EFFECT OF MATCHING SURFACE ON PAD FORCE IN FLANGING AND TRIMMING OPERATION OF SHEET METAL

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Abstract - *The project work deals with the matching or contact surface of holding block which affect the pad force in flanging and trimming operation. The different holding area that control the output of the process have been studied. Their effect on pad force, thinning and formability are analysed using AutoForm software. The outcome of the study verifies the effectiveness of holding area used for flanging and trimming operation of sheet metal process which affect the pad force, which was helped in optimization of parameters.*

It been observed that change will come with change in matching surface. Reductions in stripping force reduce the gas spring cost. The optimum matching surface has to define which does not affect the final product quality with reduction in cost

Key Words: Pad Force, Trimming, Flanging, AutoForm, Sheet Metal, etc

1. INTRODUCTION

1.1 CUTTING OR SHEARING

Cutting is perhaps the most common operation performed in a stamping die. The metal is severed by placing it between two bypassing tool steel sections that have a small gap between them. This gap, or distance, is called the cutting clearance. Cutting clearances change with respect to the type of cutting operation being performed, the metal's properties, and the desired edge condition of the piece part, hardness of sheet metal. Cutting clearance often is expressed as a percentage of the metal's thickness. The most common cutting clearance used is about 10 percent of the metal's thickness. Very high force is needed to cut metal. The process often introduces substantial shock to the die and press. In most cutting operations, the metal is stressed to the point of failure, which produces a cut edge with a shiny portion referred to as the cut band, or shear, and a portion called the fracture zone, or break line.

There are many different cutting operations, each with a special purpose. Some common operations are:

A. Trimming: The outer perimeter of the formed part or flat sheet metal is cut away to give the piece part the desired profile. The excess material usually is discarded as scrap.

B. Notching: Usually associated with progressive dies, notching is a process in which a cutting operation is performed progressively on the outside of a sheet metal strip to create a given strip profile.

C. Blanking: A dual-purpose cutting operation usually performed on a larger scale, blanking is used in operations in which the slug is saved for further press working. It also is used to cut finished piece parts free from the sheet metal. The profiled sheet metal slug removed from the sheet by this process is called the blank or starting piece of sheet metal that will be cut or formed later.

D. Piercing: Often called perforating, piercing is a metal cutting operation that produces a round, square, or special-shaped hole in flat sheet metal or a formed part. The main difference between piercing and blanking is that in blanking, the slug is used, and in piercing the slug is discarded as scrap. The cutting punch that produces the hole is called the piercing punch.

1.2 FLAGING

Flanging is similar to the bending of sheet metal except for one factor; that is, during flanging the metal bent down is short compared to the over all part size. Flanges usually follow the contour of the part so that uniform flange width obtained.

Flange operation is a metal forming process in which a force is applied to a piece of sheet metal, causing it to bend at an angle and form the desired shape. These can be either straight or curved. Straight flanges are made by simple bending of a portion of sheet-metal material, with no flow of material involved in the process. Curved flanges seem to utilize simple bending technique as well; however, this is accompanied by stretching or compressing action on the material, which induces the material to flow.

The material flow is similar to that in drawing or other cold work. It is similar to the bending operation, except that the amount formed down(or up) is small in relation to the remainder of the part.

A flange is used to strengthen the edges of sheet metal parts. It also adds rigidity to the edge and smoothness the sharp edges left by the cutting operation. Often, parts are flanged to aid in assembly, as the flanges may be welded, riveted etc. In Fig.1.3, a sheet metal tab is being formed downward. The length of the tab will dictate how the flange is formed. This tab is carefully designed, and can be trimmed so that there are cuts, or tears, in the tab at intervals, so that the tab can be flanged around corners or curves. The simple downward motion of the press will flange the tab, but usually a cast steel pressure pad is added to the upper casting. This pressure pad holds the metal while the tab is being flanged down. Steel inserts are added to the lower post and upper casting for high production die lines.

2. LITERATURE REVIEW

Rasika S. Khairkar, Satish G. Bahaley[1] Shearing is the process to cut sheet using pair of blades, by applying shear stress along the thickness of the sheet. Shearing happens by extreme plastic deformation followed by breaking which propagates deeper into the thickness. The upper blade id fixed to the ram assembly that moves vertically and lower knife is fixed in the stationary table. This project is rooted on the necessity of industry to develop a shearing machine for cutting 5mm thick stainless steel sheet. In this project we will design a CAD model of shearing machine and analyse using FEA technique.

Emad Al-Momani, Ibrahim Rawabdeh [2] Metal blanking is a widely used process in high volume production of sheet metal components. The main objective of this paper is to present the development of a model to predict the shape of the cut side. The model investigates the effect of potential parameters influencing the blanking process and their interactions. This helped in choosing the process leading parameters for two identical products manufactured from two different materials blanked with a reasonable quality on the same mold. Finite Element Method (FEM) and Design of Experiments (DOE) approach are used in order to achieve the intended model objectives. The combination of both techniques is proposed to result in a reduction of the necessary experimental cost and effort in addition to getting a higher level of verification. It can be stated that the Finite Element Method coupled with Design of Experiments approach provide a good contribution towards the optimization of sheet metal blanking process.

Rahul Nishad, Amol Totre [3] The study shows the different methodologies used for the prediction of the optimum parameters involved in the sheet metal blanking process and optimization of these parameters. The different parameters that control the output of the process have been studies in detail and their effect on the quality of the blanked material is analysed using different methodologies. The outcome of the study verifies the effectiveness of each methodology used for the optimization of the parameters.

Obermeyer, E.J. Majlessi [4] This paper presents a review of current industrial research and development in blank-holding technology, and its effect on the formability of sheet metals. The first section of the paper introduces a brief historical background of how and why the formability of sheet metal is defined in terms of a two-dimensional strain map. It also describes how the measure of formability depends on the state of strain, which in turn depends on the specific experimental technique used. Section 2 briefly reviews research work dealing with both experimental and theoretical determination of the forming-limit diagram (FLD), the focus being to demonstrate the significance of the strain path on the FLD by showing how the calculated limit strain depends on the strain history. Sections 3 and 4 demonstrate that for a given sheet material and part geometry, the parameters involved in stamping practice can significantly affect the formability of the material. It is shown how the blank-holder force and the way it is applied on the blank affects the state of stress and strain within the part, and also influences the strain path. Section 3 reviews open- and closed-loop control of the blank-holder force, and demonstrates that by properly adjusting this parameter the working window between the tearing and wrinkling boundaries can be expanded. The research work reviewed in this section employed a uniformly-distributed blank-holder force, which varied with time (punch depth). The application of this technology to large, industry-size panels is mostly reported by the Japanese automobile industry. Section 4 describes how the real-time control of the blank-holder force has been expanded to include spacial as well as time variations. The papers reviewed in this section deal with the multi-force variable-blank-holding technique and report considerable improvement in formability. Significant development in this area has been made in Germany, leading to the construction of production-size presses. So far as an optimum trajectory of blank-holder force variation is concerned, the results are inconclusive. It appears that an ideal trajectory depends on both part geometry and material type. Considering that different materials show different sensitivity to various modes of failure, the above observation is not unexpected. © 1998 Published by Elsevier Science S.A.

Patel Shubham, Patel Bhargav [5] The pneumatic system has gained a large amount of importance in last few decades. This importance is due to its accuracy and cost. This convenience in operating the pneumatic system has made us to design and fabricate this unit as our project. This unit, as we hope that it can be operated easily with semi-skilled operators. The pneumatic press tool has an advantage of working in low pressure, that is even a pressure of 6 bar is enough for operating the unit. The pressurized air passing through the tubes to the cylinder, forces the piston out whose power through the linkage is transmitted to the punch. The work piece thus got is for required dimensions and the piece can be collected through the land clearance provided in the die. The die used in this is fixed such that the die of required shape can be used according to the requirement. This enables us to use different type punch dies resulting in a wide range of products. Different types of punch as requirement can be thus got. According to the work material the operating pressure can be varied.

Durgesh Rathod, Snehal Pisal [6] Nowadays, the world is focusing more towards automation. Each and every work of human is reduced by machine, but few areas of manufacturing such as electrical panels, trolleys, chimneys etc the usage of bending machines requires high cost and need skilled labour to operate it. So this project is aimed to design and modify die and punch the bend. Hydraulic sheet bending machine consist of hydraulic jack, bending die, punch, fixture. The present work includes the modelling and simulation (stress analysis) of hydraulic operated sheet metal bending machine subjected to load. This necessitates the optimization of production processes, and enhancement of product quality. The modelling is done using SOLIDWORKS software and stress analysis is carried out using advanced fem tool ANSYS.

Muhammed Emin Erdin [7] Typical V-bending process was performed to investigate the effect of holding force on springback behaviour of 1050-H14 aluminum alloy plates annealed at 1200 c for 20 minutes. Tests were conducted on a universal testing machine with 600 V-bending mold. Various holding force were applied at the end of the bending processes to investigate the hardening effect on springback values. The test data that application of holding force has a significant affirmative effect on springback values.

3. CAD MODEL

The sheet model is design for the test purpose for the flanging and trimming operation of material BH220 of thickness of 0.6mm.

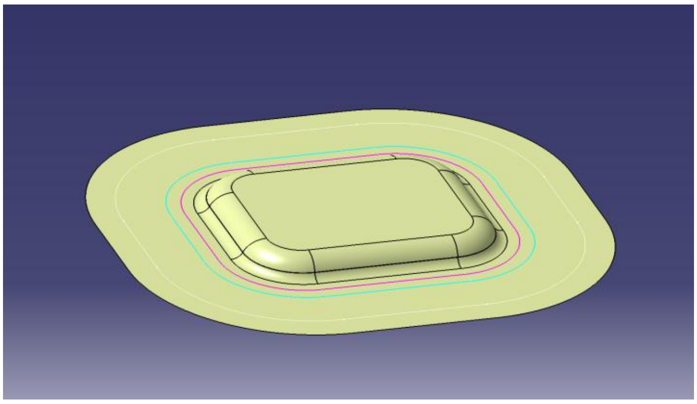

Fig -1: CAD MODEL

4. CALCULATION

4.1 ASSUMPTIONS

- The uniformly formed sheet metal is used.
- We take the BH340 steel which is now a day highly used in automobile industries. The mechanical properties of BH220 as follows:

1. K (GPa) = Strength coefficient = 0.63
2. n = Work hardening coefficient = 0.22
3. E (GPa) = Young's modulus = 206 GPa
4. μ = Poisson's Ratio = 0.3
5. p = Density = 7.8 × 10-6 Kg/mm3
6. UTS (GPa) = Ultimate Tensile strength= 0.36 GPa
7. YS (GPa)= Yield strength = 0.23
8. Thickness= 0.6

- The Length of the Trim line = 440mm
- The Length of the Flange line = 402mm
- The height of the Flange = 6 mm
- The angle of the Flange = 900

4.2 FORCE CALCULATION

TRIMMING OPERATIO

- Total length of cut, L =440 mm.
- Sheet thickness, t = 0.6mm.
- Tmax = 275 N/mm2
- Total cutting force = L x t x Tmax
- Total cutting force = 440 × 0.6 × 275
- Total cutting force = 72600 N
- Stripping force = 15% of the cutting force= 10890 N

FLANGING OPERATION

- Flanging force =1/2 * S * L * t
- L= Length of periphery to be flange in mm
- t= Sheet thickness in mm
- S= Tensile strength
- L= 402mm
- S= 366MPa
- t= 0.6mm
- Flanging force = 44139.6N
- Pad force = 0.67*S*L*t = 0.67*366*402*0.6
- Pad Force= 59147.064 N

5. SIMULATION RESULT IN AUTOFORM

After designing the model, the model are analysed in AutoForm software. The sheet metal operation is carried out under computer aided software to ensure that the change in pad surface area is affecting the final product and change in pad force is seen or not.

It is essential to carry out the simulation in order to prevent practical tryouts. Tryouts are always costly and also time consuming instead if operation are simulated using computer adied engineering software.

It provides an opportunity to improve the design.

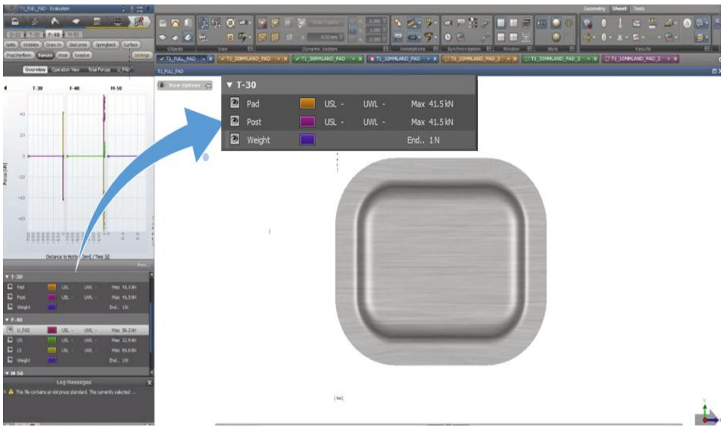

Fig -2: Pad force of 100% matching area of trimming operation in AutoForm

In order to find out the change in matching area affect the pad force in trimming and flanging sheet metal operation various number of matching area are take in simulation. Four matching surface area are take i.e. 100% ,60%, 30% &15%.

In Autoform input bending / trimming force & area of contact with gap control of 0.5mm take place. In fig 3. Show the result pad force of 100% matching area in trimming operation gives the value of pad force is 41.5kN.

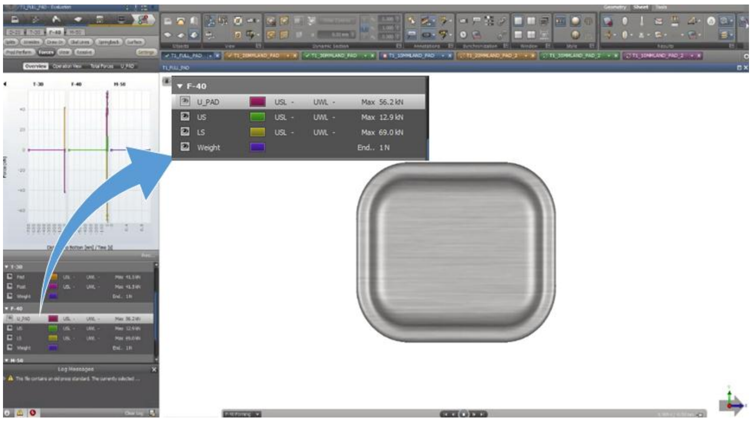

Fig -3: Pad force of 100% matching area of flanging operation in AutoForma

In fig 3 shows the value of pad force of 900 bending of 0.6 mm BH220 sheet with 100% matching or holding area gives the pad force of 56.2kN.Similarly three more results has taken out in order of 60%, 30% & 15% holding area of pad in both the sheet metal operation.

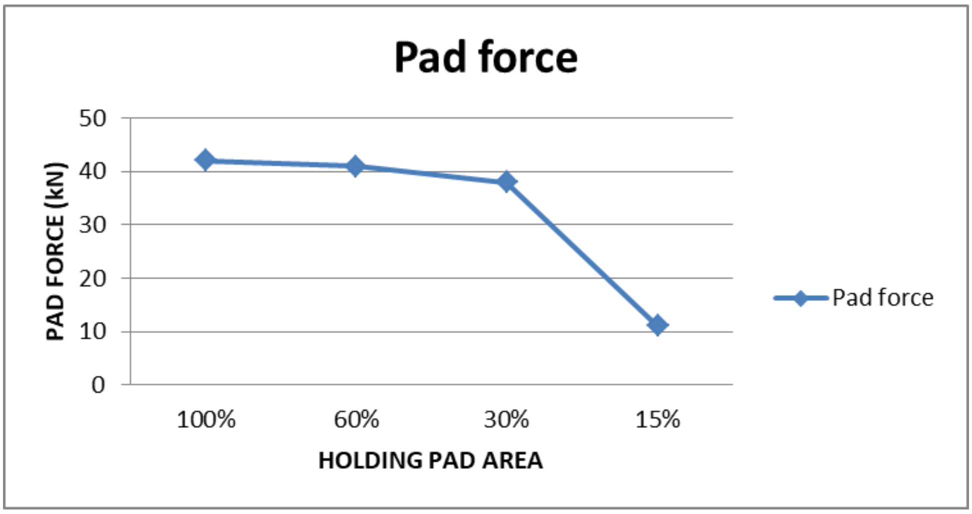

Chart -1: Effect of holding area on pad force in trimmimg operation

In AutoForm software change in the holding area simulation of flanging and trimming operation are carried out results are shown in fig.4 & fig.5.

In trimming operation minimum pad force are seen at 15% of holding area which is 10.5kN and for flanging operation the value of minimum pad force is 51kN at 30% of holding area in gap control.

The frictional coefficient is 0.14. The size of element is 0.3mm and number of initial elements is 4444.

In AutoForm software the gap control between upper pad and lower pad of the trimming operation and flanging operation are kept 0.5 mm.

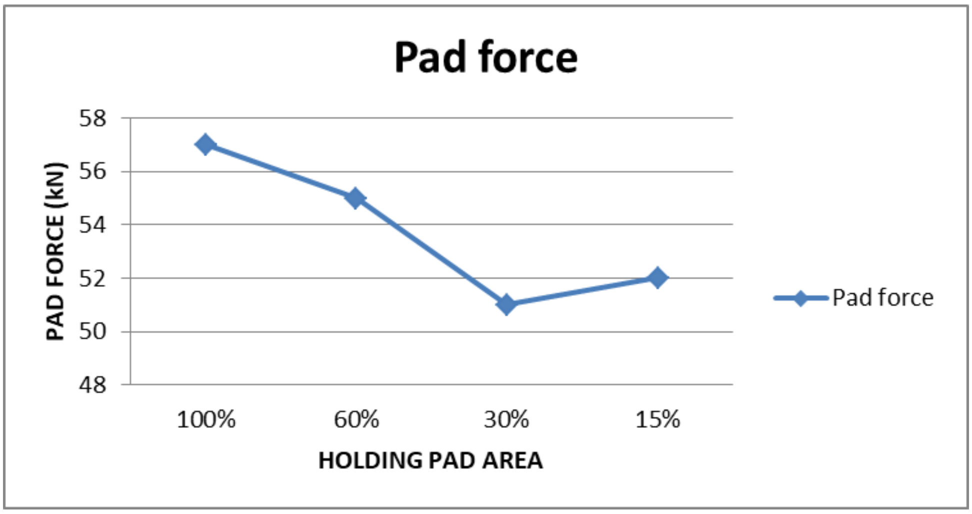

Chart -2: Effect of holding area on pad force in flanging operation

6. CONCLUSIONS

It seen in the simulation results the Pad force are changing with change in the matching surface or change in active or holding force. As we seen in Trimming Die the stripping force is come less in calculation then in simulation software. As reduction in the matching surface in Trimming operation Die reduce the stripping or holding force. In Trimming Operation the pad force or Stripping force is less at 10% of the matching surface.

It also seen in simulation of pad force of the Flanging Operation are changing with change in the matching surface. The pad force is decrease as matching surface is decrease at some point after that we see increase in pad force. In Flanging operation the minimum pad force are seen in the 30% of the matching surface. As decrease the surface area the surface manufacturing cost and time also saved.

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