Simulation of process of manufacturing v-figurative type section from blank with holes

This work presents the results of simulated process of manufacturing V-figurative type section from blank with round holes. The reasons of distortion of round holes and transformation of holes to shape of an ellipse are described. The features of forming of section depending from holes are revealed. The mathematical simulation is executed in the program LS-DYNA of version 971.

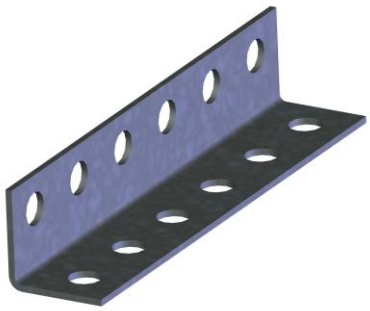


Figure 1. The section of V-figurative type with section dimensions 30x30x2 with holes

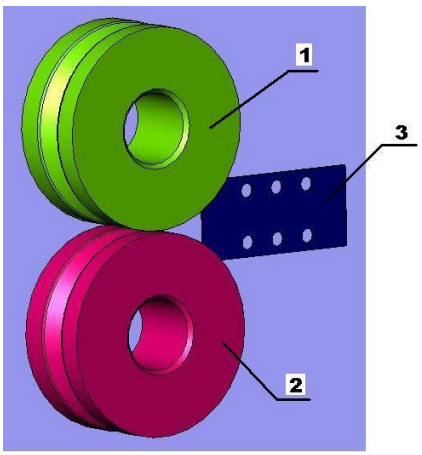


Figure 2. The roll tool for manufacturing the V-figurative section: 1 - upper roll; 2 - lower roll; 3 - blank with holes

In present paper the process of manufacturing of V-figurative section from blank with round holes is described. The holes of the round shape have diameter of 10 mm. There is a distortion of the shape of holes during forming blank in roller caliber.

The purpose of mathematical simulation in this work is to research the distortion of the shape of holes at of the V-figurative section and as to definite the values of holes and their effect on cross-section of the section.

The V-figurative section with section dimensions 30x30x2 was chosen as an object of simulation: section height of 30 mm, blank thickness of 2 mm (figure 1). Strip width is 58 mm contains two lines of punching with frequency of step of 25 mm and diameter of holes 10 mm. The distance from a strip edge up to centre of holes makes 10 mm. The section's material is a low carbon galvanized steel 08kp, material of the roller is a tool high carbon steel 9HC.

The initial models of the roller tool and blank with holes (figure 2) was created in the program Solid works and further was transmitted in the program Ansys through the *.x_t file. Preprocessor and postprocessor of the program Ansys were used in this work. The solution was executed to the program LS-DYNA.

The roll tool was set as absolutely rigid body (Rigid #20 in materials LS-DYNA), finite element model was generated only on their surface, using the type element Shell 163.

For model of a material section was used a bilinear isotropic model (*MAT _ PLASTIC _ KINEMATIC − model #3 of a material in the program LS-DYNA) with yield strength 250 MPa and for a type of a finite element − Solid 164 with the single-point reduced scheme of integration on volume basis with the control Hourglass 4.

For creating a contact surfaces between the roll tool and section the type of contact forming surface-to-surface (FSTS) was used.

On the roll tool were generated the conditions of limitation from displacement and was authorized the effect of the moment on the coordinate (X).

Finite element model consisted of 9400 solid elements and 960 shell elements (figure 3).

Some results of simulation are given in the figures 4-6.

Contours of plastic deformations (von mises) are demonstrated in a figure 4. The obvious influence of holes on a strain figure on cross-section of a section is characteristic. The greatest plastic deformations are observed in a zone of a bend of the section (in a corner zone of a section) and in some zones near holes. The places of these zones are connected to a direction of deformation of a blank and values of force at roll forming. The schedules of distribution of plastic deformations around to the hole in time period are demonstrated in a figure 5. Distribution of plastic deformations around to the hole in time period is demonstrated in a figure 6. The arrangement of maximum plastic deformations characteristically takes place under a corner to a rolling direction, which is connected to gradual deformation of blank. The spikes of deformations under an angel of 54 deg

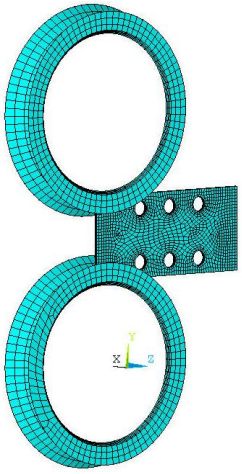


Figure 3. Finite element model of roll tools and blank with holes

since T = 0,038 sec. take place characteristically, and since T = 0,048 sec. the second spike in a diametrically opposite direction has a place. In figure 6 the spikes, the places of maximum deformations, are showed red color.

The practical tests completely confirm results of simulation. The shape of holes on stages of forming a section at simulation and on an actual finished section is identical (figures 6-8).

The application of the program LS-DYNA allows to simulate practically any forming process in a metal forming and to receive technologically dates for design stages of a technological equipment and mills.

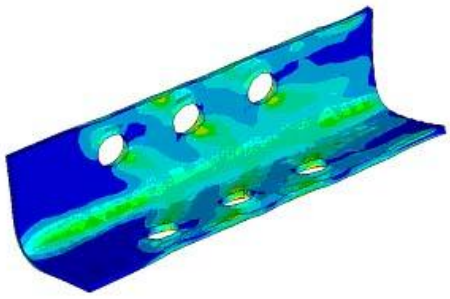
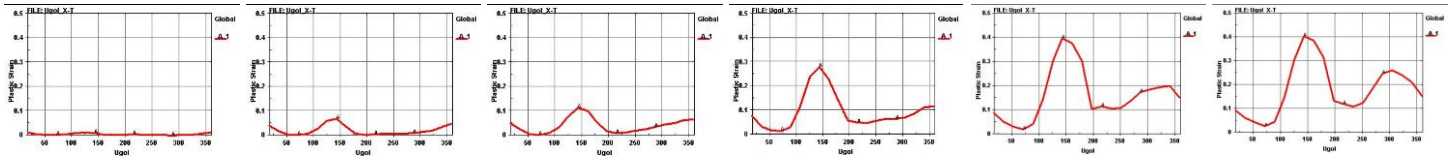
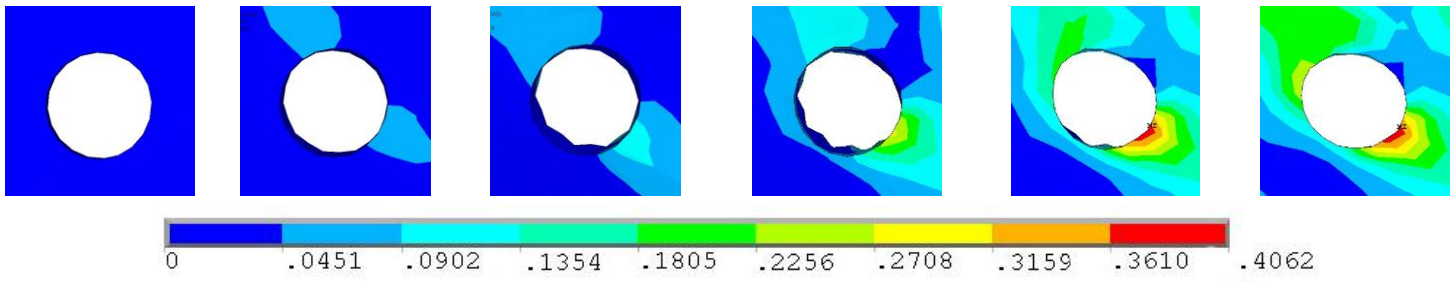


Figure 4. The section obtained at simulation



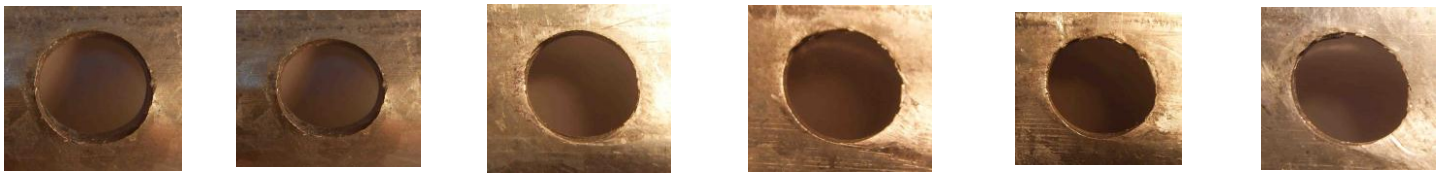
T=0,009 sec. T=0,018 sec. T=0,028 sec. T=0,038 sec. T=0,048 sec. T=0,057 sec.

Figure 5. The schedules of distribution of plastic deformation on holes from an outside (since a top point clockwise)



T=0,009 sec. T=0,018 sec. T=0,028 sec. T=0,038 sec. T=0,048 sec. T=0,057 sec.

Figure 6. Stages of accumulation of plastic deformation and change of the shape of a hole at simulation



T=0,009 sec. T=0,018 sec. T=0,028 sec. T=0,038 sec. T=0,048 sec. T=0,057 sec.

Figure 7. Stages of change of the shape of a hole practically

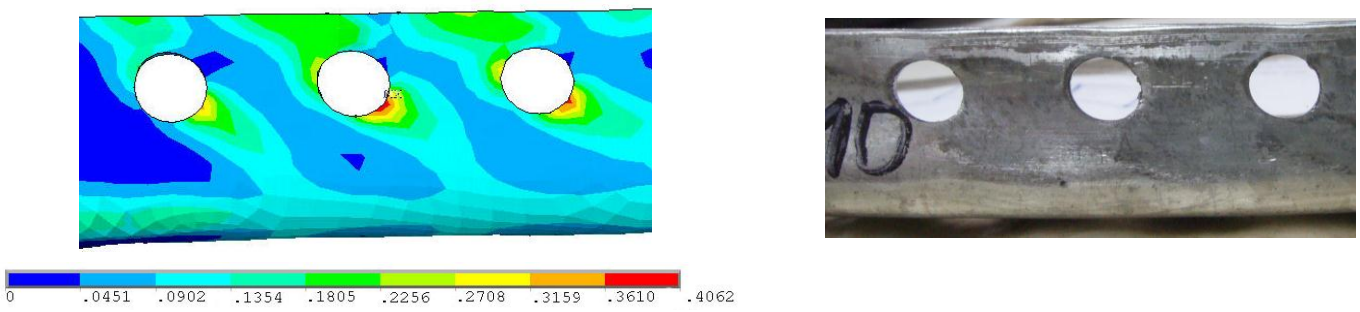


Figure 8. The shape of holes at simulation and practical researches