УДК 004.942:539.3

SIMULATION OF THE PROCESS OF PUNCHING A HOLE IN SHEET METAL WITH A CYLINDRICAL PUNCH IN ANSYS EXPLICIT DYNAMICS IN THE EULER FORMULATION

Verameichyk A.I., PhD, Ass. Prof.
Brest State Technical University, Brest, Belarus

Punching holes in sheet metal is the most common sheet metal punching operation. Due to its high performance and relative ease of execution, it is very popular. Recently, there has been a need to improve some elements of the equipment due to the emergence of new materials, high-speed methods of processing them, as well as the requirements for the quality of processed products. This leads to the need to develop computer models of the punching process, allowing you to vary the modes and parameters of the process. The use of modern systems of automation of engineering calculations (SAE-systems) is currently one of the most effective ways to solve such problems in the study of the stress-strain state of bodies, the assessment of strength characteristics and the prediction of the durability of structures. The ANSYS finite element analysis software system is one of the most effective SAE systems. The ANSYS software with a special ANSYS Workbench interface allows you to successfully solve various problems of deformable solid mechanics, liquid and gas dynamics, thermophysics, etc.

ANSYS Workbench 2019 R2 uses the ANSYS Explicit Dynamics environment for solid-state dynamic analysis, which allows calculations of fast-flowing, highly nonlinear processes in Lagrange and Euler formulations and provides an opportunity to solve all the main problems of explicit dynamics and fast-flowing processes. ANSYS Explicit Dynamics is an explicit dynamics calculation program that is fully integrated into the unified Workbench work environment. The program performs calculations using the ANSYS Autodyn solvers, but in contrast, it uses the same graphical user interface as the widely used ANSYS Mechanical solver and other analytical systems of the ANSYS Workbench platform. Explicit Dynamics is part of the ANSYS Mechanical Enterprise license. [1].

The simulation was carried out taking into account the actual conditions of the punching process on the crank press КД2128. In the process of punching, the punch presses the detachable part of the metal from the entire workpiece into the hole of the die. In the initial stage of the operation, after elastic deformation, the process of plastic deformation of the workpiece, which is inevitable for plastic materials, is noted. To reduce plastic deformation in such operations, the edges of the punch and the die are sharp with a small gap between them [2]. The gap between the punch and the die varied from 5 to 15 % of the thickness of the punched metal on the side. The thickness of the punched sheet t=4 mm, material-steel 20 – National Standard. The material of the die and punch is steel Х12МФ – National Standard, hardness 57-60 HRC.

The geometric model is constructed using the ANSYS SpaceClaim graphics module. The 3D model of the punch-sheet-matrix system is shown in Fig. 1.

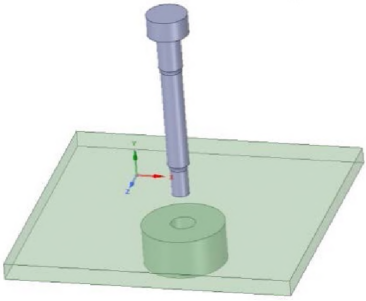

Fig. 1. 3D model of the system

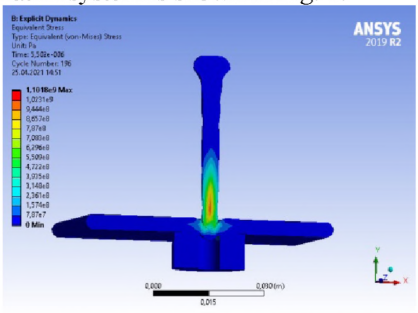

Fig. 2. Typical Mises equivalent stress distribution

Euler methods allow you to track the flow of material through the faces of cells on a grid area fixed in space. These methods are ideal for modeling the flow of materials with very large deformations [3]. When forming the problem in the ANSYS Explicit Dynamics module, the Euler grid and the initial concentration of materials were created automatically based on the geometry.

The study of the stress-strain state in the punch model and the punching force under different processing modes and geometric parameters of the punch-sheet-matrix system is carried out. A typical distribution of equivalent voltages is shown in Fig. 2.

The maximum permissible load is calculated depending on the length of the working part of the punch. The maximum length of the working part at which it is possible to carry out the punching process is set. The influence of the speed of movement of the punch on the stresses arising in it is investigated. Modeling of a punch with a modified shape of the working part did not reveal significant stress jumps along the length of the tool during the punching process, which indicates that changes in the punch configuration will not have a negative impact on its strength.

The conducted studies allow us to optimize the shape and size of the working area of the punch, the gap between the matrix and the punch, depending on their materials and the thickness of the sheet.

[1] https://cae-expert.ru/product/ansys-explicit-dynamics.
[2] https://www.robur.ru/articles/faktory-vliyayuschie-na-kachestvo-i-usilie-probivki.
[3] Muhutdinov A.R. Osnovy primeneniya ANSYS Autodyn dlya resheniya zadach modelirovaniya bystroprotekayushchih processov: uchebnoe posobie. Kazan': KNITU, 2016. – 244 c. – ISBN 978-5-7882-2115-1.

МОДЕЛИРОВАНИЕ ПРОЦЕССА ПРОБИВКИ ОТВЕРСТИЯ В ЛИСТОВОМ МЕТАЛЛЕ ЦИЛИНДРИЧЕСКИМ ПУАНСОНОМ В ANSYS EXPLICIT DYNAMICS В ПОСТАНОВКЕ ЭЙЛЕРА

Рассматривается моделирование процесса пробивки отверстий цилиндрическим пуансоном в среде ANSYS Explicit Dynamics Эйлеровым методом.