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EFFECT OF VARIOUS PARAMETER ON WRINKLING IN DEEP DRAWING CYLINDRICAL CUPS WITH DIFFERENT MATERIAL

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Abstract: Deep drawing process is a sheet metal forming process in which a sheet metal blank is made by the mechanical action of a punch applied on the die. Thus, the process of transformation of the shape of the deep-drawing process with material retention. For reduce various defects in deep drawing process it is required to control some parameters of deep drawing process. Sheet-metal drawing process is a more complex operation or process than cutting operation or bending operation. A number of defects can occur in a drawn or finishing product of a deep drawing process. It is required to reduce the effect in deep drawing process otherwise production cost is simultaneously increased. Lubrication, blank holding force, the force of the punch, sheet metal, sheet thickness, the deep drawing process is regulated wrinkling effect of all effect parameters, faults and fractures have a tremendous effect. Conducting an experiment on a universal testing machine. The main issues studied in this work are the material flow (occurrence of defects such as wrinkling and fracture) of the layers of the specimen and the required drawing force

Index Terms: Deep Drawing, Effects, Metal Forming, Material properties, Wrinkling

I. INTRODUCTION

Deep drawing is a sheet-metal-forming process which is used to make cup-shaped, box- shaped, or other complex-curved and concave parts. It is performed by placing a piece of sheet metal over a die cavity and then pushing the metal into the opening of the die with the help of the punch. The blank must usually be held down flat against the die by a blank-holder. Common parts made by drawing include beverage cans, ammunition shells, sinks, cooking pots, and automobile body panels.

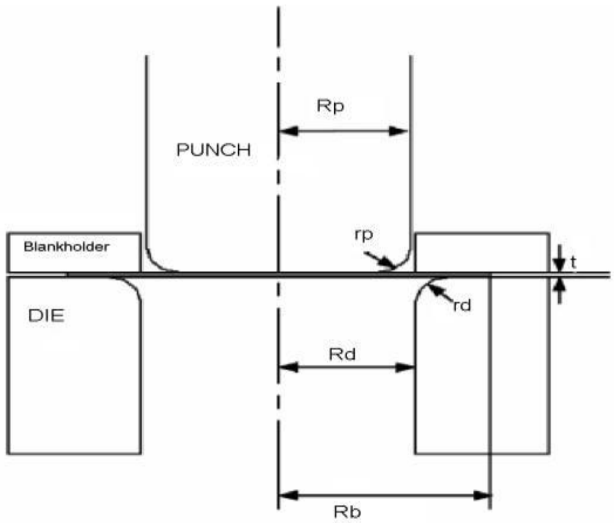
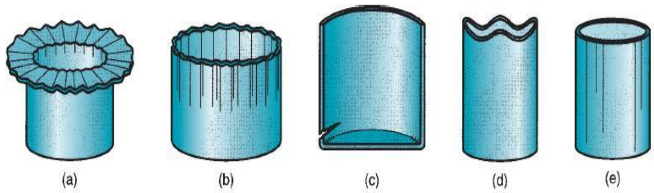


Figure 1 : Geometry parameters of deep drawing

Rp : Punch radius, m
r_p : Punch edge radius, m
t : Blank thickness
R_b : Blank radius, m
R_d : Die radius, m
r_d : Die edge radius, m

II. DEFECT IN DEEP DRAWING PROCESS



Deep Drawing is more complex operation and more thing can be wrong. Number of defect can be occur in drawn product of deep drawing process,

- Wrinkling in the flange,
- Wrinkling in the wall,
- Tearing,
- Earing,
- Surface scratches.

Wrinkling in the flange : Wrinkling in drawn part consist of series of ridges that from radially in the undrawn flange of the work piece due to compressive buckling.

Wrinkling in the wall : If and when wrinkled flange drawn in to the cups, these ridge appear in the vertical wall.

Tearing : Tearing is an open crack in the vertical wall, usually near the base of the drawn cup, due to high tensile stress that cause thinning and failure of metal at this location. This type of failure can also occur as the metal is pulled over sharp die corner.

Earing : This is the formation of Irregularities in the upper edge of deep drawing cup, caused by anisotropy in the sheet metal. If the material is perfectly isotropic, ears do not form.

Surface scratches : Surface scratches can occur on the drawn part if the punch and die are not smooth or if lubrication is insufficient

III. OBJECTIVE OF STUDY

Main objective of our project is to reduce the following defects:

- To reduce the wrinkling in the flange of the drawn product,
- To reduce wrinkling in the wall of the drawn part,
- To reduce the tearing in the drawn product,

- To reduce earing in the drawn product,
- To reduce surface scratches in drawn product,
- To minimize the cost of the product.

IV. LITERATURE REVIEW

Prof. Dr. Ing. H. Hoffmann[1] , Technology exerted a far greater influence on the development of our past then most history books give credit for. As late as the 19th century, craftsmanship and technology where practically synonymous. It is only with the advent of mechanization- though the use of machine. That the term technology took on a new meaning of its own of deep drawing process and wrinkling effect in the metal forming. Nowadays, the technology is one of the bastions of our modern lifestyle and the basis for our prosperity, in which metal forming technology plays a central role. Alongside the manufacture of semi- finished products through rolling, wire drawing and extrusion, the production of discrete components using sheet metal and solid forming techniques is of major significance. Its fields of application range from automotive engineering, production line and container construction through to the building construction, household appliance and packaging industries. The machine tool, with its capacity to precisely guide and drive one or more tools for the machining of metal, has become a symbol of economic metalworking. In the past, the work processes typically seen in metal forming technology used to be executed in a series of individual operations on manually operated machine tools. Today, however, automatic production cells and interlinked individual machines through to the compact production line with integrated feed, transport, monitoring and finished part stacking systems are the state of the art. Developments in this field created the technological basis to allow the benefits of formed work pieces, such as a more favorable flow line, optimum strength characteristics and low material and energy input, to be combined with higher production output, dimensional control and surface quality.

Sanjay K. Asodariya[2] reviewed deep drawing is the part of forming process in which sheet metal drawn into die capacity by action of punch. Sheet metal drawing is a more operation than cutting or bending. Black holding force, punch force, material property of sheet metal, thickness of sheet, velocity of punch, these are all affecting parameters in deep drawing process. Die radius has the greatest influence on the deep drawing of stainless steel blank sheet follow by the blank holder force and the friction coefficient. It is shown that a blank holder force application and local lubrication scheme improved the quality of the formed part It has reviewed that in world forming process is most concerning process. Forming is process through the which desired shape can be achieved without metal removing. In forming process, A deep drawing process has been covered so this paper deals with the various parameter of deep drawing process which plays major role to obtain the finish part as well as optimization technique to improve the productivity and quality of product. Lubrication is also play effective role in deep drawing process by using lubrication in deep process wrinkling effect is reduced.

Kleiner M. et al[3], this paper describes necessities and functional aspects if lightweight construction as well as the common problems in manufacturing lightweight materials, semi- finished products, components, and structures. Due to constantly increasing ecological concerns and demands for higher performance, lightweight construction is a key factor to success mainly in the transportation sector but also in general engineering, machine tools, and architecture. This paper deals with the present and future contribution to the creation of lightweight components and structures manufacturing technology. Forming technology can substantially contribute to lightweight construction. It is pointed out how load adaptation is the central key to success. Therefore, a wide range of solutions are discussed in order to overcome limitations in forming.

Jyhwen Wang et al[4], this paper, The present study aims to determine optimum blank shape design for deep drawing of arbitrary shape cups with a uniform trim allowance at the flange is caused by non uniform material flow and planer anisotropy in the sheet. In this research, a new method for optimum blank shape design using first divide into multiple shape and target shape set for each stage of analysis the cycle is repeated until the converge result are achieved to test the propose method three example of cup drawing in every case converge result are achieve few iteration. The systematic method for optimal blank design is found to be very effective in the deep drawing process. It deals with Finite element method to minimize the impact earring piece formed with the help of The aim of the present study is to determine the optimum blank shape design for deep drawing of cups with a uniform allowance at the flange. The non-uniform flange, is caused by non-uniform material flow in the sheet. In this research, the maximum is simply proposed a new method for shape design using finite element analysis. The deformation process is classify or divided into number of stages. A shape error metric is required or used to measure the amount of earing and also used to compare the target shape set for each stage of the analysis. This error metric is then used to decide whether the blank needs to be modified. A simple but very effective method is proposed to derive the optimal blank shape for deep drawing of a cup having a uniform flange. In the proposed method, the deformation process can be classify or divided into number of steps. An intermediate flange contour is assigned as the target for blank optimization at each stage. In the optimization process, a shape error is calculated by comparing the deformed contour of the blank and the desired target contour. Based on the Characteristics of the material flow, the blank geometry is repeatedly modified until the Shape error is within a predetermined tolerance. The blank modification method was used in single stage and multiple steps blank optimizations. It was found that, in simple deep drawing, dividing the deformation process into stages and correcting blank geometry early can reduce total CPU time in finite element simulation. Theoretically, earring can be reduced or eliminated by using the optimized blank derived from tooling geometry, process parameters, and material properties. The method can also be efficient and effective in optimizing blanks in complex stamping.

Mohammad Reza Morovvati et al[5], this paper is about the one of the deep drawing process and wrinkling behavior on two layer comparison sheets. Due to the required the material properties of the metal sheet two layers, it is very difficult to the finite element method to find out or decided to the relative possibility of wrinkling in the multilayer sheets. The failure mode of sheet metals is depends on the blank holder force. By decreasing the blank holder force, wrinkling turns out as a major failure mode, when the fractured increase results. Thus, this paper find out that the effect of blank holder forces on Fractures and wrinkling in deep drawing process of metal sheet having single and two layers. In this study, proper BHFs were driven to eliminate the wrinkling and to avoid the fracture in the single and two-layer sheets the following results are obtained: The higher the Strength of sheet material, the more the required BHF to eliminate its wrinkling during the Deep drawing process. Also, less BHF can be used for a sheet with higher ductility to control its wrinkling. For instance, required BHF for Al1100 is about 44% less than the BHF for ST12. The forming force of the sheet with higher yield strength is more than the sheet with lower strength as an example forming force of ST12 is up to 35% more than the forming force for Al1100.An increase in initial blank diameter causes the drawing ratio to reduce, and subsequently, it increases required forming force. The required BHF and forming force for a two-layer sheet depend on the characteristics of its components and are less than the values for the stronger sheet and more than the values of the weaker one. The required BHF and forming force for AI lay-up are 7% and 5% higher than the values for SI lay-up respectively. A great compatibility between finite element and experimental results was observed for BHF and forming forces.

T. S. Yang et al[6], Efficiency in the industrial sector due to its deep drawing process is very useful. Deep drawing process is affected by many variables, such as the blank shape, punch and die profile Radius, material formability and so on. In particular, in order to get the best products in the deep drawing process, the blank size is a very important factor. In this paper, in finite element method square cup drawing cup height are used to investigate the process. In order to test the product in a square cup drawing processing height and load to predict the formation of FEM, The current simulation results are compared with experimental data. Finite element is used for drawn products designed profile analysis, and proposed the creation of a mechanism to reverse the initial blank shape of a square cup drawing simulation. The design of the initial blank shape is also certified for use drawn up by the gain profile designed cups. The main superiority of the drawn cup using the modified blank's shape over the circular blank shape is that the drawn cup height is more uniform; and in addition the maximum punch load, effective stress and effective strain of drawn square cup are smaller.

Amir Atrianet al[7], In this paper, the effects of number of parameters on the deep drawing process of laminated sheets are studied. The main reason to carry out such a process is take the advantages of different materials, such as high strength, low density and corrosion resistibility, at the same time and in a single component. High-strength materials and components it is possible to take advantage of the direction of the formation processes, as less waste. The research work steel / copper laminate sheets deep drawing process is deals or concerned with the experimental and finite element study. The main issues in the study sample and the drawing force required levels of material flow. Based on the finite element simulations and the deep drawing tests of composite blanks carried out in the present research work and the results obtained, the conclusions can be summarized as follow: Fairly good agreement of the experimental and finite element results showed that the FEM can be used in parameter studies of any industrial procedure. In the present investigation, the required drawing force was overestimated about 10% by the FE simulations. A linear relation was obtained between the initial blank diameter and the maximum necessary force. This was demonstrated by both the experimental and numerical techniques. It was also shown that increasing the initial blank diameter from 7.5 cm to 10 cm, resulted in about 100% increase in the required maximum drawing load. It was found that similar to single-layer deep drawing, the required maximum punch force during the deep drawing of the composite blanks takes place when the outer diameter of the deep drawing component reaches about 0.77 of the initial blank diameter. Layer stacking sequence played a significant role in this process. By changing the layer sequence, one can obtain different properties for the product. With this regard, it was found that the experiments, Finite element analyses presented a relation between the stacking sequence and the frictional condition. Distributions of the circumferential stress and thickness strain in the drawn cup indicated that the most dangerous area to fracture is the punch profile radius region. This prediction was also verified by some defects observed after deep drawing operation several double-layer specimens.

A Sokolova et al[8], Due to the wide range of different properties – such as stiffness,high strength, vibration resistance, high damping capacity and the lightweight metal/polymer/metal sandwich composites find their application as various body-parts in the automobile industry. In this research the formability of sandwich composites with different core thickness and sample size was studied for the deep drawing process using two flat punches of different size and shape. It is composed of three-layered sandwich of behavior that can be said is quite a punch influenced by the geometry and thickness of the core. The results were analyzed and photogrammetically, metallographically. Commission geometric patterns using a variety of sandwiches as well as the limits of deep drawing process, the deformation of the inner and outer sheets sandwich deformation shows significant differences. Polymer core outer skins have a significant impact on the formability. Slight differences in strain distribution in the flange region of outer sandwich sheets with different core thickness could be observed. The crimping of the cover skin in the punch rounding strongly depends on the polymer core thickness. It was also observed, that the thicker the core, the more resistive is the outer sheet to drawing. Comparable to the rotation symmetrical cup deep drawing process of forming with square punch leads to the appearance of two maxima of tension in the diagonal direction and one maximum for the sandwich inner sheet in perpendicular direction to the punch. The outer sheet shows strong maxima of strain in the transition area of cup head/edge as in the case of square cap deep drawing test.

V. EXPERIMENTAL PROCEDURE

Experimental work carried on universal testing machine. Specification of universal testing machine is given below.

Specification	TFU C-600
Maximum capacity (KN)	600
Measuring range (KN)	0-600
Least count (N)	100
Clearance for tension test (mm)	50-700
Clearance for compression test (mm)	0-750
Ram stroke (mm)	160
Piston speed at not load (mm/min)	0-150
Clearance between column (mm)	610
Connected load (K.W.)	2.1
Operating voltage	400-440
Phase	3

Table 1: Sheet Material Specification

This deform process is affected by a lot of parameters which can be sorted according to their relative importance as follows, the tool geometry, the material properties, the friction and lubrication conditions, and the interaction between the press and tool including the elastic behaviour of the tool and the press. Successful deep drawing depends on many factors, where the most important element to a successful deep drawing operation is initiating the material flow. Experimental of deep drawing process is listed below;

Figure 2: Universal Testing Machine

- Calibrate the universal-testing machine
- Choose the scale in the testing machine.
- Measure the thickness and the diameter of the test specimen.
- Measure the die throat diameter.
- Lubricate the die surface and its throat.
- Place the specimen in position on top of the die and locate the die holder, and finally place the punch in a proper position.
- Place the die set between the two platens of the testing machine.
- Applied the load gradually until the cup is completely drawn.
- Takes off the die set and get the formed cup.
- Measure the average height of the cup.

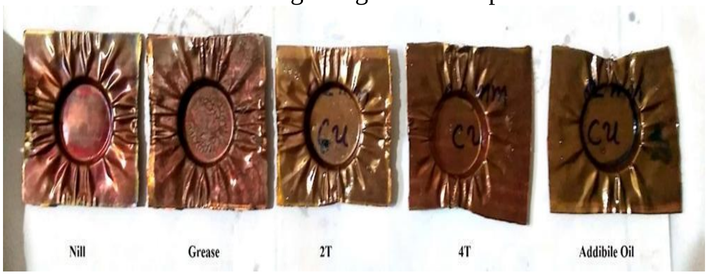


Figure 3 : Copper 0.2 mm Thickness Blank

Figure 4 : Copper 0.4 mm Thickness Blank

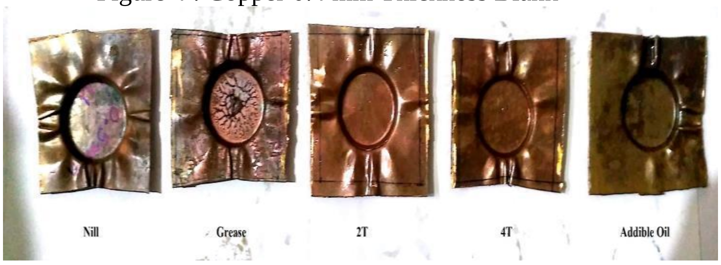


Figure 5 : Copper 0.5 mm Thickness Blank

Figure 6 : Brass 0.4 mm Thickness Blank

Figure 7 : Brass 0.5 mm Thickness Blank

VI. RESULT AND DISCUSSION

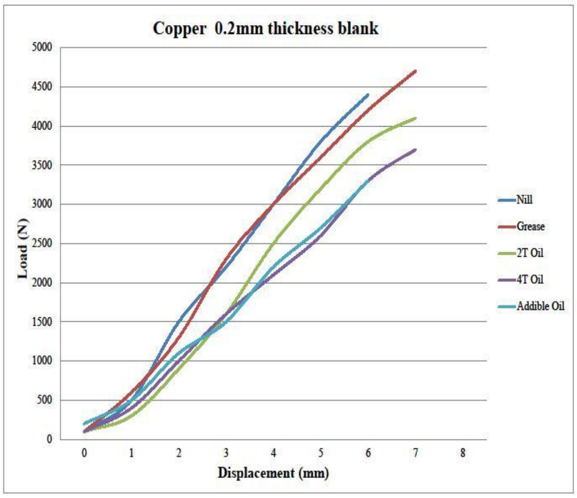


Figure 8: Load vs Displacement curve of Cu 0.2 mm thickness sheet

For this sheet for 6 mm displacement required load in the presence of different lubrication is shown below. From the table it is seen that for the 6 mm displacement minimum load is required as compare to other lubricants.

Cu 0.2 mm thickness blank			
Sr No.	Lubricant	Displacement (mm)	Load (N)
1.	Nill	6	4314.48
2.	Grease	6	4102.50
3.	2T Oil	6	3767.80
4.	4T Oil	6	3014.87
5.	Addible Oil	6	3102.12

Table 2: Copper 0.2 mm Thickness Blank

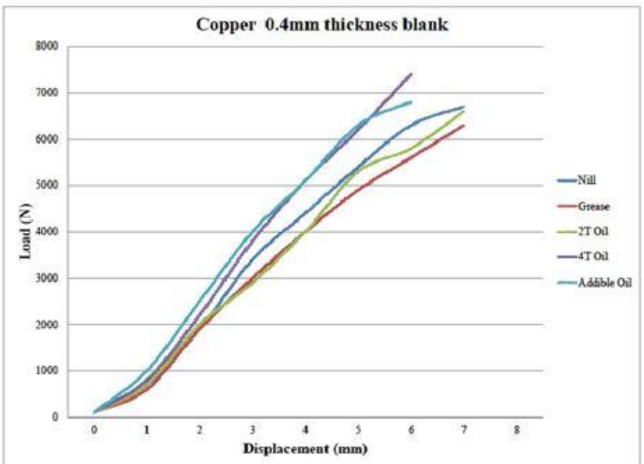


Figure 9: Load vs Displacement curve of Cu 0.4 mm thickness sheet

For this sheet for 6 mm displacement required load in the presence of different lubrication is shown below. From the table it is seen that for the 6 mm displacement minimum load is required as compare to other lubricants.

Cu 0.4 mm thickness blank			
Sr No.	Lubricant	Displacement (mm)	Load (N)
1.	Nill	6	5978.70
2.	Grease	6	5398.30
3.	2T Oil	6	5686.50
4.	4T Oil	6	7000.20
5.	Addible Oil	6	6865.80

Table 3: Copper 0.4 mm Thickness Blank

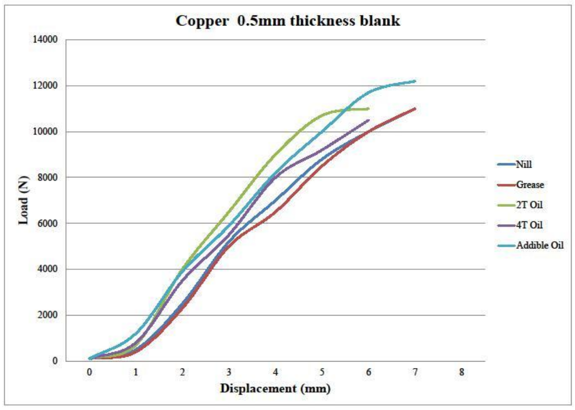


Figure 10: Load vs Displacement curve of Cu 0.5 mm thickness sheet

For this sheet for 6 mm displacement required load in the presence of different lubrication is shown below. From the table it is seen that for the 6 mm displacement minimum load is required as compare to other lubricants.

Cu 0.5 mm thickness blank			
Sr No.	Lubricant	Displacement (mm)	Load (N)
1.	Nill	6	9515.9
2.	Grease	6	9495.2
3.	2T Oil	6	11095.5
4.	4T Oil	6	10458.6
5.	Addible Oil	6	11627.6

Table 4: Copper 0.5 mm Thickness Blank

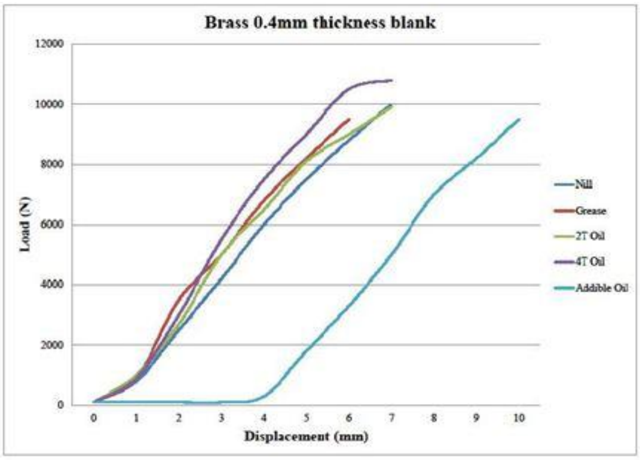


Figure 11: Load vs Displacement curve of Br 0.4 mm thickness sheet

For this sheet for 6 mm displacement required load in the presence of different lubrication is shown below. From the table it is seen that for the 6 mm displacement minimum load is required as compare to other lubricants.

Br 0.4 mm thickness blank			
Sr No.	Lubricant	Displacement (mm)	Load (N)
1.	Nill	6	8267.3
2.	Grease	6	90698.1
3.	2T Oil	6	8846.7
4.	4T Oil	6	10323.7
5.	Addible Oil	6	2945.2

Table 5: Brass 0.4 mm Thickness Blank

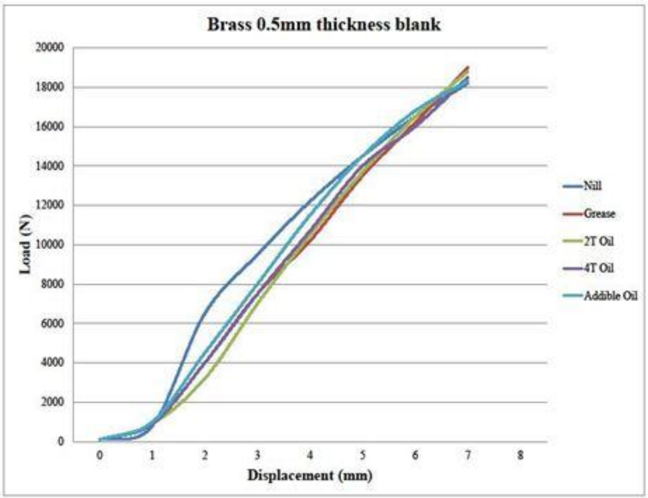


Figure 12:Load vs Displacement curve of Br 0.4 mm thickness sheet

For this sheet for 6 mm displacement required load in the presence of different lubrication is shown below. From the table it is seen that for the 6 mm displacement minimum load is required as compare to other lubricants.

Br 0.5 mm thickness blank			
Sr No.	Lubricant	Displacement (mm)	Load (N)
1.	Nill	7	17627.9
2.	Grease	7	17917.4
3.	2T Oil	7	17809.1
4.	4T Oil	7	17780.3
5.	Addible Oil	7	17902.8

Table 6: Brass 0.5 mm Thickness Blank

VII. CONCLUSION

The start of the process more deformation is take place as compare to the applied load while at the end of the process more load is take place as compare to the displacement. Initially to deform the sheet less amount of load is required and after that for sheet plate deformation large load is required. The forming force of the sheet with higher yield strength is more than the sheet with lower strength. It is conclude that the increasing the total thickness of a material its resistance to deformation is increases. The wrinkling in the drawn products is concerned with the less blank holding force. The higher the strength of sheet material than the more blank holding force is required to eliminate its wrinkling during the deep drawing process. The effect of the tearing will be remove by the providing proper clearance between punch and die. The surface scratches will be eliminate by the providing proper lubrication.

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