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Design and Analysis of Blanking and Piercing Die Punch

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Abstract

The sheet metal working processes are widely used in almost all industries like automotive, defense, medical and mechanical industries. The major advantage for using metal working process is to improve production rate and to reduce the cost per piece. Nowadays many people are working for developing die punches with innovative ideas. This project is also based on new design for die punch. The project mainly focuses on different operations done on single setup of die punch in a single stroke, presently these operations are done on three separate setups which leading to reduce the production rate and increasing cycle time with cost as well. The theoretical calculations were done for calculating cutting force, tonnage required, Von-Mises stresses, fatigue life, buckling load and total deformation. The 3D parts are modeled in CATIA-v5 and saved in .stp file format so that it can be imported from any of the analysis software. As per the companies requirement cad drawings are drawn in AUTOCAD software. The various analyses like Von-Mises stress analysis, fatigue life, are carried out on Ansys 14.0 workbench analysis software and results are compared with theoretical results. The results are within 5% of allowable limit.

Key Words: Die punch, FEA, Ansys. Catia-V5,Autocad.

1. INTRODUCTION

Processing steps involved in sheet metal industries, and increased knowledge in this process will help to improve the process and help in increase the production range of industry. Now a day's sheet metal component are widely used in the day today life its ranging from household electrical component to big industries such as TV, camera, electrical ovens, computer as well as in automotive parts, aviation industries to reduce the cost as well as reduce the weight of the component and increase the performance of the product. Sheets with 0.2 to 20 mm thickness and higher are processed in industries depending on the requirement of customer or consumer or appl Forming processes like Piercing, Blanking, stamping and bending are very widely used in the making of sheet metal parts and it assembles different processes to manufacture sheet metal parts. Piercing and Blanking are metal shearing processes in which the input sheet material is sheared to a destination shape.

Types of Dies

The theory of sheet metal behavior kept as a backbone for the development of various kinds of dies which are differentiable through their function. In some of the dies, the sheet metal should be cut off from the strip and the remaining part is removed as a scrap.

Compound Dies

The die which undergone to more than two cutting operations like blanking and perforating etc. can be performed continuously in a single stroke. In compound die, the upper punch is connected to the ram comes in constant with metal and pierces the hold.

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Combination Dies

The die which undergone the cutting and forming operations are combined and carried out in a single operation. First blank is prepared in the die and then it is held by pressure pads and drawn. All this is achieved entirely within the die assembly by use of cam actuated punch and die members or by designing the die for use on a double action press which has two independent rams or slides on moving inside another.

Progressive Dies

In progressive dies, the work pieces move from the first station to successive which carries variable operations, to be performed in individual station. Each stations works in series manner and the work piece is placed in stock till at the end of station which cuts off finished piece. End of the each stroke, the stock is moving towards by one station and the complete work piece is constructed in a single stroke of ram.

Die Construction

The die set is the primary portion of every die construction. It made up of upper die and lower die both are machined in parallel in size. The portion of the die is provided with the shank which is used to clamp in the ram of the press. Both the upper die and lower die are aligned with the guide pins.

Problem Statement

The aim of this project is to reduce cycle time of existing process of milling, blanking and drilling operation for component. These all operations need be combined in a single setup of die punch with a proper tool design. The monthly volume of component is 4000 to 6000 nos. Hence company needs cycle time reduction and cost reduction as well on these hinges to meet global competition. The existing cycle time of operations is approximately 4 minutes..

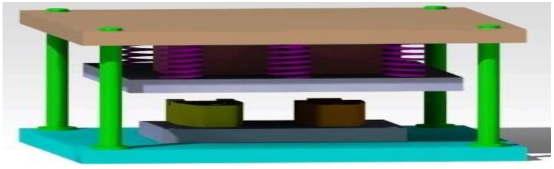

Fig -1.2 : 3D model of die punch

From Sheet Metal Forming Processes and Die Design

Blanking and punching dies are known as cutting dies. They may be simple, combination, or compound. A blanking die is generally cheaper to make and faster in operation than a trim die.

Blanking Services Information

Show all Blanking Services Providers Blanking is a manufacturing process where a punch and die are used to remove blanks in preparation for processing and finishing.

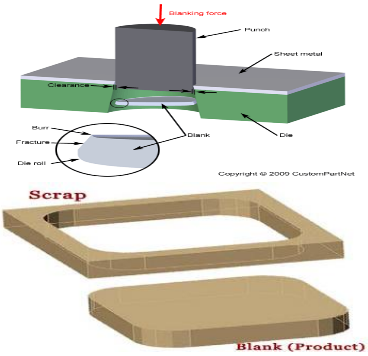

Fig 1.3: Blanking process. Blanking workpiece.

II. LITERATURE REVIEW

[1]Vishwanath M.C - The selection of any multi-operation tool, such as progressive die or combination Die , is justified by the principle that the number of operations achieved with one handling of the stock and produced part is more economical than production by a series [2]of single [3]operation dies and a number of handling for each single die[4] The tool wear curve obtained by Högman shows the relationship between tool wear and punch- die clearance[5].

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III. DESIGN OF DIE PARTS

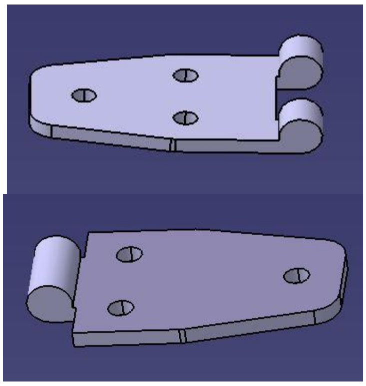

Fig -2.1: Component Model (Male and Female part)

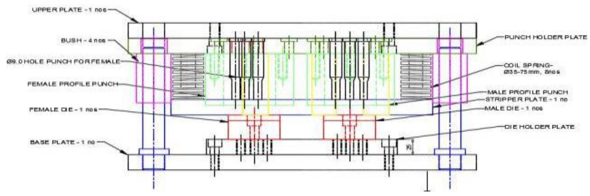

Fig -2.3: 2D Drawing of die punch assembly

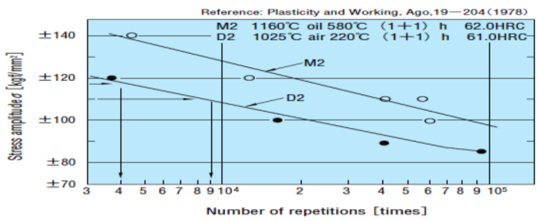

Fig-2.4: Fatigue characteristics of tool stee

Details	Specifications
Material	St-37
Thickness	6mm
Shear strength	320-350N/mm2
Tensile strength	370-450N/mm2

Table -1: Material Properties of component

Property	Value	Units
Young's Modulus	210000	N/mm²
Poisson's Ratio	0.3	-
Shear modulus	7900	N/mm²
Mass density	7700	Kg/m³
Tensile strength	1736	N/mm²
Compressive Yield Strength	2150	N/mm²
Yield strength	2150	N/mm²
Thermal Expansion Coefficient	1.04e.005	1/K
Thermal Conductivity	20	W/(m-K)
Specific Heat	460	J/(Kg-K)

Table -2: Material Properties of Die Punch material (D2 steel)

IV. ANALYSIS IN ANSYS

Analysis of Piercing punch

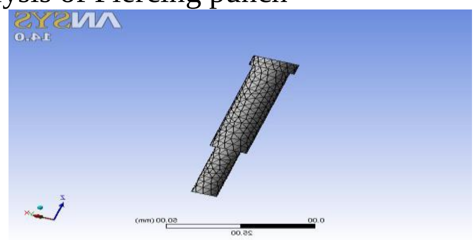

Fig- 4.1: Meshed model of Piercing punch.

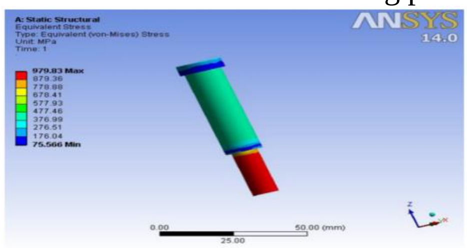

Fig- 4.2: Von-Mises stresses on piercing punch.

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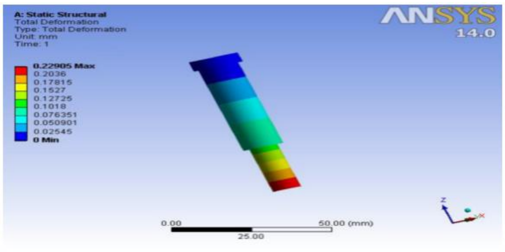

Fig- 4.4: Total deformation of piercing punch.

As shown in the analysis results, the minimum deformation is 0 mm at top of the punch and Maximum deformation is 0.2290 mm at the tip of punch.

As shown in the analysis results in fig 8, the minimum life is 250 cycles and Maximum life is 100000 cycles

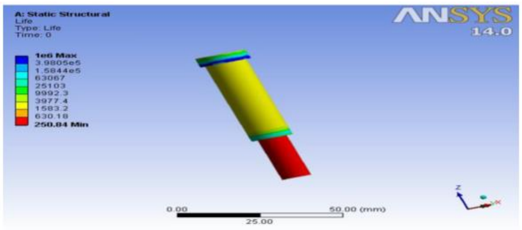

Fig- 4.5: Fatigue life of piercing punch

Analysis of slotting punch

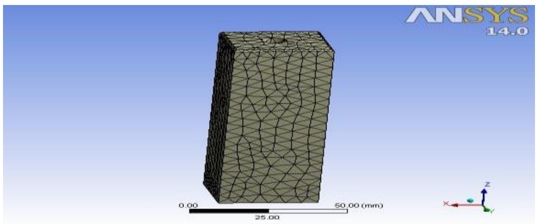

Fig- 4.6: Meshed model of Slotting punch.

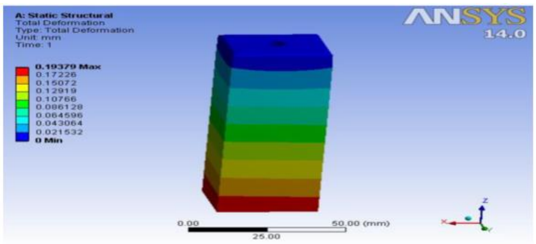

Fig- 4.7: Total deformation of piercing punch.

As shown in the analysis results, the minimum deformation is 0 mm at top of the punch and Maximum deformation is 0.1937 mm at the tip of punch.

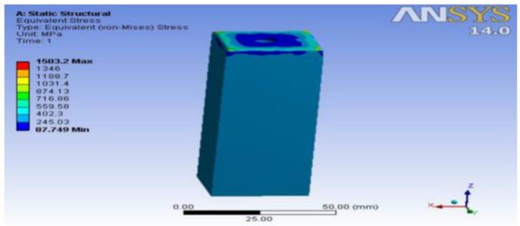

Fig-4.8: Von-Mises stresses on slotting punch.

As shown in the analysis results, the minimum Von-Mises stress is 87.749 Mpa and Maximum Von-Mises stress is 1503Mpa.

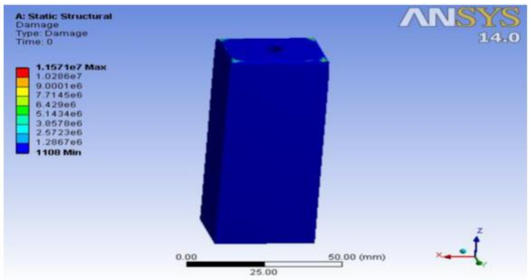

Fig- 4.9: Fatigue life of slotting punch.

As shown in the analysis results, the minimum life is 1108 cycles and Maximum life is 1.15e7 cycles.

Analysis of profile blanking punch

Fig- 13:

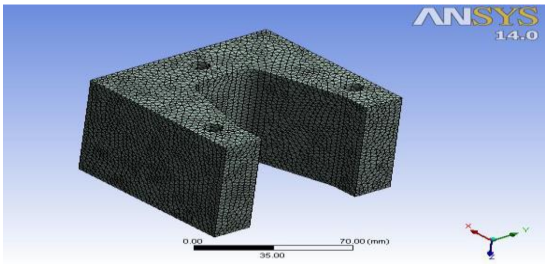

Fig- 4.10: Meshed model of profile cutting punch.

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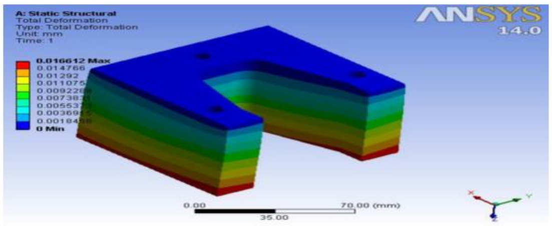

Fig- 4.11: Total deformation of profile blanking punch.

As shown in the analysis results, the minimum deformation is 0 mm at top of the punch and Maximum deformation is 0.01662 mm at the tip of punch.

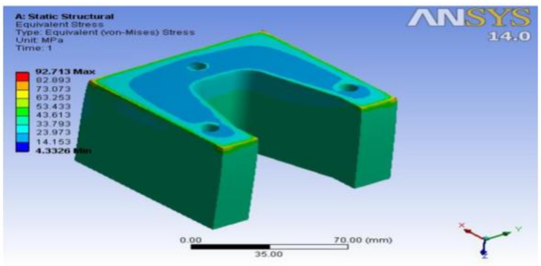

Fig- 4.12: Von-Mises stresses on profile blanking punch.

As shown in the analysis results, the minimum Von-Mises stress is 4.33 Mpa and Maximum Von-Mises stress is 92.71Mpa.

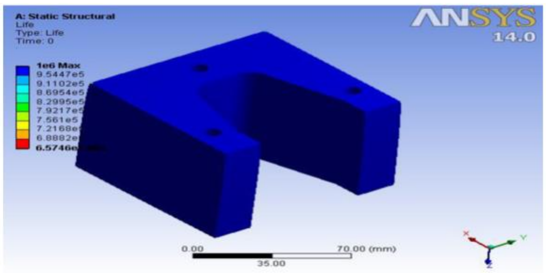

Fig- 4.13: Fatigue life of profile blanking punch

As shown in the analysis results, the minimum life is 65000 cycles and Maximum life is 100000 cycles.

V. Results and Discussion

First step is to decide the geometry of the Die-Punch tool, while having consideration on this; we need to take component which is selected for the optimization or alteration of manufacturing process. Here alternative method of manufacturing selected is punching; when a punching operation is selected first parameter under scanner is the amount of material required to be eliminated from the original raw material. Further in this process we need to decide the number of cycles for which this punch is been designed, here we are utilizing this punch for at least fifty thousand repeating punching operations, keeping in mind the monthly production of these parts around five thousand quantities.

Sl.No	Description	Total Deformation(mm)		
		Theoretical	Ansys	Error (%)
1.	Piercing Punch	0.2200	0.2290	3
2.	Slotting Punch	0.1896	0.1937	2.1
3.	Profile blanking Punch	0.01582	0.0166	4.8

Table -3: Fatigue life results.

Sl.No	Description	Fatigue life(cycles)		
		Theoretical	Ansys	Error (%)
1.	Piercing Punch	97000	100000	3
2.	Slotting Punch	>1e6	>1e6	-
3.	Profile blanking Punch	>1e6	>1e6	-

Sl. No	Description	Von-Mises Stress (N/mm2)		
		Theoretical	Ansys	Error (%)
1.	Piercing Punch	1020	979	3.5
2.	Slotting Punch	1480	1503	1.5

Maximum working stress for piercing punch is 927 N/mm², which is less than the Von-Mises stress 1020 N/mm².Hence punch will not fail under applied load of 59383N.

Maximum working stress for Slotting punch is 400 N/mm², which is less than the Von-Mises stress 1480 N/mm².Hence punch will not fail under applied load of 358400N.

Maximum working stress for profile blanking punch is 37 N/mm², which is less than the Von-Mises stress 96 N/mm².Hence punch will not fail under applied load of 226800N.

Critical buckling load for piercing punch is 356029N.Actual load on piercing punch is 59383N, which is less than 356029N.Hence buckling will not occur.

VI. CONCLUSION

In this project a die punch for blanking and piercing operation is designed and analysed for component. The theoretical calculations were done for calculating cutting force, tonnage required, fatigue life and stresses. The 3D models created in Catia-V5 and analysis is done on Ansys 14.0 workbench. The main objective of the project is to improve productivity and reduce production cost. The exiting cycle time for blanking and piercing operation is approximately four minutes which manufacturing cost is around six rupees. After implementation of this project we can expect the cycle time will be 30 to 40 secs and cost will be around 1.5 to 2 rupees.

REFERENCES

1. Optimum selection of variable punch-die clearance to improve tool life in blanking non-symmetric shapes Soumya Subramonian, Taylan Altan, Bogdan Ciocirlan, Craig Campbell.

2. Strain-controlled fatigue properties of steels and some simple approximations by M.L. Roessle, A. Fatemi.

3. Flanging using step die for improving fatigue strength of punched high strength steel sheet by Purwo Kadarno, Ken-ichiro Mori, Yohei Abe, Tatsuro Abe.

4. Computer aided blanking die design using CATIA by H. M. A. Hussain.

5. Study of the contribution of different effects induced by the punching process on the high cycle fatigue strength of the M330-35A electrical steel by Helmi Dehmani, Charles Bruggerb, Thierry Palin-Lucb, Charles Mareauc, Samuel Koechlina.

6. Analysis of Wire-EDM finishing cuts on large scale ZrO2-TiN hybrid spark plasma sintered blanks by Frederik Vogelera, Bert Lauwersa and Eleonora Ferrarisa.