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METHODS FOR PREDICTING THE QUALITY OF EXTRUDED PARTS

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Abstract. Methods for modeling extrusion processes aimed at predicting the margin of plasticity, shaping and shape deviations in the form of sinks, which characterize the quality of stamped parts, are considered.
Keywords: extrusion, modeling methods, shaping, defect prediction, deformability.

Extrusion methods are distinguished by a variety of technological options in comparison with other processes of forming parts and make it possible to obtain precision parts of very complex shapes that in most cases do not require refinement [1–4]. Cold extrusion processes have inherent limitations and disadvantages, among which characteristic defects of parts can be distinguished, such as curvature, non-adherence, non-filling of mold elements, sinks, clamps, cracks, ruptures, etc. [3].

Therefore, predicting the quality of stamped parts, including the assessment of the forming limit for workpieces and the final forming of parts, is an urgent task, the solution of which is important for designing technologies [2, 3]. To solve these problems, various methods of theoretical analysis, computer simulation and physical modeling are used. [2–6].

The problem of prediction of deformability is important for cold volumetric stamping processes occurring in extreme power and deformation modes. The application of the phenomenological theory of deformability for solving these problems allows to answer the following questions: what is the strain degree limit for the workpiece and what is the degree of using the plasticity reserve in the performed deformation operations [2]. This is necessary to clarify the possibility of implementing the next plastic deformation operations, including intermediate heat treatment. Exceeding the limit value of the degree of using the plasticity reserve for material leads to a sharp deterioration in the performance properties of the products. One can note the advantage of applying the deformation criteria taking into account the treatment history for technological processes of complex monotonic and nonmonotonic deformation [2, 3].

The energy upper bound method is effective in predicting forming, deformation unevenness and the formation of defects in parts [1, 3]. Determining the direction of the predominant metal flow and predicting the sequential forming of a stamped part based on the procedure of minimizing the solution obtained by the energy method was difficult for combined extrusion processes. It was considered to be that the using kinematic (velocity) parameters as variable ones is inefficient. But, as studies have shown, considering the speed as a variable parameter that optimizes the reduced deformation pressure for given kinematic module, taking into account the power of cuts on all boundaries, is permissible [1].

Finite element models of cold and hot extrusion processes show very accurate predictions of the shape deviation of parts extruded using hollow and solid workpieces, as well as the stress-strain state of parts. Predicting the formation of defects in the form of hole expansion sinks, clamps, non-adherence and spatial deviations during radial, backward and forward extrusion using FE models help to establish the area of rational parameters and the possibility of defect-free manufacturing of parts [3–5]. By comparing the simulation results with the shape of experimentally obtained steel (steel 10) samples and parts made of aluminum alloys, it was found that on real samples sinks are formed, the shape and dimensions of which correspond to the sinks on the FEM models [6] (Fig. 1).

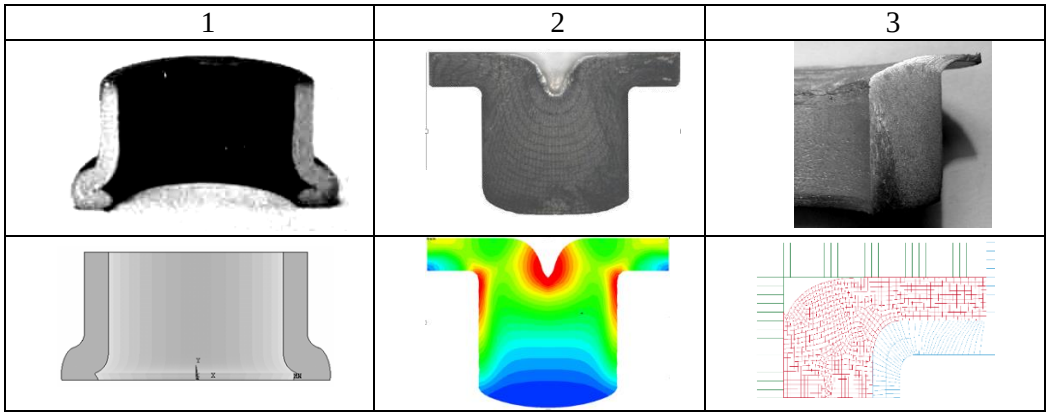

Fig. 1. Comparison of the results of experimental and computer studies on the prediction of defects such as sinks when extruding parts with a flange

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МЕТОДИ ПРОГНОЗУВАННЯ ЯКОСТІ ДЕТАЛЕЙ, ОДЕРЖАНИХ ВИДАВЛЮВАННЯМ

Анотація. *Розглянуто методи моделювання процесів видавлювання, спрямовані на прогнозування запасу пластичності, формоутворення та відхилень форми у вигляді утяжин, які характеризують якість деталей, що штампуються.*

Ключові слова: *видавлювання, методи моделювання, формоутворення, прогнозування дефектів, деформовність.*

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