ISSN (Print) : 2347-6729
ISSN (Online) : 2348-3105

International Journal on Recent Researches in Science, Engineering & Technology (IJRRSET)

A Journal Established in early 2000 as National journal and upgraded to International journal in 2013 and is in existence for the last 10 years. It is run by Retired Professors from NIT, Trichy. Journal Indexed in JIR, DIIF and SJIF.

Volume 7, Issue 3
March 2019.
JIR IF : 2.54

Research Paper
Available online at: www.jrrset.com

SJIF IF : 4.334
Cosmos: 5.395

Received on: 04.03.2019 **Published on:** 28.03.2019 **Pages :** 59-64

A REVIEW ON SPRING-BACK IN SHEET METAL V BENDING

Dr.S.Prabhakar
IES College of Engineering, Thrissur, Kerala, India

ABSTRACT

One of the major problems in sheet metal forming processes is the elastic recovery of sheet during unloading of punch, called spring-back, which affects the dimensional accuracy of the product. This phenomenon will affect by various parameter such as process parameter and material parameter, etc. This paper deals with a review on Spring-back in Sheet Metal V Bending Process for the various materials are CK67 steel, aluminum and stainless steel.

I. INTRODUCTION

The sheet metal forming process involves a combination of elastic–plastic bending and stretch deformation of the work piece. These deformations may lead to a large amount of spring-back of the formed part. It is desired to predict and reduce spring-back so that the final part dimensions can be controlled as much as possible.

One of the most common metal working operations is bending. This process is used not only to form parts such as flanges, seams etc. but also to impart stiffness to the part by increasing its moment of inertia. The terminology used in bending is shown in figure 1.

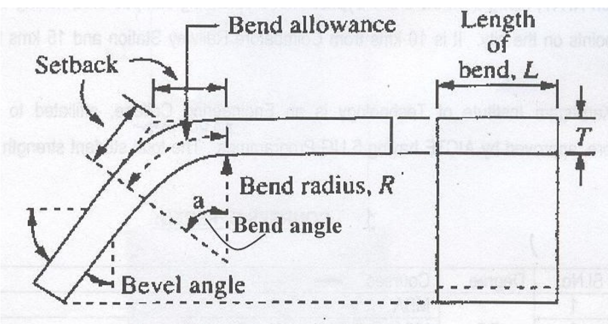


Figure 1: Bending terminology.

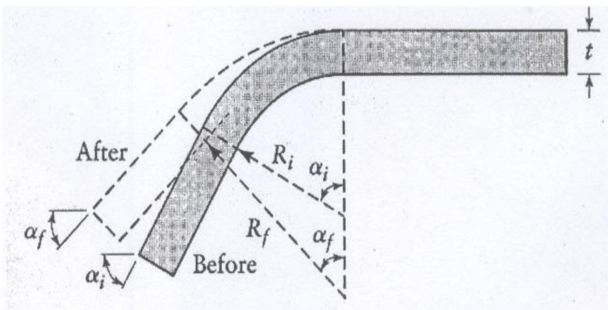


Figure 2: Terminology for spring back in Bending.

The outer fibers of the material are in tension and the inner fibers are in compression. Theoretically, the strains at the outer and inner fibers are equal in magnitude and are given by the equation.

$$e_0 = e_i = \frac{1}{(2R/T)+1} \quad \text{……..(1)}$$

II. SpringBack

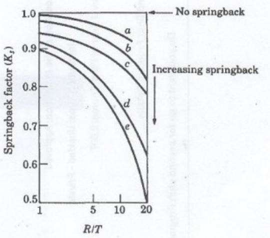
Because all materials have a finite modulus of elasticity, plastic deformation is follow' by elastic recovery upon removal of the load; in bending, this recovery is known as *springback.* As shown in Fig. 1, the final bend angle after spring back is smaller and the final bend radius is larger than before. This phenomenon can easily be observed by bending a piece of wire or a short strip metal. Spring back occurs not sheets or plate, but also in bending bars, rod, and wire of any cross-section. A quantity characterizing springback is the springback factor Ks, which is defined as follows. Because the bend allowance is the same before and after bending (see figure 1), the relationship obtained for pure bending is from this relationship, Spring factor, Ks is defined as:

$$\text{Bend allowances} = \left(R_i + \frac{t}{2}\right)\alpha_i = \left(R_f + \frac{t}{2}\right)\alpha_f \quad \text{………………..(2)}$$

$$K_s = \frac{\alpha_f}{\alpha_i} = \frac{(2R_i/t)+1}{(2R_f/t)+1} \quad \text{…………………...(3)}$$

where Ri and Rf are the initial and final bend radii, respictively. It can be noted Fromeqution 2 that Ks depends only on the R/t ratio. Where R is the minimum bend radius. A springback factor of Ks =1 indicates no springback, and Ks=0 indicates complete elastic recovery (see figure 3).

Figure 3: Spring back factors K_s for various materials. R is the minimum bend radius.
(a) 2024-0 and 7075-0 aluminum;
(b) Austenitic stainless steels;
(c) 2024-T aluminum;
(d) ¼-hard austenitic stainless steels;
(e) ½-hard to full-hard austenitic stainless steels.



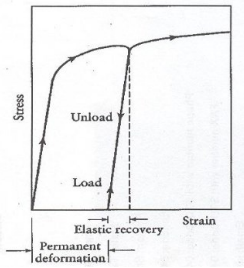


Figure 4: Schematic illustration of loading and unloading of a tensile-test specimen. Note that during unloading, the curve follows a path parallel to the original elastic slope.

Figure 3

The amount of elastic recovery - as shown in figure 4 - depends on the stress level and the modulus of elasticity, *E,* of the material; hence, elastic recovery increases with the stress level and with decreasing elastic modulus. Based on this observation, an approximate formula has been developed to estimate spring back: In this equation, *Y* is the uniaxial yield stress of the material.

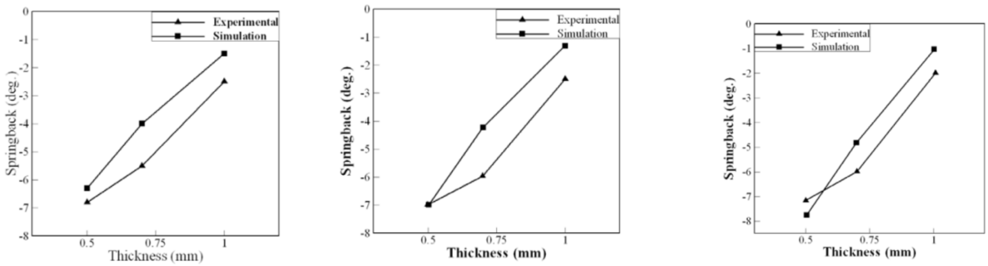
$$\frac{R_i}{R_f} = 4\left(\frac{R_i Y}{Et}\right) - 3\left(\frac{R_i Y}{Et}\right) + 1 \quad \text{………………(4)}$$

3. Spring-back of CK67 steel sheet

3.1. Effect of sheet thickness

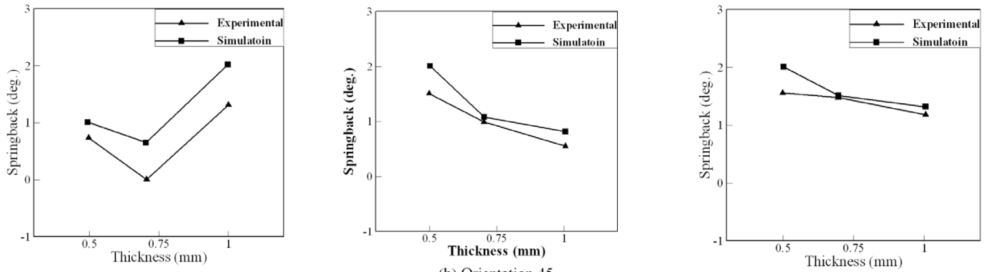
The influence of sheet thickness on springback in V-die bending at various sheet orientations for punch tip radii 2 mm and 4 mm, respectively. The values on the vertical axis may be positive or negative. The negative value of spring-back is called spring-go. By increasing the sheet thickness from 0.5 mm to 1 mm, the amount of spring-back and spring-go decreases; i.e. the sheet bend angle becomes closer to the die angle. There was an exception for the thickness 0.7 mm at the punch tip radius 4 mm. Fig. 5. Shows the effect of the sheet thickness on spring-back at various sheet orientations for the punch tip radius. As it is seen from the figure, by increasing the sheet thickness, the amount of spring-back decreases. This is in agreement with the results obtained for V-die bending.

In sheet metal forming processes, the less the spring-back or spring-go, the better be the process parameters selected. According to the diagrams, the experimental and simulation results are in good agreements. [1]



(a) Orientation 0 (b) Orientation 45 (c) Orientation 90

Fig.5. Effect of sheet thickness for punch tip radius 2 mm; V-die bending.

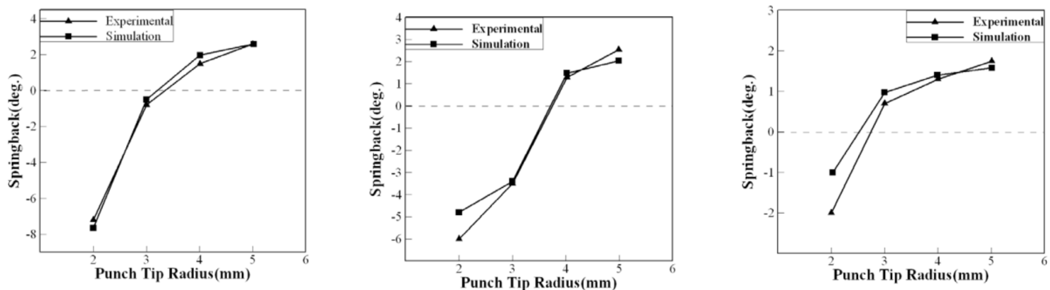


(a) Orientation 0 (b) Orientation 45 (c) Orientation 90

Fig. 6. Effect of sheet thickness for punch tip radius 4 mm; V-die bending.

3.2. Effect of punch tip radius

The changes in the spring-back/spring-go versus punch tip radius for orientation 90° at various sheet thicknesses in V-die bending. As the results show in the illustrated figures, for any of the sheet thicknesses, at a certain value of the punch tip radius there is no spring-back/spring-go. The spring-go phenomenon occurs at smaller punch tip radii. By increasing the punch tip radius, spring-go is converted into spring-back; at punch tip radius 2 mm there is only spring-go, and at punch tip radii 4 mm and 5 mm there is only spring-back. The experimental and FEM simulation results showed that the spring-go characteristic occurred at the punch tip radius less than a certain value, and the amount of the spring-go decreased as the punch tip radius increased. In addition, the amount of the spring-back increased as the punch tip radius increased. The thickness of the sheet is very vital to select a suitable punch tip radius for the reduction of the spring-back/spring-go phenomena. For instance, for thickness of 0.5 mm, R = 3 mm is a suitable radius.[1]



(a) Thickness 0.5 mm (b) Thickness 0.7 mm (c) Thickness 1 mm

Fig. 7. Effect of punch tip radius for orientation 90_; V-die bending.

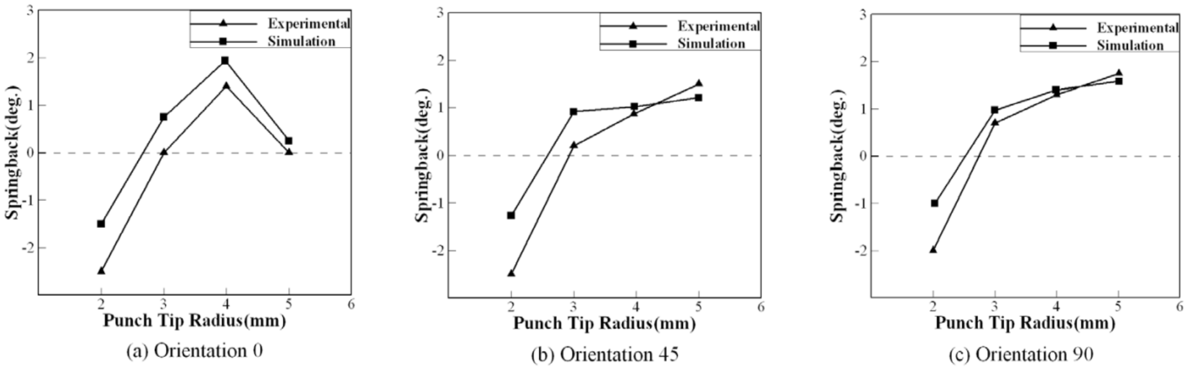


Fig. 8. Effect of punch tip radius for thickness 1 mm; V-die bending.

4. Spring-back of aluminum and stainless steel

There were obtained 22 data groups grouped around die width parameter. Recorded measurement results were subsequently analyzed, and several springback graphics were obtained, a few appeared in this paper. Next, some of them for stainless are shown from Figs. 3 and 4 under the same die width and die radius (50 and 2 mm, respectively) and different thicknesses. Springback values in air vee bending must be positive, negative values appearance means that bending has changed into bottom vee bending. This situation has occurred in some aluminum specimens when the die width (wd) was the smallest (16 mm). Because of that, these values have not been taken into account in this study. Fig. 5 shows the values around zero for that experimental condition, and the evolution of the springback for the other die widths (50, 35 and 22 mm). [2]

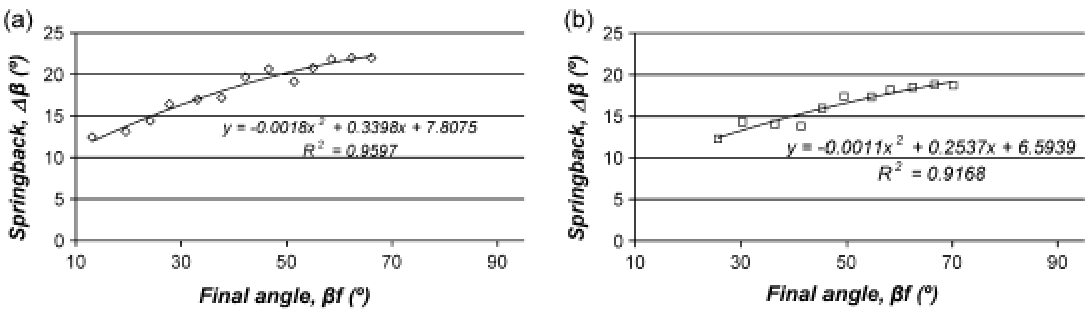


Fig. 9. Springback vs. final bending angle graphic of: (a) 1mm and (b) 1.5mm stainless.

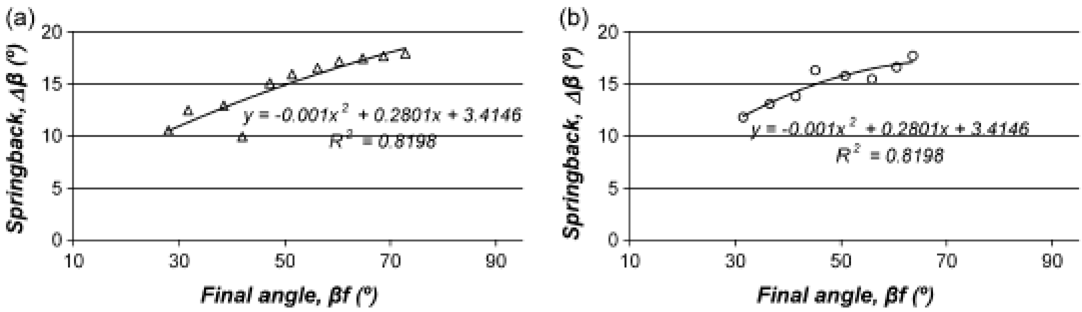


Fig.10. Springback vs. final bending angle graphic of: (a) 2mm and (b) 3mm stainless.

5. Spring-back of stainless steel sheet metal

Average curve of each graph was drawn, and corresponding spring-back equations formulated. Polynomial curve method has been found to be the most appropriate among the tried five different methods here. Results from the first and second methods were presented for all thickness values in Fig. 13. In Fig. 13, Method 1 requires that the gap between the punch and female die be equal to the thickness of the sheet material, and the punch be held on the die for 20 s. Method 2 requires that a gap between the punch and female die equal to the thickness of sheet material be given, but the punch, not held on the die, be removed as soon as bending is over. According to the results obtained, the more the punch load is held on the sheet metal, the lesser spring-back values become. That is to say, holding the punch load on the sheet metal more increases the bending time, but decreases the value of spring-back. [3]

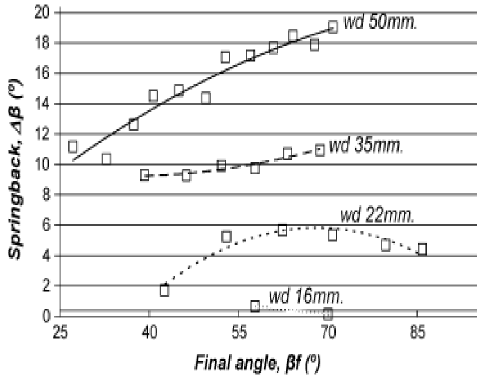


Fig.11. Springback vs. final bending angle graphic of 1.35mm aluminum, different

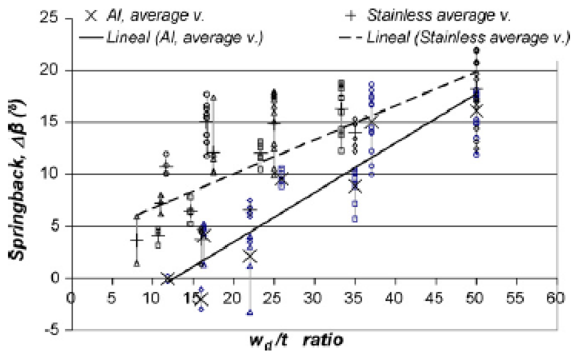


Fig. 12. Springback vs. wd/t ratio graphic, aluminum and stainless.

5. Spring-back of stainless steel sheet metal

Average curve of each graph was drawn, and corresponding spring-back equations formulated. Polynomial curve method has been found to be the most appropriate among the tried five different methods here. Results from the first and second methods were presented for all thickness values in Fig. 13. In Fig. 13, Method 1 requires that the gap between the punch and female die be equal to the thickness of the sheet material, and the punch be held on the die for 20 s. Method 2 requires that a gap between the punch and female die equal to the thickness of sheet material be given, but the punch, not held on the die, be removed as soon as bending is over. According to the results obtained, the more the punch load is held on the sheet metal, the lesser spring-back values become. That is to say, holding the punch load on the sheet metal more increases the bending time, but decreases the value of spring-back. [3]

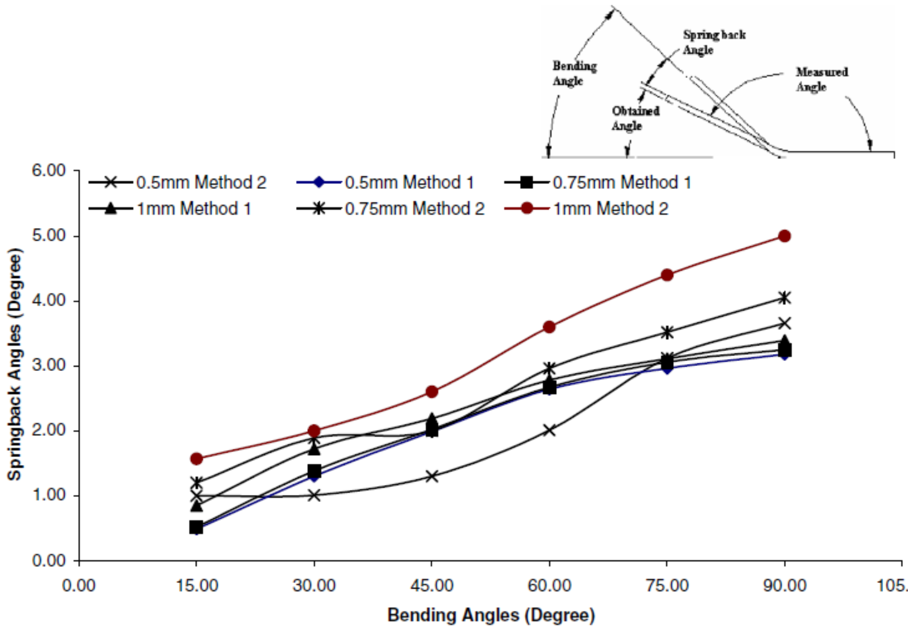


Fig.13. A combined presentation of the spring-back graphs obtained from both first and second methods.

As thickness of sheet material and bending angle increase, there is an increase in the spring-back values, too. An increase in bending angle affects spring-back more than the thickness of the sheet material. It is known that springback depends on the material and parameters of the process. Dimensions of die, bending angle, and especially press depth are very important to spring-back. So some crushing is noticed around the bending points of the materials, which are pressed between the die and the punch. Thus, crushing around the bending fields prevents sensitive determination of the spring-back value. [3]

Conclusion

Parameters Influencing Spring-back in sheet metal forming process for various materials are CK67 steel, aluminum and stainless steel was reviewed for V-die bending processes. Can minimize the spring-back to increasing the sheet thickness resulted in a decrease in the spring-back, optimum punch tip radius was reduced spring-back, The bending angle to the rolling direction, suitable die designs, bending radius, punch penetration, increasing the time to keep the punch on renders decrease in the spring-back value. Holding the punch load decreases the spring-back value etc.

References

[1] M. Bakhshi-Jooybari , B. Rahmani, V. Daeezadeh, A. Gorji. The study of spring-back of CK67 steel sheet in V-die and U-die bending processes. Materials and Design 30 (2009) 2410–2419.

[2] M.L. Garcia-Romeu , J. Ciurana , I. Ferrer. Springback determination of sheet metals in an air bending process based on an experimental work. Journal of Materials Processing Technology 191 (2007) 174–177.

[3] Ozgur Tekaslan, Nedim Gerger, Ulvi Seker. Determination of spring-back of stainlesssteel sheet metal in V bending dies. Materials and Design 29 (2008) 1043–1050.

[4] Komgrit Lawanwomg, Hiroshi Hamasaki, Ryutaro Hino, Fusahito Yoshida. A novel technology to eliminate U-bending springback of high strength steel sheet by using additional bending with counter punch. Procedia Engineering 81 (2014) 957 – 962.

[5] Ling Ye, Lee HP, Cheok BT. Finite Element Analysis of Spring Back in L Beanding of Sheet Metal, J Mater Process Technology.2005;168(2):296:302.