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RESEARCH OF THE CONSTRUCTION PARAMETRES IN ELEMENTS OF FASTENING OF TIP ON THE DURABILITY OF SPLIT CUP-TIP TOOL

Abstract: *The results of studies of the construction parametres in elements of fastening on the cylindrical surface of the fixing holes of the insert on the durability and dynamic characteristics of the improved design of split cup-tip tool for wheelset processing are presented. It is approved that the radial force on the cylindrical surface of the fixing holes of the insert is of a significant effect on the stiffness characteristics of split cup-tip tool.*
Keywords: *Lathe processing, wheelsets, cup-tip tools, stiffness, normal stresses.*

1. INTRODUCTION

Lathe processing of wheelsets is a complicated production step, which is characterized by relatively low productivity and a number of distinctive features [1,2].

Analysis of the restoration methods of the wheelset rim contour showed that in the nearest future there will remain the priority for edge cutting machining, i.e. either by taking advantage of programs for turning or by copy turning on a wheel lathe. [1]

The process of wheelset machining by turning possesses such distinguishing features as a wide range of fluctuation allowance and hardness of the surface [2]. Depending on the mode of failure of a wheelset contour the cutting depth represents a variable and can be as deep as 14 ... 16 mm, and the hardness of the surface can be up to 900 HB and more. Moreover, the wheelset has a complex structural shape, resulting in the cutting tool contact angle change during processing, that is why the width of the cut in some areas of the wheel contour can be as much as 27 mm. These changeable factors during the pre-programmed mode of processing lead to the complex fluctuations of heat and power load on the tool, which resilts in premature tool failure due to chipping and breakage of the insert, as well as plastic deformation or destruction of the insert mechanical fixing elements and the body of the instrument.

Currently for roughing and finishing processes the widest application got cup-tip tools with dockable carbide tips of different diameter. The main disadvantage of this design is the lack of reliable deployment and secure fixation in the radial direction on the cylinder bore of the insert surface.

2. PROBLEM STATEMENT

In order to improve the reliable deployment and secure fixation in the radial direction on the cylinder bore of the insert surface, as well as to improve the stiffness characteristics of split cup-tip tool there was developed an advanced design of split cup-tip tool [3], shown in Figure 1, which consists of holder *1*, mandrel *2*, insert *3*, slotted elastic sleeve *4*, bolt *5*, nut *6*. Face surface of the cylindrical extension of the mandrel is made conical and contacts with the conical part of the thrust split sleeve, while the other side is in contact with the end portion of the bolt head. The sleeve is pressed against the tool holder by nut *6*.

To analyze the durability and stiffness of the insert fixturing of the considered design ANSYS software was used for calculating normal stresses at the cutting edge of basic and advanced split cup-tip tools. To construct a design model and to determine the stresses in the cutting edge of the cup-tip tool the methods given in [4] were used.

The highest possible cutting force components were applied to the cutting edge of the split cup-tip tool: P_x = 8 kN, P_y = 5 kN, P_z = 16 kN, which arise when roughing the locomotive wheelsets on the wheel lathe 1836.

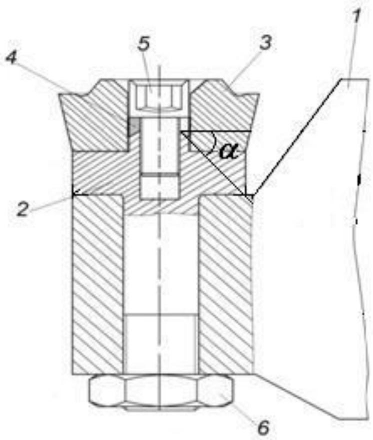

Figure 1 - Advanced design of split cup-tip tool

To determine the effect of the taper mandrel angle of faceting α on the grip conditions of the insert in the plane XY, as well as the nature and magnitude of the stresses in the tool tip, calculations were done for the values of the angle α = 30º, 45º, 60º.

Tool tip stress values were analyzed in the highest points of their concentration: near the fixing screw (point 1), close to the tip (point 2). An example of this calculation is shown on Figure 2.

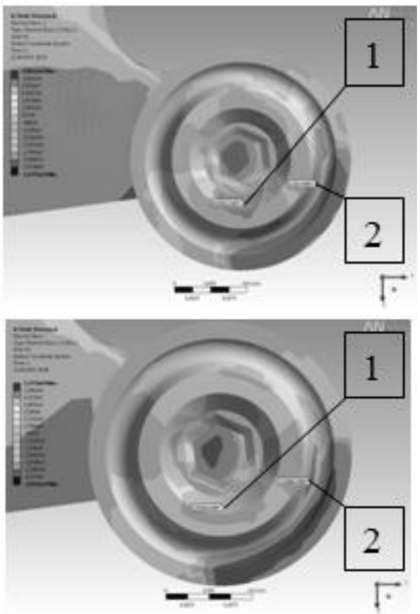

Figure 2 - Distribution of normal stresses σ_{xy} in the cutting tool insert depending on the angle α of the cone sleeve

Figure 3 shows the normal stress calculated by ANSYS software as a function of angle α of split cup-tip tool at the indicated points in the *x* direction.

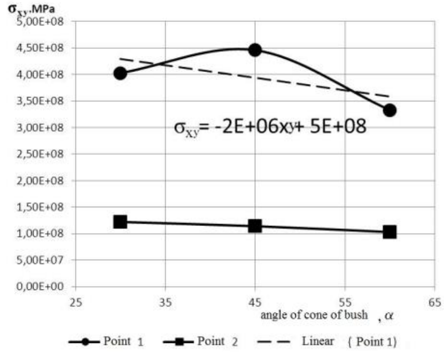

Figure 3 - Graph of normal stresses σ_{xy} in the cutting tool insert depending on the angle α of the cone sleeve at points 1 and 2

Thus as a result of the analysis of the obtained relationships it was found that close to the cutting edge (point 2) the maximum stress σ_{xy} = 125MPa occurs when the cone angle α = 30º; and the minimum σ_{xy} = 100MPa, when the cone angle α = 60 º. Near the screw clamping (point 1), the maximum stress σ_{xy} = 450MPa occurs when the cone angle α = 45º, and the minimum σ_{xy}=320MPa, when the cone angle α = 60 º.

Dynamic design of the split cup-tip tool was carried out by plotting the frequency response for the primary natural mode of vibration of the insert (movement defined at point 2), as shown on Figure 4.

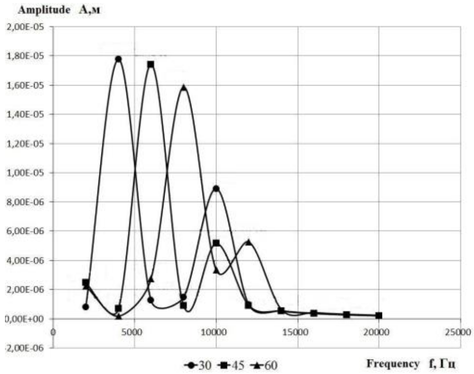

Figure 4 - Frequency response of natural oscillations of the insert cutting edge, depending on the angle α of the cone sleeve

Figure 4 shows that as the angle α gains 60º there is twice decrease in the amplitude of oscillation (from 18 mkm at α = 30º to 9 mkm at α = 60º). The natural frequency of the insert increases from the value 4 kHz at α = 30º to 8 kHz, with the cone angle α = 60º, i.e. amplitude-frequency characteristic shifts to higher frequencies, indicating a more rigid fixing of the insert.

3. CONCLUSION

The stresses in the cutting plate of the split cup-tip tool in a radial plane decrease by 1.4 times.The oscillation amplitude of the insert twice decreases, while frequency twice increases.Thus our studies have shown that a rational angle of the cone sleeve to maximize rigid fixturing of the insert in the XY plane is the angle α = 60º.

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