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DETERMINATION OF THE OPTIMUM BLANK SHAPE IN RECTANGULAR CUP DRAWING

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ABSTRACT
Base of computer model for projection of deep drawing processes is analytic model, and based on its entrance date (dimension, material) we can calculate necessary parameters of process. From the numerical analysis of the drawing force value is carried out the conclusion about the importance of the initial forms of material. The rectangular deep drawing process is widely used in sheet metal forming, but there are various associated defects, such as earing, wrinkling, tearing, etc. Influence of initial shape on the drawing force is presented in this work. From the analysis, a new blank model, has no ears, and obtained the lowest force.
Key words: deep drawing, blank shape, numerical simulations

1. INTRODUCTION
Modern production which is based on metal forming tends to the increased analysis of forming processes in digital environment before the actual production set-up. Thus avoid the costly and complex experiments. In the paper are analyzing starting form a real case, the principal trial methods for the assessment of the blanks forms and dimensions of the deep drawn rectangular parts and then using the FEM are simulated the processes of deformation of investigated blanks.

2. THEORETICAL DETERMINATION OF THE SHAPE AND DIMENSIONS OF THE RECTANGULAR PART
It is considered to obtain a rectangular part which dimensions are presented in Figure 1.
The scheme from figure 2 graphic shows the development of corners of the initial material [1,2] rectangular part. For the initial form of material taken three cases (Table 1): form rectangle, form octagon, and in the third example of optimized shape which obtained from initial forms using the FEM. The simulation results provide excellent prediction of optimal blank shape for the square cup in single stage and multiple stage analysis[3,4].

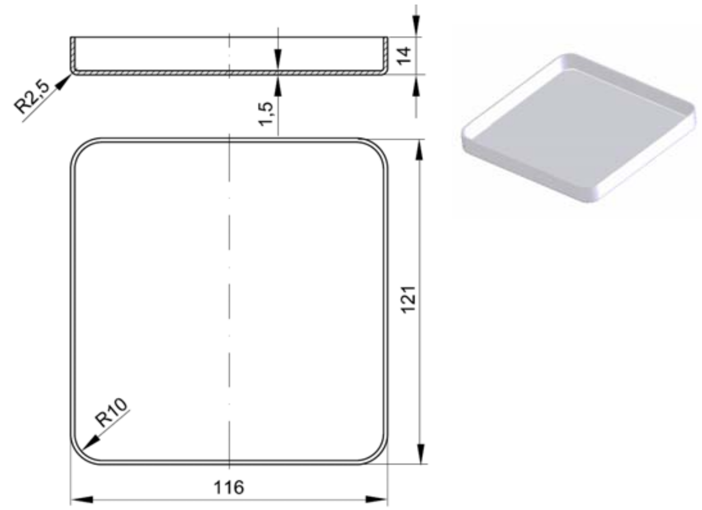

Figure 1. Sketch of the rectangular part

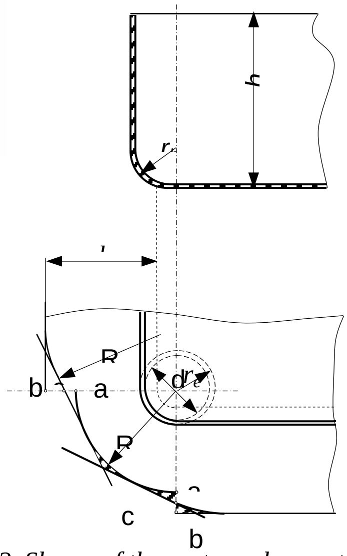

Figure.2. Sheme of the rectangular part shape determination[1]

3. NUMEICAL SIMULATION OF RECTANGULAR PART DEEP DRAWING

A commercial explicit finite element program Abaqus CAE was used for the simulation. The surfaces of the tool parts were discredited by quadrangle surface elements, assumed to be perfectly rigid (Figure 3). The blank sheet was discretized by quadrangle elements, representing the material with an elasto-plastic constitutive law. Model which is presented in Fig.3 consisted of 3800 elements.

For the material hardening determination the Krupkowski law was used. Other material data were: Young's modules E=2,1×10^5 N/mm^2; Poisson's ratio ν=0.3 and Density ρ=7800 kg/m^3. A Coulomb friction law was used with a friction coefficient of 0,1.

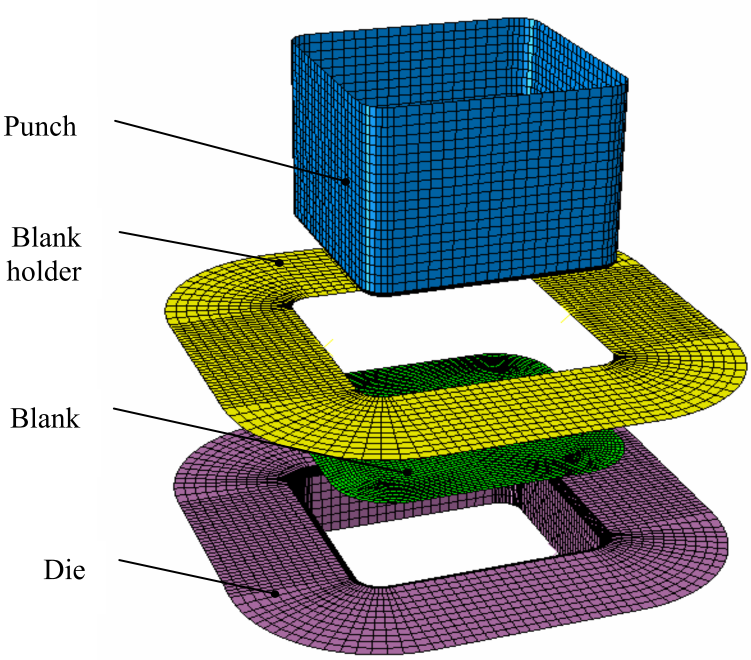

Figure 3. FEM model

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Table 1. Simulation results[5]

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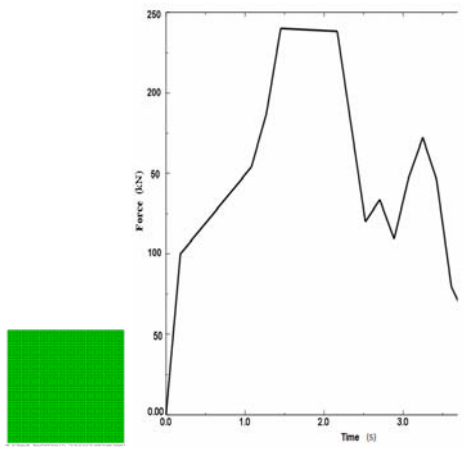

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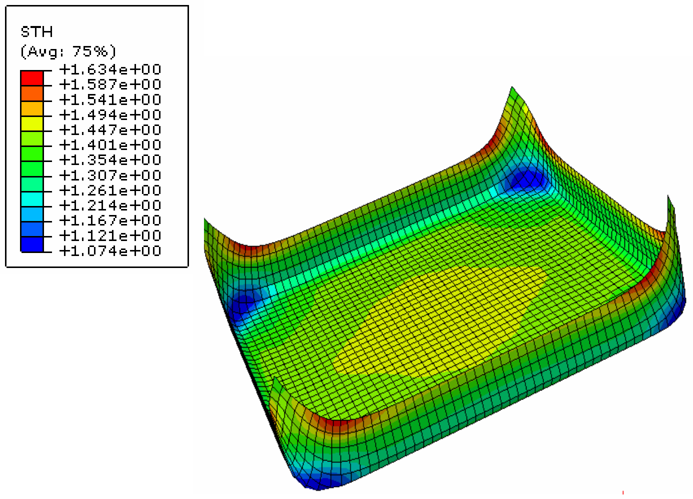

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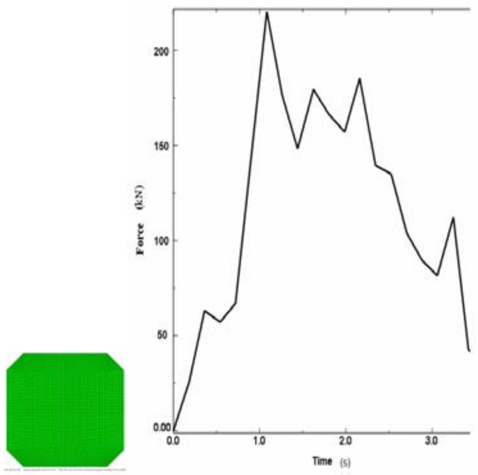

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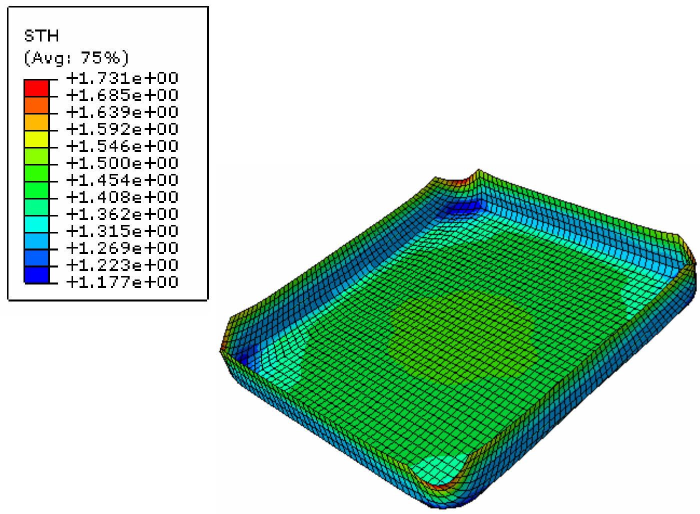

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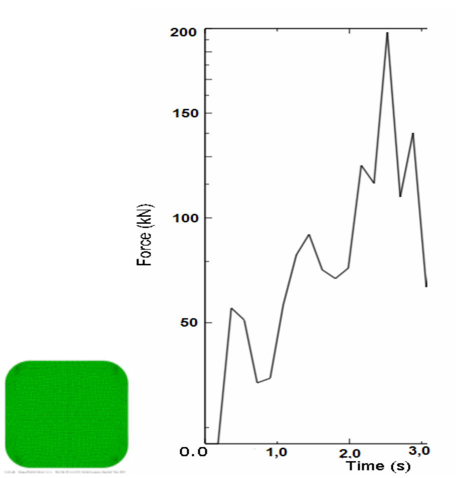

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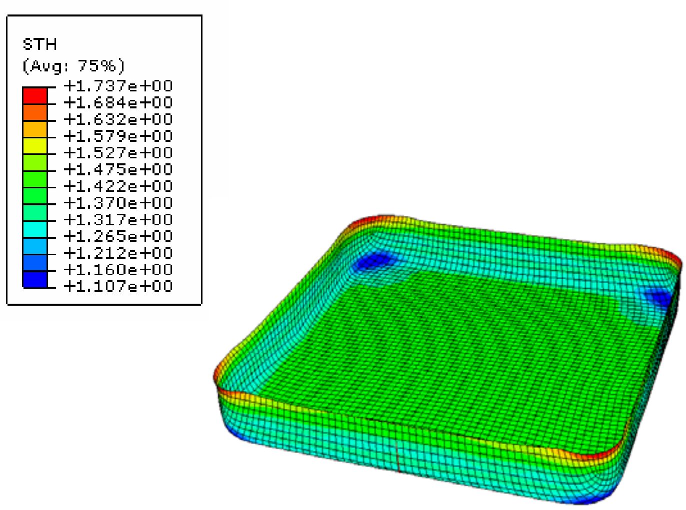

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4. CONCLUSIONS

The complex state of deformation in the case of rectangular parts forming lead to difficulties in assessment of blank shape and dimensions. It is provided a numerical simulation of deep drawing with various forms of the initial blank (Table 1). The simulation results are shown in the pictures in the Table 1. The method is implemented using finite element modeling of sheet metal forming process which helps in achieving the deformed shape of the blank. In this paper, an optimum blank shape is determine that has not cause earing. By determining the optimum blank shape, the loss of material due to trimming can be minimized. The reduction of forming load and the increase of maximum forming limit are also possible.

The optimal blank not only prevents the wastage of material or reduces product development period but also improves product quality and reduces occurrence of defects like wrinkling and tearing to some extent.

Can be given the conclusion that the blank of octagon form more favorable than the rectangular. Drawing force of optimized initial form is 33% smaller than the initial material of a rectangle form, and 22% smaller than the initial material of octagon shape. Also, using the initial blank of rectangular form occur a thinning of material, which is on critical limit of given part. It is recommended avoiding of this initial blank.

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