A Review: Effect of Various Potential Parameters on Shearing Processes

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***Abstract* - Shearing is one of the oldest process of metal cutting without melting, oxidation and formation of amorphous material. They can be divided in to blanking, wedge action cutting, tearing and breaking. The sheet metal cut and deform in downward direction and cut may be straight or curve as per requirement. There are various parameters which are included in any shearing process. The process of identifying process influencing parameters of various shear processes and their effect on shear force, sheared edge geometry and surface quality are observed and also various optimization method s for eliminating the adverse effect of such potential parameters are identified by different authors which is included in this review paper.**

***Index terms* - Shearing, potential parameters, sheared edge geometry, surface quality, shear force, optimization**

I .INTRODUCTION

Shearing is a oldest method of cutting of sheet metal in a straight line without the generation of chips and without melting or oxidation. So it is basically sheet metal cutting. The most cutting methods are performed by the application of shear force so that it called shearing. When shear force is applied, shear stress in the material will go beyond the ultimate shear strength and the material will break and separate at the cut location. This shearing force is given by two tools, one above and one below the sheet material. Tools can be die and punch assembly or pairs of blades one is upper blade and one is lower blade. The tool above the sheet delivers a speedy downward blow to the metal sheet that rests over the lower tool. The cut may be straight or curved [1].

II. PRINCIPLE

There are wide machines for performing shearing sheet metal from snips to static and portable power machines. But the principle remains same for the snips as well as for power machines is the, Shearing action of a moving blade in relation to a fixed blade [2].
The standard type of bench shear and all guillotines are used for straight line cutting in which principle is remain same that is , one blade is fixed(bottom) and another blade is moving(upper) which is inclined and brought down to meet the fixed one [2].
Following is diagram showing basic principle of shearing.

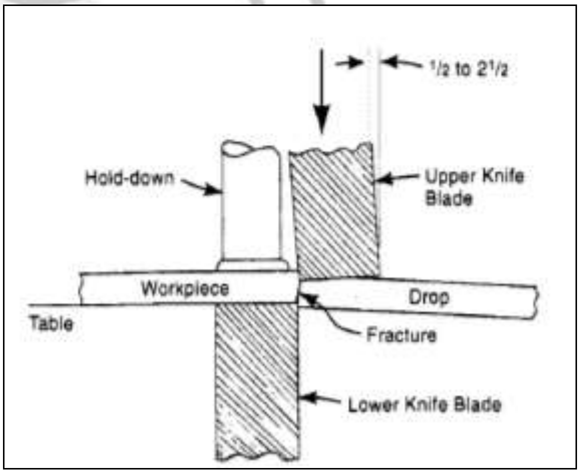

Fig-1 shearing principle

The moving cutting member is commonly actuated by:
1. Hand lever.
2. Foot treadle.

III. VARIOUS SHEARING PROCESSES [1]

A. Nibbling

It is a sheet metal operation in which a long cut is made by punching a series of overlapping holes or slits in the work piece.

B. Slitting

It is a shearing operation that divides sheet or coiled sheet metal into narrower widths.

C. Blanking

This is the operation carried out on presses and consists of cutting the outside contour of a stamping. Punching-This is also a press operation and consists of cutting holes of various shapes in sheet etc. Generally it is continuous operation.

D. Trimming

It consists of removal or cutting away of excess material left around the parting lines in the previous operations. Trimming is similar to blanking and is done in special type of trimming dies.

E. Notching

This is the operation of removal small amount of metal from the edges of work pieces by the notching action usually obtained with the help of a nibbler.

F. Lancing

It is special form of piercing operation.

G. Broaching

In this cutting is carried out series of stepped cutting edges. For consecutive shearing of hole or contour with accuracy it is used

H. Burnishing

This is smoothing operation which can be carried out with compression or friction or both. Sometimes It is called shaving.

I. Dinking

Flat hard wood platen is used for the cutting or piercing of any shape.

IV. STEPS IN SHEARING PROCESS

Step-1- As the top cutting member is moved downwards and brought to bear on the metal with continuing pressure, the top and bottom surface of the metal are deformed.

Step-2- As pressure increases, the internal fibres of the metal are subjected to deformation. This is plastic deformation prior to shearing.

Step-3- After a certain amount of plastic deformation the cutting members begin to penetrate. Uncut work hardens at the edge.

Step-4- Fracture begins to run into the work hardened metal from points of contact of the cutting members. When these fracture meet, the cutting member penetrate the whole of the metal thickness [1-2].

V. LITERATURE REVIEW

The Process of identifying process influencing parameters of various blanking process includes an in-depth literature review of the factors that have been suggested by various authors. It is collected from various journals, popular research related sites and various free articles from different sources.

H. P.Weaver and K. J. Weinmann evaluated stages of sheared edge creation and effect of blade gap and dullness on sheared edge using micro hardness scanning techniques. *AISI 1020* hot rolled steel is used. Minimum work hardening and sharp blade caused edge cracking. Removal of the severely work hardened material of the sheared edge will abolish edge cracking [3].

S.K. Maitia et al. studied clearance of tool, friction, thickness of sheet, size of punch and die and layout of blanking on the sheet deformation on mild steel thin sheet. The punch load variation with the help of stress distribution and tool travel in the sheet has been obtained.

The results indicate that a tool clearance reduction causes in increase in blanking load. The coefficient of friction is also increased with an increased in blanking load. These considerations are very similar to the case of blanking of component of large size. Twice inter blanking site distance is also play important role in the sheet thickness reduction and the thinning of sheet at the intermediate regions between the two blanking sites for a particular sheet thickness [4].

Ming Li presented the effect of sharpness, clearance, and cutting angle on Micromechanisms of distortion and rupture on aluminum alloy sheet. It is found that the localization zone is obtained for the conventional 0^0 cutting and does not extend from upper blade tip to the lower blade tip. However, the straight localization zone appears for angled cutting and does extend from the top blade tip to the bottom blade tip. This explains the burr formation mechanism and profiles of cut surface as well as the emergence of the secondary burnish areas. It is noticed that for aluminum alloys cracks initiate and propagate well ahead of the moving blade tip nonetheless of the blade sharpness. Following the development and propagation of the localization zone, the initiation, growth and coalescence of micro voids occur ahead of the macroscopic crack tip [5].

R. Hambli investigated the effect of the interaction between the the wear state, clearance and the thickness of the sheet on the evaluation of the blanking force and geometry of the sheared edge and profile after sheared. He has chosen DOE for analyzing described process. It indicated that maximum shearing force, the angle of fracture and the surface depth after fractured are influenced by the material condition and geometric characteristics of the tool [6].

R. Hambli et al. evaluated the blanking process and structure of the blanked surface. And saw that it is influenced by both the tooling (clearance and tool geometry) and properties of the work piece material (blank thickness, mechanical properties, microstructure, etc.). The objective of the present work is to develop a methodology to obtain the optimum punch-die clearance for a given sheet material by simulation of the blanking process [7].

Ridha Hambli presents industrial software called BLANKSOFT for sheet metal blanking processes optimization. The code allows for the forecast of the geometry of the sheared profile, the mechanical state of the zone of shear, the height of the burr, wear evolution of the punch versus the number of the blanking cycles and the force–penetration curve. The approach is based on an original theoretical investigation formulated from plasticity theories. This program is designed by considering diverse points, such as material and geometry of product as well as the wear state of the tool. The numeral results obtained by the proposed programs were compared with experimental ones to justify the credibility of the proposed software [8].

R. Hambali et al. presented an experimental consideration into the blanking process using tools with four different wear states (wear radius 0.01, 0.06, 0.012, 0.2 mm) and four different clearances (5%, 10%, 15%, 20%). The aim was to study the outcome of the interaction between the clearance, the state of the tool wear and the thickness of the metal sheet on the evolution of the blanking force and the geometry after sheared. This investigation shows that for minimizing the blanking force, the clearance should be set at 10%, however, and for minimizing the angle of fracture and the fracture depth, it is preferable to set the clearance at 5%. When the clearance is set at 10%, the process is slightly harder to tool wear, as far as the blanking force reaction is concerned. Whether clearance should be set at 5% or 10% eventually depends on the first concern of the practitioners [9].

Nobuo Hatanakaet et. al. presented the Numerical simulation of the blanking process of metal sheet, i.e. the development of rollover, surface of burnish and burr, is done using a rigid–plastic finite element code proposed by the authors. The Jeong expression is considered for the ductile fracture criterion and is tied-up with the simulation. The length of rollover increases as the clearance between the punch and die increases, and material n value increases. On the other hand, the length of burnish increases as the clearance decreases and the material *n*-value decreases. The height of burr increases linearly correlation with respect to the radius of edge tool. A traditional simulation method is suggested that predicts the formed burnish length from the clearance and *n*-value of material. To assert the results of the finite element simulation, blanking experiments were also carried out using metal sheet of 3mm thickness under various clearances and for different materials. The experimental results show good accordance with the finite element simulation results [10].

R. K. Guduru et al. evaluated mechanical properties using shear–punch testing of mild steel, pure Al, Zn, brass, Al 6061, Austenitic and Martensitic stainless steels. A new method using 1% offset criterion in co-occurrence with normalized shear–punch curves was used to determine the shear yield strength. A linear association between the shear data and tensile data was fixed for yield and ultimate strengths. The distinction of the yield and ultimate shear strength was investigated as a function of the thickness of sample and clearance of die–punch for soft, medium and high strength materials [11].

T.B. Hilditch and P.D. Hodgson conducted Trimming experiments on metal sheet with two drawing steels, an aluminum alloy and a magnesium alloy with the help of specially designed die in a mechanical press. The punch-die clearance was differ and data obtained on the rollover and height of burr as a function of the clearance. Specimen was also partially trimmed to study initiation of crack, the generation of the fracture surface profile and mechanism of formation of burr. The results showed that while the height of burr and depth of rollover generally increased with increasing clearance for all studied materials, there were contrast in the fracture surface profile shape, the shape of burr, and the mechanism of formation of burr, between the two steels and the two light alloys. The major cause of these differences appeared to be the rate of propagation of crack through the sheet material [12].

Emad A and Ibrahim Rawabdeh presented Finite Element Method and Design of experiments in the Optimization of Sheet Metal Blanking Process by considerating the effect of potential parameters influencing the blanking process and their interactions like the material type, thepunch-die clearance, the thickness of the sheet and theblank holder force and their interactions on the geometry of the sheared edge especially the burrs height The process signatures shows that the material types as well as the geometric characteristics of the tools and their configuration influence the burrs height of the sheared edge[13].

Xin Wuet et. al .studied the Characterization of sheared edges of dual phase steels advanced high strength steels are usually sensitive to edge cracking during sheet metal forming. In this study mechanically sheared edges were characterized for three different dual phase steels (DP600, DP780 andDP980), sheared with three various die clearances (5%, 10%, 15%) and along rolling and transverse directions. Microstructures of the materials were provided first, and then the sheared edges were examined by OM and SEM that betray the morphology and random rupture of the sheared edges. A factorial analysis was experimented to unveil the general trends of the processing parameters on four edge zones [14].

Prof. T. Z. Quazi, and R.S.Shaikh studied the influence of parameters such as the type of material, the punch-die clearance, the sheet thickness and their interactions on the geometry of the sheared edge especially the height of burr. The blanking process optimization carried out by using Design of Experiment (DOE), Finite Element Method (FEM) with ANSYS Package, Simulation with ABAQUS-Explicit software, Blank soft Software and Neural Network Simulation in order to achieve the intended model objectives .They also concluded that There is no universal optimal clearance value for minimizing the blanking force, the clearance should be set at 10% and however, to minimize the angle of fracture, the depth and the burrs height; it is advisable to set the clearance at 5%. When the clearance is set at 10%, the process is slightly more robust to tool wear, as far as the blanking force response is concerned, whether clearance should be set at 5% or 10% [15].

T.Z.Quazi et al. have studied the blanking process optimization and presented the outcome of clearance, thickness of sheet and material this inspection shows that, in order to diminish the burrs height, the clearance should be set at 5 % with almost no blank holder force. The presented investigation of the blanking process makes it possible to predict optimum process parameters. It is viable to reduce the lead-time by using Taguchi Methods and Design of Experiment technique in the design process, where computer software can replace many time consuming experiments [16].

J. A. Soares et al. evaluated the effect of punch–die clearance impact on the sheared edge quality of thick sheets. The aim was the study of the clearance effect on the punched holes quality, 8 mm LNE38 metal sheet. Clearances of 0.2% up to 15% between the punch and die were investigated.
The impact of the punch–die clearance on the propagation of crack was also analyzed, i.e., good results for gaps within the traditional ideal range and occurrence of burr for clearance of 15% [16].
Rahul B. Lahoti and **Nitin G. Phafat**(2014) presented the optimization method for blanking parameters for AISI 1018 and AISI 202 steel sheets using ANFIS.
In another paper they optimized blanking parameters of AISI 1018, A 653, AISI 304 Using Genetic Algorithm. The main objective of the process design in metal blanking are choose the leading process parameters in an optimal way to ensure high quality parts. Design of experiments is a tool for increasing quality of the process by eliminating causes of variation without eliminating causes. Experimentation is carried out with the help of DOE by full factorial method. The aim of the study is to examine effect of the sheet thickness and
punch stroke on different materials. GA optimization technique used to optimize process parameters [17-18-19].

VI. SUMMARY

Shearing is the one of the oldest and reliable method for sheet metal cutting operation. There are various method and operations which is called shearing methods for sheet metal cutting.
There are some potential parameters which can be different as per methods like clearance, sheet metal thickness, sharpness and dullness blade, type of tool material, type of work material, cutting angle which can be effect shear force, sheared geometry, quality of the finished part, cost and ultimately reputation of particular manufacturer, so to overcome this kind of problem various authors have suggested some optimization techniques so that we can eliminate adverse effect and do the work with quality.

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