Imrovement of the cold forming technology of the parts such as longeron

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Abstract. As a result of modeling in LS-PREPOST preprocessor of the program LS-DYNA a range of radii of curvature edge transition matrix \(27.5 \degree \leq R \leq 48 \degree\) is obtained, which allows to produce defect-free stamping slots for longeron shock absorbers of tractors KAMAZ-5460.

Introduction
Production of high-quality parts for today is one of the main tasks of the leading engineering enterprises. The particular interest represents the frames with curved in a vertical plane longerons, constituting the cargo carrying part of the vehicle. These spars are arching in the locations of the front and rear wheels, which provides large stroke wheels, lowers the center of gravity of the car and, therefore, increases its stability. Spars, curved in the vertical plane, used in the construction of tractors such as, for example, models KAMAZ 5460

Method
The complexity of manufacturing of the parts is in the occurrence of defects in the recesses places: in the tension zone (there is a rupture of the sheet and dent) and in the zone of coagulation (excessive tightening of metal). These zones are shown in Figure 1.

![Fig. 1. Area defects on the spar](image)

The reasons of the defects in cold forming can be: defects of the raw material, discrepancy between the material mechanical properties and technical requirements, thickness, formability, surface quality, insufficient detail manufacturability; imperfect design stamps or improper exploitation; improperly developed technology, etc. \[1\]

Improperly designed blanks and semi-finished products in the die, improper form and sizes of the punches, matrixes, feeding, fixing and pressing parts, insufficient or excessive clamping force, small rigidity of the stamp – all this may be the cause of such types of defects, as variation in wall thickness, folds, teaser, anguishes, unfinished stamping, material gaps, etc.\[2\]
The sheet material to be stamped, usually has anisotropy of mechanical properties due to trademark of material and technological modes of its receipt, which can have both positive and negative effects on the course of sustainable technology of metal forming processes under different temperature and speed regimes of deformation. [3, 4]

In the process of forming by pressure treatment, as the die cavity filling, in some areas of a blank the deformation path varies. [5]

Causes of defects can also be incorrect or inaccurate installation stamp wear and damage of its parts, weakening and improper adjustment springs. [2]

So-called recess under shock absorbers obtained by the sheet metal forming operation, 8 mm thick. The depth of recess is 70 mm.

In the production the raw material is subjected to incoming inspection and spar is tech part (its shape is simple enough), therefore a possible cause of the above defects is imperfect design stamps, namely irrational geometry of deformation element stamp.

Rational choice of tool geometry will ensure production of high quality parts.

The spar is obtained by the forming process, however, the mechanism of deformation in this case can also be viewed as single point extraction operation. The most critical parts of the working stamp elements are their surfaces wetted during drawing with stamped the material: rounding, transitional chamfer, thresholds, etc.

Metal forming processes today are among the most advanced technologies in engineering all over the world, because provide high quality products at low resource consumption. Metal forming processes technology has high rates of material use. [6]

The use of various computer programs for modeling processes allows to improve metal forming processes technology.

For calculating processes it is often used modeling of technological processes applying finite element modeling software. The programs, which are used in the calculation of production processes in metal forming are the LS-DYNA, ANSYS, ABAQUS, etc. [7]

Purpose of the calculations is to improve manufacturing spar truck KAMAZ-5460 techniques with the help of molding operation computer simulation. Modeling was performed using the software package LS-DYNA and preprocessor LS-PREPOST, in the result the influence of parameters of the working parts of the instrument for a metal (corner radius edge transition matrix R) was investigated.

LS-DYNA - a multipurpose program that uses the explicit wording of the finite element method (explicit finite element method) - is designed to analyze the nonlinear dynamic response of three-dimensional inelastic structures. [8] The Finite Element Method - numerical method for solving complex engineering problems. [9] It was originally used in studies aimed to research and study of electromagnetic fields. [10]

Grid of the blank and instruments surfaces finite element is created in the licensing program UGS NX 7.5 and imported into the preprocessor LS-PREPOST of LS-DYNA program. It is presented in Figure 2.
Tool on the core technology and thinning rate while simulating in LS-DYNA program are shown in Table 1.

When drawing the details of the material with the thickness exceeding 6 mm radius of curvature of the matrix must meet the following conditions:

\[ R = (2..4) \times S, \]

where \( S \) – material thickness, mm [11].

In this case, \( S = 8 \) mm. Therefore, the range of radii of curvature of the matrix will be:

\[ 16 \leq R \leq 32_{MM}. \]

In some cases, when \( S > 3 \) mm, this condition is as follows:

\[ R = (4..6) \times S, \]

where \( S \) – material thickness, mm [11].

Then the range of radii of curvature of the matrix will be:

\[ 32 \leq R \leq 48_{MM}. \]

Considering the obtained condition for the following calculations are selected transition edge radii of \( R_{\text{curv}} \) matrix: 20, 25, 30, 35, 40 and 45 mm.

In the result of the calculations in the program LS-DYNA the following thinning values \( \varphi \) were obtained:

a) following the underlying technology (\( A = 191,2 \) mm, \( B = 261,2 \) mm, \( R_{\text{curv}}. = 18 \)mm) \( \varphi = 64\% \);

b) following the design technologies (\( A = 181,2 \) mm, \( B = 251,2 \) mm \( R_{\text{curv}}. = [20, 25, 30, 35, 40 \text{ and } 45] \) mm) \( \varphi = [58; 88; 20; 18 \text{ и } 18] \% \) accordingly.
To determine the relationship between the flow and shape of the deforming metal tool is needed to construct curves in the Cartesian coordinate system using the data obtained from calculations.

We represent the thinning change from simulation parameters as functions:

\[ L_R = f(R) \] – distribution thinning values curve \( \varphi \) depending on the radius of edge curvature of matrix \( R \).

\[ L_{(\varphi)} = 35\% \] – curve of allowable thinning values \( \varphi \) for steel \((\varphi)=35^\circ\).

\[ L_1 = 16, \; L_2 = 48 \] – curves expressing the condition of limiting the radius of curvature of the matrix edge.

Curves are shown in Figure 5.

According to the obtained graphs we define the area of rational parameters of tools for defect-free sheet metal stamping by forming operation. For options when changing the radius of curvature of the matrix, the range of radii will be as follows: \(27,5^\circ \leq R \leq 48^\circ\).

Calculation of the processes using the software allows you to explore the influence of parameters on the working parts of tools for metal and to create optimal conditions for high-quality parts from sheet material.

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