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ADVANCED DRILLING METHODS, NON-TECHNOLOGICAL HOLES

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ANNOTATION

The article discusses the issues of increasing productivity and quality when drilling non-technological. Systematization of non-technological holes has been carried out, promising methods of drilling with changing cutting conditions have been developed and introduced into production during plunge and drill entry, as well as a method of grinding, descending chips and removing it from the cutting zone.

Key words: Non-technological holes, chip crushing, chip evacuation, drilling, quality, accuracy, durability, drilling methods, cutting modes, loosening.

INTRODUCTION

In recent years, the share of materials that have high physical, mechanical and operational characteristics has been rapidly growing in industry. Their use makes it possible to obtain products with properties that even traditional materials do not possess.

They are radically different in their structural structure, the nature of achieving the required mechanical properties and production technology, which significantly complicates the choice of methods for connecting these materials to each other. The connection by the method of installing fasteners into the machined holes of the products, made of the above-mentioned materials, in most cases is the only possible way of assembling them into a structure.

Analysis of literature data shows that the accuracy of the hole obtained by drilling is influenced by the main technological parameters of the process, namely: cutting speed and feed, and a number of additional process parameters: lubrication, cooling, the mechanism of crushing and removal of chips. The presence of lubrication and cooling improves surface quality and hole accuracy and allows for higher cutting data to increase productivity. The removal of chips, eliminating their bunching in the hole, also contributes to the improvement of surface quality and hole accuracy. The most important in terms of optimizing the hole drilling process are cutting speed and feed, and they will be considered as the main factors [1,2].

Due to the lack of scientifically grounded recommendations on the choice of the drilling method and cutting modes, the productivity of the cutting process is not high, the tool life period of tools, in particular drills, is also quite low. The quality of the hole during drilling, due to delamination at the entrance and exit of the drill, the bundling of the coming off chips is very poor. These features are most acutely manifested when drilling non-technological holes in parts. [7]

The search for ways to increase productivity and improve quality when drilling non-technological holes, as well as the development of specific scientifically based recommendations on the method and technologies of drilling are currently an urgent task.

Figure 1 shows the most typical types of non-technological holes for drilling and existing methods of processing recommendations.

Non-technological holes	Recommended drilling methods
1	2

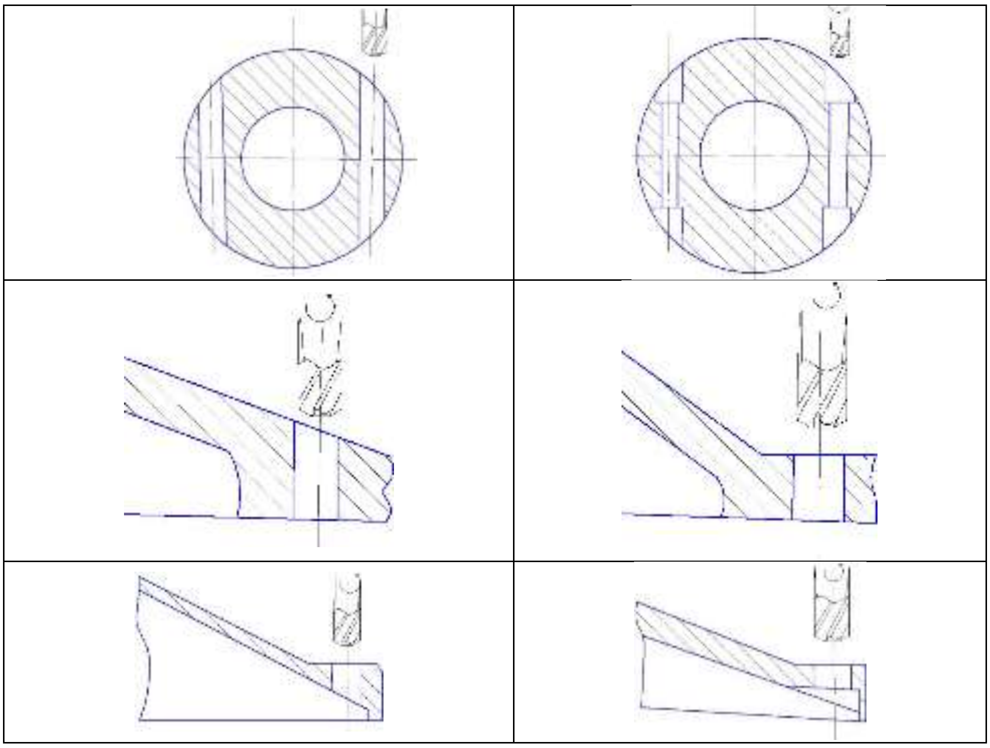

Figure 1. Types of non-technological holes and recommended drilling methods

As can be seen from Fig. 1. the process of drilling non-technological holes is complicated by the drift of the drill during cutting into the inclined and spherical surface of the part, which leads to bending of the working part of the drill, which leads to a sharp deterioration in the accuracy and quality of holes, and a decrease in tool life.

Hole diameter errors are most pronounced at the tool entry. At the exit of the tool, the diameter errors are usually smaller. This type of defects is usually caused by additional material removal from the hole walls at the drilling stage. During the drilling process, the chips move from bottom to top along the chip flute of the drill. Since the material has a low hardness, the movement of the chips leads to undesirable "pressing and sticking" of the material to the walls of the hole. Most often, this leads to errors in the shape of the holes with reduced quality.

Texture defects are caused by variable chip formation conditions due to the anisotropic structure of the material. The occurrence of fiber tearing and micro-profile defects is a consequence of the action of cutting mechanisms. Defects at the exit of the tool from the hole are the result of the development of the process of destruction in the area of the tip of the drill when it leaves the parts.

At present, to carry out the process of drilling non-technological holes, it is necessary to make special devices, use jig bushings. They also carry out preliminary preparation, perform an additional operation, which, of course, significantly increases the cost of the product. This problem is most acute when the drill leaves the cutting zone. Since it is impossible to use the special devices discussed above, used when plunging a drill.

In addition, the disadvantages of the known drilling methods are also the low quality of the machined holes, the presence of chips and loosening of materials, especially in the exit zone of the drill, and the low durability of the drill.

MATERIAL AND METHODS

As noted above, drilling into parts is the most difficult task due to the processing conditions that cause different requirements for cutting conditions and cutting tools.

The introduction of new methods for machining holes, a rational choice of cutting tools and cutting modes contribute to the achievement of the required quality of holes, to minimize their cost, and to increase the accuracy of holes.

We have proposed a method for drilling non-technological holes according to which rotation and axial movement with adjustable feed and cutting speed during plunging, drilling of a hole and exit of the drill from the cutting zone are communicated to the drill. (fig. 2) [3]

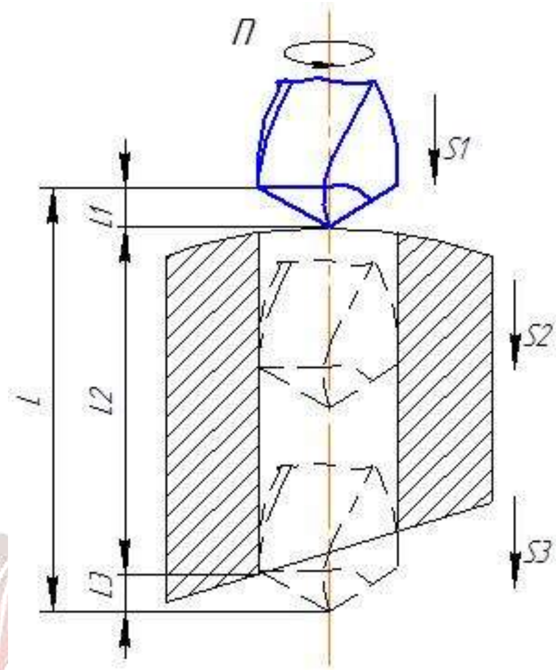

Figure. 2. Recommendations for drilling non-technological holes with variable feed.

The proposed method is carried out in the following sequence. The drill makes rotational and axial movement and in the process of drilling, after the rapid advance of the drill during plunge-in, the cutting speed and the amount of drill feed change. After the cutting edge of the drill enters the cutting zone, the feed and cutting speed are automatically adjusted according to the recommendations for drilling. Further, when the drill leaves the cutting zone, the feed rate and cutting speed are automatically adjusted again.

In order to prevent jamming of the coming and pressed chips from the cutting zone, during the drilling process, for their crushing it is proposed to periodically stop the axial feed of the drill, which will lead to separation into small parts of the chips, preventing jamming of the coming off chips between the tool and the hole, prevents pressed chips [3, 4].

This method of drilling consists in the fact that the drill is imparted with rotation and axial movement with periodic stopping of the axial movement of the drill, at least during one revolution of the drill, which makes it possible to stabilize the dynamic characteristics of the machining process, improve the quality indicators of the holes being machined by crushing the chips, eliminating the pressing when removing chips along the grooves of the drill, improving chip removal, especially when processing on automatic lines.

The effectiveness of the proposed method of drilling, in comparison with the known analogs, was assessed by the quality of the machined holes and the durability of the drill. In addition, when processing products by known methods, in the zones of the drill exit from the workpiece, chips and fraying are even visually detected.

The operation of drilling holes was carried out under the following processing modes: V = 7.5 m/s, S = 0.2 mm/rev; V = 7.5 m/s, S = 0.6 mm/rev; V = 12 m/s, S = 0.2 mm/rev; V = 12 m/s, S = 0.6 mm/rev. The existing technology provides for the modes V = 7 m / s, S = 0.1 mm / rev with periodic withdrawal of the drill to remove chips. In the process of processing, the nature of chip formation and the degree of its packing were determined. After the completion of the drilling process, using a MIM microscope, the dimensions of the delamination were determined as the maximum damaged diameter relative to the nominal diameter of the holes. The resulting defect sizes were compared with the magnitude of delamination with the traditional drilling method. The roughness of the surface of the machined hole was determined by the contact method using a profilometer. Drill wear was assessed after completion of the entire series of holes using an instrumental microscope.

According to the test results, it was found that the use of the proposed method of drilling with a periodic stop of the tool due to better crushing and evacuation of chips from the cutting zone and a decrease in the degree of its stacking allows reducing the size of delamination to 0.3-0.6 mm versus 1.05-1.3 mm with the existing method of drilling. The roughness has been reduced from Ra 7-8.5 μm to Ra 5.5-6.2 μm.

Thus, when machining with a periodic stop of the axial movement of the drill, these types of defects are absent, an increase in the durability of the drill and the achievement of the quality of the machined holes are ensured.

Further tests consisted of sequential processing of through holes at fixed cutting conditions v = 8.8 m / min, s = 0.050 mm / rev. The purpose of the tests was to compare the drilling methods in terms of durability and quality of the holes obtained.

The assessment of the degree of compliance of the hole diameters with the specified tolerance was made by comparison. The target value corresponds to a scrap probability of 0.27%. To calculate the sigma level, the hole making tolerance was used, adjusted for the size of the tool making tolerance and its wear. The corrected value of the tolerance Δcor was 30 μm.

Statistical data on the diameters of holes obtained by various drilling methods are summarized in Table 1.

Table 1
Hole Diameters Statistics

Drill	**Number of machined holes**	**Average deviation of hole diameters, mm**	**Standard deviation δ, mm**
Existing way	10	D_c+0.016	0.0035
	20	D_c+0.015	0.008
	30	D_c+0.014	0.0086
The proposed method	10	D_c+0.009	0.005
	20	D_c+0.008	0.006
	30	D_c+0.007	0.007

According to the results of experimental tests with the existing method, when drilling 30 holes, the stability of the hole diameters at a scrap level of less than 0.27%. The range of variation of hole diameters is 26 microns, with a maximum allowable value of 30 microns, which corresponds to the processing of holes of the 9th grade of accuracy.

The proposed method, with a durability of 20 holes, had a range of variation in diameters of 32 microns, which is suitable for processing holes of the 10th grade of accuracy.

The measurement of the roughness parameter of the holes Ra was carried out using a profilometer. Graphs reflecting the change in the wall roughness of the number of machined holes are shown in the figures.

The assessment of the degree of conformity of the roughness to the established tolerance will be carried out by comparing the average values for different operating time of the tool (10, 20, 30 holes). An additional estimated parameter will be the maximum roughness value.

The statistical data on the roughness of the holes are summarized in Table 2. The average roughness in is Ra3.64, the maximum value of Ra is 4.98 among 30 machined holes.

Table 2
Roughness statistics

Drill	Number of machined holes	Ra, mkm	
		Average	Maximum
Existing way	10	2,6	2,56
	20	3,1	3,38
	30	3,96	4,68
The proposed method	10	3,05	4,05
	20	2,55	3,86
	30	2,7	2,35

The proposed drilling method provides the best roughness in the details.

The effectiveness of the proposed method of drilling, in comparison with known methods, is assessed by the quality of the machined holes and the durability of the drill.

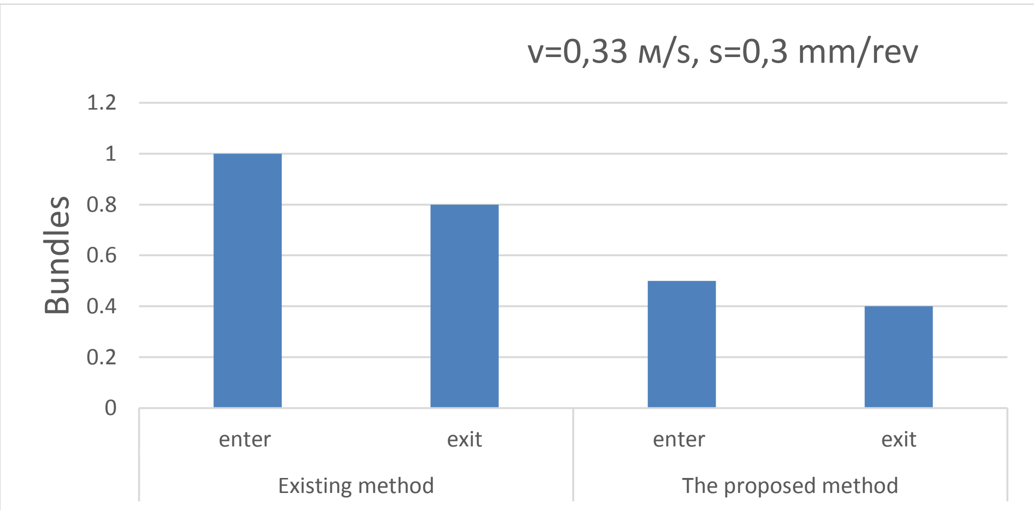

Fig. 3. Bundle Intervals

The results of the research showed that when processing non-technological holes with adjustable feed and cutting speed, depending on the drilling process, chips and loosening are not observed, the quality of the machined holes increased, the durability of the drill

CONCLUSION

1. On the basis of theoretical and experimental studies of the patterns of chip formation and its influence on quality indicators when drilling non-technological holes, processing methods are proposed that provide a significant reduction in defects, an increase in quality parameters, productivity and a decrease in production costs.

2 As a result of experimental studies of the process of chip formation and stacking of chips, a method for regulating the feed at the entry and exit of the drill from the cutting zone is proposed, which allows to improve the quality of the hole.

3. A method for obtaining chips with a predetermined length during drilling for machine tools by programmed control has been developed and proposed, which is achieved by the fact that the drill is given rotation with periodically stopping the axial movement of the drill during one revolution.

4. Based on the results of theoretical and experimental studies, the problem of increasing productivity, surface quality and hole accuracy was solved by using the proposed drilling methods. The use of technology for drilling accurate and high-quality holes with changes in cutting conditions depending on the position of the drill, made it possible to increase the accuracy and quality of holes.

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