CODEN: MINSC5 – 420
Received: April 26 , 2010
Accepted: June 7, 2010

Mechanical Engineering – Scientific Journal, Vol. **29**, No. 1, pp. 47–51 (2010)
ISSN 1857–5293
UDK: 621.771:669.056

Original scientific paper

INFLUENCE OF THE SURFACE QUALITY DUE TO A HOLE DERIVED IN INITIAL MATERIAL PROCESSING OF COLD SHEETS WITH DRAWING

Slavčo Cvetkov[1], **Atanas Kočov**[2]

[1]*Faculty of Mechanical Engineering, Vinica, University "Goce Delčev", Štip, Republic of Macedonia,*
[2]*Faculty of Mechanical Engineering, "SS Cyril and Methodius" University in Skopje,*
P.O. Box 464, MK-1001 Skopje, Republic of Macedonia
slavco.cvetkov@ugd.edu.mk // nasko@mf.edu.mk

A b s t r a c t: A research was performed about the influence of the surface quality due to a hole derived in initial material processing of cold-rolled steel sheets with drawing. This influence was researched through the surface quality obtained by the type of preparation of the hole surface without prejudice to the precise measurements of the achieved quality (asperity). The aim is to indicate how the type of manufacturing the holes can improve the workability of cold-rolled sheets and help solve technical production problems of drawing parts with previously made holes in the initial material.

Key words: drawing; effective deformations; effective stress: quality of the hole surface; punched; ground and unscrewing holes

1. INTRODUCTION

Openings without stringent requirement for their shape, position and dimensions and for various purposes: holes for ventilation, drainage holes for water and dirt, various exemptions for access assembly tools, forming a flat surface near a vertical wall often are found on the walls of parts made from sheets by drawing.

Their manufacturing after the process of drawing, especially in arias with complex form is quite difficult, sometimes impossible, requiring preparation of complex and expensive tools, increases the time of creation and thus the cost of the product. Therefore it is much better and more economical these openings to be performed in the initial material before drawing.

In such cases the process of drawing is different from the process of drawing with continuous surfaces. Long years of work experience with technological processes of drawing showed that very often the openings a critical place in the process of drawing are. Cracks appear on the drawing parts starting from the surface of the openings. It is therefore necessary to study the influential factors that can enhance the process of drawing and to improve utilization of available plastic properties of the material. Practice has shown that one of the influential factors is also the quality of the surface of the previously derived hole in the initial material.

2. PREPARATION FOR EXPERIMENTAL RESEARCH

The test was carried out with cold-rolled steel sheet Č 0147(RSt 13 according to DIN 17006), 1 mm thick. The sheet metal is cut in thin sheets from which with presser tools circular plates with diameter of 179 mm are cut. For the survey five thin flat circular plates with diameter of 179 mm from the examined material are prepared. One without a hole, and four with holes. At the center of four thin plates circular holes with diameter 12 mm are derived. The holes are made with unscrewing grinding and piercing. Circular plates with four different qualities of the hole surface are prepared in that way. Table 1 is gives the plates marked, dimensions of openings and the method of manufacturing.

On the drawing boards a measurement network of concentric circles and circles with d_o = 5 mm in radial directions is mechanically applied.

Table 1

Plate marked	Diameter of hole (mm)	Method of manufacturing the hole
2.4	Without hole	
3.2	12.04	unscrewing
3.4	12.14	grinding
4.2	12.0	Pressed by tool
4.3	12.0	Pressed by tool

3. PERFORMING THE EXPERIMENTS

The experimental research is carried out with hydraulic drawing on the Erickson test machine. A drawing of a flat plate without a hole until the emergence of a crack is carried out for results comparison [4].

First in the test tool a plate without a hole is inserted, and then a plate with a hole is placed on it. The plate marked 4.2 in which the hole is performed by presser tools during the drawing is positioned so that the entrance of the puncher is on the outside of the convex spherical surface. The plate marked 4.3 in which the hole is performed by the same tool is during the drawing is positioned so that the exit of the puncher is on the outside of the convex spherical surface. The drawing is performed until the emergence of a crack in the drawn plate with a derived hole.

Figure 1 shows the photograph of a drawn piece of initial material marked 3.2 on which a hole was derived by unscrewing.

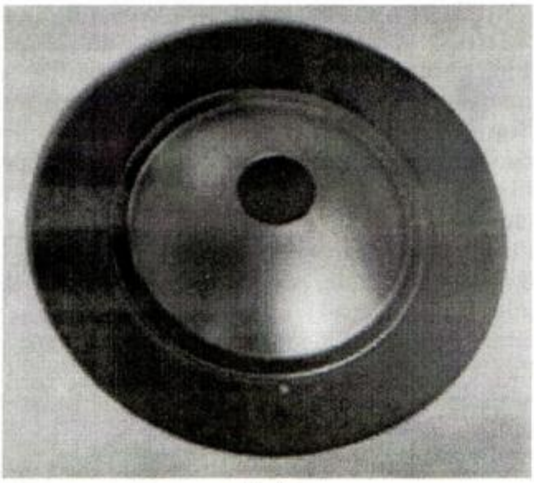

Fig. 1

4. MEASUREMENT AND PROCESSING THE RESULTS

After drawing, circles from the measurement network with a diameter d_0 are deformed into ellipses with axes d_1 and d_2. The longer axis is marked with d1 and it lies in the tangential direction, while d_2 is the shorter axis and it lies in the radial direction. The ellipse axes are measured to the nearest 0,1 mm. The measurement was carried out in the direction of rolling. By measuring deformations in one direction anisotropy impact of the material (metal sheet) is avoided. Accordingly, it is possible to compare the stress-deformational ratio for different qualities of the hole surface and compare them with the stress-deformational condition while drawing a metal sheet without a derived hole.

After measuring the ellipses' axes are determined:

1. Logarithmic deformations φ_1, φ_2 and φ_3 according to the equations [5]:

$$\varphi_1 = \ln\frac{d_1}{d_n},\ \varphi_2 = \ln\frac{d_2}{d_0} \quad \text{and} \quad \varphi_3 = -(\varphi_1 + \varphi_2)$$

2. Effective deformations (intensity of deformations):

$$\varphi_e = \frac{2\sqrt{1-m+m^2}}{2-m}\varphi_1$$

where $m = \dfrac{\sigma_1}{\sigma_1}$ is the stress ratio.

3. Effective stress (stress intensity)

$$\sigma_e = R_m e^{\varphi_m}\left(\frac{\varphi_e}{\varphi_m}\right)^{\varphi_m}$$

where:

R_m – tearing strength of the material previously examined experimentally determined

φ_m – maximum steady logarithmic deformation of material previously examined experimentally determined

4. Stress σ_1

$$\sigma_1 = \frac{\sigma_e}{\sqrt{1-m+m^2}}$$

5. Stress σ_2

$$\sigma_2 = m\sigma_1$$

5. RESULTS

Figure 2 shows a diagram of the change of experimentally obtained effective deformation fie depending on the radius of the measuring network of the initial flat metal plate for the part (piece) drawn from the initial material without a hole derived, curve marked 2.4. The same diagram gives the hanges of effective deformation fie for the parts (pieces) drawn from the initial material with a hole derived. Curves are marked 3.2, 3.4, 4.2 and 4.3 as per Table 1.

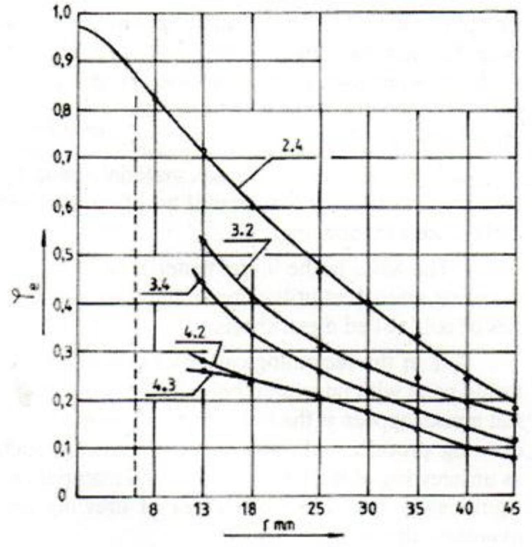

Fig. 2

Figure 3 shows a diagram of the change of experimentally obtained effective stresses σ_e depending on the radius of the measuring network of the initial flat metal plate for the part (piece) drawn from the initial material without a hole derived, curve marked 2.4 [1]. The same diagram gives the changes of effective stresses σ_e for the parts (pieces) drawn from the initial material with a hole derived.

The diagrams in Figure 2 and Figure 3 show that the smallest effective deformations and the smallest effective stresses are obtained for the drawn parts (pieces) bearing 4.2 and 4.3 [1]. These are pieces made of the initial material with presser tools made holes. This means that the smallest use of available plastic properties of the material is obtained when in the initial material a hole is derived by puncturing. The effective deformations and the effective stresses on the parts drawn with a punctured hole in the initial material starting from the outer radius derived in the direction of the derived hole are matched to $r \approx 18$ mm. In the vicinity of the hole they are different. This means that the effective size of the deformations and the effective stress for holes derived with presser tools are influenced by the way the work parts are set in the tools. This is due to the quality of the surface obtained with the technological operation penetration (crush zone and the zone of tearing the material), taking (into consideration) the thickness of the material (the side of the entrance and the exit of the puncher). Better use of plastic properties of the material is obtained if the initial material is placed so that the side of the entrance of the puncher is on the side of the material whisker with higher tensile stresses when the hole is derived. In this case that is the on the convex side.

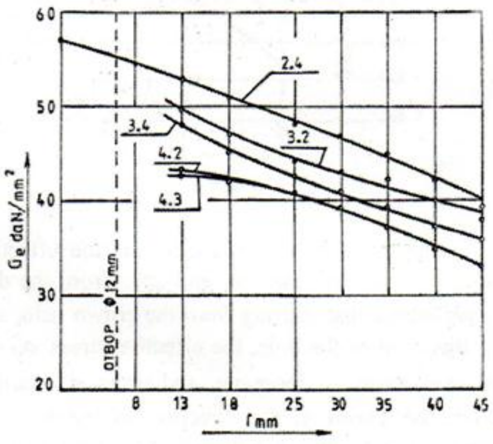

Fig 3

From the diagram it can be concluded that more effective deformations and effective stresses and thus better utilization of plastic properties of the material is obtained if the hole is performed with grinding, curve 3.4.

The biggest effective deformations and effective stresses and thus the best utilization of available plastic properties has the piece drawn from the initial material with a hole made by unscrewing, curve 3.2.

The change of deformations φ_1, φ_2 and φ_3, for the most favorable case (piece 3.2) is shown in Figure 4 [2, 3. 5].

The curves in the diagram in Figure 4 show that tangential deformation φ_1 and the deformation of the thickness of the wall φ_3, starting from the crown halo towards the hole, are steadily increasing in absolute value. While the radial deformation φ_2 from the crown halo increases up to the diameter d = 70 mm, and then decreases until it reaches zero on the hole surface.

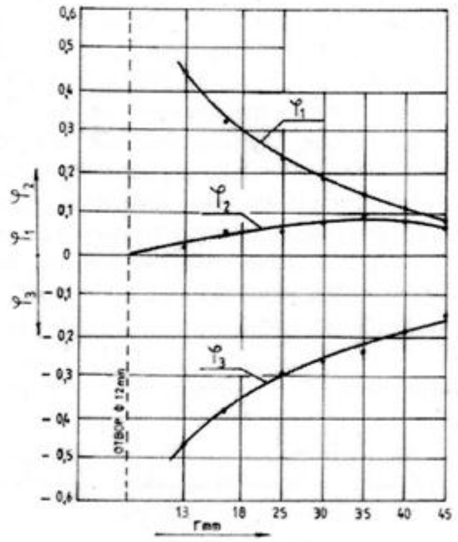

Fig. 4

Figure 5 shows the change of the effective stress σ_e and stresses σ_1 and σ_2. From the diagram means that starting from the crown halo, and in direction of the hole, the effective stress σ_e increases, stress σ_1 increases, and stress σ_2 starting from the crown in the direction of the hole increases slowly, and then decreases so that it reaches zero on the hole surface.

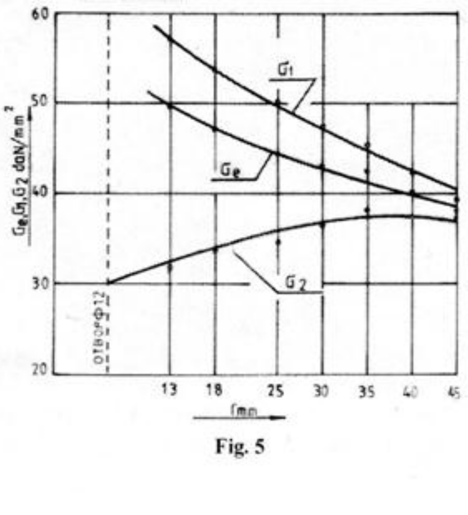

Fig. 5

6. CONCLUSION

– Holes derived in the initial material produce deterioration of the workability of cold-rolled metal sheet by drawing.

– The quality of the hole surface derived in the initial material has impact on the utilization of the plastic properties of the sheet metal while processing cold-rolled sheets by drawing.

– With holes derived in the initial material by piercing with presser tools the workability, in other words the utilization of the plastic properties of the material during the drawing process, is the worst. The placement of the initial material has also influence. Better results are obtained if the entrance side of the puncher tool after the drawing is on the side of the wall whose surface fibres are exposed to higher tension.

– The holes in the initial material made by grinding increase the workability of cold-rolled metal sheets by drawing.

– The holes in the initial material made by unscrewing allow best utilization of the plastic properties of cold-rolled metal sheets.

– If in the technological process of manufacturing parts with punctured holes in the initial material cracks appear at the hole for some reason in the drawing process, with additional processing, such as unscrewing of the holes in the initial material can significantly improve the process of drawing and overcome the problems.

REFERENCES

[1] В. Стрезов, *Технологија на обработка со деформација*, Машински факултет, Скопје 1982+

[2] М. В. Сторожев, Е. А. Попов, *Теория обработки металлов давлением*, Машиностроение, Москва 1977.

[3] Б. Деведжич, *Обрада материјала*, I део, Скопје 1982.

[4] Ј. Лазарев, *Мерни методи, мерења и обработка на податоци*, Машински факултет, Скопје, 1981.

[5] Б. Мусафија, *Обрада метала пластичном деформацијом*, Светлост, Сарајево 1979.