ANALYSIS OF SPRING BACK EFFECT IN METAL COMPONENTS.

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ABSTRACT

several shapes and size and sectional pipes form an important fragment of Indian Seamless tube market. The study work brings out the problem of Spring-back effect on sectional seamless steel tubes faced in production. The work will perform the analysis & amendment to be done on land width of Die in controlling the spring back of sectional seamless steel tubes. The work also includes the quality declaration trials taken during the production of sectional seamless steel tubes.This yashashree tubes and pipes pvt.ltd is focused in manufacture of the continuous tubes. It Manufactures tubes for most expanded solicitations like domestic and export uses, e.g. Auto axles, basic systems, Profitable Vehicles, Two-Three Wheelers, Bearings, Oil industry, Petrochemical Industry, Refineries, Fertilizer plant, Boilers, Heat Exchangers, Pressure vessel, Hydraulic and Pneumatic Cylinders, etc. .It also exports the continuous tubes to, Europe, Gulf countries etc. The plant is devised for manufacturing of seamless tubes from input round bars or ingots, various rolling mills are mounted to produce seamless tube in hot and cold condition. Tubing made by linking together the ends of a flat strip are known as welded tubes. Seamless tubes manufactured by hollowing out solid heated billets in a blanking mill and then cold drawing process continued. Cold drawing is the process of reducing the dimensions of sectional tubes as per required size. Both the tension & compression acts on the tubes. So required thickness of tube is achieved.

Keyword : *Contraction,, and spring back,*

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1. INTRODUCTION

The cold drawing process can be analyzed theoretically, by two broad categories of analysis namely, energy analysis and force equilibrium analysis. The energy methods are more comprehensive and can be used to solve cold drawing problems that are outside the purview of force equilibrium methods but the latter are relatively simple and sufficiently accurate for most practical purposes.[1]

Force equilibrium analysis assumes an absence of redundant work, which, does not contribute to the deformation process. The planes perpendicular to the drawing axis are assumed to remain normal throughout deformation, friction is considered to be constant and it is assumed that the metal does not work harden/In practice, none of these assumptions are Correct but in cold drawing, redundant work is small, planes remain normal to the drawing axis and the coefficient of friction is very small. Also, a sensible selection of mean yield stress compensates for work hardening. The force equilibrium approach, therefore, provides a fairly accurate approximate solution for the cold drawing problem. [1]

2. LITRATURE SURVEY

Maciej Pietrzyk and Lucjan Sadok (1990) Completed thermo-mechanical analyses which incorporate internal state variables are becoming common place. Their work provides results aimed at validation of the flow approximation for steady-state analyses of the tube-drawing process with free surfaces. Analysis of all results shows that the predictions of the model are very close to the measurements for both hydrodynamic and ordinary lubrication conditions. [2]

K.Sawamiphakdi, G.D.Lahoti et al. (1991) implemented The ABAQUS program for the determination of drawn tube dimensions, mechanical properties and drawing forces. The proper hot-rolled tube size can be calculated from the requested drawn tube size by using the geometrical analysis program. The drawn tube dimensions, mechanical properties and required forces can be determined by using the pre- and post-processing program and the ABAQUS program. [3]

Zhengjie Jia. (1994) discussed the three Dimensional Simulations of the Hollow Extrusion and Drawing Using the Finite Element Method. Three dimensional rectangular hollow extrusion and drawing with a curve-lined-edge rectangular cross- section of the billet through steam-lined dies have been simulated by the finite element method (ABAQUS). It has thus been shown that for the design of the process for hollow product, based on the character of the deformation of the product, the process type should be properly chosen and the process conditions should be properly controlled in order to obtain desirable product quality. [5]

Ramanan Kartik (**1995)** worked on computer aided design of dies for cold drawing. The objective of this work was to develop a CAD system that would design dies and mandrels for the cold drawing of sections of various shapes from round tubes. The system would have the capability to determine the proper hot-rolled tube size from the required cold drawn shape, thereby controlling the total reduction in area and reducing the number of passes involved in the drawing. Based on the process and product parameters, the system would calculate the drawing force requirements and stress-strain data for the work piece. [6].

A.L.R. de Castro (1996) carried out an experimental program in order to evaluate the influence of effect of die semi-angle on mechanical properties of round section annealed copper bars. From their work it was clear that die semi-angle has more effect on mechanical **Kamaruzuman bin lias (2001)** studied the use of ANSYS as finite element software for analyzing the behavior of flow patterns of material, force and speed of sliding under the plastic deformation state in the drawing process. [7].

Laila S.Bayoumi (2001) obtained an analytical solution for the problem of cold drawing through flat idle rolls of regular polygonal metal tubular sections from round tube. This solution is based on obtaining a compatible velocity field that satisfies kinematic conditions to yield the strain-rate components.[8]

3. REASERCH METHODOLOGY

- Designing of Die and Plug for sectional Tubes (circular OD and hexagonal ID) Using CAD.
- Simulate the Process by Using ANSYS as finite element analysis Software.
- Dimensional Study for spring back.
- Validation with Experimental results

4. Spring back analysis of circular seamless tubes:-

Condition that occurs when a metal or alloy is cold-worked; upon release of the forming force, the material has a tendency to partially return to its original shape because of the elastic energy stored in the part during the forming process. This is called Spring back. Spring back is one of the main sources of geometrical and dimensional inaccuracy in metal forming operation. It is influenced by tool design, lubrication, as well as by material properties such as elastic behavior, work hardening and particularly, the Bauschinger effect. Generally a material with higher yield strength will have a greater ratio of elastic to plastic strain, and will exhibit more spring back than a material with lower yield strength. On other hand, a material with a higher elastic modulus will show less spring back than a material with lower elastic modulus. [2]

The prediction of spring back by finite element method strongly depends on the accurate simulation and realistic modeling of the forming operation so that the final state variables such as stress and strains can be predicted correctly.

5. MATERIAL SELECTION FOR DIE AND PLUG

Tool steels are used to construct the die components subject to wear. They are used in a variety of press working operations. These steels are designed especially to develop high hardness levels and abrasion resistance when heat-treated

The plain carbon and low-alloy steels are readily machinable and weldable. These low cost steels are used for machine parts, keys, bolts, retainers, and for support tooling. Cast-steel dies are used for large drawing and forming dies where maximum impact toughness is required. At carbon levels of 0.35% and higher, cast-alloy-steel dies can be effectively flame-hardened at points of wear.

Cast irons are a plural term for cast iron because many different compositions having special properties are used for shoes, plates, dies, adapters and other large components. Die irons are often alloyed to permit flame hardening when used for the wear surfaces of large sheet metal drawing and forming dies. The ductile (nodular) irons retain the casting advantages of cast iron, while having toughness, stiffness and strength levels approaching those of steel.

6. REASERCH OBJECTIVE

- To measure Spring-back in various shaped Seamless tube
- To study defects in hexagonal tubes of cold drawing process.
- Study of various designs for dies and plugs.
- Modeling of Dies & Plug for hexagonal shaped tubes using CAD software.
- To simulate the cold drawing process using ANSYS and analyze the results.
- Optimization of the tool profile (Dies and Plugs

7. ANALYSIS OF COLD DRAWING BY ANSYS

Ansys is the software based on Finite element method. It is the most useful software used for analysis & stress-strain calculations. First we see what is FEA or FEM.The ANSYS 10.0 Family of Products continues ANSYS commitment to provide the highest quality engineering tools to help you with all of your design and analysis needs.

7.1 Spring back analysis of circular seamless tubes through simulation:-

Two studies of springback analysis were done for 25.4 mm OD size of the tube in ANSYS 10.0. In first study the land was taken 10mm on die and spring back was measured, while in second study the land portion was taken equal to 5 mm. Then the comparisons of springback in the tubes were done and also compare with the experiment.

In both the cases the model was modeled as quarter model. 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 be rigid with high young's modulus. The mesh was used as the mapped brick type mesh. The element type for die, plug, and the tube was use as solid 95. The contact was defined between the die and tube and between plug and tube using target 170, and contact 174 respectively. A symmetric boundary condition is applied to the side faces of the die, plug, and tube. The die, plug is constrained to move in any direction; the plug is given a displacement in X direction so that it passes completely through the die.

. The true stress strain curve for tube fig-1 shown.

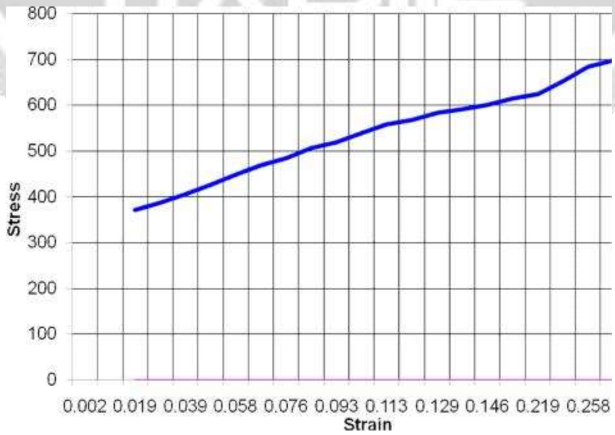

Fig. 1. True stress strain curve for ST-52 material (tube)

7.2 Modeling work in ANSYS-

First 2-D half geometry of die & tube about axis of die. Create area by key points, nodes. This is as shown in fig.2 for that go to,

Main menu >> Preprocessor >> Modeling >> Create >> Key- points>> in active CS Give the co-

ordinates of points of die & tube & for centerline. For area,
Main menu>>Preprocessor>>Modeling>>Create>>Areas>> Arbitrary>>through Key points. Then select the nodes to create area.

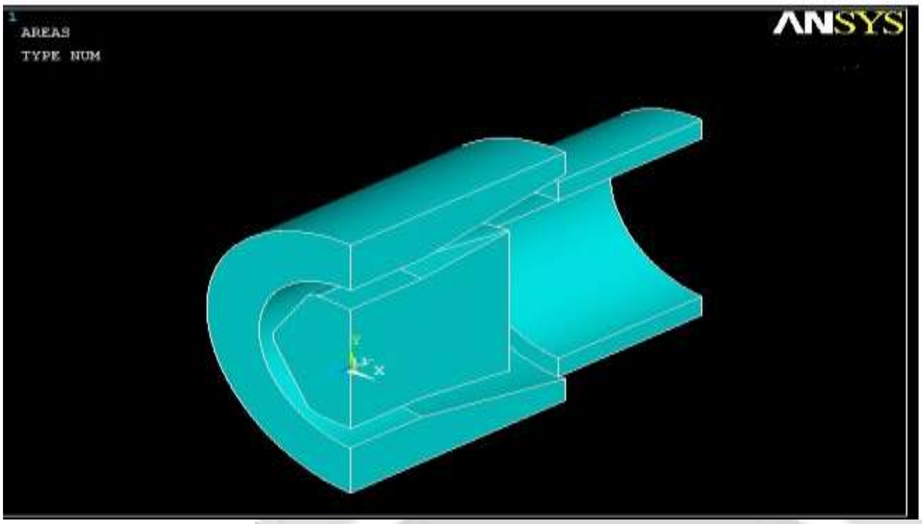

fig.2 3-D model of die & tube

7.3 General Postprocessor

Main menu>> General Postprocessor>> Read results>>Last set

Mainmenu>> Generalpostprocessor>> Plotresults>> Contourplot>> Nodal Sol. / Elemental Sol.

8. RESULT & DISCUSSION

As described above contact nonlinear analysis of tube drawing with fixed plug is done in ANSYS, results are von misses stress and displacement plot.The dimensional study is done for 10 mm Die land and second for 5 mm. Optimum die land is selected for minimum springback. For the same von misses stesses are plot for checking design safety.stress strain curve is obtain for simulating non-linear elastic propertyof tube.

8.1 ANSYS RESULTS FOR 10MM DIE LAND

8.1.1Von misses stress plot

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

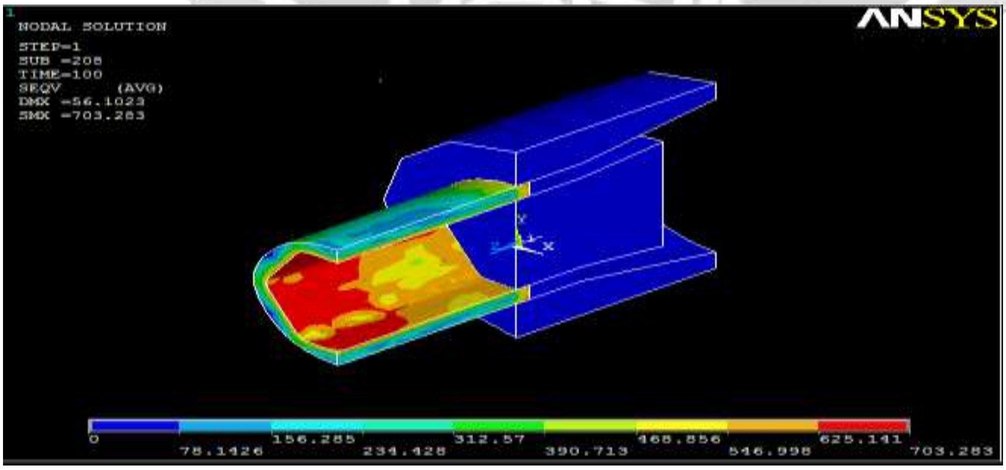

Fig-3 Von misses stress plot

Above von-misses stress plot from fig.6.1. Shows that maximum stress induced is 703.283 which is well below the ultimate stress value thus is no braking of tube takes place.

8.1.2 Stress-strain plot

As stess-strain curve is given as input for simulating material properties of various materials like ST-52 for tube. stress strain curve is obtain from ANSYS general postprocessor as shown below in fig.4

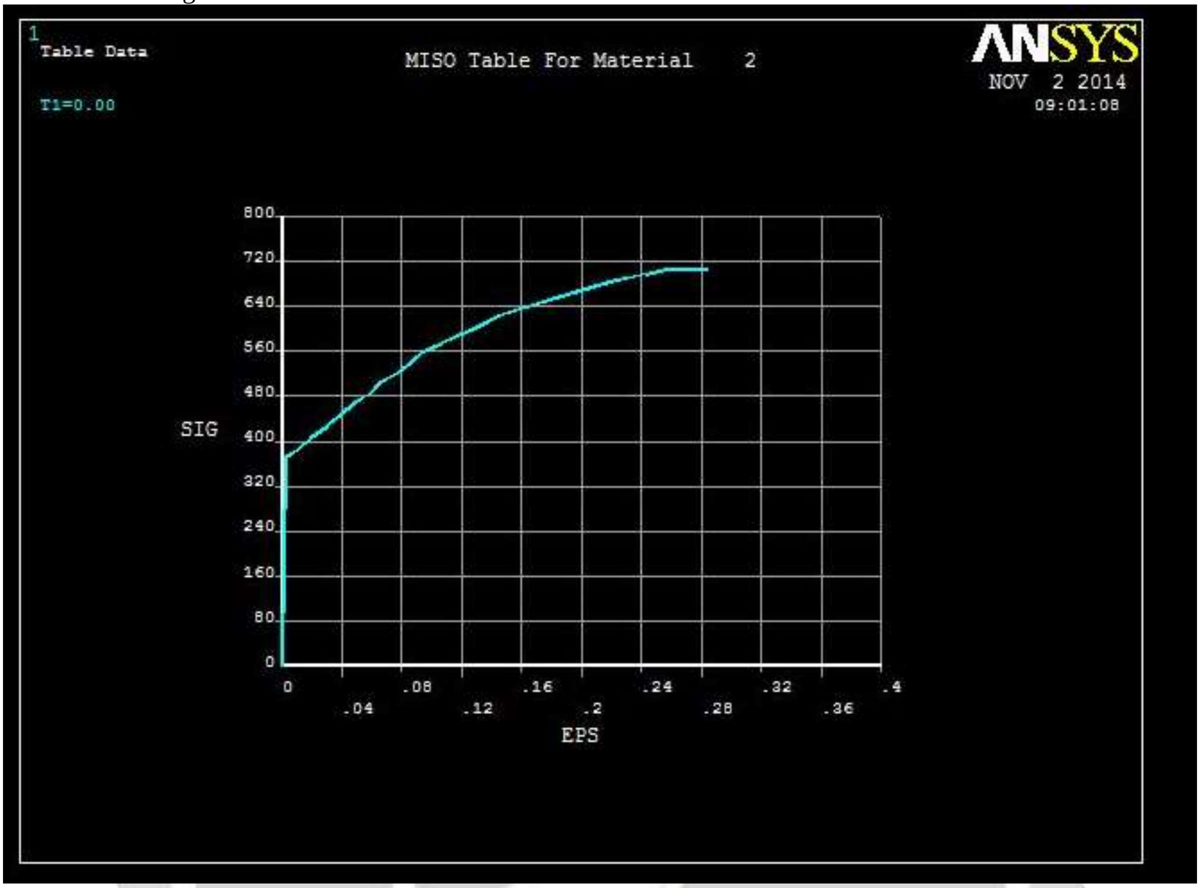

Fig.4.Stress strain plot from ANSYS

It is clear from stress strain plot that cold drawing of tube is simulated properly showing multilinear elastic property.

8.2 Table no.1 Displacement plot of 10mm die land

Sr.No	Node	X	Y	Z
1	9686	-27.1	-15.1	0
2	10490	-27.1	-17.35	0
3	8686	-26.6	-35.8	0
4	8685	-26.85	-39.4	0
5	10626	-32.25	-36.6	0
6	9656	-32.5	-18.2	0
7	10494	-37.4	-27	0
8	8690	-32.25	-36.6	0
9	8714	-26.85	-39.4	0

9.CONCLUSION

- 3D modeling of the tube drawing process helped in visualization and conceptualization. The modeling saves the research time and minimizes the risk of design failure.
- When the sectional tube is drawn through a die of average nominal dimensions, it is generally observed some dimensional variation due to elastic spring back.
- Simulation of the process helps to check the design of dies and plug as well helps to visualize the formation of hexagonal shaped tube.
- 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.
- The simulation helps to predict the dimension and the spring back of the tube.
- The spring back results obtain by FEA was found in an agreement with the experimental studies.
- The end effect found in the simulation was also found in experiment
- The FEM analysis can also be used for predicting the dimension of the actual process. Hence results in minimizing failures.
- The simulation techniques can also be used for validation of die and plug design when used for sectional tube formation such as rectangle, square, hexagonal, ovule, elliptical, octagonal etc.

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