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OPTIMISATION OF BLANKING PARAMETERS FOR AISI 1018 AND AISI 202 STEEL SHEETS USING ANFIS

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Abstract— ***Blanking is sheet metal cutting operation mostly used in industrial sector. A part is cut between punch and die in a press machine means of physical process called shearing operation. The first step in this operation is that cutting the sheet in appropriate shape with maximum shear zone and minimum burr height. General guidelines for process are available but it is not sufficient to overcome difficulties in designing the blanking process. Designing of blanking process is mostly depends on experimentations and trial-error iterations. It is very costly and time consuming. Aim of the designer is increase the quality of the product with minimum cost. In this paper, Design of Experiments (DOE) is used for proper combinations of the process parameters. Optimization of the process is done with the use of Artificial Neural Fuzzy Interface System (ANFIS)***

Keywords— blanking, optimization, ANFIS

INTRODUCTION

Blanking is a widely used process in sheet metal components. It is a cutting operation material cutting in punch and die interface. Blanking is a cutting process in which a piece of sheet metal is removed from a larger piece of stock by applying a great enough shearing force. In this process, the piece removed, called the blank, is not scrap but rather the desired part. Among the shearing processes blanking is one of the most frequently used due to its reliability and capability of mass production. Sheet metal forming processes like blanking, stamping and bending are very commonly used in the manufacture of sheet metal parts and it takes a combination of different processes to manufacture sheet metal parts. Blanking is metal shearing processes in which the incoming sheet material is sheared to a desired shape. In blanking, the removed piece of material is the product. Blanking is one of the processes in which the sheet undergoes severe deformation since the sheet metal is sheared or separated to have the slug and part. The sheet material in between the punch and die undergoes very high deformation and is sheared as the punch penetrates the sheet material with velocity As shown in figure, blanking process consists in a metal sheet positioned over a die in which a punch passes through to plastically deform the metal until a crack propagates and leads to complete separation of blanked part. The sheared/blanked edge is made of different zones based on material deformation that has occurred. The ratio of the different zones is influenced by parameters like the punch-die clearance, punch stroke, sheet thickness of the material and sheet material properties to name a few. A large shear zone and small rollover and burr are generally preferred in the blanked part.

DESIGN OF EXPERIMENT (DOE)

Designed experiments are a systematic approach to optimizing process performance; they are also used for knowledge acquisition. Traditionally, the setting of a single factor is changed at a time until the response is improved. This one-factor-at-a-time approach is inefficient because no measures of interactions between the factors are available, and because the accuracy of the effect estimates is usually poor. In manufacturing are DOE is very useful technique for experimental investigations. Experimental design is a powerful approach for product development. In this research, A statistical technique, General Full Factorial Design (GFFD), Factorial Design has been employed to investigate the effect of blanking parameters on shear zone and burr height.

Influence of Sheet thickness (ST)

The sheet thickness of blanked part is directly effect on shear and fracture zones of blanked part. In general various blanked parts are not same thickness it is vary as per the requirement. Clearance between punch and die is depends upon the sheet thickness of the material. Clearances are varying as per the requirement of product.

Influence of Punch stroke (PS)

The stroke length of a press machine is selected depending on the details of the job at hand. In blanking formation, the stroke length is short being on the order of 10 to 90mm. It is necessary to select the stroke length taking care about the formed height of the product. In sheet metal cutting operation compressive and tensile forces are created in work piece and these lead to deformation in order to balance out tensions in sheet, punch stroke is varied. Too long or to short stroke length decreases the working efficiency. To short stroke, there are the problems that it is difficult to see inside the die and that is difficult to take out the product. Stroke length is always more than 2.5-3 times of sheet thickness. A punch stroke length of more than three times the product height can be said to be a safe stroke length.

Influence of Material (MT)

Material is the important criteria in blanking operation because different materials have different mechanical and chemical properties so it directly affect on cutting of blanked part. To achieving excellent dimensional control, accuracy and repeatability material is important criteria. Different parts require different material as per their requirement so different types of materials are used in blanking process.

EXPERIMENTAL PROCEDURE

The problem studied here of a Blanking operation is metal sheet thickness of 1, 1.5, and 2mm. Mild Steel (0.18% C) and Stainless Steel 202 (0.15% C) was blanked using a 63 ton press machine. Die diameter is 132 mm and Clearance is ±0.02 mm which is constant. The design of experiments by full factorial method gives 9 no. of runs for experimentation.

Table 1 Experimental result

Sr. No.	Sheet Thickness	Punch Stroke	AISI 1018		AISI 202	
	(mm)	(mm)	Shear Zone (mm)	Burr Height (mm)	Shear Zone (mm)	Burr Height (mm)
1	1	30	0.5	0.27	0.2	0.64
2	1	60	0.55	0.29	0.3	0.44
3	1	90	0.6	0.28	0.4	0.28
4	1.5	30	0.7	0.2	0.3	0.35
5	1.5	60	0.7	0.18	0.4	0.29
6	1.5	90	0.9	0.16	0.5	0.16
7	2	30	0.9	0.1	0.4	0.11
8	2	60	1	0.1	0.5	0.1
9	2	90	1	0.11	0.5	0.02

MATHEMATICAL MODELING

Mathematical modeling is done by using regression analysis in Minitab 16 software.

Regression analysis

AISI 1018

The regression equation is

Shear zone = 0.0028 + 0.417 sheet thickness + 0.00222 punch stroke

Table 2 Regression analysis of AISI 1018 for shear zone

Predictor	Coef	SE Coef	T	P
Constant	0.00278	0..6695	0.04	0.968
sheet thickness	0.41667	0.03622	11.50	0.000
punch stroke	0.0022222	0.0006036	3.68	0.010
S = 0.0443576		RSq = 96.1%		RSq(adj) = 94.7%

he regression equation is

Burr height = 0.459 - 0.177 sheet thickness - 0.000111 punch stroke

Table 3 Regression analysis of AISI 1018 for burr height

Predictor	Coef	SE Coef	T	P
Constant	0.45944	0.02198	20.91	0.000
sheet thickness	-0.17667	0.01189	-14.86	0.000
punch stroke	-0.0001111	-0.0001982	-0.56	0.595
S = 0.0145615		R-Sq = 97.4%		R-Sq(adj) = 96.5%

AISI 202

The regression equation is

Shear zone = - 0.0278 + 0.167 sheet thickness + 0.00278 punch stroke

Table 4 Regression analysis of AISI 202 for shear zone

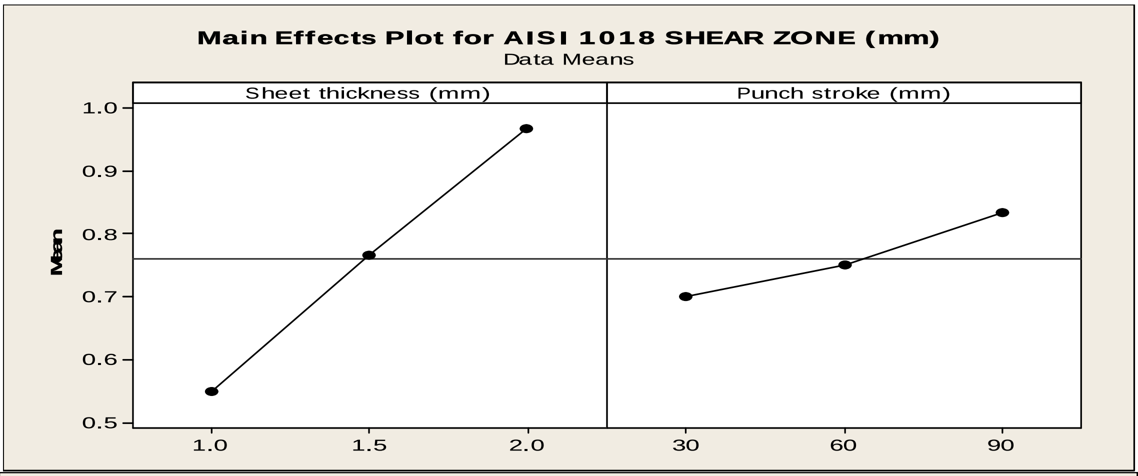
Predictor	Coef	SE Coef	T	P
Constant	-0.02778	0.04592	-0.60	0.567
sheet thickness	0.16667	0.02485	6.71	0.001
punch stroke	0.0027778	0.0004141	6.71	0.001
S = 0.0304290 R		Sq = 93.8% R		Sq(adj) = 91.7%

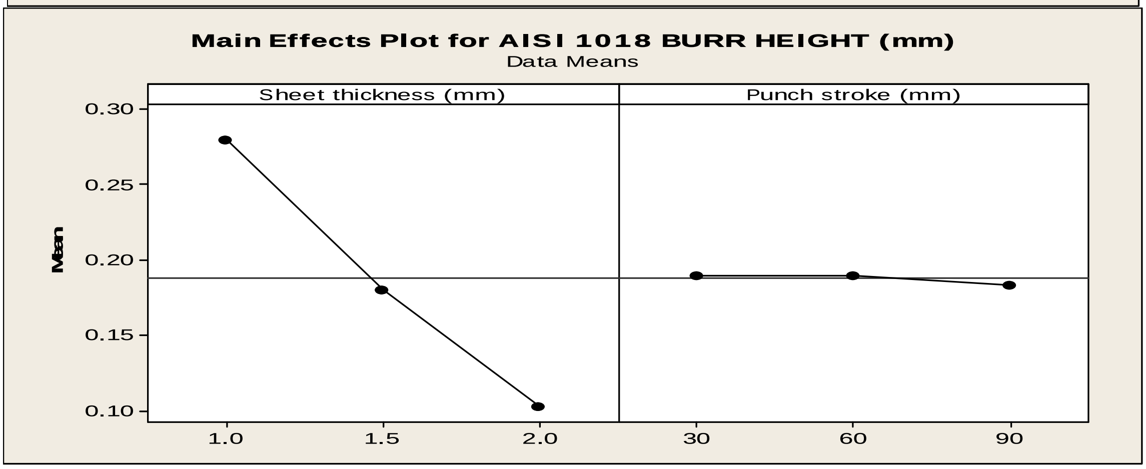
The regression equation is
Burr height = 1.04 - 0.377 sheet thickness - 0.00356 punch stroke

Table 5 Regression analysis of AISI 202 for burr height

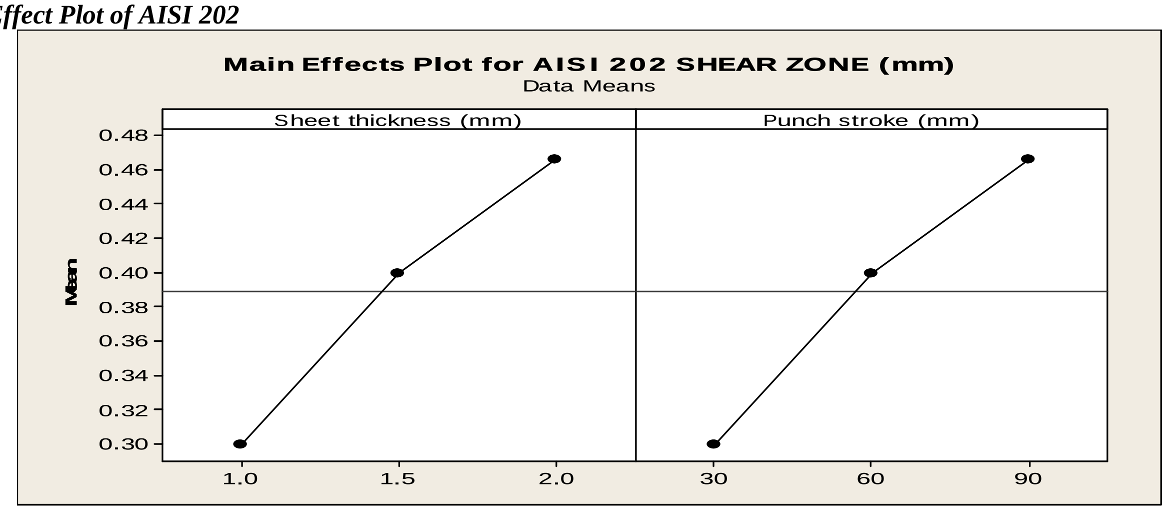
Predictor	Coef	SE Coef	T	P
Constant	1.04389	0.08830	11.82	0.000
sheet thickness	-0.37667	0.04777	-7.88	0.000
punch stroke	-0.0035556	0.0007962	-4.47	0.004
S = 0.0585077	R-Sq = 93.2%	R-Sq(adj) = 90.9%		

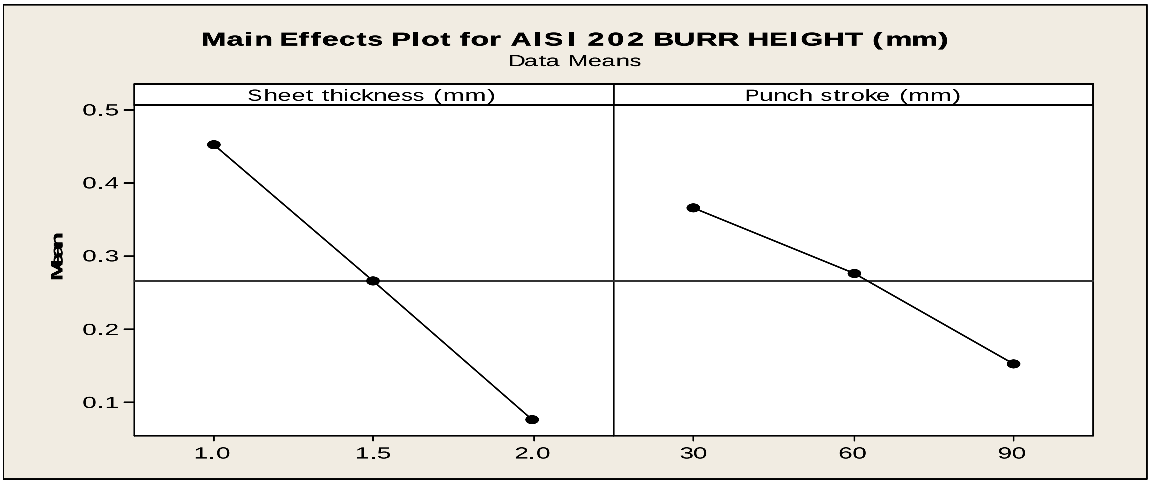
Main Effect Plot of AISI 1018





Main Effect Plot of AISI 202





OPTIMIZATION

Process parameters optimization is done by using Artificial Neural Fuzzy Interface system (ANFIS) in Matlab. The acronym ANFIS derives its name from adaptive or artificial neural fuzzy inference system. Using a given input/output data set, the toolbox function anfis constructs a fuzzy inference system (FIS) whose membership function parameters are tuned (adjusted) using either a backpropagation algorithm alone or in combination with a least squares type of method. This adjustment allows your fuzzy systems to learn from the data they are modelling. The basic structure of the type of fuzzy inference system seen thus far is a model that maps input characteristics to input membership functions, input membership function to rules, rules to a set of output characteristics, output characteristics to output membership functions, and the output membership function to a single-valued output or a decision associated with the output. It considered only fixed membership functions that were chosen arbitrarily. The ANFIS approach learns the rules and membership functions from data. ANFIS is an adaptive network. An adaptive network is network of nodes and directional links.

Rule viewer for predicting shear zone

Rules for predicting output is developed by the system. Fig. 1 shows the rules of predicting the shear zone.

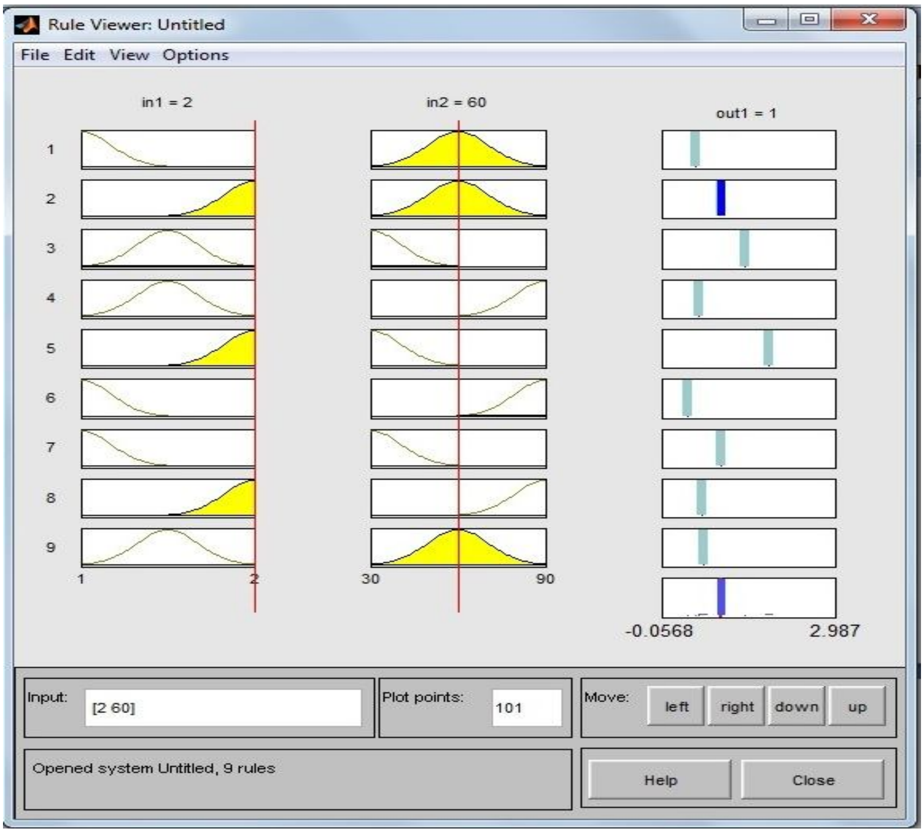


Fig. 1 Rules for predicting shear zone.

Rule viewer for predicting burr height

Rules for predicting output is developed by the system. Fig. 2 shows the rules of predicting the burr height.

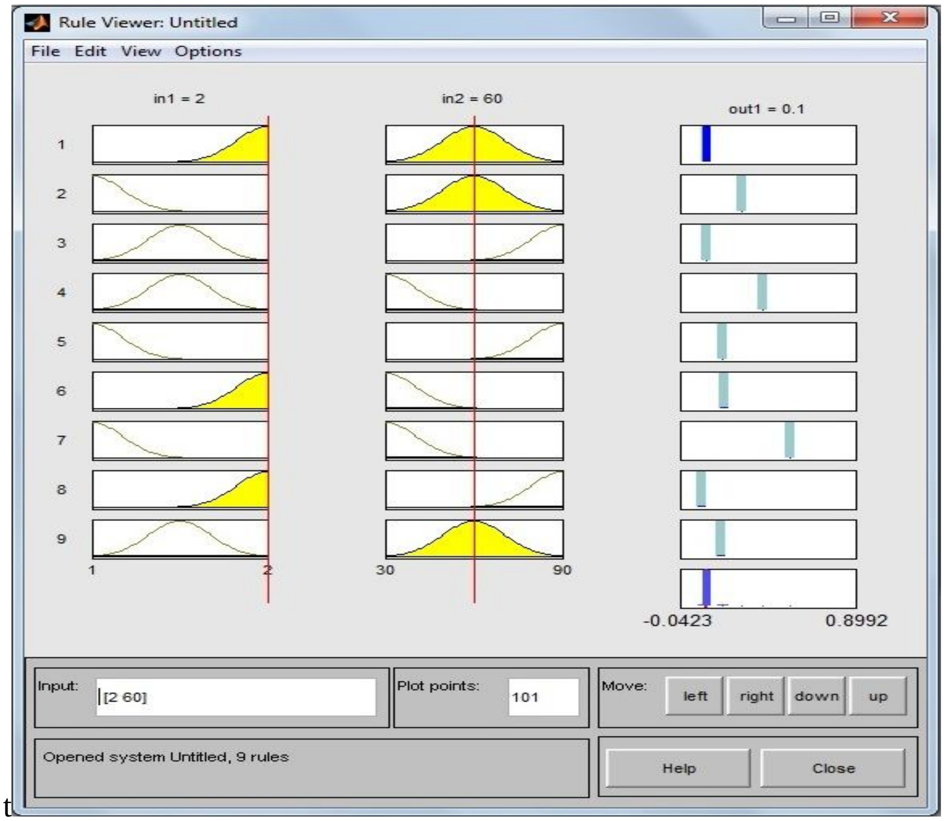


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Fig. 2 Rules for predicting burr height.

RESULT AND DISCUSSION

The experimental investigation into the blanking operation makes it possible to study the effect of the sheet thickness and punch stroke on parameters of blanking process. In this experiment we study the effect of the sheet thickness and punch stroke on shear zone and burr height of the blanked part. Maximum shear and minimum burr leads to the quality of blanked part. The investigation shows that sheet thickness is very important parameter in blanking operation. As the sheet thickness of the material increases shear zone increases and burr minimizes of the blanked part. Punch stroke is also critical parameter in blanking operation. In sheet metal cutting operation compressive and tensile forces are created in work piece and these lead to deformation in order to balance out tensions in sheet, punch stroke is varied. Too long or to short stroke length decreases the working efficiency.

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