Volume : 2 | Issue : 7 | July 2013 ISSN - 2250-1991

Research Paper Engineering

# Design and Analysis of Draw Die for Improvement in Horn Cup

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**ABSTRACT**

*The work is based on review topic with sponsored work in Ethika engg. pvt. Ltd, pune. Items often made by deep drawing include cupped baking pans, like muffin pans, and aluminum can cylinders. However, irregular items, like fire extinguishers and enclosure covers for oil filters in trucks are also made this way - as is your kitchen sink! Products made by deep drawing are deep and seamless. The finished shape produced by a drawing press depends on the position in which the blanks are pushed down. Only malleable metals that are very resistant to damage by tension and to stress can be used in this process. Industries where deep drawing is often used include the dairy industry, pharmaceuticals, plastic manufacture, and the auto industry, aerospace and lighting. Companies making parts by deep drawing need expensive presses and operations put together by trained engineers, as well as plates, molds, and other accessories. Unlike metal stamping, deep drawing uses a single piece blank, not a continuous stream of blanks.*

*The productivity of the stamping process in the industry yields better quality product at a economic price. The dissertation work is relevant in the context of developing a cost effective die with a lower lead time through the phase of Design, Development, Trials and Testing, Pilot lot production & Regular supply. The Deep draw process being critical to evaluate offers higher scope for study and research while addressing the most suitable design for the Draw Die.*

*Achieving high standard quality products in almost no time with great economy in automobile industry demands for a technology that helps exceed the engineering requirement of products. This research highlights the advantages of using Altair's HyperForm using RADIOSSto design drawing tools like die and punch for one of the automobile components along with the procedure of required blank shape. hyperform help reducing the complet product development cycle to almost less than 40% of what it usually took using conventional methods.lesser effort and easy to model the complete set up important features with different design parameters, improved the product development without compromising quality. The challenge was to developed the wrinkle free component restricting percentage thinning to 20%. Different design iterations were carried out to get the best possible product in minimum time. Design changes where done in the existing die design to make it cost and time effective by saving workmanship involved in its development. Simulation revealed the need of optimizing the blank apart from die modification , to get rid off the wrinkles.*

**Keywords : metal forming simulation, draw beads, wrinkles, % of thinning, formability.**

## 1. Introduction

Metal stamping refers to the process of shaping and cutting metals into particular forms, and is generally used in producing components for structures or large pieces of machinery. It may also be used to mold metal sheets into specific shapes for use in common everyday items, including cans and cookware. Zinc, steel, titanium and aluminum are among the most common metals used for this purpose. Metal stamping is well known as a cost effective way to produce lots of different items on a large scale.

The metal stamping process works by placing sheets of metal in a press tool or die with a specially designed cavity that gives the sheet its preferred shape. The upper part of the die is attached to the press slide and the lower part is attached to the press bed. The punch pushes the sheet of metal through the die and does the actual shaping. Metal may be plated with various others after stamping to prevent corrosion or improve appearance, as well as to improve soldering ability and wear. Sheets may be pre plated before stamping, then cleaned. After stamping, most items are heat treated for strength, and then deburred to remove sharp corners, with abrasives or chemical means.

There are two different kinds of presses for metal stamping - hydraulic and mechanical. They come in a wide range of capacities, stroke lengths, operating speeds and sizes. They're growing more popular as metal stamping begins to replace other processes, including machining, fabrication, forging and die casting, due to its much lower cost and ability to handle harder metals. Metal stamping also has less expensive secondary processes, and is the only way to produce some kinds of products.

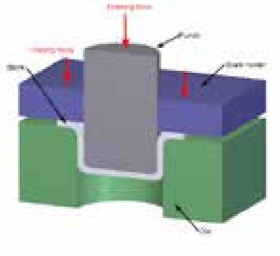

**Fig.1.1-Deep Drawing Process.**

Deep drawing is also a process of forming sheet metal through a forming die with a punch. Metal in the area of the die shoulder undergoes a lot of stress, and will result in wrinkles if a blank holder is not used to control the flow of material into the die. Material is usually thickest in the area where the metal loses contact with the punch - the punch radius - and thinnest in the areas where stresses are greatest. Deep drawing is often used to produce metal objects that are more than half their diameters in height. The metal is stretched around a plug, and then moved into the die.

**Fig.1.2- Figure for representation of a Deep Draw operation**

**1.1. Deep draw development**

Items often made by deep drawing include cupped baking pans, like muffin pans, and aluminum can cylinders. However, irregular items, like fire extinguishers and enclosure covers for oil filters in trucks are also made this way - as is your kitchen sink! Products made by deep drawing are deep and seamless. The finished shape produced by a drawing press depends on the position in which the blanks are pushed down. Only malleable metals that are very resistant to damage by tension and to stress can be used in this process.

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The productivity of the stamping process in the industry yields better quality product at a economic price. The dissertation work is relevant in the context of developing a cost effective die with a lower lead time through the phase of Design, Development, Trials and Testing, Pilot lot production & Regular supply. The Deep draw process being critical to evaluate offers higher scope for study and research while addressing the most suitable design for the Draw Die.

**2.Present Theories & Practices**

Hole punching and other cutting operations require specific and carefully maintained clearances between the punch (male component) and the die (female component). The setting of the required clearances is determined by both the stock thickness and temper. In general, die clearances increase as the stock thickness increases. The depth of punch penetration into the sheet metal stock Will also increase as softer stock is used.

Drawing, or draw forming, involves forcing a blank deeply into a die cavity and shaping it into the shape and contour of the punch face and sides. Without sufficient formability qualities, drawn blanks are subject to wrinkling, thinning, and fracturing. Draw forming requires an addition to the die set called a blank holder. The function of the blank holder, usually a ring through which the punch and ram pass, is to control the metal flow as it is forced into the die cavity. In practice, the blank holder must exert less pressure against the blank than the punch, so metal can flow into the die; yet it must exert Enough pressure to prevent the material from wrinkling.

Die making is as much of an art as a science. When all the dynamics of stamping are taken into account, the resulting part may not meet all expectations. To help fine tune the stamping process and finalize die design, die makers use an analytical tool called Circle Grid Analysis, or CGA. The application of CGA involves the etching of a pattern of small circles on the surface of the blank. This pattern deforms along with the blank as it is formed, providing point-to-point calculations of the deformation that occurred. Analyzing this stamped grid pattern suggests the location and type of rework that must be performed on the dies to produce easily manufactured parts. The CGA process is repeated on the die until an acceptable part is produced.

For the above, the Design team relies heavily on trials and testing and seldom use any forecasting tool for their own design. Without the simulation offered by the software, the designer is in no good position to evaluate his design in advance and anticipate the outcome of the forming process.

**3. Scope of Work**

- Evaluate the part design for draw ability.
- Review the existing die designs for similar components.
- Generate a General Layout for the Die for the subject part.
- Analyze the part for Draw operation using appropriate CAE software for Forming/ Draw simulation.
- Interpret the results.
- Design the die and finalize the specifications.
- Conduct trials for experimentation.
- Document the results for validation.

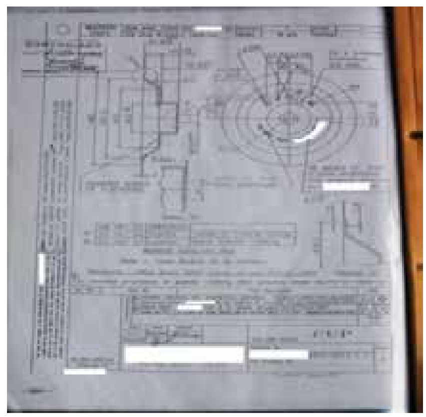

**Fig.4.1 - 2-D drawing of cup**

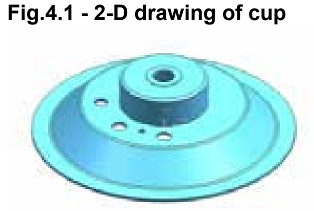

**Fig.5.1:-3-D Model of Cup**

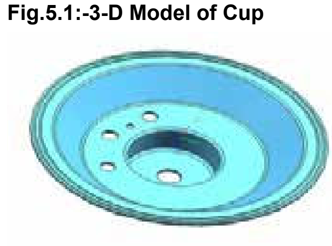

**Fig.5.2:-3-D Model of Cup**

**Fig.6.1-Trial analysis of horn cup (for splitting problem)**

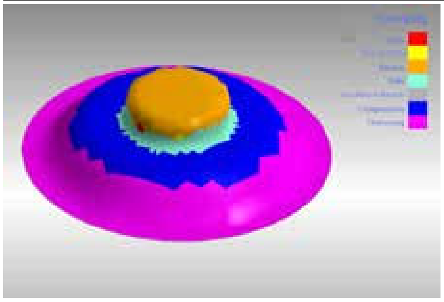

**Fig.6.2-final analysis of horn cup (for removing splitting problem)**
**Result obtained adjusting B.H.F.**

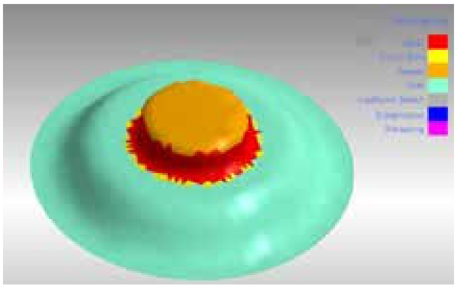

**Fig.6.3-Trial analysis of horn cup**
**(for splitting due to excess material)**

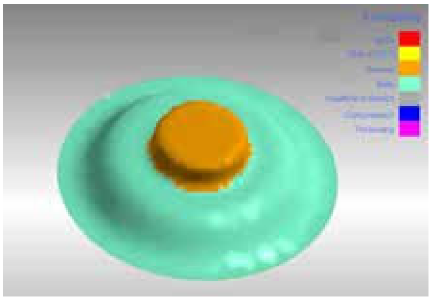

**Fig.6.4-final analysis of horn cup (Final formability removing splitting due to excess material) Result obtained adjusting thickness of material.**

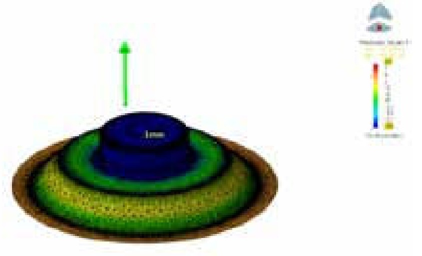

**fig.6.5-thining trial(Wrinkling). (due to insufficient stretch)**

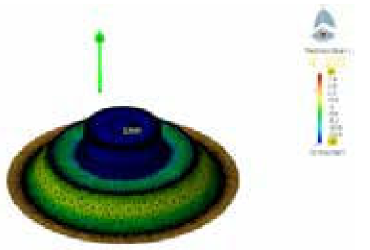

**fig.6.6-final analysis of thining (due to sufficient stretch)**
**Result obtained due to adjusting punch force & B.H.F.**

**7. Experimentation & Validation**

Experiments are to be conducted on a hydraulic press of a suitable capacity. The die would be mounted on the bolster plate of the press and the speed of the ram would be set based on the historical data as well as the input received from the analysis data (simulation).

Forming problems can be predicted before tool fabrication through the use of software that can be integrated into production routes which rely increasingly on computer technology. The prediction of forming difficulties at the component design stage ensures that the chosen geometry is compatible with the draw ability of steel. Drawing has become a highly technical process, and the development of a steel forming route no longer involves simple trial and error methods. Close collaboration between component designers, drawing engineers and steelmakers guarantees the industrial feasibility of new parts with very short development times.

The parameters influencing the draw operation and evident during the trials are:

- Type of material
- Thickness of the component
- Mechanical properties, especially the Limiting Draw Ratio
- Use of lubricant
- Blank size and development
- Blank holding pressure
- Speed of the operation

*** Validation**

The appropriate capacity press can be selected by knowing the drawing load. Working with the Presses of higher capacities may lead to many types of defects such as cracks and tearing. Blank holder pressure needs to optimized over a given range for optimized geometry. The coefficient of friction needs to be optimized for the new geometry. Generally the deep drawing objects are analyzed for their strength and failures with circle grid analysis, which is practically carried out on a sample piece, which is known as formability analysis. Alternatively, the actual trials performed over the component would directly reflect over the ease of `drawing operation' offered for the said Die design

**8. Results & Conclusion**

Many trials was done in horn cup in there formability analysis in (Radioss software) after some modification that is to change blank holding pressure and material thickness find safe horn cup in forming process.

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