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Design and Development of Die and Plug to Minimize Springback Effect in Seamless Tubes

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ABSTRACT

Indian Seamless tube market having huge potential to develop the tubes of different diameter and sectional tubes. The cold drawing process is the process of reducing the cross sectional area of wire, bar or tube by drawing the material through a die without any preheating. Cold drawing process is used for the production of bright steel bar in round, square, rectangular, hexagonal, and flat section.

The paper emphasizes on the problem of Springback effect on sectional seamless steel tubes faced in production. This study was performed for the analysis & modification to be done on land width of Die in controlling the spring back of sectional seamless steel tubes. The work also includes the quality assurance measures taken during the production of sectional seamless steel tubes. Seamless tubes manufactured by hollowing out solid heated billets in a Piercing mill and then cold drawing process continued.

In the present study, the methodology is selected for the analysis of springback during the cold drawing process to manufacture the seamless tube. To achieve dimensional stability and least springback, this analysis will be beneficial. Hence achieving the targetas reduction in scrap rate of tube due to spring back.

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I. INTRODUCTION

The cold drawing process is the method of reducing the diameter of wire, tube of various cross-sectional areas by drawing the wire, tube material through the die without any preheating. Seamless tubes are manufactured by hollowing out solid heated billets in piercing mill and then cold drawing process continued. After the completion of cold drawing process we got the tube of required size and shape because in cold drawing process both tension and compression acts on tube material.

The cold drawing process is generally a precision tube making process in which the accuracy of the product manufactured is maintained. The problems faced in the cold drawing process are discussed above. One of the major problemfaced in cold drawing process is springback in the drawn tubes.

Springback is one of the major problems faced in tube drawing. Springback is due to the elastic energy stored in the tubes during forming process. When the forming forces are removed the elastic energy is released in the

form of springback, as the tube tries to regain its original shape, and this causes a change in the dimension of the tube. Generally the springback causes the dimensions within the tolerable limit to exceed and hence causes the tube to be rejected for improper dimension.In this report the major emphasis is given on the springback studies of circular tubes and dimensional stability.

II. FINITE ELEMENT METHOD

The finite element method is a numerical analysis technique for the approximate solutions to the varieties of engineering problems. The finite element analysis method is originated as a method of stress analysis method. Finite element procedures are used in design of buildings, aircrafts, ships, spacecraft's, electric motors and many other sectors which deal with stress, heat flow, fluid flow, etc. The finite element procedure produces many simultaneous algebraic equations, which are generated and solved by using computer software's available like ANSYS, IDEAS etc.

3D MODEL DEVELOPMENT

The material for the die and the plug was D3 steel, which is generally tool steel, which contains high carbon & high chromium in it. In this analysis the die and the plug was assumed to berigid with high young's modulus.

DIE MODEL:

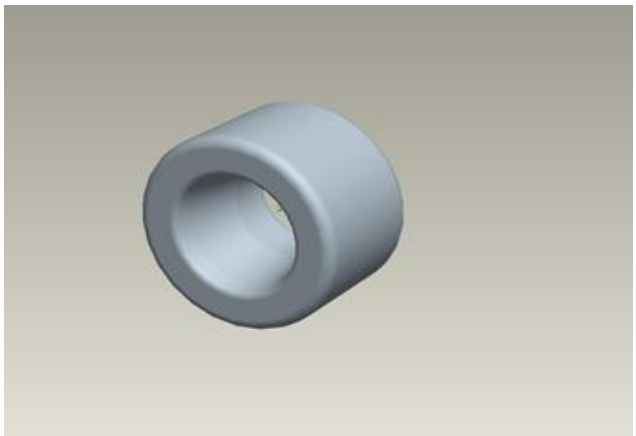

Fig1 : image of die.

PLUGE MODEL:

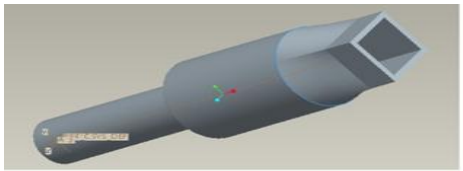

Fig2: image of pluge.

ASSEMBLY MODEL:

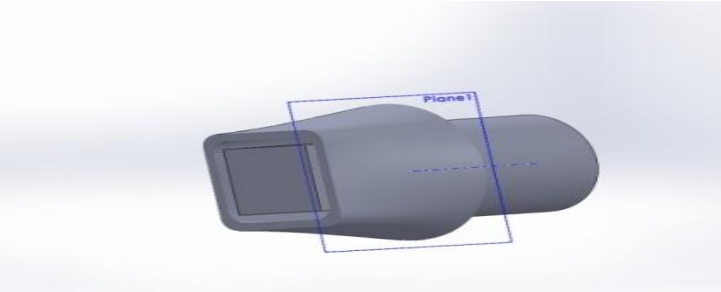

Fig3 : image of model assembly.

MESHING

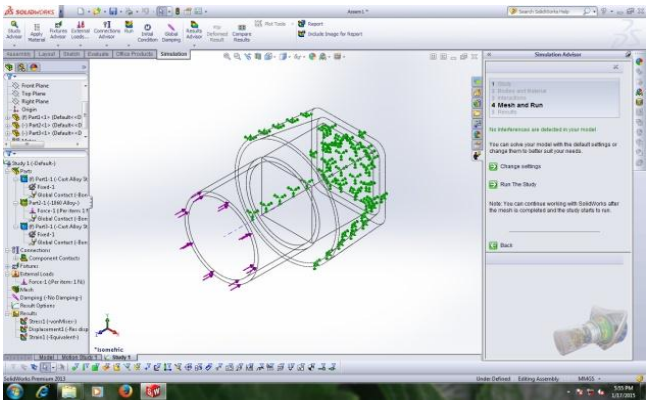

Fig4 :Meshed model of die, plug and tube assembly

III.RESULT & DISCUSSION

In order to check the design safety of tubes to avoid failure it is necessary to obtain stress plot from simulation. Von misses stress is maximum stress induced at particular point which is obtain for 10 mm die land as shown below.

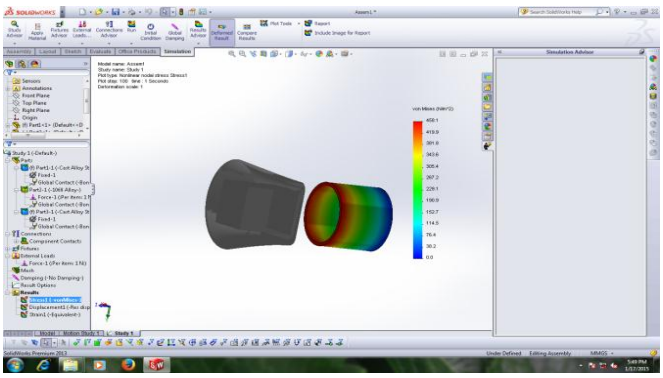

Fig5: von misses stress plot

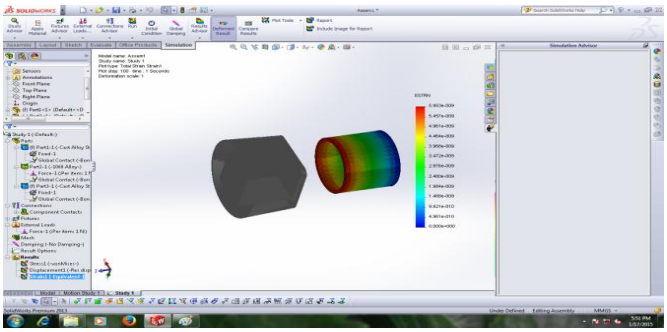

Fig6: The displacements of X, Y, Z, coordinates for 10 mm die land using ANSYS. Plot

Above von-misses stress plot from fig.5. show that maximum stress induced is 458.1 which is well below the ultimate stress value thus is no braking of tube takes place.

1. Comparison of theoretical, experimental and ANSYS result for 10 mm and 5 mm die land.

Table1: Comparison of theoretical, experimental and analytical result for 10 and 5 mm die land

Die land	Dimension	Experimental	ANSYS
05 mm	AVG. SPRING BACK FOR WIDTH AND HEIGTH.	0.27	0.308
	AVG. SPRING BACK FOR THICKNESS	0.359	0.384
	TOTAL AVG SPRINGBACK =	0.3145	0.3465
10 mm	AVG. SPRING BACK FOR WIDTH AND HEIGTH.	0.23	0.2716
	AVG. SPRING BACK FOR THICKNESS	0.2042	0.2458
	TOTAL AVG SPRINGBACK =	0.2171	0.2587

From the theoretical, experimental and ANSYS results of 10 mm and 5 mm land it is clear that elastic recovery is minimum for 10 mm also experimental results obtain are found in good agreement with ANSYS results**.**

2. Graphical result:

Spring back variation against the die land is shown below, for experimental readings springback is more 05 mm die land and springback reduced for 10 mm die land. Similarly the results are obtained for ANSYS simulations. Hence it concludes that the die land of size 10mm is better compared with 05 mm as it has minimum value of springback.

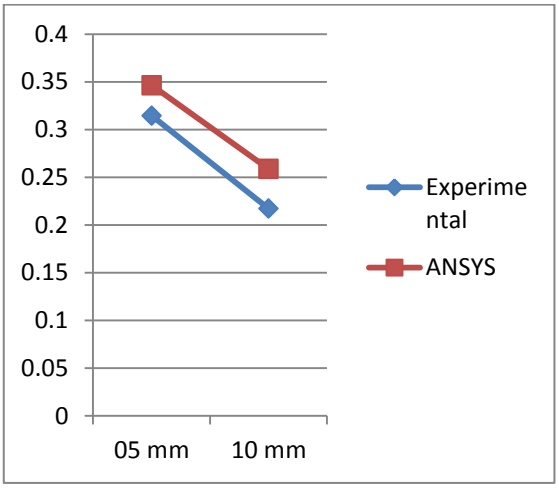

Fig no 7: spring back VS die land for experimental and ANSYS readings.

3. Discussion on result

1. The dies and plugs are designed to ensure the minimum spring back in tubes various measurements were taken for spring-back and wall thickness is tabulated.
2. Both experimental and ANSYS result shows that springback is minimum for 10mm land as compared to 5 mm land. All the theoretical, experimental and ANSYS results of 10 mm and 5 mm die land are good in agreement with each other.

IV. CONCLUSION

1. 3D model saves research time and minimizes risk of design failure of components.
2. After the completion of drawing process we observe some dimensional variations due to springback.
3. Simulation of the process helps to check the design of dies and plug as well helps to visualize the formation of hexagonal shaped tube.
4. Simulation helps to predict the metal formation as well as gives the idea of region of high stress formation. This helps us to check or correct the design of die and plug.
5. The spring back measured was found in an agreement with the experimental studies.

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