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MANUFACTURABILITY AND REALISATION OF WIRE TUNNEL

Inkulu Jagadeesh[*1] & Puli Suresh Kumar[2]
[*1]M.Tech Student, Department of Mechanical Engineering, CAD / CAM, TPIST, Komatipalli(v), Bobbili(M), VZM Dist, AP
[2]Asst. Professor, Department of Mechanical Engineering, TPIST, Komatipalli(v), Bobbili(M), VZM Dist, AP

Abstract

Wire Tunnels are the components which are used to safeguard the control cables and command cables running from front section to rear section on the surface of the missile. It has a specific Aerodynamic shape which helps to reduce the drag effects during the flight.

Wire tunnels are manufactured by using sheet metal forming process, in order to get exact shape and size of components in sheet metal manufacturing, springback effect plays a pivotal role. Prediction of springback angle helps in determining the amount of over bending (i.e. springback compensation) required so that exact bend angle can be obtained in the component. In this study, an attempt has been done to analyze the springback effect for bending operation performed on MARAGING STEEL with the variation of thicknesses of sheet from 0.3mm to 1.2mm and Hyperform software is used for simulating for springback effect in bending operation. The main objective is to get the variation of the amount of springback for different thicknesses of sheets by keeping bend angles and punch radius constant. The results showed that the values of springback increases with the increase in sheet thicknesses but, we require the wire tunnel of thickness 0.5 mm. So, manufacturing of 0.5 mm thickness is done by manufacturing the punch and die.

Keywords: *Wire tunnel, Spring back mechanism, Punch, Die.*

I. INTRODUCTION

1.1 Project background:

Sheet metal working also called as press working is among the most important of metal working processes it may be defined as chip less manufacturing process by which various components are made from sheet metal. The process is also termed as cold stamping.

Sheet metal operations done on a press may be grouped into two categories. They are,

1. Cutting operations
2. Forming operations

1.2 Spring back:

The accuracy in dimensions of sheet metal bending process is always a major concern, depending upon the amount of elastic recovery during unloading, which leads to spring back. It is an important parameter in designing bending tools in order to obtain the desired geometry of the part, hence spring-back prediction is a considerable issue in sheet metal forming. Spring-back is measured in terms of difference between the dimension of fully loaded and unloaded configuration. The major parameters that affect the spring-back are tool shape and dimension, contact friction condition, material properties, thickness of sheet, sector angle.

Literatue review

In past various researches have been done to determine the amount spring-back by means of trial and error technique which not only was an expensive process for the manufacturing and repair of the tool but also required a lot of time, causing delay in the development of the product. Another method for the prediction of spring-back using numerical simulation based on Finite Element Analysis (FEA) has emerged as a powerful tool which is now being used worldwide. Simulations lead to a less time consuming and more economical way in designing and analysis of the process.

Himanshu V. **et al,** Reported on the finite element analysis (FEA) of V-bending, U-bending, and air V-bending processes. FEA of bending is found to be very sensitive to many physical and numerical parameters. FE models must be computationally efficient for practical use. Reported work shows the 3-D FEA of air bending process using Hyper-form LSDYNA and its comparison with, published 3-D FEA results of air bending in Ansysis LS-DYNA and experimental results. FE model simplification by studying the problem symmetry is more efficient and practical approach for solution of more complex large dimensions slow forming processes.

SlotaJánetal, Spring back determination of sheet metals in various cases in air bending process. The practical part consists of two parts. First part deals with experiment of air bending process using three different categories of steel, different bending depths and different die geometry. Influence of these technological variables is illustrated and compared with results of numerical simulation of these processes. Implicit and explicit commercial codes were used. Thispaper used a modern measurement methods performed in MATLAB system.

S. Sulaiman et al,Theinvestigated spring back behaviour during sheet metal forming process on different parameters by using Numerical method. Nonlinear numerical simulation was performed by using finite element commercial ABAQUS/CAE software. The computational results show that thicker sheets exhibits smaller spring back compared to thin sheets.

Aysun et al. studied the effect of ratio of die radius and thickness of the sheet. Ratio of the die radius and thickness of the sheet verses spring back angle, are plotted it is seen that after certain level the spring back effect increases as the R/t ratio increases. In order to investigate the effect of die radius and blank thickness on the spring back angle, the following strategy was employed. Two groups of FE simulation models are generated with the identical R/t ratio that range between 1.0 and 5.0.

Luc papeleux et al studied blank holder force is one of the important parameter in the control of spring back. It was experimentally observed that the spring back increases with small forces, but decreases as the force increases for large force values. It is also important note that the values of the parameters for low coefficient of friction are significantly different than the values for mean friction coefficients.

II. PROBLEM DESCRIPTION AND METHODOLOGY

2.1 Problem statement

This project will be focusing on prediction of spring back angle for different thicknesses of wire tunnel varying from 0.5 to 1.2 mm in hyper-form,prediction of spring back helps in determining the amount of over bend required so that exact bend angle can be obtained .Manufacturing of wire tunnel of the dimensions of thickness 0.5 mm, length 600 mm, and include angle between opposite faces is 90 degrees, bend radius 3 mm.

2.2 Objectives

1. In this study an attempt has been done to analyze the spring-back effect for bending operation performed on MARAGING STEEL with thickness of sheet varying from 0.3mm to 1.2mm. In this work Hyper-form software is used for simulating the spring-back effect in bending operation.
2. The design of die and punch are modified and manufactured by considering the spring back angle so that wire tunnel of exact dimensions of sheet thickness 0.5 mm can be manufactured.

2.3 Scope of the project

1. Modelling of punch and die using SOLIDWORKS software.
2. Simulating the model and data acquisition is done by using FEA software hyper-form.
3. Manufacture of wire tunnel which is a part of a missile.

4. Spring back analysis done and the corrective action had been taken to improve the wire tunnel deformation.

2.4 Methodology:

The steps involved in the methodology are modeling, simulations for forming and spring back, manufacturing of die and punch and manufacturing of wire tunnel.

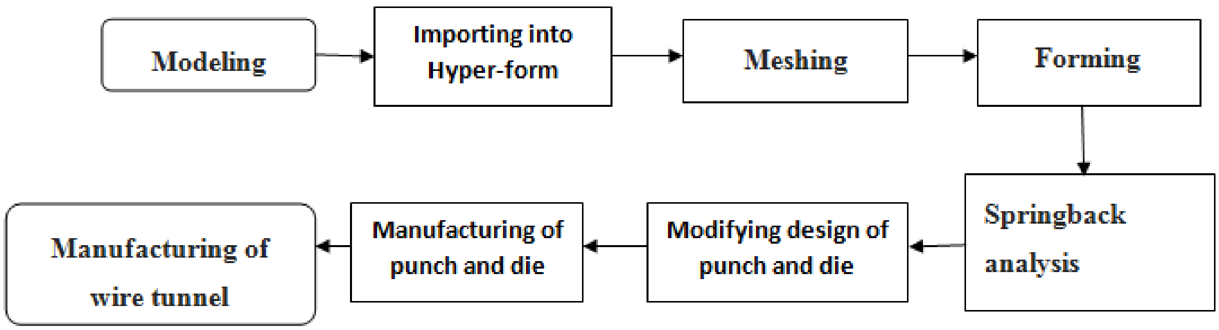

Figure 2.1: Sequence of operations carried out in the project.

III. MODELLING AND ANALYSIS OF WIRE TUNNEL

3.1 Modeling in solidworks:

Solid works is an advanced high-end CAD/CAM/CAE software package developed by solid works corporation, USA is a part of Dassault systems USA. SolidworksCorporation was founded in 1993 by Jon Hirsctickto make the process of product design easier. This easy to learn tool makes it possible for mechanical designers to quickly sketch ideas, experiment with features and dimensions and produce models and detailed drawings. It is a feature based parametric solid modelling mechanical design and automation software.

3.1.1 Modelling of wire tunnel:

The die and punch of wire tunnel of required dimensions are modelled in solid works

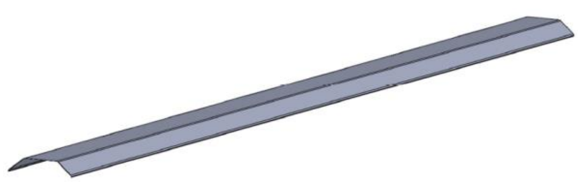

Figure 3.1: Modeling of wire tunnel

Using the solidworks software modelling of the wire tunnel in two dimensional and three dimensional planes is done. Selecting the XY plane wire tunnel profile is sketched in 2d and considering the centre axis the sketch is extruded 600 mm length in the direction of z axis, and the wire frame die model is obtained and this model is viewed in 3-D plane.

Table 3.1: wire tunnel dimensions.

Bend radius	3 mm
Width of die opening	77 mm
Bend angle	135 degrees
Length	600 mm

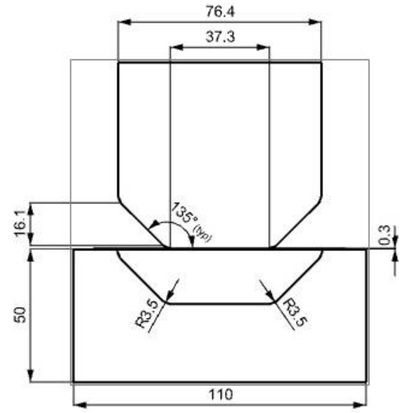

Figure 3.2 : 3-D draft model of assembly with sheet thickness 0.3 mm

Figure 4.6, illustrates the Draft sketch of assembly for 0.3 mm thickness blank with punch and die assembly next varying sheet thickness to 0.5 mm , 0.8 mm, 1 mm 1.2 mm.

3.2 Simulation for spring back effect:

The status file of the forming simulation is input to find the spring back. The status file include the information about forming, the nodes are selected on the part to constrain the degrees of freedom and after running the analysis we will get the results

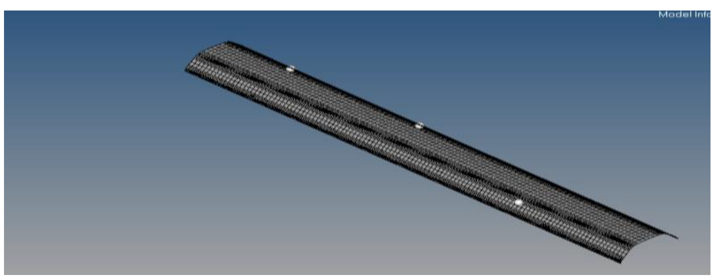

Figure 3.3: Status file of formed blank

The above hyper-form analysis will be carriedout for the sheets of different thicknesses varying from 0.3mm to 1.2mm to know the variation of spring-back angle with variation of sheet thickness by keeping the bend angle and punch radius constant but we manufacture wire tunnel of sheet thickness 0.5 mm because our design specification is 0.5mm.

IV. RESULTS AND DISCUSSIONS

4.1 Case 1: 0.3 mm thickness of blank

- **Displacement plot:**

Figure 4.1 represents the displacement plot of 0.3mm thickness of the formed blank. Maximum displacement is 0.2084mm occurs at fillet of the model. Minimum displacement occurs along the middle of the model.

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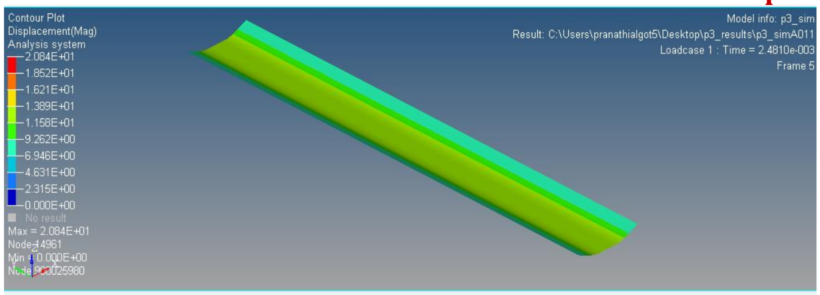

Figure 4.1: Displacement plot

- **Strain plot**

Figure 4.2 represents strain plot of 0.3mm thickness of the formed blank. Maximum strain is 0.05617 occurs at fillet of the component. Minimum strain occurs along middle of the component.

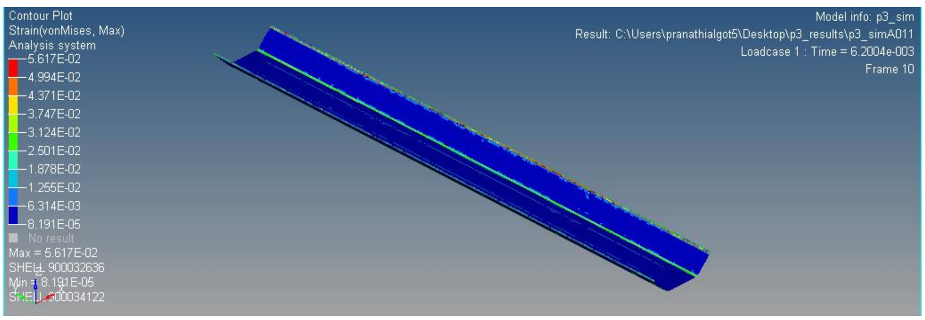

Figure 4.2: Strain plotfor 0.3 mm

- **Stress plot**

Figure 4.3 represents the stress plot of 0.3mm thickness of the formed blank. Maximum stress is 1548 MPa occurs at fillet of the component. Minimum stress occurs along the middle of the component.

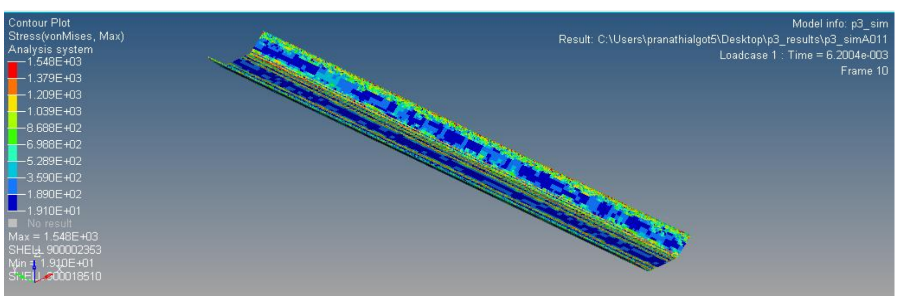

Figure 4.3: Stress plot

- **Flow limit curve**:

A forming limit diagram, also known as a forming limit curve, is used in sheet metal forming for predicting forming behavior of sheet metal. The diagram attempts to provide a graphical description of material failure tests, such as a punched dome test.

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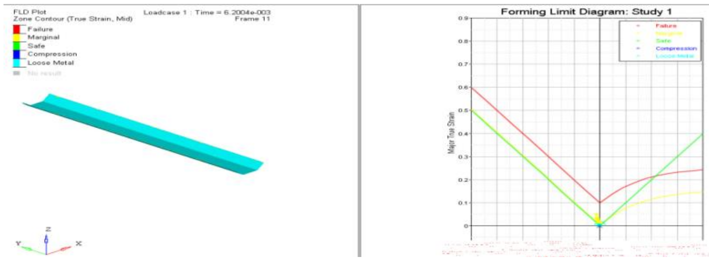

Figure 4.4: Flow limit curvefor 0.3 mm.

- **Spring-back simulation results**

The spring-back angle for the sheet of thickness 1mm is 2.35° on one side so total springback angle on both the sides is 4.7° and the included angle of formed blank after spring-back is 85.3° are shown in the figures 4.5 and 4.6.

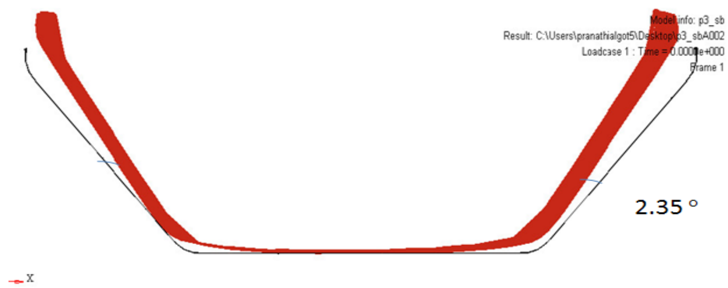

Figure 4.5: Springback angle 2.35° for sheet thickness of 0.3 mm.

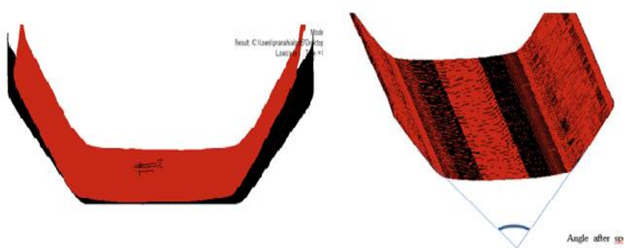

Figure 4.6: Formed blank included angle after spring-back is 85.3°

- **Results Summary:**

Table 4.1: Simulation results summary

S. No	Sheet Thickness,mm	Displacement,mm	Stress,Mpa	Strain
1	0.3	0.2084	1548	0.05617
2	0.5	0.2788	1476	0.04543
3	0.8	0.465	1514	0.04556
4	1	0.597	1519	0.07623
5	1.2	1.917	1596	0.138

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Table 4.2: Variation of springback (°) with material thickness

S. No.	Material thickness(mm)	Amount ofSpring back(°)
1.	0.3	4.61
2.	0.5	4.01
3.	0.8	3.344
4.	1	2.912
5.	1.2	2.216

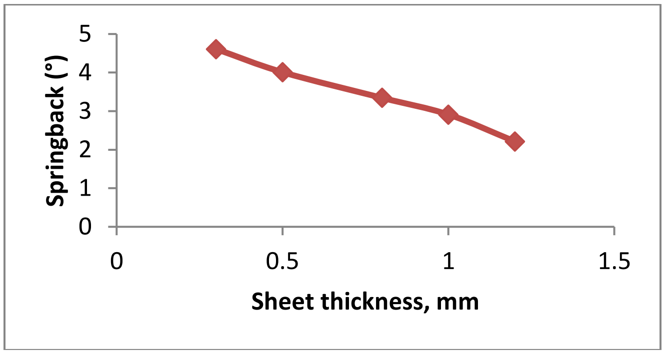

Figure 4.3: Graph between spring back angle and sheet thickness (mm)

The results obtained, from the hyper-form analysis, shows thatwhen the bending angle and the punch radius are kept constant, there is variation in the amount of spring-back offered by the sheet.

Below graphs are shows the variation of displacement. Stress and strain with variation of sheet thickness

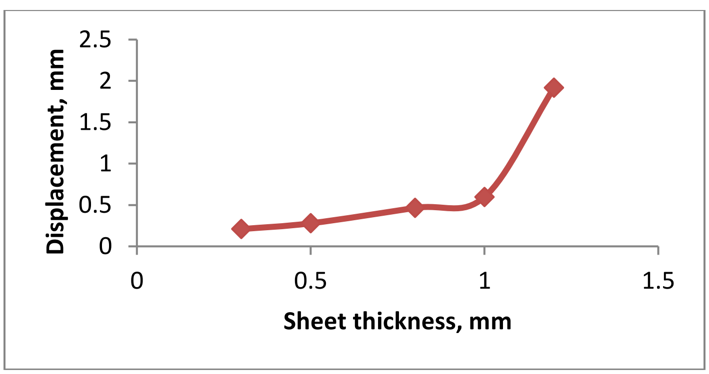

Figure 4.4: Graph between sheet thickness, mm and displacement, mm

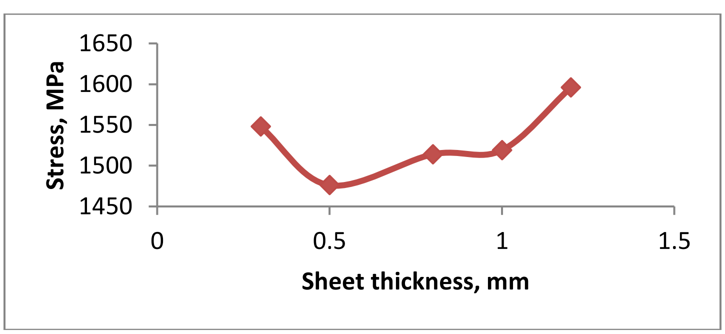

Figure 4.5 : Graph between sheet thickness, mm and stress, MPa

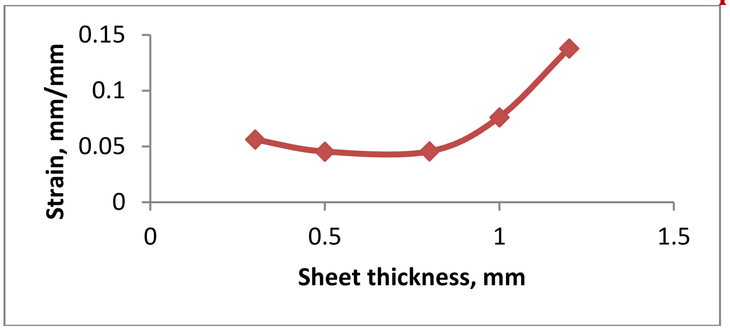

Figure 4.6 : Graph between sheet thickness, mm and strain, mm/mm

V. FABRICATION OF WIRE TUNNEL

5.1 General description of hydraulic press:

Press consists of two hydraulic single acting main cylinders (1) along with one double acting approach cylinder (2) mounted on top of a four-column type press structure. Press frame consists of Top head (3), Bottom head (4), ram table (5) and columns (6).

- **Material for press tool**

High carbon high chromium steel is used to manufacture die and punches this material is more harden than the maraging steel

- **Chemical Composition**

Element	Composition %
C	1.4-1.6%
Mn	0.6%
Si	0.6%
Co	1%
Cr	11 – 13%
Mo	0.7 - 1.2%
V	1.1%
P	0.03%

- **Wire tunnel punch**

Wire tunnel punch is clamped to top head of hydraulic press and it is constrained in all directions except in negative z-axis direction, it will move onto the die.

Figure 5.1 : Wire tunnel punch

- **Wire tunnel die**

Wire tunnel die is clamped to the bottom head of hydraulic press and it is constrined in all the directions

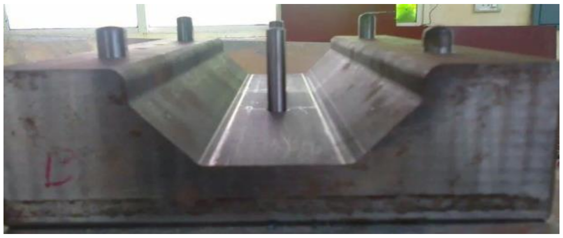

Figure 5.2 : Wire tunnel die

5.2 Manufacturing of wire tunnel:

The wire tunnel is manufactured by using the u- type bending process with the help of press tool, wire tunnel is made up of maraging steel. The force required to perform bend is largely dependent upon the bend and the specific metal bending process because the mechanics of each process can vary considerably. Proper lubrication is essential to controlling forces and has an effect on the process. In punch and die operations, the size of the die opening will decrease, thenecessary bending force .As the sheet metal is bent, the force needed will change usually. It is important to determine maximum necessary bending force to access machine capacity.

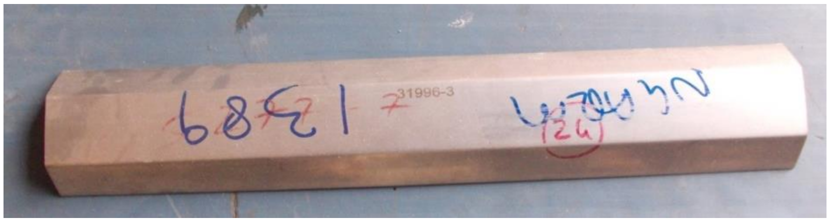

Figure 5.3: Wire tunnel

VI. CONCLUSIONS

1. The results obtained, from the hyper-form analysis, shows that when the bending angle and the punch radius are kept constant, there is variation in the amount of spring-back by varying the sheet thickness.
2. As the sheet thickness is increased from 0.3 mm to 1.2 mm, spring-back angle starts to decrease gradually from 4.61° to 2.216°
3. As per the design specification of Defense research defense laboratories (DRDL) 0.5 mm thickness wire tunnel is used so manufacturing 0.5 mm thickness wire tunnel is done
4. After the fabrication the include angle of the wire tunnel is 90.12°

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