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Static Analysis of Punch and Die Used For LSV Link Bracket Using SolidWorks

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ABSTRACT

This project gave importance to the methodologies which is used to simulate whole static analysis of aerospace sheet metal components and the study of how different mechanical properties propagate and influence the component fabrication. Since sheet metal forming is a major constituent of a wide range of products it is vital to work on methodologies that enable detailed evaluation of forming processes. Developments in computer-aided engineering have made simulation-based process and product development efficient and useful since it allows for detailed, rapid evaluation of the capabilities and qualities of both process and product. Simulations of individual forming processes are useful in gaining the complete sequence of a product's forming processes. Simulation-based forming is a product development methodology that aims at minimizing the physical testing of prototypes and manufacturing systems by using computer aided engineering (CAE) tools to evaluate the performance of a component. Finite element (FE) analysis is an indispensable CAE tool used to predict the performance of both the component and its manufacturing process.

Keywords *- Finite Element Analysis, Bending, Forming, NX one step Formability.*

1. INTRODUCTION

Press tool is a device/method used for producing sheet metal components in large bulk by applying an external force with the benefit of a machine tool called press. Press tools are mainly manufactured for high degree of component production. Press tools consists of various elements, the complete assembly of these elements makes a press tool. Press tool operations are classified as cutting, non-cutting and hybrid press operation. Majority of Automobile and Aerospace products are manufactured using Sheet metal forming technology. After the implementation of the press tools some of the costlier processes are made economical by this operation.

2. COMPONENT STUDY

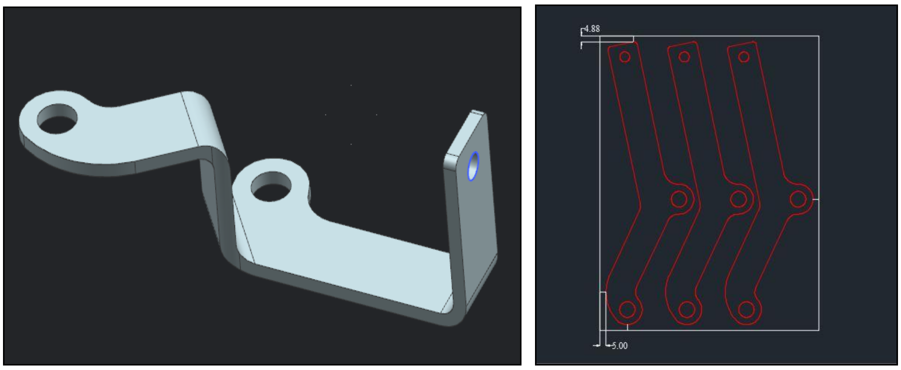


Fig 1: 3D Model of the Component and Strip Layout of the Component.

Strip layout is used to design the component and arrange them for the economical use in the production process. The sheet metal which is used for production of the component must be fully utilized such that the wastage of the material is minimal.

%Area of Utilization= (Area of the blank x no. of rows x100)/ (Pitch x Strip width)

= (6664.3618x15x100) / (330x335)
=90.426%

Therefore the percentage area utilization is 90%.

Component Details	
Name of the component	LSV Link Bracket
Material	IS2062 MS
Length of the component	236.3 mm
Width of the component	72.05 mm
Thickness of the material	4.5mm
Mass of the component	0.237012353 Kg

Table 1: Component Details.

Chemical Composition	
Carbon (C) %	0.25%
Phosphorus (P) %	0.055% Max
Sulphur (S) %	0.055% Max
Silicon (Si) %	0.040% Max
Chromium (Cr) %	0.2-0.35Max

Table 2: Chemical Compositions.

Mechanical properties	
Max Stress	410-530 N/mm^2 Min
Yield Stress	250 N/mm^2 Min

Table 3: Mechanical Properties.

3. TOOL DESIGN

3.1 Blanking Tool Design

3.1.1 Press Force Calculations

The blanking and piercing operation taking place in a single tool. The calculation of tonnage for this progressive tool is as shown below.

3.1.1.1 Shear Force for Blanking

Shear Force= Length of Cut x Thickness x Shear Strength
Shear Strength=328 N/mm^2 (80% of tensile strength)
= 553.0394 x 4.5 x 328
Shear Force=816286.1544N=816.28KN.

3.1.1.2 Shear Force for Piercing 1 (diameter 13*2 holes)

Shear Force= Length of Cut x Thickness x Shear Strength
Shear Strength=328 N/mm^2 (80% of tensile strength)
= (40.84*2) x 4.5 x 328
Shear Force=120577.392N=120.57KN.

3.1.1.3 Shear Force for Piercing 2 (diameter 8.30*1 hole)

Shear Force= Length of Cut x Thickness x Shear Strength
Shear Strength=328 N/mm^2 (80% of tensile strength)
= 26.0786 x 4.5 x 328
Shear Force=38492.0136N=38.49KN.

3.1.1.4 Press Force

Press Force = (Shear force for blanking +shear force for piercing1+shear force for piercing 2)

= (816286.1544N +120.57392+38.4920136N)

Press Force = 975352.088N = 975.35KN.

3.1.1.5 Press Tonnage/Capacity

Press Tonnage= Press Force/ (1000*9.81)

= (979543.3844+120.57392+38.4920136) / (1000*9.81)

= 99.42Tons ≈100Tons (By experience)

Depending on the press availability we selected 100 Tons press machine.

3.2 Clearance Calculations

3.2.1 Cutting Clearance

1. Formula method

Cutting Clearance/Side = 0.005 x Sheet Thickness (mm) x Square Root of Shear Strength (Kgf /mm^2)

= 0.005 x 4.5 x SQRT (328)

= 0.407mm/Side

2. Percentage method

Cutting Clearance = 8 % of sheet thickness

= (8/100) x 4.5

C = 3.6 mm/Side

As per the practical consideration C=5mm/Side is considered.

3.3 Forming Tool Design

Forming Force= Component thickness (mm) x Forming perimeter (mm) x Ultimate tensile Strength (N/mm^2).

=4.5 x (265.8672) x 530

=634093.27N

=634.093272 KN=64.63Tons

Pad Force (P) = 25% of forming force

= 0.25 x 634.093272=158523.318N

= 16.15 Tons

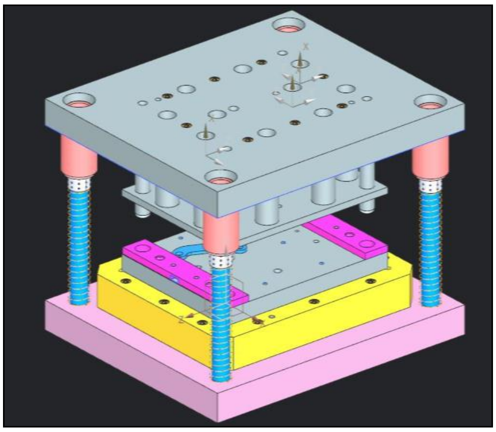
Total force = Forming force + Pad force

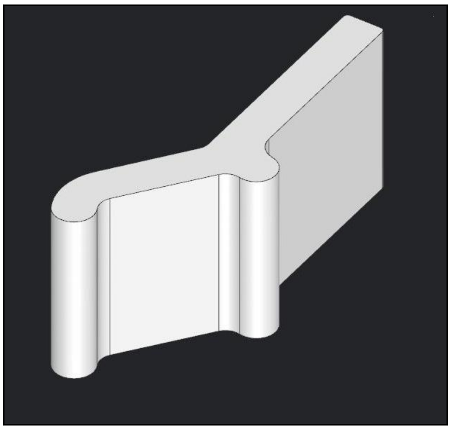
= 64.637+16.15

= 80.78 Tons≈81Tons≈100Tons (Standard available)

Depending on the press availability we selected 100 Tons press machine.

4. MODELLING OF THE TOOLS USED





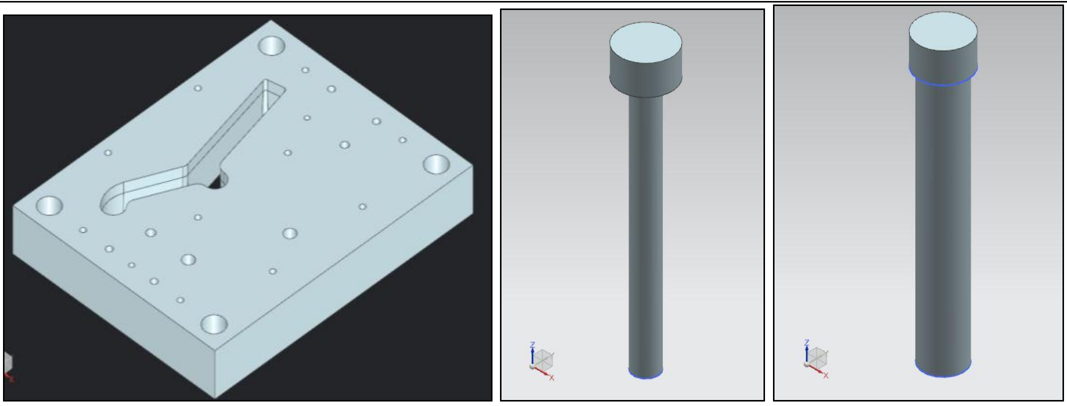


Fig 2: Progressive tool, Punch and Dies used for Blanking and Piercing operation.

The above fig 2 shows the progressive tool, punch and dies used for the manufacture of LSV link bracket, since the blanking and piercing operation takes place at the same tool the progressive tool has been designed in order to maintain the dimensional accuracy and the quality of the component. So two types of punches are used for the piercing operation with different diamenters as shown in fig 3.

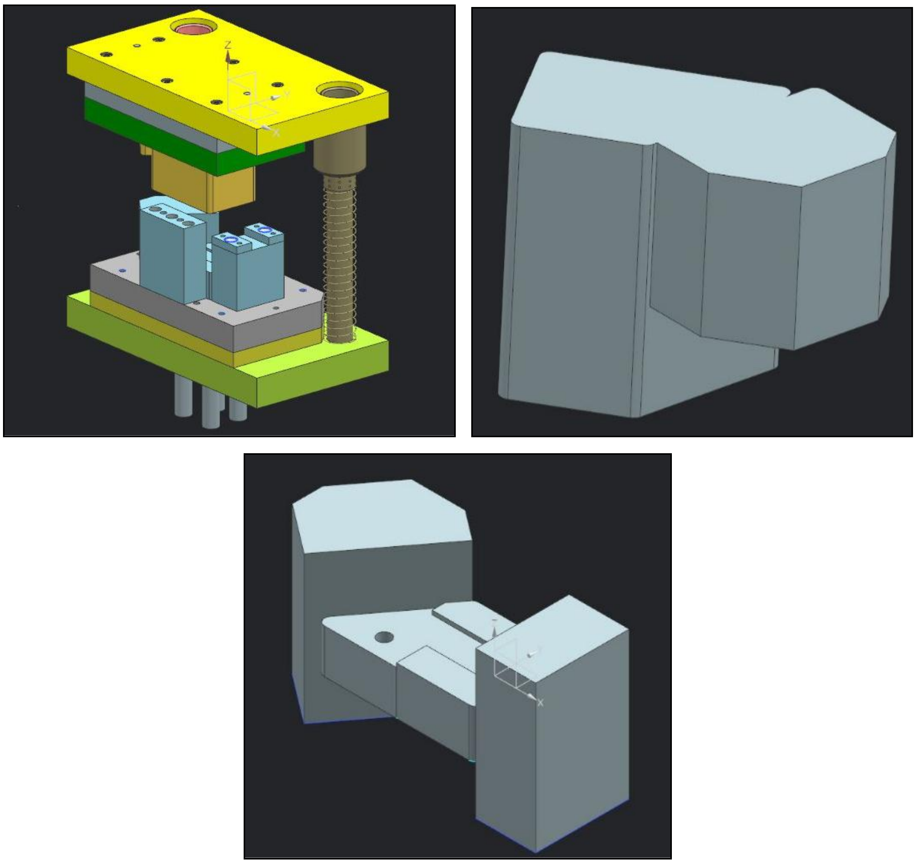


Fig 3: Forming tool, Punch and Dies used for Forming Operation.

The above figures shows the forming tool, punch and dies used for the manufacture of LSV link bracket, since the thickness of the component is more the tool has to be designed such that it qualifies at the inspection stage, it should be withstanding the effects caused due to the spring back during the forming operation.

5. RESULTS AND DISCUSSION

5.1 FE Analysis

The design calculation that is used for calculating blanking and piercing operation under the head of progressive tool calculations is shown in the above section 3. From the calculation, we obtained the shear force of 99.4ton but this value cannot be directly used to in the analysis, as the nearest standard value for selection of press available in the standard for manufacturing operation is 100tons. Hence, in this analysis we are using 100tons Hydraulic press for blanking and piercing operation.

A good quality of mesh is used to build the FE model of Punch and Dies and required mesh qualtiy is checked before runing the FEA analysis.

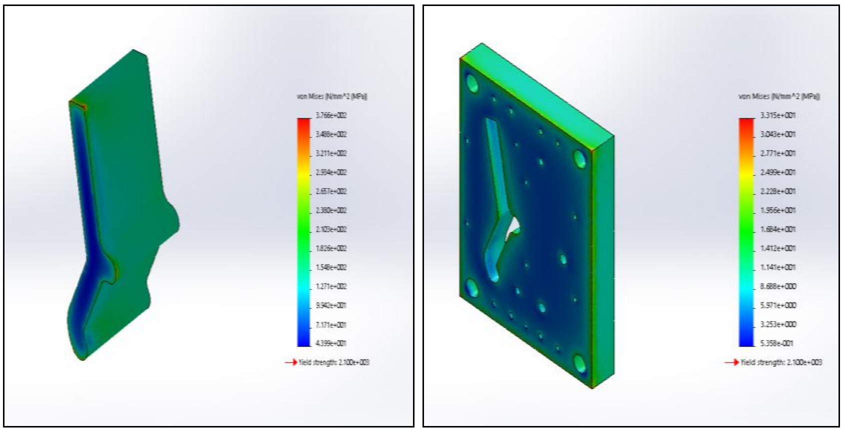


Fig 4: Maximum von-Mises Stress plots of Banking Punch and Die.

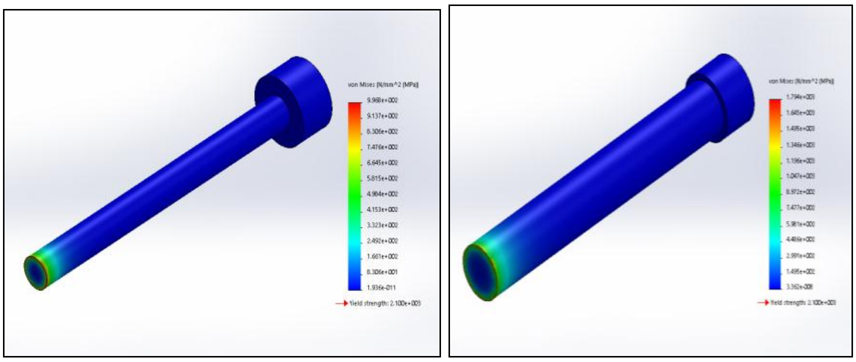


Fig 5: Maximum von-Mises Stress plots of Piercing Punch of Dia 8 and Dia 13.

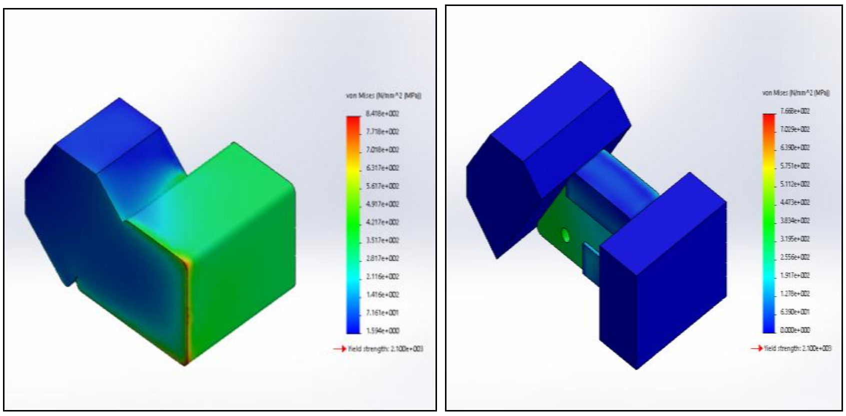


Fig 5: Maximum von-Mises Stress plots of Forming Punch and Die.

Static structural analysis are conducted for all the model using the loads as calculated in the section 3 and results shown only for maimum von-Mises stresses.

The results obtained from the FEA analysis are tablulated below for maxmium and minimum von-Mises stress, displacememt and strain values and conclusion are drwan based on the results summary (Refer Table 4).

Component Name	Load, tons	von-Mises Stress, N/mm^2 (MPa)		Static Displacement, mm		Static Strain	
		Max	Min	Max	Min	Max	Min
Blanking Punch	100	376.55	43.993	0.812	0	0.0130	0.002236
Blanking Die		33.15	0.536	0.041	0	0.0011	0.000148
Piercing Punch Dia 8		996.78	0.000	0.105	0	0.0359	0.00
Piercing Punch Dia 13		1794.44	0.000	0.202	0	0.0472	0.00
Forming Punch		841.80	1.594	0.220	0	0.0034	0.000019
Forming Die		766.83	0.000	0.074	0	0.0026	0.00

Table 4: Results Summary for all Load Cases.

6. CONCLUSION

The main aim of this project was to design, manufacture and analysis of the press tool for LSV Link Bracket, and the work is successfully completed. Designing section was carried out using Auto CAD and 3D modelling by Unigraphics NX10 software. Static analysis was done with the help of Solid works, by which the design was checked for its safety.

It was not a theoretical study, but it was the practical work done. Press tool is manufactured successfully to produce LSV Link Bracket. The study of each element of press tool and its design and its manufacturing is shown in this work. Since the component thickness is more it was so challenging to design a tool which overcomes the defects which may occur during the production of the component which is more in thickness compared to other sheet metal products.

REFERENCES

1. G.R. Nagpal, Tool Engineering and Design, Khanna Publishers.
2. N.B. Suresh, A Learners to Press Tools, published by Pannaga international academy, 4th edition [2010].
3. Prakash H. Joshi, Press Tool: Design and Construction, Wheeler Publishers.
4. Ivana Suchy, Hand Book of Die Design, McGraw-Hill companies [2006].