DOI: 10.30888/2410-6615.2020-03-01-006

УДК 621.74

MODELING THE PRESSURE TREATMENT PROCESS
МОДЕЛИРОВАНИЕ ПРОЦЕССА ОБРАБОТКИ ДАВЛЕНИЕМ

Gerasimova A.A. / Герасимова А.А.
c.t.s., as.prof. / к.т.н., доц
Valleeva L.M. / Валеева Л.М.
ass.kaf./acc. каф
National University of Science and Technology "MISIS",
Moscow, street the Lenin prospect,4,119049
Национальный исследовательский технологический университет "МИСиС",
Ленинский проспект,4,119049

Abstract. *The results of the finite element modeling of cold extrusion of carbon steel, the stress-strain state of massive dies at high cyclic stresses characteristic of the cold extrusion of steel are presented. The possibility of significant amplification of dies in their working area by creating a variable external pressure from the rims of a special design is shown. Dies banding with variable external pressure, proportional to the internal pressure in the die, is aimed at increasing the technical resource of the tool.*

Key words: *cold stamping, modeling, variable stress, die, rim.*

Introduction

One of the main tasks of modern engineering technology is to improve the accuracy and quality of blanks. This task is most fully realized when using processes based on cold plastic deformation. Among the most progressive processes based on cold plastic deformation is cold forging *[1]*. It is one of the most productive methods for manufacturing parts from steel, non-ferrous metals and their alloys with high ductility.

This method is widely used in mechanical engineering and other branches of the metalworking industry *[2-5*]. The use of this technology makes it possible to manufacture parts of particularly complex shapes that cannot be obtained using other methods of pressure treatment. Molding the metal without destroying its integrity allows you to increase the utilization rate of the material up to 95% even for parts of complex configuration.

Such processing is carried out in several operations, which provides a gradual and consistent change in shape: from the initial shape of the workpiece to the desired shape of the product. In the process of metalworking, the material is hardened and its plasticity decreases. In order to increase plasticity and reduce the resistance to subsequent deformations, inter-operative annealing is used.

High resistance to deformation leads to an increase in the number of punching transitions, decrease in the durability of die tooling and requires the use of technological lubricants and equipment of increased power, which leads to tangible initial investments in this method of metal processing by pressure. Cost must be offset by greater productivity and the possibility of automation. One of the main factors limiting the use of cold forming processes is the destruction of a tool from high cyclic stresses in a tooling. The process of destruction in metals as a phenomenon of accumulation and development of defects has been investigated by a number of authors, for example, in *[6]*, but today, to evaluate the performance of a

tool, Mises energy criterion is often used.

Methods and Materials

The magnitude of the stress intensity is compared with the allowable stresses in the metal during its axial testing. To determine the rational variant of the technological process of manufacturing parts by cold extrusion, today it is possible to effectively carry out computer simulation. Below are presented the results of a simulation of one of the cold extrusion options for a typical part. For the calculation in the QForm software package, the following process data were taken:

1. Geometric contours of the workpiece and tools are imported from CAD.
2. The workpiece is a plastic medium, the tools are an elastic medium.
3. Equipment - hydraulic press, the speed of movement of the tools is constant.
4. The initial temperature of the workpiece and tool - 20 ° C.
5. Coefficient of friction 0.15.
6. The axisymmetric problem was modeled.
7. The parameters of the hardening curve, mechanical and temperature properties of steel 20X.

Solid-state modeling of a tool kit with a blank of steel was realized. For the axisymmetric scheme of plastic deformation, the right half of the section of rotation bodies is drawn.

As a result of the carried out finite element modeling of cold extrusion processes, the fields of elastic deformations, displacements and equivalent stresses in high-loaded parts of the tooling are determined. For fixing the instrument, the boundary conditions are assumed: die with rim (in the study they are united by one body) rests on the bottom end (Fig. 1).

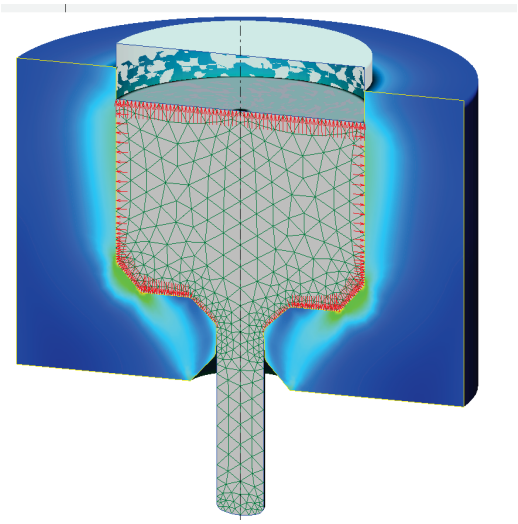

Fig. 1. Grid of finite elements and effective stress in the die

The calculated values of equivalent stresses in the die for such a high degree of cold deformation during extrusion of a bar can exceed 5-7 thousand MPa, which is several times higher than the allowable values for tool steels, and even hard alloys used for relatively small products withstand no more than 2500 -3000 MPa. Simulations obtained fields of displacement of the die body and other parameters (Fig. 2). The supporting lower surface of the die in this virtual experiment is fixed

with the possibility of sliding in the radial direction. The simulation has shown that under such stress the die will collapsed during the first processing cycles.

The usual ways to reduce the loads in the cavity of the matrix are to increase the thickness of its wall (Fig. 2) and pressing one or more bands.

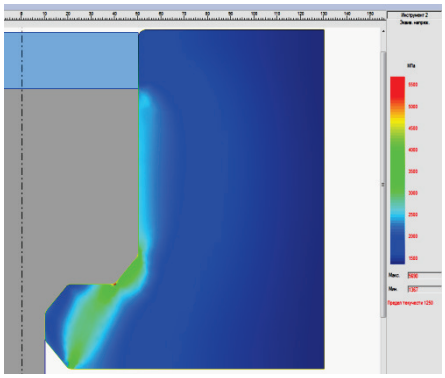

Fig. 2. The stress field in the die for increasing thickness of its wall

From the figure above it follows that with an increase in the wall of the matrix from 40 to 80 mm the stresses in it decrease to 5700 MPa, but they also significantly exceed the allowable values. The use of presstressed structures partially solves the problem of the strength of a highly loaded tool, however, with a wide amplitude of cyclic deformations, fatigue failure of the tool occurs on the internal surface of the die.

Thus, the variable internal operating voltages can be partially balanced additionally by the outer part of the rim. Such banding allows to reduce tensile tangential stresses in the working cavity of the matrix when critical stresses occur, as well as to reduce high compressive tangential stresses in the die from the bandage when relieving the force and internal pressure in the cavity.

This method of strengthening the matrix during cold extrusion can be attributed to one of the methods of "proportional banding" of working cavity. Reducing the amplitude of the cycle of stresses and deformations in the working cavity of the diees and in general of high-pressure vessels is the way to increase their resource.

Conclusions

1. The scheme of cold extrusion of a steel product with the use of rims of the arched structure and installation of fastenings on the annular bearing surface of the external contour of the bandage is investigated.

2. The proposed design of the tool has the properties of proportional bandaging, creates useful variable compressive stresses. The expected effect of the use of such a snap is to increase the technical resource of the tool and develop the capabilities of the process of cold extrusion of metals.

References:

1. Semenov E.I. Forging and forming: 4-volume Guidance. – M.: Mashinostroenie, 2007. – 384 p.

2. Gerasimova A.A., Radyuk A.G., Titlyanov A.E. Wear-resistant aluminum and chromonickel coatings at the narrow mold walls in continuous-casting machines //

Steel in Translation, 2016. - 46(7), pp. 458 - 462.

3. Fomin A.A., Gusev V.G. Safe machining of blanks with nonuniform properties // Russian Engineering Research, 2013, n.33, pp. 602-606. DOI: 10.3103/S1068798X13100043.

4. Gluschenkov V.A. Hardening of metals in metal forming – Samara: Publishing House of Samara State Aerospace University, 2012. –36 p.

5. Efremov D.B, Gerasimova A.A., Gorbatyuk S. M., Chichenev N. A. Study of kinematics of elastic-plastic deformation for hollow steel shapes used in energy absorption devices // CIS Iron and Steel Review — Vol. 18 (2019), pp. 30–34. DOI: 10.17580/cisisr.2019.02.06

6. Kolmogorov V. L. Plasticity and destruction. – M.: Metallurgy, 1997. –336 p.

Статья отправлена: 04.02.2020 г.