

THE WELDING LINE DIRECTION INFLUENCE ON SPRINGBACK BEHAVIOUR OF A U-SHAPED PART MADE FROM TAILOR WELDED STRIPES

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Abstract. This paper refers to some experimental tests concerning the formability and springback of a U-shaped part manufactured from tailor welded stripes. The final geometry of the obtained part is seriously affected by springback phenomenon. This paper work is trying to prove out the important role of welding line direction with respect to the forming force direction has on the springback phenomenon. The influence of the welding line orientation on the tailor welded stripes springback is examined during experimental tests using transversal and longitudinal welding line.

Keywords: tailor welded stripes, welding line direction, springback,.

1. INTRODUCTION

Recently, the automobile industries have been trying to develop various types of model and high-quality low-cost cars to meet the customer's requirements and to find new ways of establishing this goal effectively. For the purpose of achieving the above presented objectives, different methods using various welding processes (such as laser-welding, mash seam-welding processes, etc.) were developed [1, 2].

A tailor welded blank consists of two or more sheets that have been welded together in a single plane prior to forming. The sheets can be identical, or can have different thickness, mechanical properties or surface coatings. Welding line can be placed transversal or longitudinal as a function of the forming direction [3]. (Fig. 1)

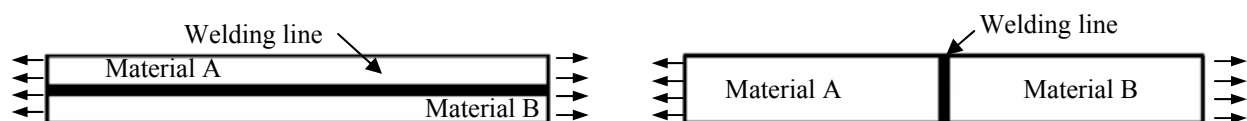


Fig. 1. Different positions of the welding lines as a function of the forming direction

Despite all the made efforts concerning formability of tailor welded stripes, accurate prediction of the springback remains elusive [2]. Many studies presents a wide range of information about the formability and failure patterns of welded stripes. Springback is mainly influenced by the punch and die profile radii, initial clearance between punch and die, friction conditions, rolling direction of the materials, blankholder force, material properties (elastic modulus, Poisson's coefficient, constitutive behavior in plastic field) etc. [4, 5].

The purpose of this study was to investigate the welding line direction influence on the springback effect of the tailor welded stripes. To achieve this goal, experimental tests were carried out with different orientation of the welding line with respect to the forming force direction.

2. EXPERIMENTAL RESEARCHES CONCERNING THE WELDING LINE DIRECTION

The tailor welded stripes used in the experiments were made from FEPO and E220 steel. Strips of 350×30 mm dimensions and 0.7 mm thickness were cut from the metal sheet along to the material rolling direction (fig. 2).

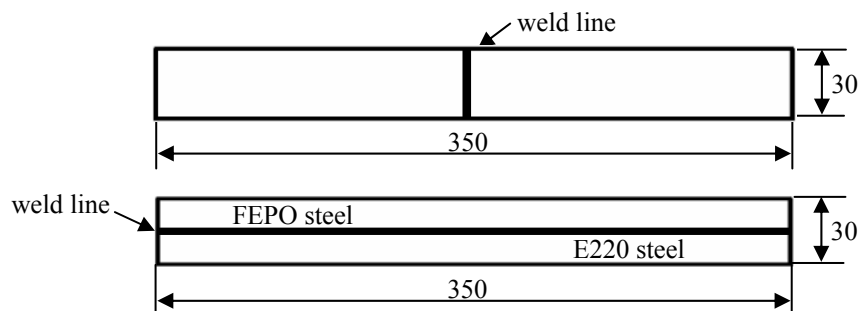


Fig. 2. Tailor welded strips with transversal and longitudinal weld line (unit: mm)

In table 1 are presented the mechanical properties of FEPO and E220 steel determined for 0° material rolling direction.

Table 1. Mechanical properties of the base materials

Material name	Young modulus MPa	Tensile strength MPa	Uniform Elongation %	Total Elongation %	Plastic strain ratio r	Strain-hardening coefficient n
FEPO	200 825	281	17.3	28,8	1.86	0.234
E220	204 000	348	10.2	20,4	1.42	0,190

2.1 Experimental Layout

The experimental tests were realized using a die for rectangular parts that allowed utilization of different blank holder forces. The device is presented in figure 3. The experimental tests have been done with different welding line orientation with respect to the forming direction. The blankholder force was maintained constant to 10 kN. The forming force was generated using a mechanical tensile test machine. The profile of the obtained part and the parameters of springback were measured with a numerical controlled scanning machine Roland Model MDX-15 (Fig. 4), and the obtained data was processed in CAD software.

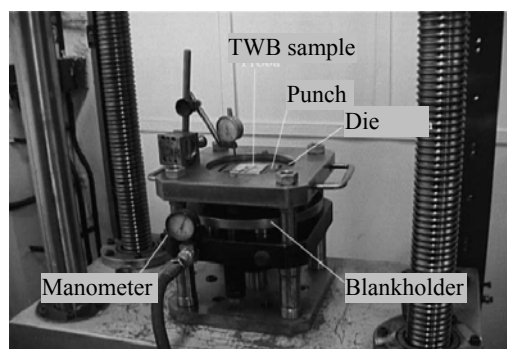


Fig 3. Experimental device



Fig. 4. Measuring installation

Springback parameters that were observed during the tests are presented in figure 5:

- θ_1 – sidewall angle between real profile and theoretical profile;
- θ_2 – flange angle between real profile and theoretical profile;
- ρ – curvature radius of the sidewall.

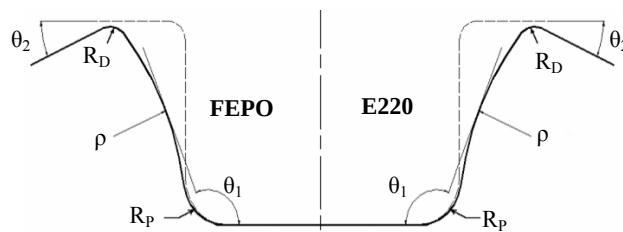


Fig. 5. Geometrical springback parameters

2.2 Experimental Results

In figure 6 are presented two parts made by tailor weld blanks with transversal and longitudinal weld line.



Fig. 6. Parts made by TWBs with transversal and longitudinal weld line

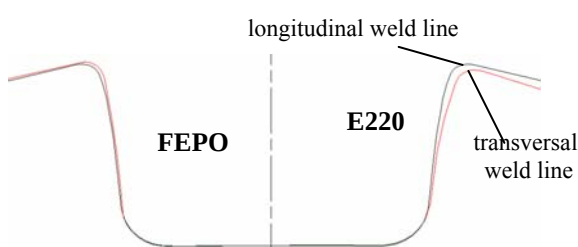
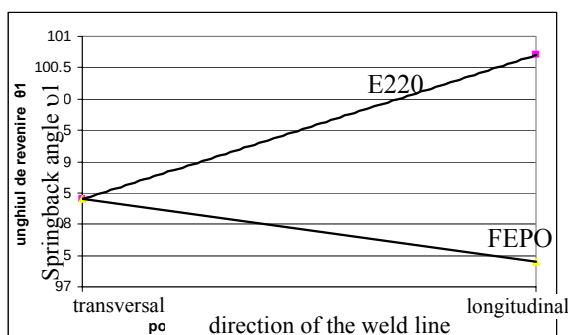
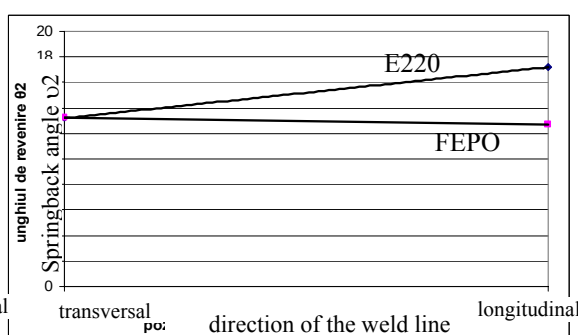


Fig. 7. Weld line direction influence on springback of TWBs

The values of springback parameters are recorded in table 2 and presented in figures 8, 9 and 10.

Table 2. Springback parameters

Welding line orientation	FEPO						E220					
	Angle θ_1 [grd]		Angle θ_2 [grd]		Angle θ_1 [grd]		Angle θ_2 [grd]		Angle θ_1 [grd]		Angle θ_2 [grd]	
	Theoretic value	Measured value	Theoretic value	Measured value	Theoretic value	Measured value	Theoretic value	Measured value	Theoretic value	Measured value	Theoretic value	Measured value
transversal	90	97.4	0	12.7	:	180.47	90	100.7	0	17.2	:	106.79
longitudinal	90	98.4	0	13.2	:	168.36	90	98.4	0	13.2	:	168.36

Fig. 8. Influence of weld line direction on angle θ_1 Fig. 9. Influence of weld line direction on angle θ_2

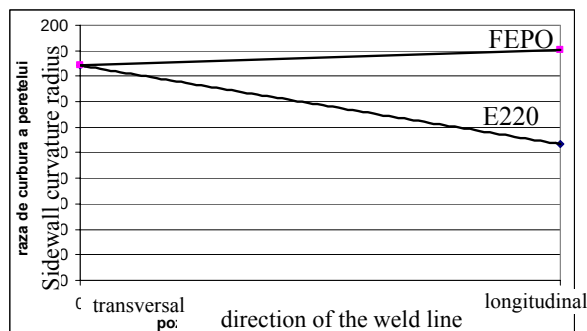


Fig. 10. Influence of weld line direction on sidewall radius ρ

4. CONCLUSIONS

The influence of welding line direction with respect to the forming direction is the following:

- the TWB part with the weld line placed longitudinally have both angles θ_1 and θ_2 approximately equal with those of the FEPO steel area from the part with transversal weld line;
- the part area made by E220 present a springback intensity higher than the part with longitudinal weld line;
- sidewall radius of the longitudinal weld line part is smaller than the sidewall radius of FEPO area from TWBs with transversal weld line and smaller than sidewall radius of E220 area.
- use of TWBs with longitudinal weld line leads to a diminution of springback effect. The springback intensity of parts with longitudinal weld line is given mainly by the springback of the weld line.

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