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REVIEW ARTICLE

ANALYSIS OF SPRING BACK IN TUBE BENDING

[1*]Senthiil, P. V., [2]Miruduneka and [3]Aakash Sirusshti

[1*]Head, Director Advance Manufacturing Technology, Mechanical Engineering, St.Peters University, Chennai-600054, Tamilnadu, India
[2]VS Mirudhuneka, SAP Consultant, IBMLtd, DLF Towers, Chennai, Tamilnadu, India
[3]Aakash Sirusshti, Department of Mechanical, SRM University Vadapalani Campus, Chennai, Tamilnadu, India

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ABSTRACT

Spring back is the major issue in the bending of tubes. Presently trial and error methods are followed in the production of components for compensating the spring back problem. This takes an ample amount of time and money for the industries. More quantity of components gets rejected due to this problem. So this makes the companies to go for a solution to this problem. In this project the spring back analysis of hollow cylindrical tubes of various thickness and diameter is made. In this project we propose artificial neural network in which initial parameters are fixed to get desired final shape. An experimental method of bending the tubes is done to obtain the initial parameters. Then the initial parameters comprising of input values and target values are taught to the artificial neural network in the learning cycles. The network error is reduced by doing further iterations. Then the validation of the values is made. Now the input value is given to get the required output value. Comparison between the results obtained by both artificial neural network and experimental method is carried out to show the integrity of artificial neural network. Now we can get to compare the required spring back value from artificial neural network and experimental method within the area taught to it.

INTRODUCTION

Today, the hollow structural members are widely produced instead of the solid ones in manufacturing industry, and have a good developing trend in future. In the report of American Iron and Steel Institute (AISI), the proportion of light hollow members in the typical autos made in North America has been raised to 16% from 10% in the past fifteen years. Now, General Motor Corporation (GM) has made many light hollow members, including the engine cradle, the radiator cradle, the under beam, the shed cover joist, the inner support, and so on. The hollow members have a high performance/mass ratio, have a special advantage regarding the stiffness and bearing capacity due to strain hardening effect. The further improvement of the stiffness and intensity of the hollow member would be required to economize material and develop the technology. Hollow components are mostly produced by cold working process. Arun venkatesh *et al.* (2006). After the bending process is complete and the tooling has been withdrawn the bent tube spring backs due to the elastic nature of the tube material. This is called spring back or the elastic recovery of the tube. During the bending process internal stresses are developed in the tube and upon unloading the internal stresses do not vanish. After bending the extrados is subjected to residual tensile stress and the intrados is subjected to residual compressive stress. These residual stresses produce a net internal bending moment which causes spring back. Neural computing requires a number of elementary processing units called neurons, to be connected together into a neural network. In most common networks neurons are arranged in layers with the input data fed to the network at the input layer. The data then pass through the network to the output layer to provide the solution.

***Corresponding author: Senthiil, P. V.**
Head, Director Advance Manufacturing Technology, Mechanical Engineering, St.Peters University,Chennai-600054, Tamilnadu, India.

Literature Review

There are several methods available for cold-bending or hot-bending hollow cylinders. But the most popular method is cold bending of hollow Yang Jialing, Reid (1997), in their paper proposed an approximate method for the evaluation of the plastic hardening softening behavior i.e., the relationship between the bending moment and the curvature of pipes subjected to pure bending. Theoretical predictions from the simple analytical expressions suggested in this paper give results of the critical curvature, the critical strain, the maximum bending moment and the maximum change of the pipe diameter, which are in good agreement with the experimental ones during uniform ovalization. Based on observations of four-point bending tests, a local collapse model following the end of uniform ovalization stage is proposed to describe the softening behavior of purely bended pipes. Strano (2005) in his paper has suggested a computer-based methodology, called Tube ProDes, for process design of the rotary draw bending of tubes The minimum tool requirements for the rotary draw bending of tubes are the bend die, the clamp die and the pressure die. When, due to the tube geometry, bending is more difficult, the use of a mandrel and a wiper die might be necessary. Xi wang, *et al.* (2001), Especially when bending long tubes, subsequently assembled into complex parts, trial and error is often required for calculating over bending and to reduce or eliminate the risk of defects (wrinkling, excessive thinning and flattening).Mei Zhan *et al.* (2006) in their paper presented a numerical formulation method for compensating spring back. In their paper they explain that spring back inevitably occurs when the load is released due to the elastic property of the material. This leads to an increase in the radius of curvature and a reduction in the bending angle of the bent tube and further leads to the decrease in the geometric accuracy of the tube part and makes it difficult to fit the tube with others

Literature Summary

Spring back is the major issue which we come across while bending tubes as we saw from the literature review. Spring back is the geometrical difference between loaded and unloaded configurations of the tube. Dimensional error and material distortion are the major outcome of spring back effect. In practical applications, spring back is compensated by using a trial and error method and over bended angle is adjusted. But it needs a lot of time and also the cost is high. So a process control method is required for the spring back compensation.

Experimental Method

In this project the spring back analysis of hollow cylindrical tubes of various thickness and diameter are to be made.

Fig. 1. Bending roll

The use of mandrel and pressure guide plate in tube bending on a tube-bending machine greatly increases the required bending torque. Jun Zeng *et al.* (2008). The reason is that, not only the resistance to purely plastic flow bending of the tube must be overcome in the bending operation, but also the resistance of frictional forces generated at points where the mandrel and pressure plate contact the surface of the work to be bent. Experiments were conducted by using lubricants in the mandrel and removing scales. Xie daji *et al.* (1998).

Fig. 2. Bending roll and fixture with tube

They also conclude that production of bent tubes with minimized out-of-roundness in the bend zone requires lubrication of the mandrel and guide plate, cleaning of the tube surfaces to remove scale, and setting the mandrel at a 2-3 mm lead relative to the area of deformation

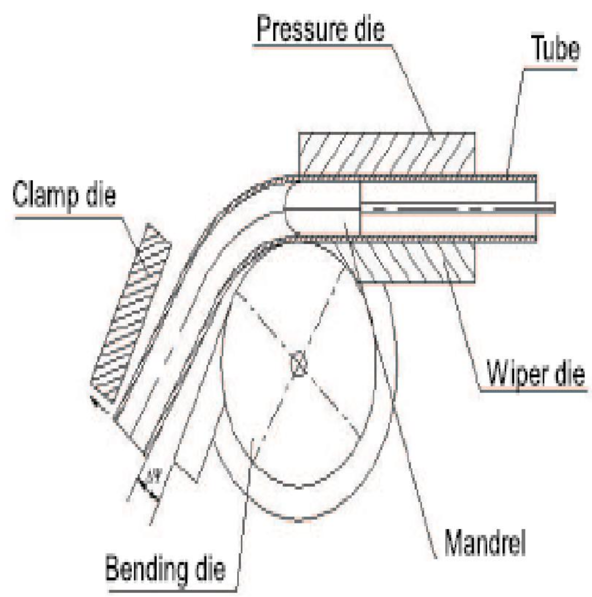

Fig. 3. Spring back of a bent tube upon unloading

Artificial neural network can be proposed in which initial parameters are fixed to get desired final shape. Inamdarl *et al.* (2000). An experimental method of bending the tubes is to be done to obtain the initial parameters. Then the initial parameters comprising of input values and target values are to be taught to the artificial neural network in the learning cycles. The network error is reduced by doing further iterations. Then the validation of the values is to be made. Now the input value is to be given to get the required output value. Comparison between the results obtained by both artificial neural network and experimental method is to be carried out to show the integrity of artificial neural network. Now we can get the required spring back value from artificial neural network within the area taught to it. Yang Jialing, *et al.* (1997).

Table 1. Experimental method spring back value

TUBE	TUBE DIAMETER (mm)	WALL THICKNESS (mm)	BENDING RADIUS (mm)	SPRINGBACK ANGLE (deg)
1	21.35	2.76	85	2.05
2	26.65	2.87	115	2
3	33.4	3.4	125	1.68
4	42.15	3.55	90	1.78
5	48.25	3.7	110	2.32
6	60.35	3.9	135	1.77
7	73	5.15	150	1.87

Artificial Neural Network

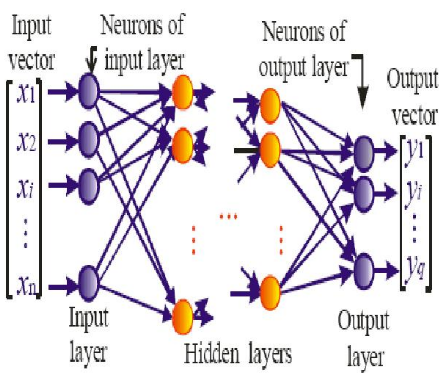

Fig. 4. General architecture of neural network

Table 2. Artificial neural network input

TUBE	TUBE DIAMETER (mm)	WALL THICKNESS (mm)	BENDING RADIUS (mm)
2	26.65	2.87	115
4	42.15	3.55	90
6	60.35	3.9	135
7	73	5.15	150

Conclusion

The spring back values obtained from experimental bending and neural network predictions are compared and the results are tabulated below

Thus from the table we can see that the neural network prediction is almost similar to the experimental bending results. We can now predict the spring back value of any number of tubes which has outer diameter, wall thickness and radius within the region of values taught to the neural networks. This avoids unnecessary time and money wasted in trial and error method of bending tubes to find spring back compensation. This project would be very useful for the industries which bend tubes of their required dimension which is not available as standard size. In that case this project may come in handy for the engineers to predict the spring back compensation.

REFERENCES

Arunvenkatesh, T, Prof Deivasigamani, R. 2006. "Analysis of spring back in deep drawing Process", MOSIM.

Inamdarl. M, Datel. P.P, Narasimhan. K, Maiti1. S.K and Singh. U.P. 2000. "Development of an Artificial Neural Network to Predict Spring back in Air Vee Bending", International *Journal for Advanced Manufacturing Technology*.

Jun Zeng, Zhaoheng Liu, Henri Champliaud. 2008. "FEM dynamic simulation and analysis of the roll-bending process for forming a conical tube", *journal of materials processing technology* 1 9 8 pp 330–343.

Mei zhan, He yangy and Liang huang. 2006. "A numerical-analytic method for quickly predicting spring back of numerical control bending of thin-walled tube", Journal of material science and technology, vol.22 no.5.

Strano M. 2005. "Automatic tooling design for rotary draw bending of tubes", *International journal of advanced manufacturing technology*.

Xi wang, Jian cao 2001. "Wrinkling limit in tube bending", vol. 123

Xie daji, Feng shengbo, Zhao rufa, Hu degui, Gu shouren, Wang zengmei.1998. "New development of the magnetic method for residual stress testing",*Acta mechanica solida sinica*, vol. 11, no. 2.

Yang Jialing, S.R. Reid. 1997. "Approximate estimation of hardening-softening behavior of circular pipes subjected to pure bending", *Acta mechanical sinica* (english series), vol.13, no.3.

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