Volume XXI 2018
ISSUE no.1
MBNA Publishing House Constanta 2018

Scientific Bulletin of Naval Academy

SBNA PAPER • OPEN ACCESS

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To cite this article: A. Chioibas, Scientific Bulletin of Naval Academy, Vol. XXI 2018, pg. 483-492.

ISSN: 2392-8956; ISSN-L: 1454-864X

doi: 10.21279/1454-864X-18-I1-072

INFLUENCE OF FRICTION IN THE DRAWING A CYLINDRICAL PART STEEL – PART II

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Abstract. In this paper we analyze the variations of the deformations, of the flow stresses, of the thickness of the walls, in the case of the simulation of the drawing process carried out under two conditions: without using the lubricant and using one in liquid form. The analysis presented aims to determine the influence of friction on the quality of the drawing B steel piece.

1. Introduction

It is known that lubrication influences the quality of a work-piece. This quality implies both the low surface roughness and the dimensional precision of the work-piece. An analysis of the state of stress and deformation of the material during processing with or without lubrication gives information on this quality.

2. Conditions of the simulation

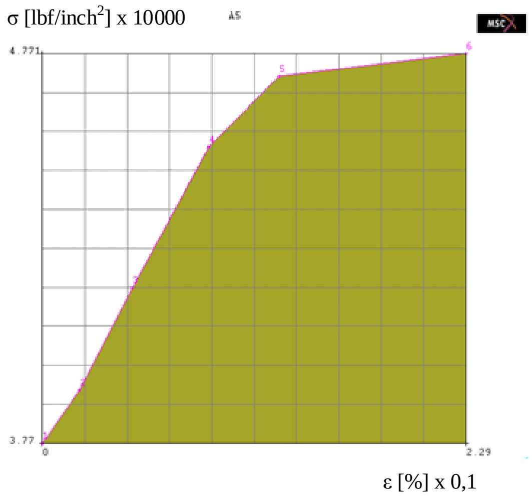
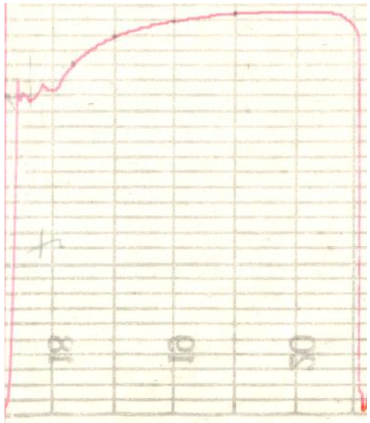


Figure. 1: Characteristic curve σ-ε for B steel introduced by points

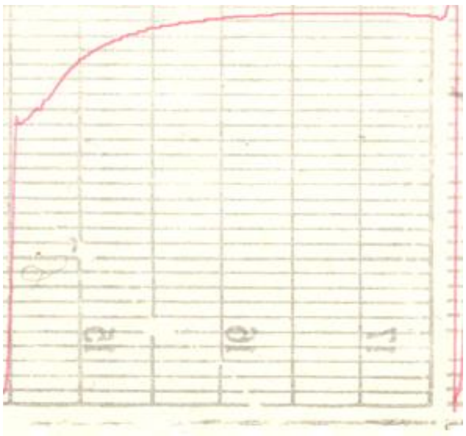
Deep drawing process simulation was performed without thin wall thickness with the aid of finite element software named Marc-Mentat [1]. The piece is cylindrical flange, flat base, connected with

the vertical wall. The blank is a disc made of a deep drawing steel disc A5 mark being considered as steel B [2], with a diameter of 17 mm and a thickness of 0.4 mm ([3], [4]).
To achieve the the simulation had to be introduced through the points of the characteristic curve σ-ε (Figure 1) [1], which has been used characteristic curve recorded data from the tensile (Figure 2 [5], [7]).
The form of the active elements is shown in Figure 3. They were considered rigid linear elastic with $E = 2.1 \cdot 10^5$ N/mm^2 and Poisson's ratio $\nu = 0.3$ [1].
Their dimensions are: the punch diameter d_p =7.7 mm, the die diameter d_m = 8.5 mm, the punch radius r_p = 2 mm, the die radius r_m = 2.5 mm, the height of piece h = 5 mm, the clearance of active elements j = 0,4 mm, coefficient of deep drawing without thinning admissible m = 0.56 ([3], [5]).

a)



b)



c)

Figure 2. The characteristic traction curve of steel B for test specimens taken at different angles to the rolling direction: a) 45°; b) 0º; c) 90º

Should be mentioned that in the graphic representations the total deformation equivalent values are given in percentage, of flow stress von Mises criterion - in psi (= 6894.8 N/m2), of variation force (depending on the increment) - in lbf (= 4.44 N) and of the variation cross-sectional thickness (for all representations noted by b) - in inch (= 25,4 mm) (in the abscissa is considered half of the value of the diameter of the piece, which is flared with the die radius).

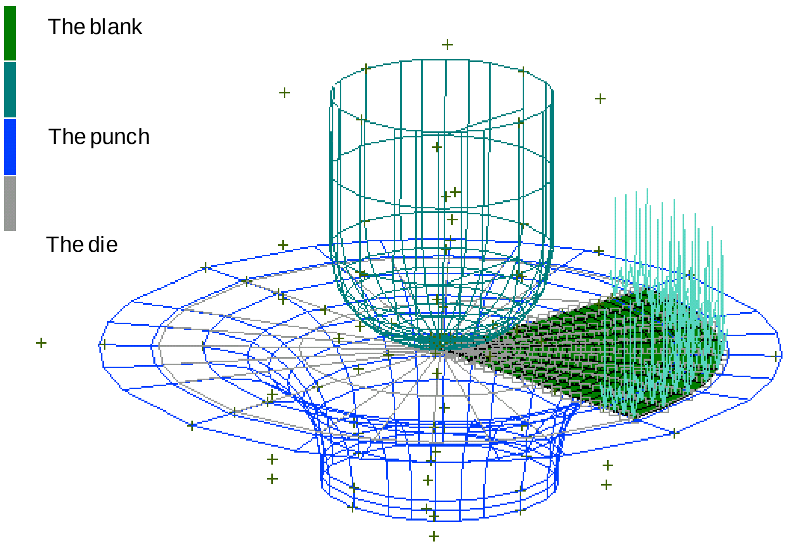


Figure. 3 Meshing of the active elements, of the blankholder and of the blank in finite

3. Results of numerical simulation

Initial deep drawing process simulation was performed under the following conditions of friction: μ = 0.08 for contact between the blank and the die and μ = 0.25 for contact between the blank and punch. To see the influence of friction on the development process resumed deep drawing simulation for μ = 0.22 value at the contact between the blank and the die. The coefficient of friction between the blank and punch is kept the same.

3.1. The coefficient of friction at the contact between the blank and the die μ_{m-s} = 0.08 at the contact between the blank and punch μ_{p-s} = 0.25

It analyzes the state of stresses and deformations and variation of wall thickness in the longitudinal section for the case when using the lubricant.

3.1.1. Variation of total strain. The maximum values of the deformations are formed in the area corresponding radius the punch (Figure 4).

This is justified the deformation history of this portion of material: to get here this portion of the material passed from a flat blank shape by the tensile + compressive dominant compression in the connection area between the flange and the wall piece, then by the tensile-compression dominant stretch in the wall piece and finally has reached this strong area harden. The high level of deformation is explained by obtaining cylindrical walls.

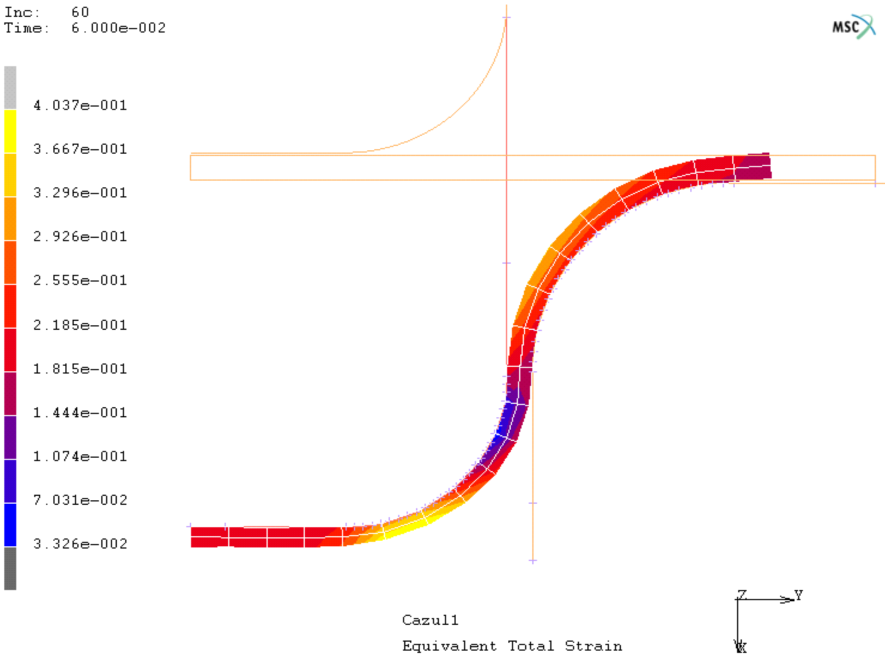


Figure. 4. Variation of total strain equivalent for B steel piece

3.1.2. Variation of tension flow after von Mises criterion

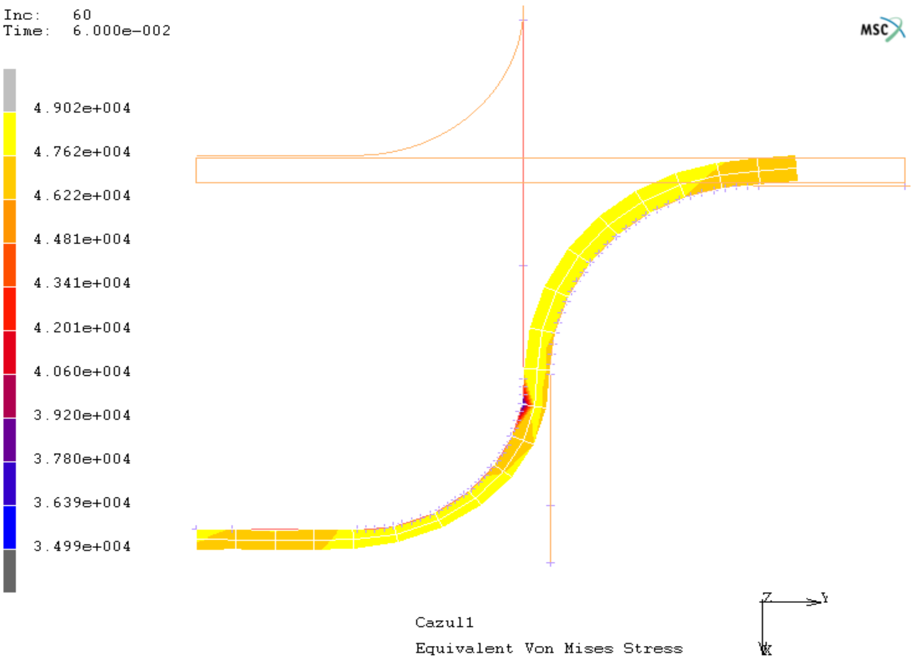


Figure 5. Variation of tension flow after von Mises criterion, for B steel piece

The values of the flow stress are maximum in the whole piece, with a very small exception in the inner part of the cylindrical wall (Figure 5). Compared with other types of steels [6], these stresses have lower values due to a very good plasticity of A5 steel.

3.1.3. The diagram force – stroke

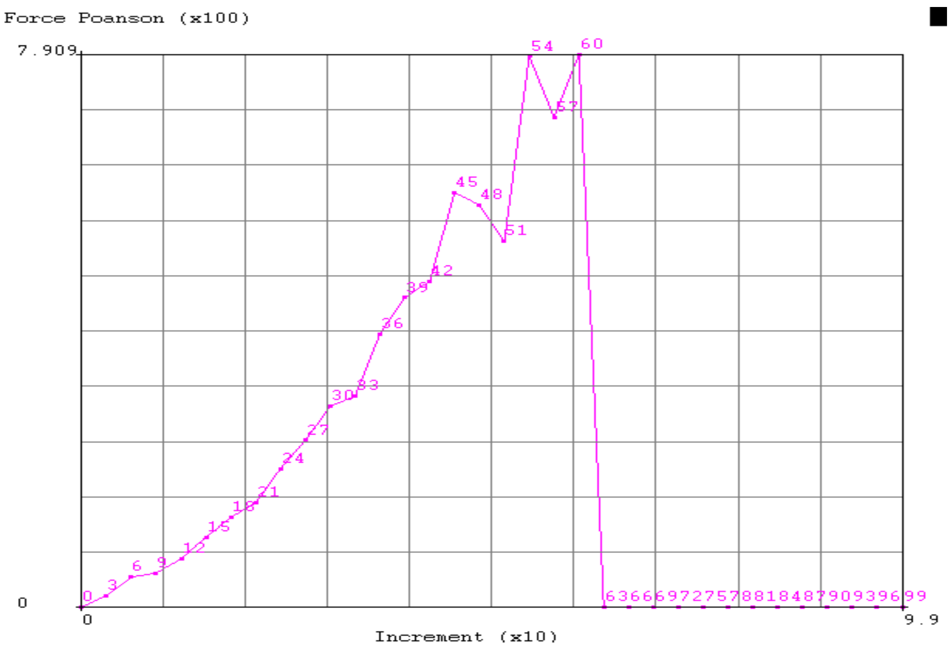


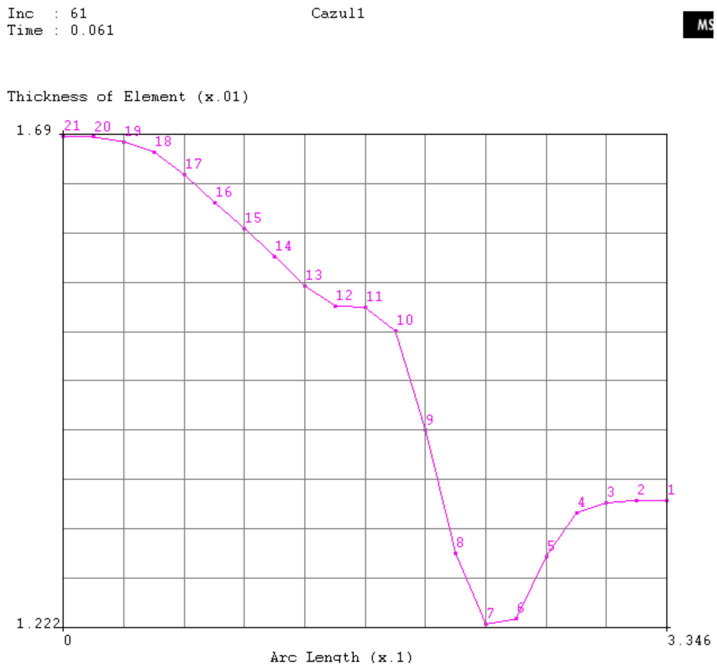
Figure 6. The diagram force – stroke for B steel piece

The diagram force - stroke punch is shown in Figure 6. The force of the punch required to deform A5 steel is in accordance with its good plasticity; we also see the correlation of this diagram with both the variations in deformations as well as the flow stress.

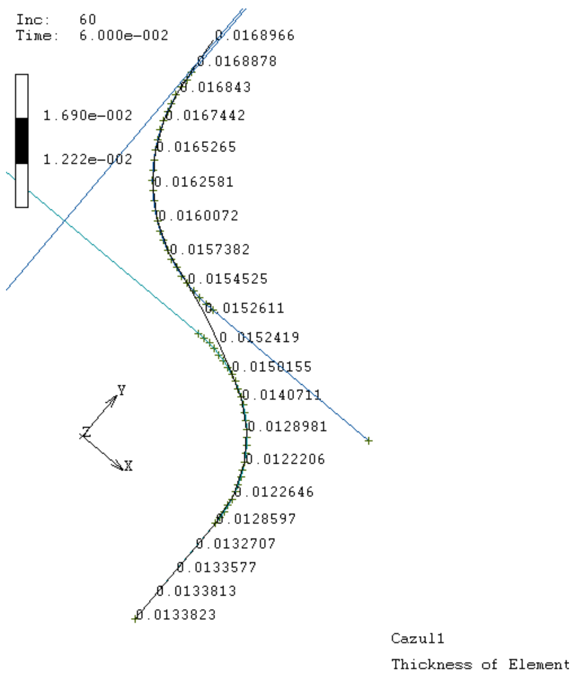
3.1.4. Variation of wall thickness in longitudinal section

From figure 7a deduce the conclusion that there is a bulging piece of the bottom. It is due to a residual bending moment caused by bending and straightening of the material which passes over the die radius and the stretch corresponding formation of part wall. This moment determines the final curving, which represents a form of the elastic comeback, because the material of the basis punch is in contact with only the punch radius.

From figure 7b is observed that the thinning increases from the point of connection to the radius of the bottom of the punch, on a part of the area connected, after which it begins to decrease slightly right of this area so that the thickness achieve the nominal value on the input portion in the radius of the die, the material is then thickened to flared end portion of the work-piece.



a)



b)

Figure 7. Variation of thickness in longitudinal section for B steel piece

3.2. The coefficient of friction at the contact between the blank and the die $\mu_{m\text{-}s} = 0{,}22$ at the contact between the blank and punch $\mu_{p\text{-}s} = 0.25$

It analyzes the state of stresses and deformations and variation of the wall thickness in the longitudinal section if the drawing is done without the use of the lubricant.

3.2.1. Variation of total strain

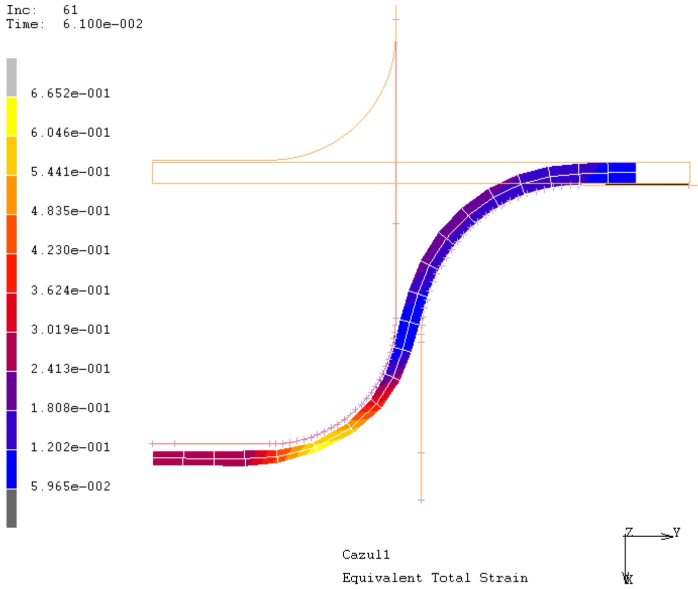


Figure 8. Variation of total strain equivalent, without lubricant, in case of steel B piece

In figure 8 are shown the values of equivalent total strains under conditions of changing the coefficient of friction. The maximum values of these deformations in the steel piece are highlighted in the radius punch. In this case, the thinning piece is very pronounced and deformation values are about 31% higher than with lubricant.

3.2.2. Variation of tension flow after von Mises criterion

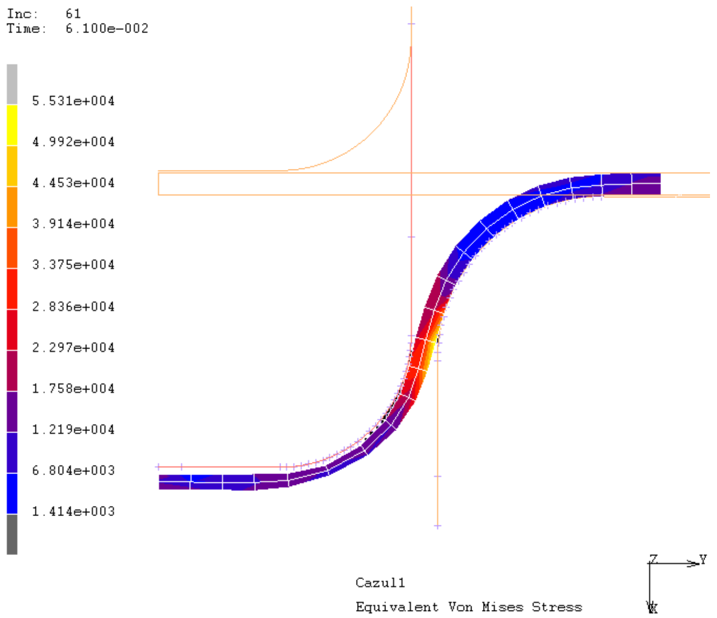


Figure 9. Variation of tension flow after von Mises criterion, without lubricant, in case of steel B piece

In figure 9 is present the values of flow stress after von Mises criterion under conditions of changing the coefficient of friction. It is noted that the maximum value of the flow stress is recorded in the cylindrical wall area.

3.2.3. The diagram force – stroke. The force-stroke diagram of the punch is shown in Figure 10. It is noted that the maximum force is less than when the lubricant is used, because the part breaks during processing.

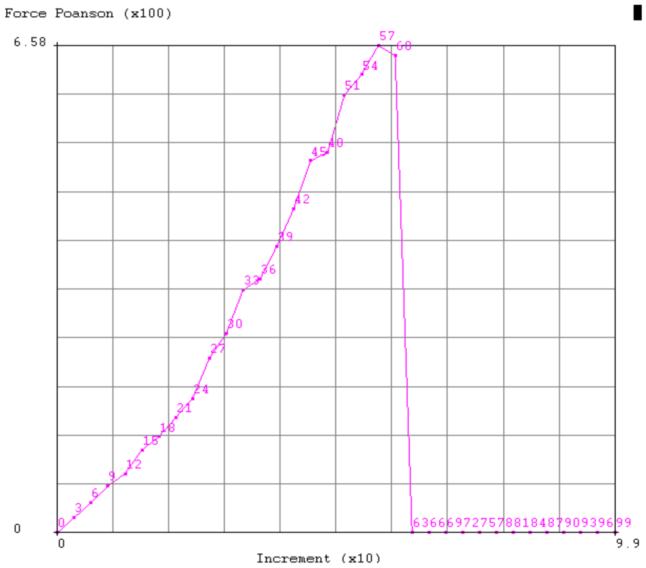
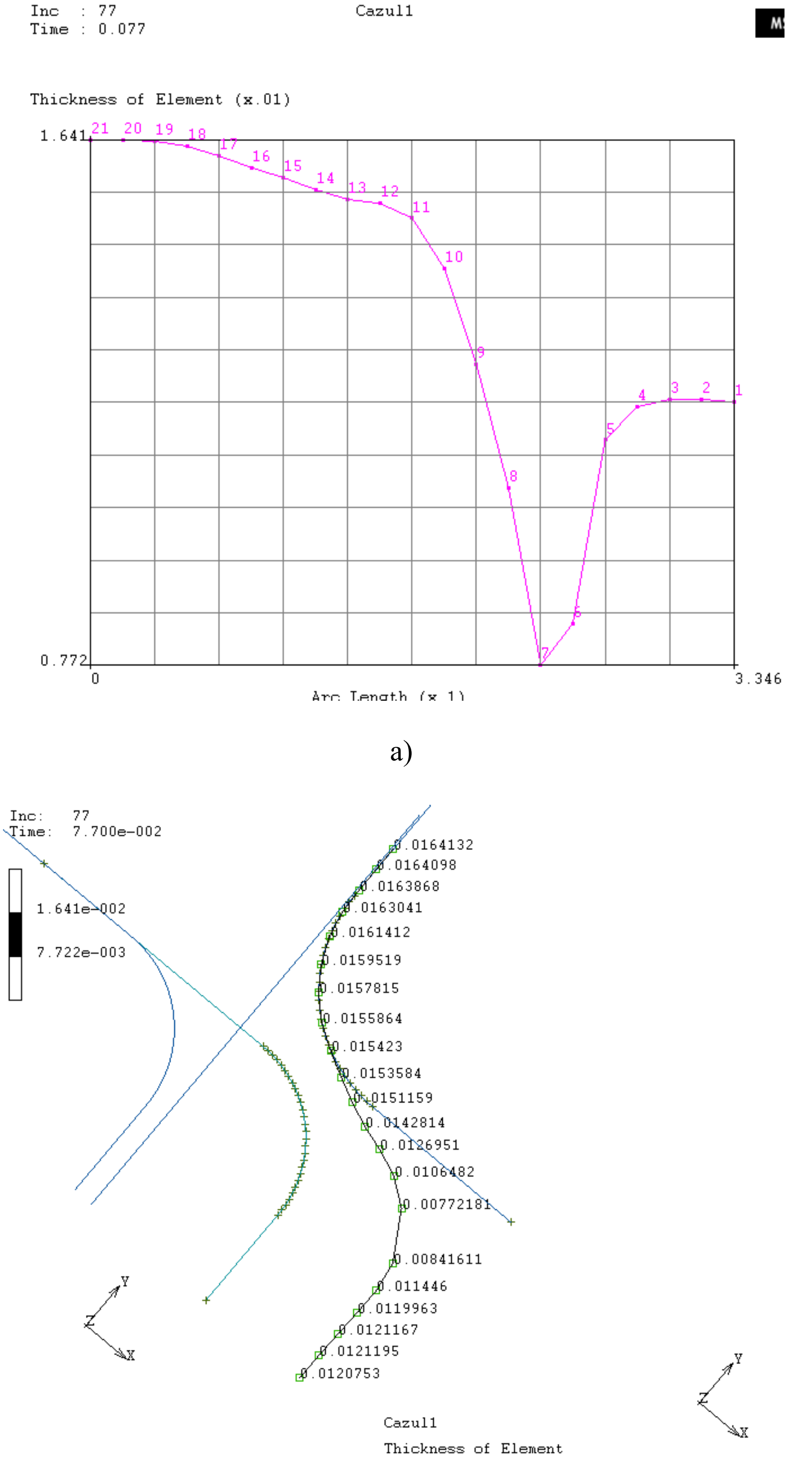


Figure 10. The diagram forge-stroke in case of steel B piece, without lubricant

3.2.4. Variation of wall thickness in longitudinal section

Variation of wall thickness in longitudinal section is shown in Figure 11. Thinning material is evidenced in the bottom flat. In the case of steel wall thickness decreases abruptly at the beginning of the bottom punch radius. The large distance between nodes suggests loss of continuity of the material, which is in accordance with the maximum deformation values corresponding to that area. Then the thickness starts to increase slightly reaching the nominal value near the exit of the die radius; follows thickening material to end the flared portion of the piece.



a)

b)

Figure 11. Variation of thickness in longitudinal section, without lubricant, in case of steel B piece

4. Conclusions

Comparing the latest results (corresponding to conduct of the drawing process without lubricant) to those outlined in section 3.1, for steel B (brand A5), the following conclusions results:

- Increase the coefficient of friction leads to scrap;
- Can't discuss about manufacturing quality of steel piece drawing, because is not met the criterion of physical continuity of the material.

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References

[1] * * * *MARC-Mentat* 2003 Manual de utilizare Licenţă Universitatea Dunărea de Jos Galaţi
[2] * * * *STAS 290/1 - 92*
[3] Romanovski V. P. 1970 *Ştanţarea şi matriţarea la rece* Editura Tehnică Bucureşti
[4] Romanovski V. P. 1980 *Îndrumar pentru presarea la rece* Editura Tehnică Bucureşti
[5] Chiobaş A. 2004 Cercetări privind influenţa condiţiilor de deformare asupra calităţii pieselor ambutisate Teză doctorat Bucuresti
[6] Chiobaş A. 2016 *Influenta frecarii in procesul de ambutisarea unei piese cilindrice din otel – partea I* Sea Conf Constanta
[7] Mocanu, D.R., şa 1982 *Încercarea materialelor vol I: Încercări distructive ale metalelor* Editura Tehnică Bucureşti