

## RESEARCH AND TECHNOLOGY OF ADVANCED SPECIAL DRILLS FOR HOLE DRILLING IN STRUCTURAL METALS UNDER THE CONDITIONS OF JSC “OKMK”

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**Abstract:** *This article presents a research study on advanced special drills designed to improve the efficiency and quality of hole drilling processes in structural metals under the operating conditions of JSC “OKMK”. Drilling is one of the most critical machining operations in mechanical engineering, as it directly affects dimensional accuracy, surface quality, and the structural reliability of manufactured components. Improving drilling technology requires an in-depth analysis of tool geometry, cutting parameters, and material properties. The study analyzes various types of advanced drills, their geometric characteristics, cutting speed, feed rate, and cooling conditions. Special attention is paid to the influence of drill design on chip formation, heat generation, and hole quality. High-quality holes significantly affect the strength of joints, assembly accuracy, and the overall service life of machine parts. The article also evaluates the effectiveness of modern drilling technologies and provides recommendations for selecting optimal drilling tools and technological parameters to increase productivity and reduce tool wear under industrial conditions.*

**Keywords:** *Drilling process, structural metals, advanced drills, hole quality, machining technology*

### INTRODUCTION OF DRILLING PROCESS IN STRUCTURAL METALS.

Hole drilling is a widely used machining operation in the production of structural metal components. In mechanical engineering and metallurgical industries, holes are required for assembly operations, fastening elements, and welded or bolted joints.

The efficiency and quality of the drilling process depend on several technological factors, including drill material, cutting geometry, cutting speed, and feed rate. Improper selection of drilling parameters leads to increased tool wear, poor surface quality, and dimensional inaccuracies.

Therefore, the optimization of drilling technology is a key task in modern manufacturing systems.

#### Advanced Drills, Types and Technological Advantages

Currently, various types of advanced drilling tools are used in industrial practice, such as twist drills, annular cutters, and specially designed drills with modified cutting edges. Annular cutters remove material only along the perimeter of the hole, leaving a

solid core, which significantly reduces cutting forces and energy consumption while increasing productivity.

The main advantages of advanced drills include.

- ☑ Improved cutting edge geometry that enhances chip evacuation.
- ☑ Reduced friction and heat generation.
- ☑ Increased tool life and machining stability

Modern drill designs allow machining at higher cutting speeds while maintaining hole accuracy and surface quality

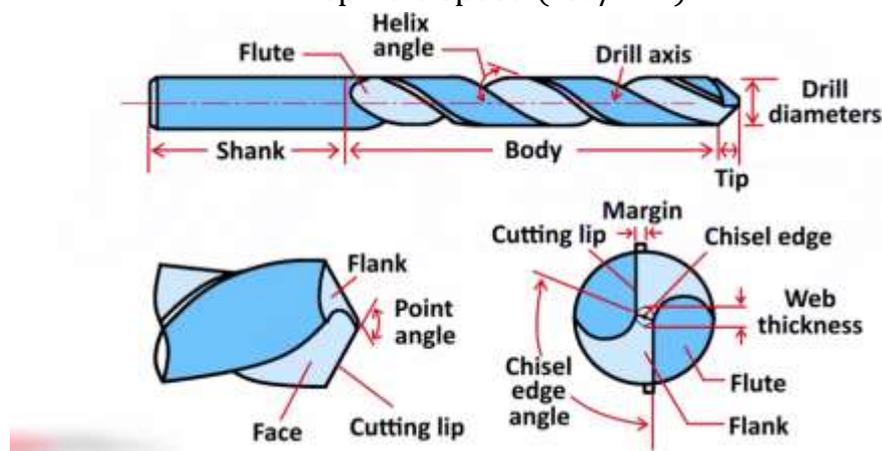
Hole Quality and Machining Conditions.

Hole quality is evaluated based on parameters such as surface roughness, roundness, cylindricity, and perpendicularity. These parameters are critical for ensuring proper assembly and structural reliability of machine components. Studies show that drilling conditions, including cooling and lubrication methods, have a significant impact on hole quality. The application of advanced cooling techniques, such as cryogenic or minimum quantity lubrication (MQL), reduces thermal loads and improves surface integrity

Introduction to the Mathematical Modeling of the Drilling Process In order to analyze and optimize the drilling process in structural metals, it is necessary to describe the machining conditions using analytical and empirical relationships. Mathematical modeling of drilling parameters allows the evaluation of cutting performance, tool load, and machining efficiency under different technological conditions. The main technological parameters influencing the drilling process include cutting speed, feed rate, drill diameter, thrust force, torque, and material removal rate. These parameters are interrelated and directly affect hole quality, tool wear, and productivity. Therefore, the use of well-established machining equations provides a reliable basis for comparing conventional and advanced drilling tools.

$$V_c = \pi \cdot d \cdot n$$

$n$  – spindle speed (rev/min)



For comparison purposes, the basic geometry of a conventional twist drill is presented as a reference for understanding the improvements introduced in advanced special drill designs.

Table 1

Cutting parameters and surface roughness during drilling of structural steel using advanced special drills

No.	Cutting speed (V), m/min	Feeding (S), mm/piece	Drill diameter (D), mm	Tool material / coating	Surface roughness (Ra)
1	50	0.18	10	Carbide (Tin)	1.9
2	60	0.15	10	Carbide	1.6
3	70	0.12	10	Carbide	1.3
4	80	0.10	10	Advanced special drill (multi coating)	22

The table presents the experimental results obtained during hole drilling of structural metals using advanced special drills under the operating conditions of JSC "OKMK". The influence of key cutting parameters, including cutting speed, feed rate, drill diameter, and tool material with advanced coatings, on surface roughness and tool life was systematically investigated.

The results indicate that an increase in cutting speed combined with a reduction in feed rate leads to a noticeable improvement in surface quality, as evidenced by lower surface roughness (Ra) values. This behavior can be attributed to more stable cutting conditions, reduced built-up edge formation, and improved chip evacuation characteristics of advanced drill geometries.

Furthermore, the application of modern carbide drills with multilayer coatings significantly enhances tool durability. Coatings such as TiAlN and AlCrN reduce friction and thermal load at the cutting zone, resulting in extended tool life and increased endurance. These improvements are particularly important under industrial production conditions, where productivity, dimensional accuracy, and tool reliability are critical factors.

Overall, the presented data confirm that the proper selection of drilling parameters and advanced special drill designs contributes to improved machining performance, higher surface quality, and increased operational efficiency in structural metal drilling processes.

#### Conclusion

This research focused on the study and technological application of advanced special drills for hole drilling in structural metals under the operating conditions of JSC "OKMK".

Drilling remains one of the most widely used machining operations in heavy industry and metallurgical enterprises, where requirements for dimensional accuracy, surface quality, productivity, and tool reliability are continuously increasing.

Therefore, the selection and optimization of drill design, cutting parameters, and tool materials play a decisive role in ensuring efficient and stable production processes.

The results of this study demonstrate that conventional drilling tools are often insufficient to meet modern industrial demands, especially when machining structural metals with increased strength and hardness.

In contrast, advanced special drills, particularly those manufactured from cemented carbide and equipped with modern multilayer coatings, provide significantly improved performance.

The application of such drills leads to a noticeable reduction in cutting forces, improved chip evacuation, and enhanced thermal stability in the cutting zone, which are critical factors for maintaining machining accuracy and tool integrity under continuous production conditions.

One of the key findings of this research is the strong influence of cutting parameters on surface roughness and tool life. Experimental data confirm that increasing cutting speed while simultaneously optimizing feed rate results in improved surface finish, as reflected by lower Ra values. This improvement can be explained by more stable cutting conditions, reduced formation of built-up edges, and smoother material removal mechanisms.

These factors are especially important in drilling operations, where poor surface quality can negatively affect the functional performance and fatigue strength of structural components.

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