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STUDY OF THE ROLLED STOCK SEPARATING INTO WORKPIECES USING BREAKING BY BENDING WITH STATIC-DYNAMIC LOADING

ДОСЛІДЖЕННЯ РОЗДІЛЕННЯ ПРОКАТУ НА ЗАГОТОВКИ ЗА ДОПОМОГОЮ ЛОМКИ ЗГИНОМ СТАТИКО-ДИНАМІЧНИМ НАВАНТАЖЕННЯМ

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At the present stage of mechanical engineering development, the problem of energy resources and metal economical use during its processing specifies ever increasing requirements to technology and equipment for separating raw materials into workpieces. This requires the development of already known and the creation of new effective separation processes and equipment for their implementation [1].

In this paper, a method of separating rolled stock using cold breaking by bending is considered. The idea of the method consists in a preliminary stress concentrator applying to the rolled stock and bending of the rolled stock until it breaks in the stress concentrator. A brittle crack in terms of its potential is an ideal tool for waste-free separation of solid materials into parts. At the same time, the energy consumption for cutting is approaching to its minimum possible theoretical level [1]. However, the widespread adoption of this separation method is hindered by the unstable nature of crack propagation. This leads to a low quality of the resulting workpieces.

The development and application of effective methods of destruction control can significantly improve the method of rolled stock breaking into workpieces and also create fundamentally new methods suitable for obtaining workpieces for machining. They are based on understanding the reasons leading to undesirable fracture deviations from a given trajectory. This allows to propose effective ways to improve the quality of the resulting surface [2].

However, in the process of shock loading at high rates, the bending of the specimen is accompanied by elastic deformations and vibrations at the contact with the supports and the tool. In this case, the fracture process becomes uncontrolled due to the instability of the crack trajectory [2]. Insufficient information about the causes of this phenomenon and possible methods of dealing with it contributes to the belief that supercritical destruction is an uncontrolled process. It cannot be used for high-quality separating of rolled stock into workpieces [1]. This is explained, among other things, by the complexity of describing the destruction dynamics, and by the prevailing disproportion between the development of theoretical and experimental methods for studying the cracks propagation in dynamic fracture mechanics [2].

It is also necessary to take into account the inertial loads arising from the displacement and rotation of the specimen halves in the process of separation using the method of breaking by bending.

To solve this problem, it is proposed to load the specimen with a static force before separation. This allows to provide the initial displacement of the specimen in contact with the supports and to reduce the vibration of the specimen and the tool. The possibility of preliminary static loading in combination with a high deformation rate allows to create a complex stress state scheme in the specimen, which provides the required geometric accuracy and quality of the resulting workpieces [1, 2].

Conclusions:

1. Combined static-dynamic loading during cold breaking by bending allows to reduce high-frequency vibrations of the «tool – specimen – support» system, and also to eliminate the violation of the specimen contact with the supports, to reduce the peak values of the forces from the side of the punch and supports.

2. The presence of a static force at the moment of impact provides a certain initial level of tensile stresses in the zone of the stress concentrator, which increases crack controllability. It is assumed that a fracture crack will always propagate in the area of tensile stresses, which improves the quality of the workpieces being separated. A more noticeable improvement in the quality of the workpieces will manifest itself when separating specimens of large cross-sections.

3. The reactive forces from the side of supports from the static force action coincide with the direction of the inertial forces of the specimen halves and additionally break the specimen. In this case, with an increase in the specimen length, the value of its separation from the supports in the initial phase of loading decreases, which has a positive effect on the quality of the obtained workpieces.

4. The magnitude of the static force required to eliminate the separation of the specimen from the supports depends on the stiffness of the contact between the head and the intermediate punch and increases with the increase in the stiffness of the contact between the head and the intermediate punch. The contact stiffness value between the head and the intermediate punch should be selected as optimal one due to the special design of the punch.

5. The obtained experimental results confirm the adequacy of the specimen separation mathematical model by the breaking method under dynamic and static-dynamic loading. It has been experimentally established that the value of the preliminary static force must be at least 40% of the force at which the specimen is failed.

6. Analysis of the values for the brittle cracks breakthrough rates shows that they are practically the same under dynamic and static-dynamic loading and are, respectively: $60Si7$ – $120\,m/s$; C45 – $80\,m/s$ $(Fig.1)$; $37Cr4$ – $70\,m/s$; $C20$ – $50\,m/s$. The crack velocities do not reach critical values, and therefore the quality of the separated workpieces is quite high.

7. The obtained results can be used to improve the technology of the separating rolled stock into dimensional workpieces by the method of cold breaking bending.

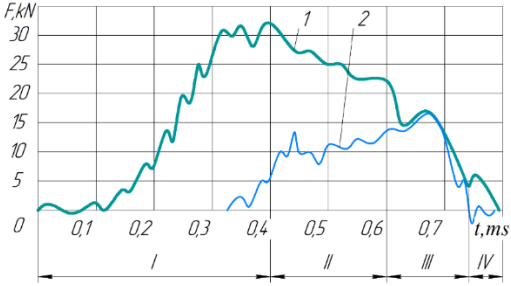

Fig. 1. Zones of crack propagation under dynamic loading of specimens from steel C45 according to the three-point bending scheme:
$1 - F_4 = f(t)$ – technological force at the punch;
$2 - F_6 = f(t)$ – force at the support

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SOME ASPECTS OF THE USE OF POROUS FILTERS DURING ALUMINIUM CASTING

ДЕЯКІ АСПЕКТИ ВИКОРИСТАННЯ ПОРИСТИХ ФІЛЬТРІВ ПРИ ВІДЛИВАННІ АЛЮМІНІЮ

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Основне призначення жолобів і литникових систем – нетурбулентна подача металу в порожнину литійної форми. Однак, з урахуванням того, що