Experimental Study of Springback for Air vee Bent Sheet Metal

Nitin Singh Thakur[1] A. K. Jain[2]
[1]ME IVth sem student [2]Associate professor
[1, 2] Jabalpur Engg. College Jabalpur (M P)

Abstract—*Traditionally, springback has attempted to be expressed in handbook tables or inspringback graphics. But both ways of giving expression to springback amount show shortcomings. This paper presents new springback graphics for air vee bent sheet metal parts. The developed experimental procedure has two main stages. First, the material identification by means of tensile test has been done. Next, bending tests for several specimens of different thicknesses have been carried out. Hence, springback values for different bending angles (among 22◦ and 90◦) of aluminum and stainless steel specimens were obtained and converted into graphics for the air bending process. Moreover, the most of the theoretical influences related to springback has been ascertained and they are discussed in detail. The obtaining of these new graphics enlarges the data that a sheet metal designer can use either to obtain the final geometry values of an air bending part or to design of bending dies.*

Key Words: - sheet metal, Bending,

I. Introduction

Springback occurs not only in flat sheets or plate, but also in rod, wire, and bar with any crosssection. This recovery or springback causes deviations in the desired final shape; therefore, the part after the springback may not be within tolerance limits, stopping of being suitable for the application for which it was designed.

II. Sheet Metal Bending

Most sheet metal bending operations involve a punch die type setup, although not always. There are many different punch die geometries, setups and fixtures. Tooling can be specific to a bending process and a desired angle of bend. Bending die materials are typically gray iron, or carbon steel, but depending on the work piece, the range of punch-die materials varies from hardwood to carbides. Force for the punch and die action will usually be provided by a press. A work piece may undergo several metal bending processes. Sometimes it will take a series of different punch and die operations to create a single bend. Or many progressive bending operations to form a certain geometry.

Sheet metal is referenced with regard to the work piece when bending processes are discussed in this section. However, many of the processes covered can also be applied to plate metal as well. References to sheet metal work pieces may often include plate. Some bending operations are specifically designed for the bending of differently shaped metal pieces, such as for cabinet handles. Tube and rod bending is also widely performed in modern manufacturing.

III. Sheet Metal Roll Forming

Roll forming of sheet metal is a continuous manufacturing process, that uses rolls to bend a sheet metal cross section of a certain geometry. Often several rolls may be employed, in series, to continuously bend stock. Similar to shape rolling, but roll forming does not involve material redistribution of the work, only bending. Like shape rolling, roll forming usually involves bending of the work in sequential steps. Each roll will form the sheet metal to a certain degree, in preparation for the next roll. The final roll completes the geometry.

This channel could be produced with a punch and die. However, in that case, the length of the channel would be limited by the length of the punch and die. Roll forming allows for a continuous part, (limited practically to the length of the sheet metal coil), that can be cut to whatever size needed. Productivity is also increased, with the elimination of loading and unloading of work. Rolls for sheet metal roll forming are typically made of grey cast iron or carbon steel. Lubrication is important and affects forces and surface finish. Sometimes rolls will be chromium plated to improve surface quality.

IV. Experimental procedure

The developed experimental plan consists of obtaining bend parts within an interval of 22◦ and 90◦ as bending angle. The experimental procedure has two stages. In the first one, the experimental study consists of the material identification by means of tensile test. The adoption of a material model is important, because the material properties have influence over the bending process. Two different common sheet metals, with different thickness, are formed: aluminum (very low work hardening) and stainless (high work hardening).

Fig.1: Ferrous sheet metal

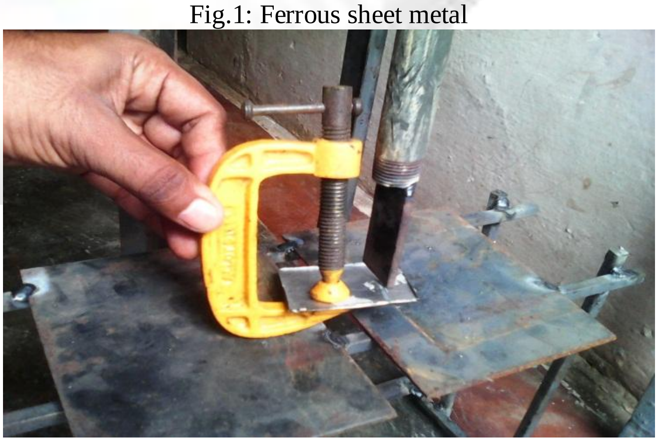

Fig.2: sheet metal with clamp

Fig.3: Experimental setup

In the second stage, bending tests for several specimens have been performed on a laboratory testing machine, anMTStensile testing machine. The dimensions of the bending specimens are 130mm×50 mm. Their thicknesses are 1 and 1.35mm for aluminum samples, and 1, 1.5, 2 and 3mm for stainless sheet metals. To be able to do bending tests, a bending sub-frame has been built, and as a unit, placed in the laboratory machine. This test machine allows a

very accurate force–displacement registration. In the sub-frame, high quality industrial bending tools are used (MECOS tools). A punch of 0.8mm radius and a 'V' type-bending die with four different widths (16, 22, 35 and 50 mm) were used as bending tools. Nowadays, bending tool combinations with a reduced die width are increasingly being used .

As well as bending sub-frame, a loaded bending angle measurement fixture was developed, because its determination is essential for the computation of the springback amount. The transducer leans on the internal surface of one of the bent sheet straights legs. The vertical displacement

V. RESULTS

Table .1 Spring back effect in 1 mm Stainless steel

Sr. No.	Final Angle in Degree	Spring back Angle in degree
1	10	10
2	20	13
3	30	18
4	40	21
5	50	24

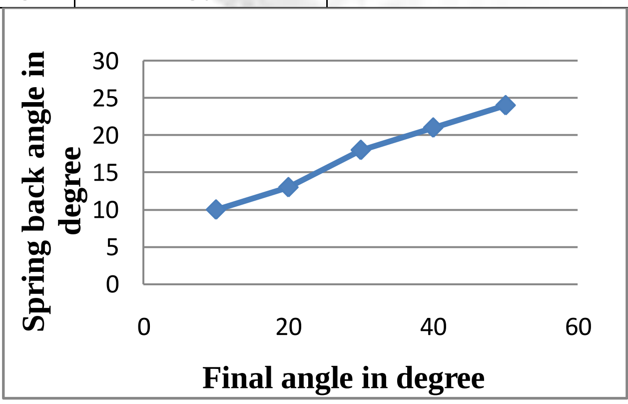

Fig.4: Spring back effect in 1 mm Stainless steel

Table .2 Spring back effect in 2 mm Stainless steel

Sr. No.	Final Angle in Degree	Spring back Angle in degree
1	10	12
2	20	17
3	30	19
4	40	24
5	50	22

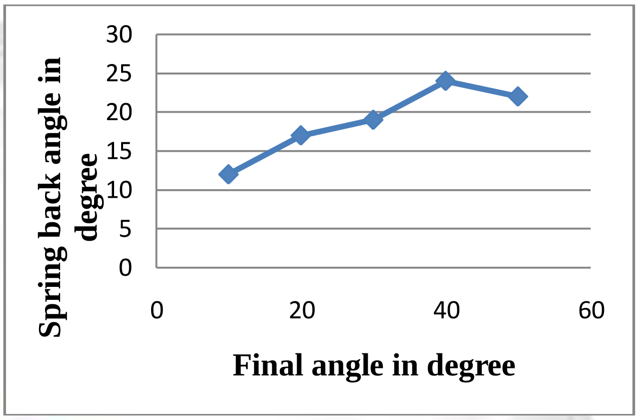

Fig.5: Spring back effect in 2 mm Stainless steel

Table .3 Spring back effect in 3 mm Stainless steel

Sr. No.	Final Angle in Degree	Spring back Angle in degree
1	10	8
2	20	11
3	30	17
4	40	19
5	50	21

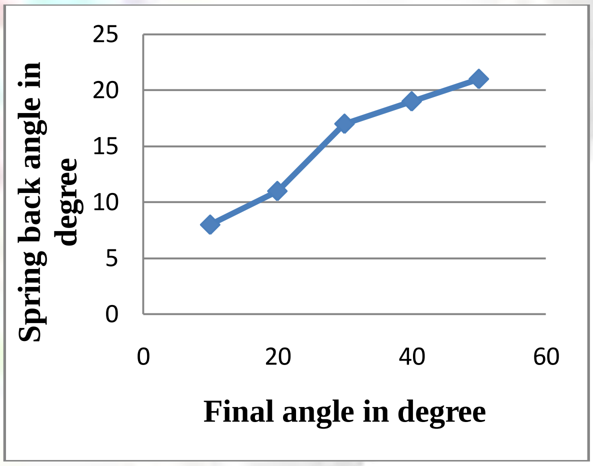

Fig.6: Spring back effect in 3 mm Stainless steel

VI. CONCLUSION

First of all, it has to be reminded that springback can be minimized by using suitable die designs but cannot be eliminated. For getting that reduction or compensation, springback graphics are used. This work presents some of this kind of useful graphics that relate springback with the main parameters that have influence over this phenomenon.

Finally, this experimental work has been to carry out a prediction tool based on a neural network, so the developed tool can predict the springback amount, the final bending radius and the punch penetration.

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