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INFLUENCE OF THE CUTTING PART GEOMETRY ON STRENGTH OF THE RHOMBIC INDEXABLE INSERT DURING ROUGH TURNING

***Abstract**: The stress and strain state of the loaded rhombic indexable inserts made of various tool materials was investigated in the article. Comparison of strength of the indexable inserts when changing the cutting part geometry was performed.*
***Key words**: the indexable insert, the radius nose, volumetric strain, stress.*
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Introduction

In the conditions of automated machining on the machines with numerical control, it is rational to use the indexable inserts installed in the special holders, since the time for adjustment of the cutting tool is reduced. The indexable inserts of the various shapes, the cutting part geometry, etc. are manufactured depending on the machining type. The requirements for manufacturing the indexable inserts of the various shapes are presented in the official documents [1-10].

The cutting tools must have high wear resistance and strength. These operating properties are ensured by applying a special coating on the insert and selecting the appropriate geometry of the cutting part of the insert. Let us consider the strength characteristics of the indexable inserts with the radius nose and without the radius.

Materials and methods

The experiment to determine the stress and strain state of the indexable inserts during rough turning of the steel workpiece was performed in the Comsol Multiphysics program. Two models of the rhombic indexable inserts with the radius nose (1 mm) and without the radius were built. The models dimensions of the rhombic indexable inserts are presented in the Fig. 1.

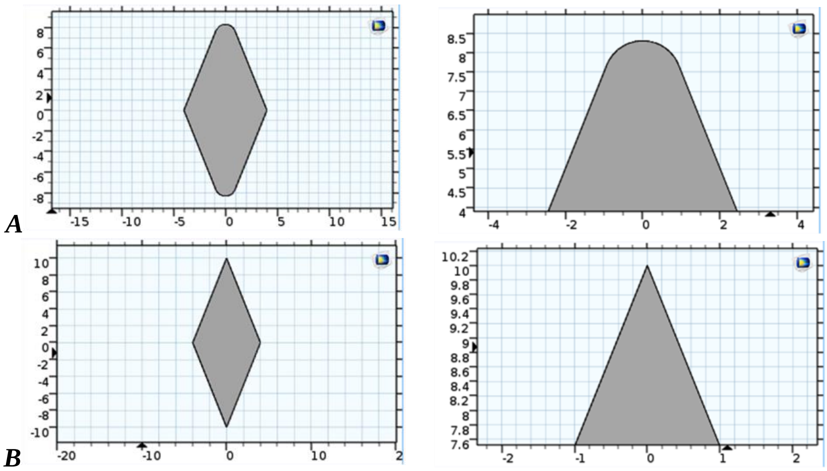
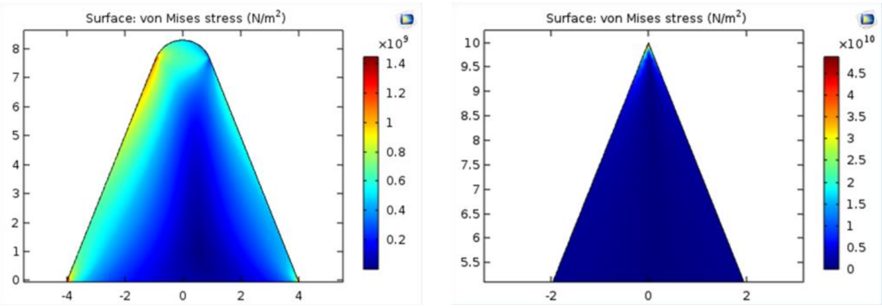


Figure 1 – The models of the rhombic indexable inserts: *A* – with the radius nose (1 mm); *B* – without the radius.

The models dimensions of the indexable inserts were given in millimeters. The properties of following tool materials were assigned to the models of the indexable inserts: Al_2O_3-20Mo (cermet), T1 (high-speed steel), TiC (carbide), WC (carbide). The cutting forces of 2.5 kN were applied to the main cutting edge and the nose of the rhombic indexable inserts along the *X* and *Y* coordinate axes. The inserts were rigidly fixed in the holder during the cutting process.

Results and discussion

The color contours of von Mises stress were formed after the computer calculation on the models of the rhombic inserts. The color of the contour describes stress intensity of material of the indexable insert during rough turning. The distribution and the value of von Mises stress in the insert material during rough turning of the workpiece are presented in the Fig. 2.



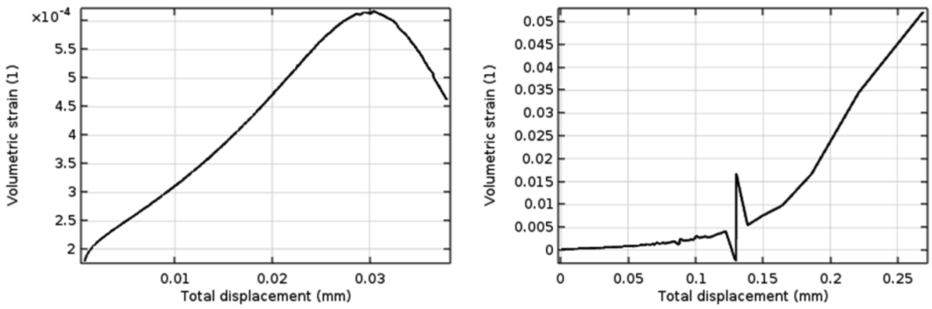
A *B*

Figure 2 – The distribution and the value of von Mises stress in the inserts made of Al_2O_3-20Mo alloy during rough turning: *A* – with the radius nose (1 mm); *B* – without the radius.

Machining with the insert with the radius nose is accompanied by the formation of the local zone of maximum stress of material from the side of the main cutting edge. The radius nose of the insert is subjected to stress uniformly. The auxiliary cutting edge is deformed to a lesser extent.

Machining with the insert without the radius is accompanied by the local distribution of maximum stress of material in the nose area. The main and auxiliary cutting edges are less deformed. The value of material stress of the indexable insert with the radius nose about an order of magnitude less than the value of material stress of the indexable insert without the radius.

The dependencies of volumetric strain of the insert material on the value of the insert displacement are presented in the Fig. 3. The maximum values of the insert displacement according to the corresponding graphs scales are the readings obtained in the area of the insert nose.



A ***B***

Figure 3 – The dependencies of volumetric strain of the insert on the total displacement of the insert made of Al_2O_3-20Mo alloy: *A* – with the radius nose (1 mm); *B* – without the radius.

The graphs show that under the same cutting conditions, strength of the indexable insert with the radius nose is 8 times more than strength of the indexable insert without the radius. The use of the indexable insert without the radius can lead to destruction of the nose during removing allowance from the workpiece in the conditions of rough turning. The maximum values of volumetric strain of the indexable inserts made of various tool materials are presented in the table 1.

Table 1. The maximum values of volumetric strain of the indexable inserts made of various tool materials.

Tool material	Parameter	
	Volumetric strain	*Total displacement, mm*
Al_2O_3-20Mo	0.0037/0.144	0.038/0.269
T1	0.045/1.59	0.52/3.66
TiC	0.003/0.132	0.03/0.219
WC	0.0017/0.068	0.017/0.121

In the numerator – the insert with the radius nose, in the denominator – the insert without the radius.

When comparing the coefficients from the summary table, it is determined that for the given geometry, the indexable inserts made of carbides are subjected to least compression deformation.

Conclusion

The use of the carbide indexable inserts with the radius nose during rough turning allows to reduce internal stresses in the tool material by about 10 times compared to the similar indexable inserts without the radius. This increases efficiency of the indexable insert, which is relevant for machining on the automated equipment. The inserts made of cermet and carbide (TiC) are equally resistant to compression deformation.

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