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

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. In blanking, the blanked piece of material is the product and while in piercing, the material that is blanked is scrap while the remaining part of the strip is the product, as shown in the Figure. In this project, blanking and piercing are used to produce component. Blanking is one of the processes in which the sheet undergoes brutal deformation since the sheet metal is separated to have the slug and part.

Industries involved in sheet metal manufacturing shear cutting methods are widely used for high and low cost production. Shear cutting process is more advantages over the other conventional metal or sheet metal cutting operation. Sheet metal cutting operation is common in most of the 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 application.

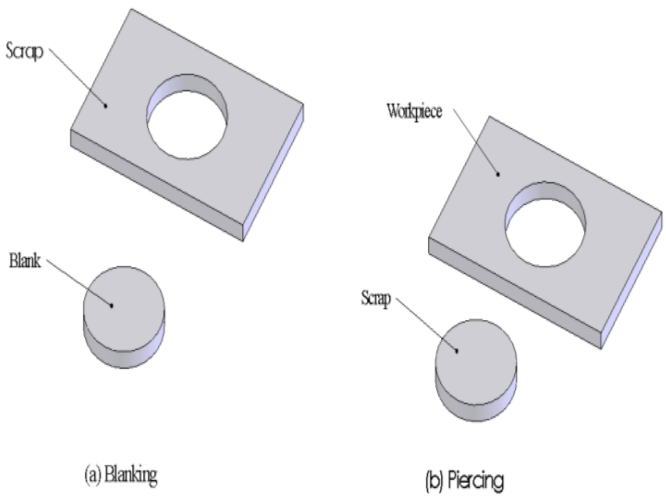

Fig -1: Blanking & Piercing

2. 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. After the implementation of this project we can expect this to 30 secs.

3. BLANKING AND PIERCING DIE PUNCH

3.1 3D models of Die Punch and Component

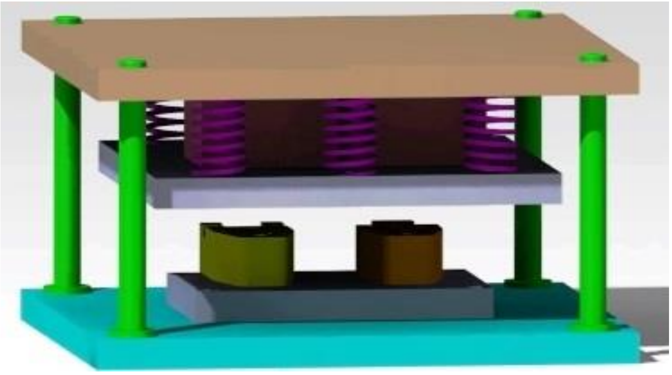

Fig -1: 3D model of die punch

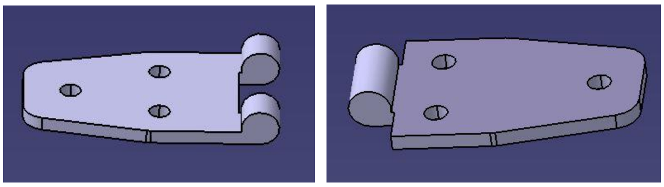

Fig -2: Component Model (Male and Female part)

3.2 2D Drawing of Die Punch

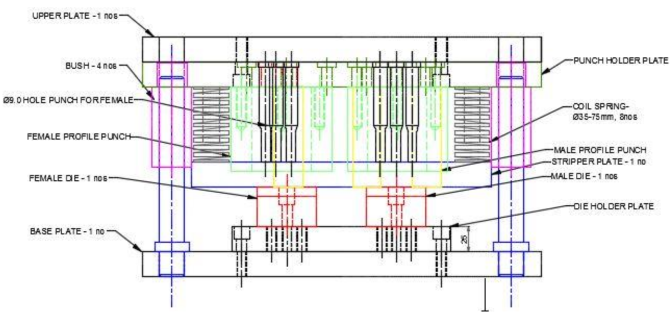

Fig -3: 2D Drawing of die punch assembly

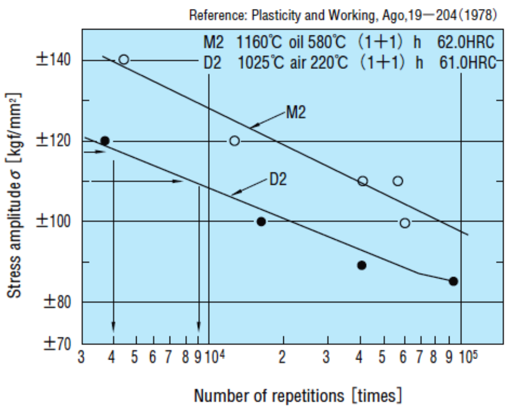

Fig-4: Fatigue characteristics of tool steel

Table -1: Material Properties of component

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

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

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)

4. ANALYSIS IN ANSYS

In this project the analysis is carried out in Ansys 14.0 work bench. The punch is critical element in die punch, hence analysis is carried out on punches and the results are compared with theoretical calculations for validation. The material used for punches is D2 steel/HCHCr.

4.2 Analysis of Piercing punch

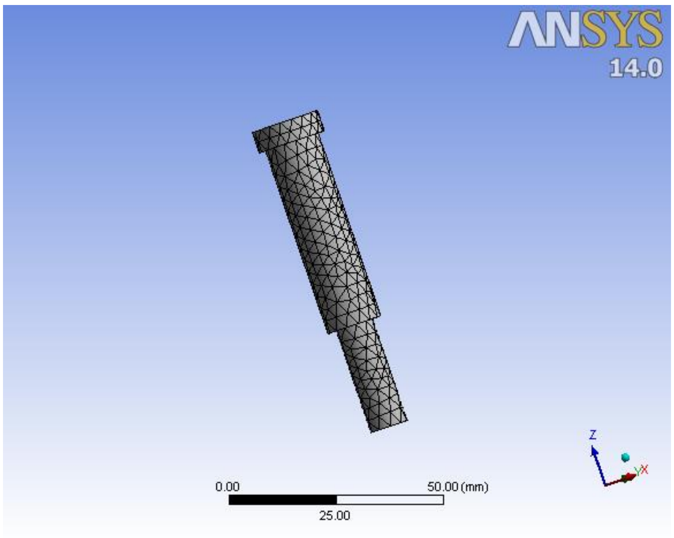

Fig- 5: Meshed model of Piercing punch.

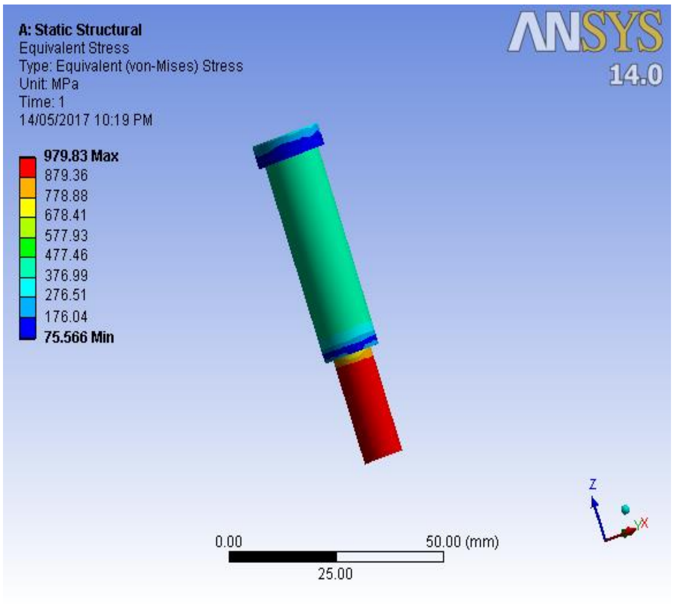

Fig- 6: Von-Mises stresses on piercing punch.

The minimum Von-Mises stress is 75.566 Mpa and Maximum Von-Mises stress is 979 Mpa.

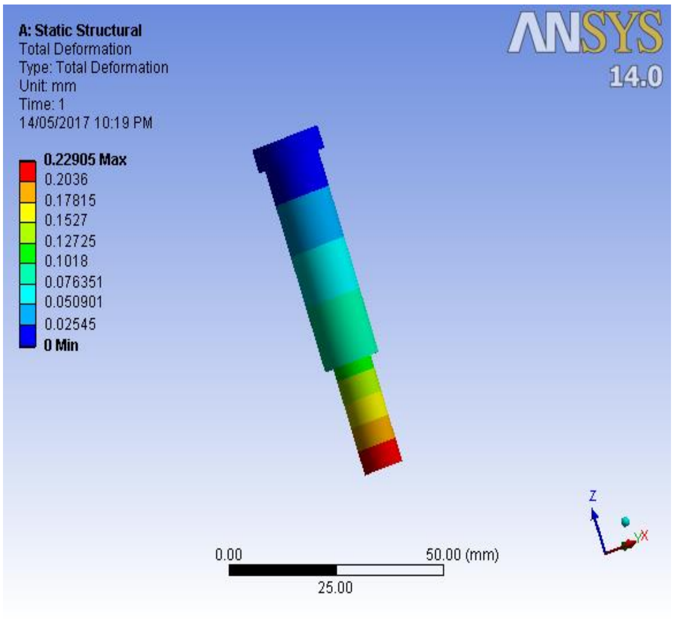

Fig- 7: Total deformation of piercing punch.

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

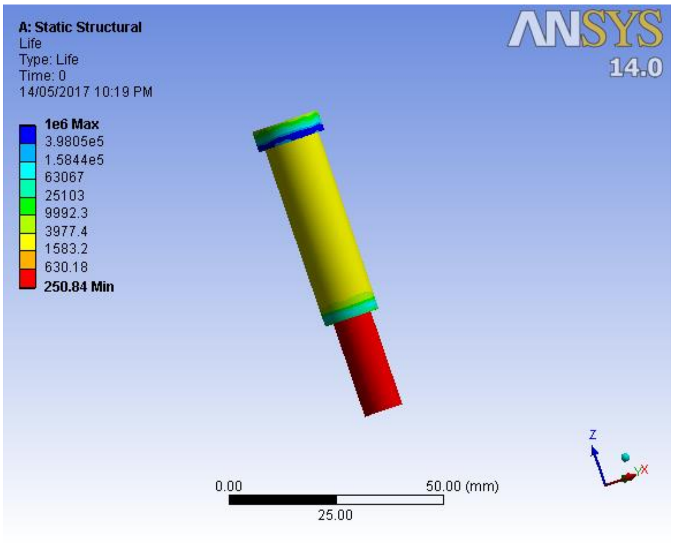

Fig- 8: Fatigue life of piercing punch.

4.2 Analysis of slotting punch

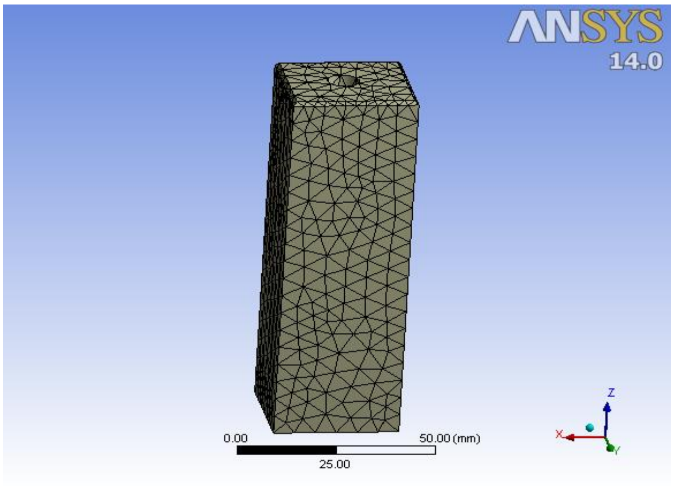

Fig- 9: Meshed model of Slotting punch.

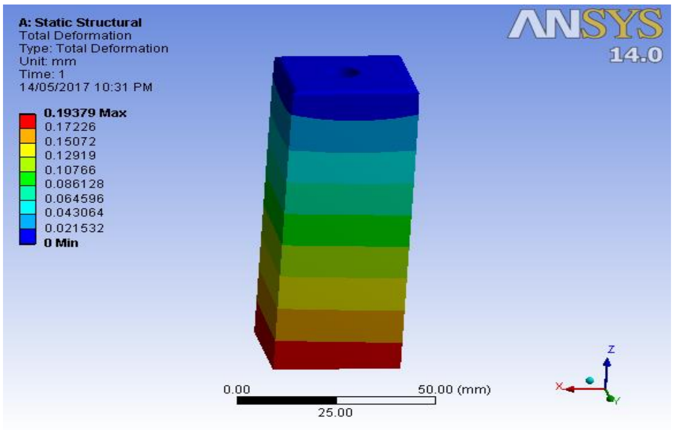

Fig- 10: Total deformation of piercing punch.

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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.

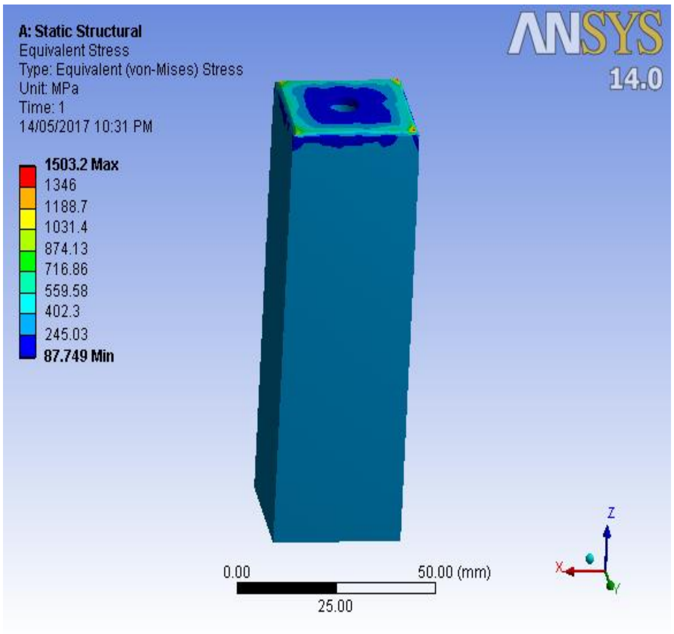

Fig- 11: Von-Mises stresses on slotting punch.

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

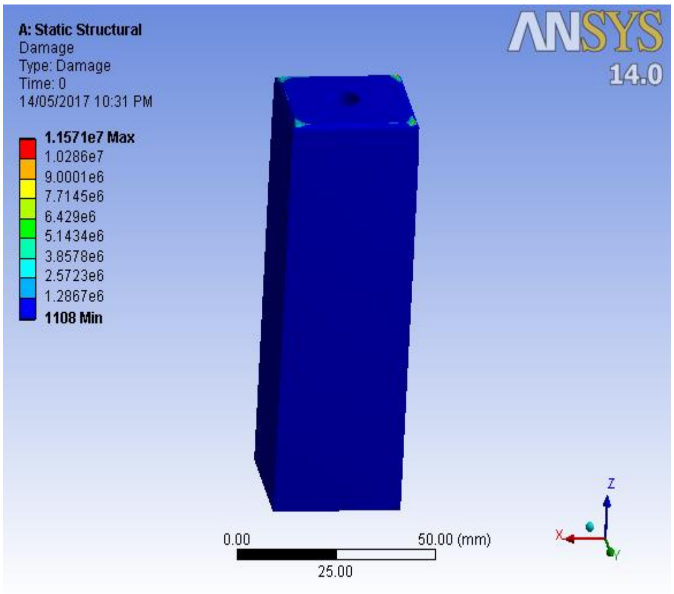

Fig- 12: Fatigue life of slotting punch.

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

4.3 Analysis of profile blanking punch

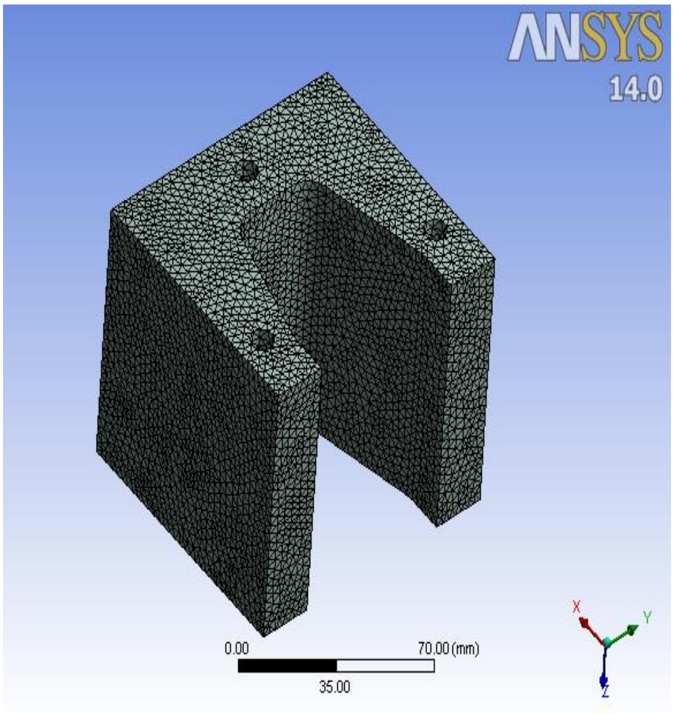

Fig- 13: Meshed model of profile cutting punch.

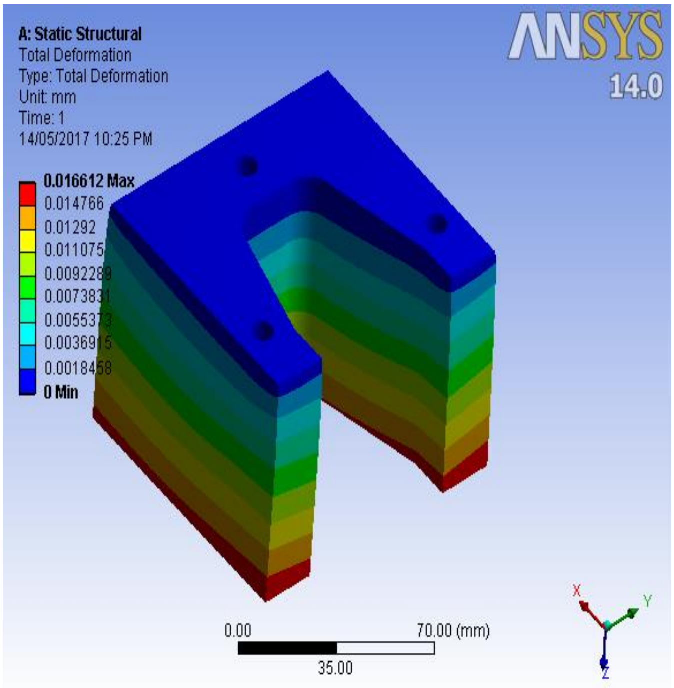

Fig- 14: Total deformation of profile blanking punch.

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.

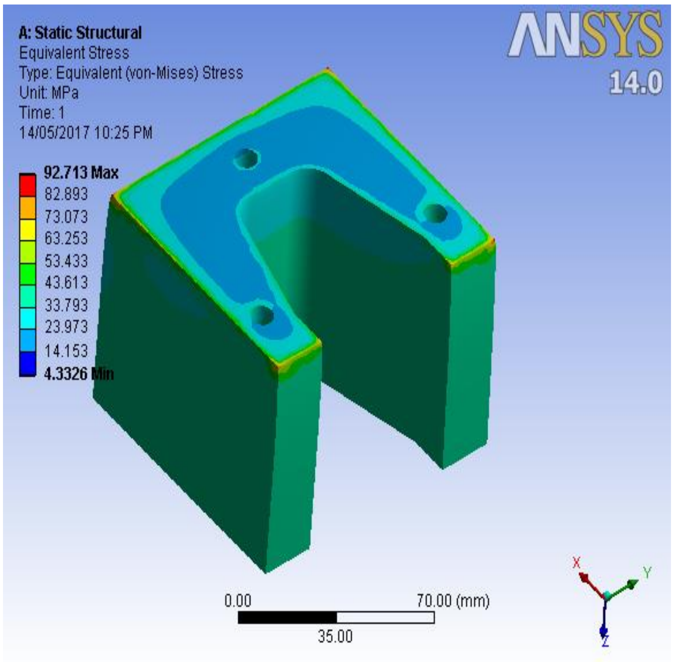

Fig- 15: Von-Mises stresses on profile blanking punch.

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

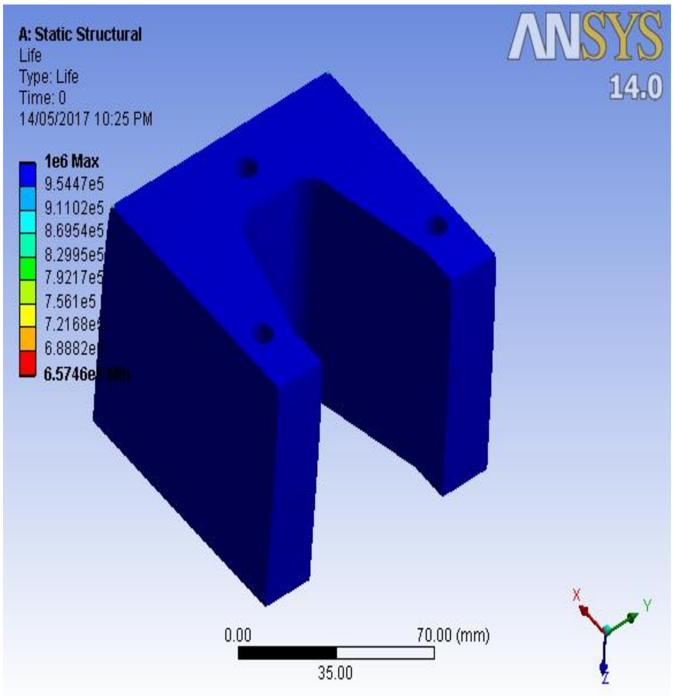

Fig- 16: Fatigue life of profile blanking punch

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

5. 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.

Table -3: Total deformation results.

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 -4: 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	-

Table -5: Von - Mises stress results.

Sl. No	Description	Von-Mises Stress (N/mm^{2})		
		Theoretical	Ansys	Error (%)
1.	Piercing Punch	1020	979	3.5
2.	Slotting Punch	1480	1503	1.5
3.	Profile blanking Punch	96	93	3.5

Maximum working stress for piercing punch is 927 N/mm^2, which is less than the Von-Mises stress 1020 N/mm^2.Hence punch will not fail under applied load of 59383N.

Maximum working stress for Slotting punch is 400 N/mm^2, which is less than the Von-Mises stress 1480 N/mm^2.Hence punch will not fail under applied load of 358400N.

Maximum working stress for profile blanking punch is 37 N/mm^2, which is less than the Von-Mises stress 96 N/mm^2.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.

6. 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.

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