication of a wide rangeof products in many industries. The reason behind sheet metal industry gaining a lot of attention in modern technology is due to the ease with which metal may be formed into useful shapes by plastic deformation processes in which the mass and volume of metal are conserved and metal is displaced from one location to another.
AIM AND SCOPE OF THE PROJECT :
In many of the cases after the sheet was successful draw in deep drawing process, the fracture at the shell of the specimens always occurred and thus cause the defects on the product. It is one of the most common undesired outcomes in deep drawing because if this happen, the product is in defectscondition and the deep drawing process must be redone againusing another specimen. This fracture is caused by excessive punch force, excessive blank holder force, excessive friction between blank and tooling, insufficient clearance between punch and die and insufficient punch or die corner radius. In this project the effects of deep drawing process parameters on the deep drawn rectangular cup are investigated both by experimentally and numerically. The study is initiated by modelling deep drawing tools. The deep drawing process parameters namely blank material, lubricating conditions are varied. The experiments are carried out with the help of universal testing machine by fixing the deep drawing tools. The simulations are performed in finite element code by importing the tool into the FE code. The dimensions of the deep drawing tool, the size of the blank, properties of the material, the varied process parameters and various other criteria considered for simulations are given in chapter 3 elaborately. From the simulations punch force variations, thickness distributions and dome heights are evaluated for all conditions. Failure initiation and propagation is also observed. From the overall analysis of the results, optimization of the deep drawing process parameters for the formability of different sheet metals is suggested. In this study, for simplification of the process, some parameters of deep drawing process are not considered

.

Assistant Professor,
Department of Mechanical Engineering (ME)
Svs Group of Instituion Warangal, Telangana, India

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN:2454-9940
www.ijsem.org
Vol 14, Issue 3 Agu 2023

TASKS INVOLVED

Modeling of Deep drawing parts in computer aided designing and also in real time.

Obtaining the forming behavior of different material sheets.

Performing the deep drawing process simulations using finite element code, PAM STAMP 2G, is used.

Comparison of punch forces, and dome height of different material sheets is investigated.

Suggesting optimistic parameters to obtain quality product of different metal sheets from the formability study of the material.

1 EXPERIMENTS PLANNED

The deep drawing process tool consists of a die, blank, blank holder and punch. The blank is placed between the die and the blank holder. The blank holder is placed between the punch and the blank. The punch placed over the blank holder which is used to draw the blank during deep drawing process.A blank holder is used in almost all the applications of the deep drawing process. An appropriate tools selection makes the deep drawing process success. The shape of the drawn part depends on the shape of the die and punch. The punch radii and die radii has an important effect on the process. For example, sharper die corner radius results in increase of the punch load.

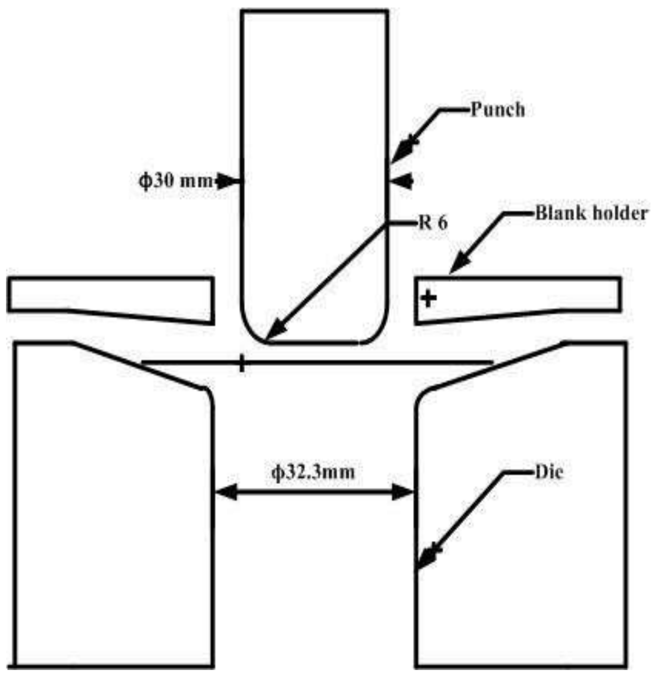


Fig 3.1 Deep drawing process setup

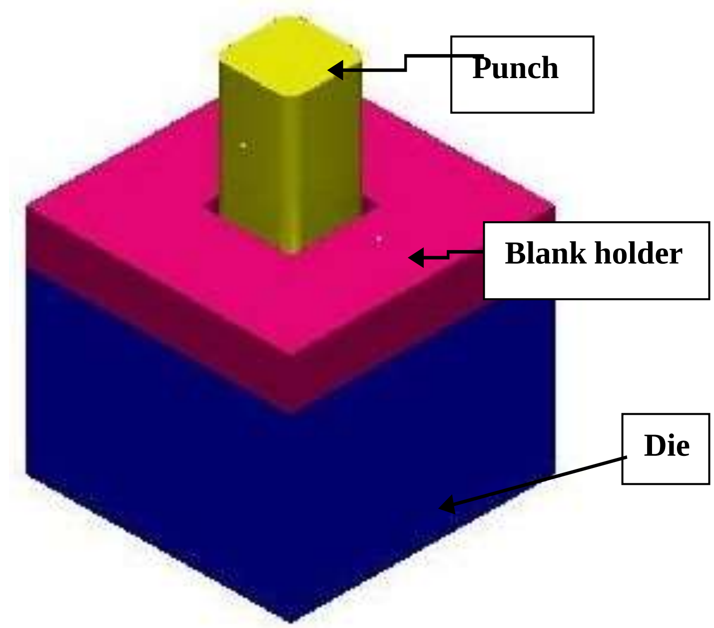


Fig 3.2 Assembled setup in PAM STAMP 2G andExperimentation

All the experiments are conducted at a die angle of 12.5^0, punch diameter of 30mm with a corner radius of 6mm and die diameter of 32.3mm with a corner radius of 5mm. The blank materials considered are 0.9mm of Al AA-6111 T4 and0.8mm of SS304, Brass. The size of the blank considered as 55x55mm and the experiments are conducted by fixing the deep drawing setup to the universal testing machine.

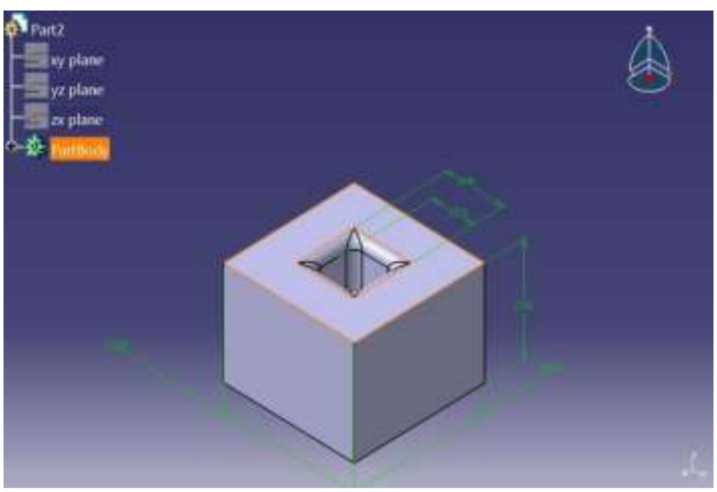
TOOLS DESIGN DETAILS

Using the Computer aided Design (CAD) tool, CATIA, thedeep drawing setup was developed in three dimensions. The deep drawing setup basically comprises of punch, blank holder, blank and the die. In modelling the tools die angles, punch corner radius and die corner radius were considered. Inthis case the radius of the punch was taken as 6mm with die radius as 5mm

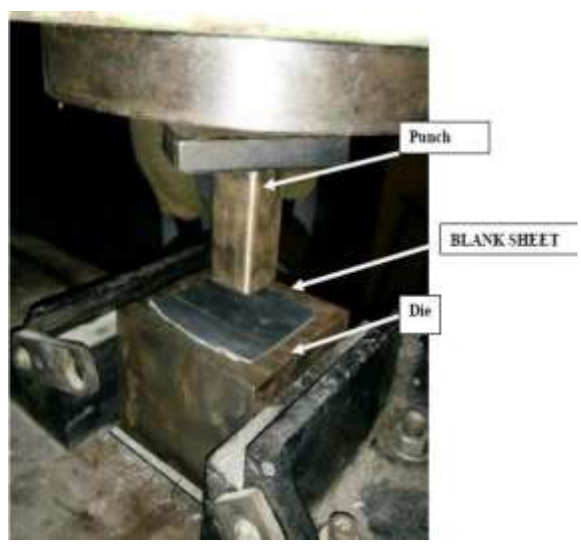
INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN:2454-9940
www.ijsem.org
Vol 14, Issuse 3 Agu 2023

Table 1 Tool dimensions and varied process parameters

Punch	Diameter Nose radius	30mm 6mm
Draw die	Die diameter Die profile radius	32.3mm 5mm
Blank	Thickness Diameter	0.8mm/0.9mm 55x55mm
Process parameters	Blank holder/Die angle Lubrication Material	12.5^o With and without Al-AA6111,SS304,Brass



3D modelled Die in CATIA



MODELLING DETAILS

Many different theories were flourished for the analysis of the deep drawing process and very different approaches existed for the analysis of the material behaviour during deformation. The primary objective of

ISSN:2454-9940
www.ijsem.org
Vol 14, Issue 3 Agu 2023

the analysis of a process was to aid in the design of a product. Such a design includes mainly predicting the material flow, forces and stresses along with forming of the part without surface defects. Frictional effects on the punch force, dome height and thickness were also considered.

SIMULATION DETAILS

Finite element method was mainly used for numerical analysis of sheet metal forming operations. Nowadays there were numerous commercial finite element codes. The simulations of two or three dimensional deep drawing operations mostly use the explicit finite element codes though there were weaknesses in the calculation of various stresses. The finite element code PAM STAMP 2G was utilized for the simulations. PAM STAMP 2G was an integrated solution for carrying out various stamping processes. It works as a unique graphical user interface that imports a CAD file, rework the geometry, mesh different parts, generation of the tools, launch the calculations by specifying the stamping process and finally post-process the results.

Three base material sheets of aluminum, SS304 and brass of size 55x55mm were taken for the simulations. A uniform meshing of size 1mm was used throughout the simulations. The yield strength was kept constant and the friction coefficients taken were 0.08 for lubrication condition and 0.12 for dry conditions. Downward stroke to the punch is given with a velocity of 5mm/min and a total of 6 simulations were performed by varying the coefficient friction and blank material. From the simulation results the punch force and dome height were evaluated.

RAW MATERIALS USED IN EXPERIMENTS

The products manufactured from the sheet metal forming processes, especially from deep drawing processes, depends greatly on the materials used. This is due to the differences in the macro and microscopic material properties. The Aluminum alloy is extensively used in the manufacture of batteries, beverage containers, decorative packaging, power storage, and in pharmaceutical industries. Also it is highly used as a heat sink or for heat reduction.

The key advantages of using aluminum for deep drawn part include:

- Aluminum is light weight metal, non-magnetic andheat treatable.
- The specific gravity of Aluminum is one-third that oflow carbon steel.
- The specific strength or the strength to weight ratio ofAluminum is excellent.
- Aluminum is rust free which makes it more useful inmanufacturing rust resistant parts.
- It is used to create a corrosion resistant and a decorative surface finish by anodizing the metal.

RESULTS AND DISCUSSION

Various process parameters like die punch clearance, punch radius; die radius and lubrication affect the formability of the blank. Also the thickness of the sheet metal, along with its mechanical properties and the shape of the blank created, affect the formability of the blank. The present study observed the variations at three different materials and the lubrication condition. The punch force and dome height for the Aluminum alloy, AA 6111, SS304 and brass sheets were

effectively evaluated from the reliable results obtained

ISSN:2454-9940
www.ijsem.org
Vol 14, Issuse 3 Agu 2023

from experiments and simulations in PAM STAMP 2G.

DOME HEIGHT EVALUATION

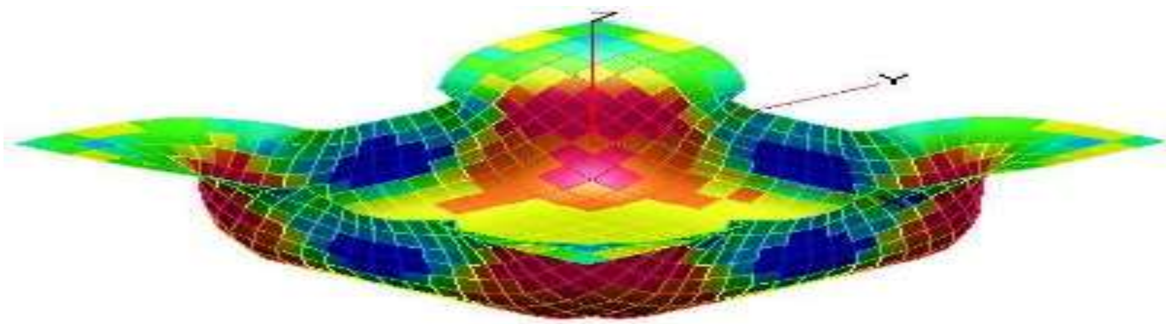
A

B

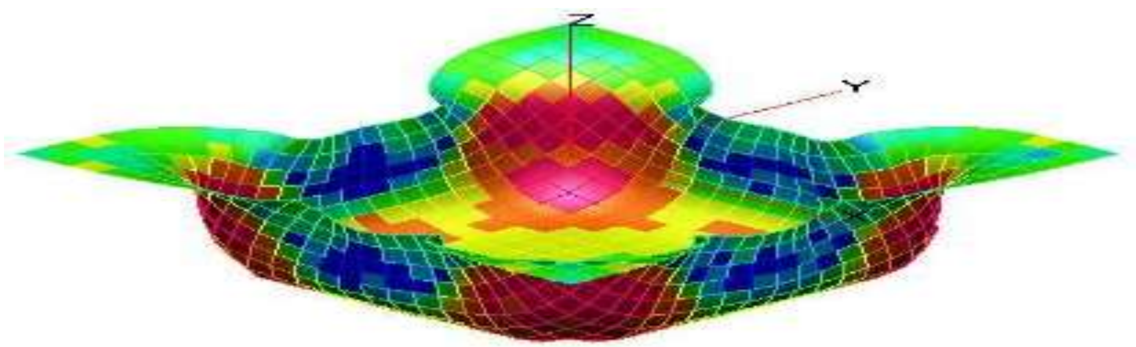
ISSN:2454-9940
www.ijsem.org
Vol 14, Issuse 3 Agu 2023

Brass sheet (A) Before deep drawn (B) After deep drawn

Stress Formation



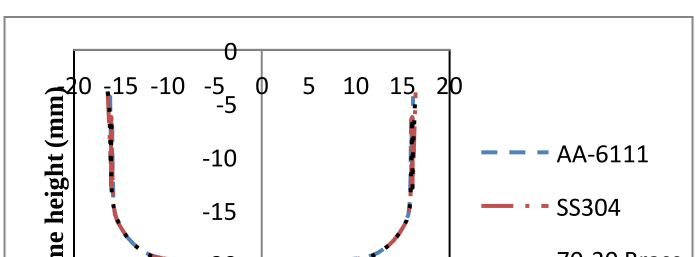
Stress Formation in (A) AA-6111 (B) SS304



Stress values of AA 6111, SS304, Brass sheet

Value	AA6111	SS304	70-30Brass
Minimum	-0.272	-0.541	-0.396
Maximum	0.457	0.989	0.725

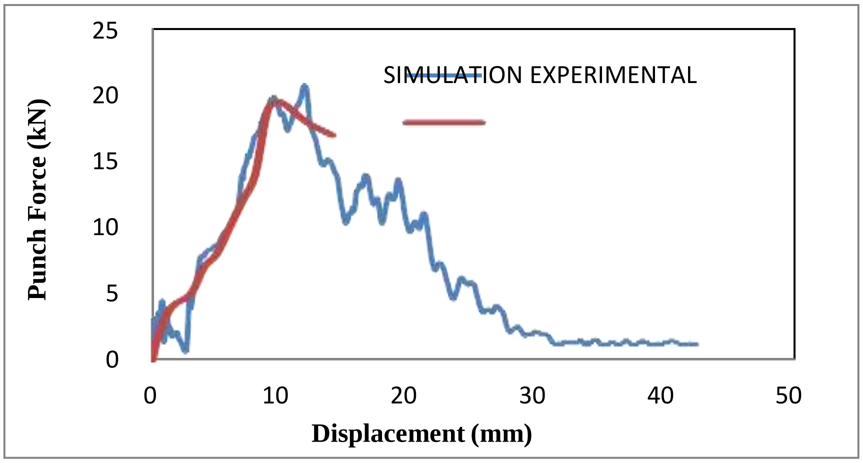
Thickness Distribution values of AA 6111, SS304, Brasssheet



INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN:2454-9940
www.ijsem.org
Vol 14, Issue 3 Agu 2023

Punch force Evaluation



CONCLUSIONS AND FUTURE SCOPE

Conclusions

The results obtained by varying all the above parameters are evaluated for the punch force. It is concluded that the punch force required for stainless steel is more whereas aluminum requires less force.
The Strain formation region is more for the aluminumalloy sheet metal when compared to Stainless steel sheets and brass sheets.
The Stress formation zone is high for SS304 sheet when compared to Aluminum alloy sheets and Brass sheets.
The thickness distribution zone is almost same for all the sheet metals only a slight variation can be observed for aluminum alloy.
The punch force required is more for SS 304 when compared to the other two materials.

Value	AA6111	SS304	70-30Brass
Minimum	0.689	0.637	0.635
Maximum	1.225	0.998	1.025

Future Scope

1. Elimination of formation of wrinkles in the cup forming by implementing blankholding force givesbetter results for formability.
2. Different blank shapes can be used to get better formability.
3. Clearance variation can be checked for angular dies thereby formability of the sheet metal can be observed.
4. Die modification can be done by implementing springaction for the blank holder

REFERENCES

1. **T. Meinders, A. vanden Berg, J. Huetink** Deep drawing simulations of Tailored Blanks and experimental verification *Journal of Materials Processing Technology* Vol.103 (2000) 65-73.

2. **Young Hoon Moon, Yong Kee Kang, Jin Wook Park, Sung Rak Gong** Deep Drawing With Internal Air-Pressing to Increase The Limit Drawing Ratio of Aluminum Sheet *KSME International Journal; VoL 15 No.4*, pp. 459- 464, 2000.

3. **K. R. Gilmour, S. Paul, A. G. Leacock** The influence of lubricant film thickness on friction coefficients during slow speed deep drawing operations *Journal of Tribology OCTOBER 2002, Vol. 124* Õ 847.

4. **M.A. Hassan, K. Hino,N. Takakura, K. Yamaguchi** Friction aided deep drawing of sheet metals using polyurethane ring and auxiliary metal punch. Part 2: analysis of the drawing mechanism and process parameters *International Journal of Machine Tools & Manufacture Vol. 42 (2002)* 633–642.

5. **H. Takuda, K. Mori, I.Masuda, Y. Abe, M. Matsuo** Finite element simulation of warm deep drawing of aluminium alloy sheet when accounting for heat conduction *Journal of Materials Processing Technology Vol.*120 (2002) 412–418.