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Research Paper

NUMERICAL SIMULATION AND OPTIMIZATION OF PUNCHING PROCESS PARAMETERS

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An approach for improving the quality of the product comes out from punching process, with the help of numerical simulation and analysis of punching process parameter. In this study, the significance of three important punching process parameter namely thickness of sheet, hardening exponent of material, velocity of punching tool are the punching process characteristics of material (SS303) sheet was determine. For this study the combination of ANSYS analysis and DOE methodology was used to determine the influence of the parameter as well as determine effect of stress and strain on work piece and generate the ideal model equation for both stress and strain to getting a first time good quality product.

Keywords: Blank sheet (SS303), Punching process, DOE methodology, ANSYS Analysis

INTRODUCTION

Most of the structure manufacturing industries use sheet metal forming process to produce the different type of different type of structure body part. In a sheet metal forming process a thin blank sheet is subjected to plastic defamation using different types of forming tools to get the desired shape of structure. For getting a good quality of the product the parameter like Deformation temperature, die diameter, punch diameter, velocity of punching tool, hardening exponent of the material, coefficient of the friction, etc., generally influence the product.

Hence for getting the better quality of the product it is essential to determine the degree of influence of the process parameter on the formability in order to optimize the appropriate condition to maximize the formability. Hasnulhadi Jaafar, Ken-ichiro Mori, YoheiAbe *et al* studied for an approach for correcting the eccentricity in slight clearance punching of ultra-high strength steel sheets having low ductility was developed to improve the quality of sheared edges of punched holes. In this process, a moving die was employed in order to correct the eccentricity between the punch and die and to ease the setting of tools. The gap between the die and holder allowed the eccentric die to move, and thus the die became concentric after several strikes. For the moving die, the depth of the shiny burnished surface on

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the sheared edge increased and that of the rough fracture surface decreased. It was found that the application of moving die in slight clearance is indispensable for high quality punching of ultra-high strength steel sheets. Kutty Santu Kaity, Arun Kumar *et al.* studied Creep behavior of U-6%Zr alloy in the t curves at 575°C for various stresses are not smooth penetration of the punch which is followed by decrease for the above temperature also show a random behavior of SEM and EDX to understand this phenomenon. At c very long time to complete the reaction.Hence, there from the supersaturated α-phase.PurwoKadarno, Ken-ichiro Mori, Yohei Abe, Tatsuro Abe *et al*. studied that the fatigue strength of a punched high strength steel sheet having 590 MPa in nominal tensile strength was improved by thickening a hole edge by means of flanging using a step die and round corner punch. The sheared edge was thickened by flanging, and then was compressed with the corner step of the die. The quality of the sheared edge for the thickened punched sheet was improved by ironing with the round corner of the punch during the thickening process. It was found that the fatigue strength of the punched sheet with thickening was larger than that without thickening because of the increases in the thickness, surface quality and hardness in the sheared edge. Hasnulhadi Jaafar, Ken ichiro Mori, Yohei Abe *et al.* studied for an approach for correcting the eccentricity in slight clearance punching of ultra-high strength steel sheets having low ductility was developed to improve the quality of sheared edges of punched holes. In this process, a moving die was employed in order to correct the eccentricity between the punch and die and to ease the setting of tools. The gap between the die and holder allowed the eccentric die to move, and thus the die became concentric after several strikes. For the moving die, the depth of the shiny burnished surface on the sheared edge increased and that of the rough fracture surface decreased. It was found that the application of moving die in slight clearance is indispensable for high quality punching of ultra-high strength steel sheets. Ken-ichiro Mori, Tomoyoshi Maeno, Takuya Suganami, Masato Sakagami *et al.* studied for Hot semi-punching of a quenchable steel sheet was carried out to eliminate laser cutting conventionally used for hot stamping of ultra-high strength steel parts. A quenchable steel sheet is semi-punched without separation of punching scraps during hot stamping, and subsequently, the scraps are removed from the hot-stamped part at room temperature. Additional channels for taking punching scraps out of dies are not required. Minimum remainder without detachment of punching scraps and no clearance between the die and punch were optimal for the hot semi-punching process. The hot punching and cold removing Loads of the quenched sheet were considerably smaller than the cold punching load, the quality of the hole edge was high and the delayed fracture around the sheared edge was prevented.

In this present work, a statistical numerical approach based on DOE and ANOVA methodology was adopted to determine degree of influence of the process parameter, a total 20 test were carried out to check the individual influence of stress and strain on the sheet by all three parameter with the help of the ANSYS software.

LITERATURE REVIEW

Patrick Worle studied that it is growing need for the engineer to developed an method for the

reinforced concrete structure by which shear capacity of the punching process increase for the flat slabs as well as for the concrete rods, And the current structural solution facing many of the technical and the economic problems. The main of the current study is to develop new structural model for increase in the shear punching capacity of the punching process.

Mohamed Achouri, Guenael Germain, Philippe Dal Santo *et al.* studied that there is accumulation of the work hardening and the damage of the work sheet due to the sequential sheet forming process. Mechanical strength of the final product depends upon the above two characteristics. And the punching process have much more effect on the stress an and the strain in the initial of the production chain, which damage the product in the punching zone, and it is very much important to take the influence of this sequential machining process. For the evaluation of the punching process parameters, it is very much necessary to characterize each and every process parameters.

Todor Vacev, Zoran Bonic, Verka Prolovic, Nebosja Davidovic, Dragan Lukic *et al.* studied that finite element analysis and the many simulation software will tremendously use in the analysis of the structural behavior of the material. This paper studied for the analysis of the behavior of the concrete column footing on the concrete slabs and the subgrade is loaded until the failure occurs. The finite element analysis and the 3 dimensional nonlinear analysis was projected in the Ansys explicit dynamics 14.5. Field parameters and the data were used for the all parameter are properly calibrated. After the final simulation when the analysis data are compared with the experimental data, then it confined an good agreement in between both, but there are many question arises for the numerical simulation, FEM and the major problem regarding to the concrete crushing.

Benardo N Moraes Neto, Joaquim A O Barros, Guilherme S S A Melo *et al.* studied the aim of the contributing in the developed design capable for the prediction of the accuracy of the punching process parameters having fibre reinforcement concrete flat slabs. There are 154 experiment were performed for the analysis of the punching process parameters which result in the high accuracy in the result of the process output parameters. The proposal is capable of the detecting the load v/s rotation of the slabs. The CEB-FIP model is used for the modeling and the analysis of the post cracking behavior of SFRC, after the final simulation the result comes from the simulation data have best agreement with the experimental one.

METHODOLOGY

The punching process of blank sheet depend upon the process parameter like thickness of the blank sheet, Hardening exponent of the blank sheet material and velocity of punching tools. The appropriate thickness of sheet allows the smooth flow of material and reduce the material wastages, similarly the punch speed enhance the flow of material in to die cavity, hence we can say that the quality of the final product determine the degree of the influence of these parameter in the sheet metal punching process. The set of component used for punching operation and the

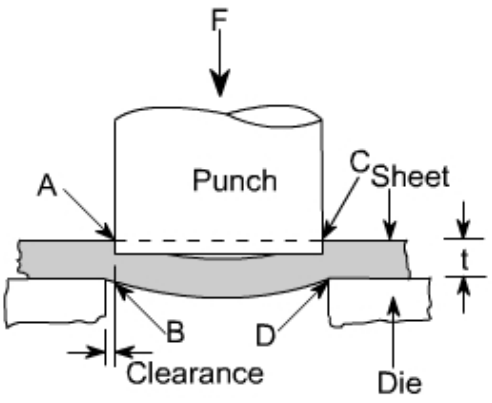
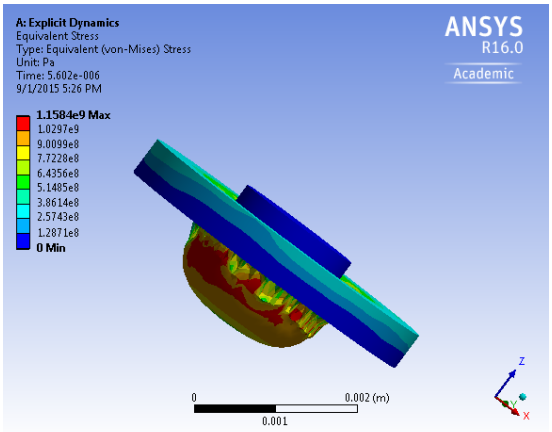
(a) Set of Component Used for Punching Operation	(b) Analysis Using ANSYS Software
	

Table 1: Process Parameter and There Level

Factors	Name	Low	Medium	High
A	Thickness (mm)	0.2	0.5	0.8
B	Hardening Exponent	0.30	0.35	0.40
C	Velocity (m/s)	150	175	200

analysis of using ANSYS software are shown in Figure (a) and (b) respectively.

The parameter and there level used for optimization of punching process parameter are shown in the given table.

Table 1 shows the chosen parameters and their levels used in the finite element simulation and with the help of DOE methodology, 20 no. of test were carried out to find the optimize parameter by using surface response methodology.

ANOVA ANALYSIS

RESULTS AND CONCLUSION

Numerical simulation for the punching process parameters is carried out in the present study, first of all the all the experiment were run in the Ansys Explicit dynamics for finding all the quality output as strain, and then for all of the experiment with their result Anova analysis is performed, now in the Anova analysis in the linear model it would found that thickness and the hardening exponent having the *P* value below 0.05, hence having the confidence interval of 95% , it means in the linear type of anova analysis the thickness and the hardening exponent are the factors which are responsible for finding the output, or the response is change by changing in the value of the thickness and the hardening exponent, similarly in the square anova analysis only thickness * thickness is the parameters responsible for finding the outputs, in the last thickness * hardening exponent and the hardening exponent * velocity having the value below than 0.05 , it mean they both are the factors which are responsible for finding the quality output, it is clear that by changing all the above parameters output which are stress and the strain are get changed, or the quality of the cold rolled product might increase or decrease by changing in the value of this process parameters.

Table 2: Anova Analysis

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	9	1055539	117282	69.23	0.000
Linear	3	764545	254848	150.43	0.000
Thickness	1	520045	520045	306.97	0.000
Hardening Exponent	1	242182	242182	142.95	0.000
Velocity	1	2318	2318	1.37	0.269
Square	3	257656	85885	50.70	0.000
Thickness*Thickness	1	175670	175670	103.69	0.000
Hardening expo* Hardening exponent	1	2643	2643	1.56	0.240
Velocity*Velocity	1	669	669	0.40	0.544
2-Way interaction	3	33338	11113	6.56	0.010
Thickness*Hardening exponent	**1**	**18258**	**18258**	**10.78**	**0.008**
Thickness*Velocity	**1**	**5793**	**5793**	**3.42**	**0.094**
Hardening exponent* velocity	**1**	**9287**	**9287**	**5.48**	**0.041**
Error	10	16941	1694		
Lack of Fit	5	16941	3388		
Pure Error	5	0	0		
Total	19	1072481			

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