

Approach in Determining the Geometric Parameters of the Cutting Tools by Modeling in Solidworks Environment

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Abstract— By modeling of the researched object are described auxiliary secant planes of the cutting wedge on tools with replaceable inserts. 3D model of the different configuration tools is developed and using virtual measurement are determined working angles for single-edged and multi-edged systems. The results are used for quickly assessment of the efficiency of the studied objects.

Index Terms— Cutting tools, Working angles, Geometric parameters, Replaceable inserts.

I. INTRODUCTION

The measurement of geometric parameters of the cutting tools is only possible in a static position (as a geometric body) [1].

Currently, the determination of working angles (in the process of cutting) is possible only through one approach related to its analytical determination. This paper proposes a new approach built into the SolidWorks environment.

II. ESSENCE OF THE RESEARCH

To create conditions for measurements of working angles of the tools is developed 3D model of turning tool (Fig.1) and 3D model of collapsible tool with two cutting inserts for making holes (Fig.2) [6-8].

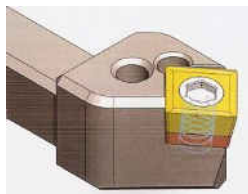


Fig.1 A model of turning tool



Fig.2 A model of collapsible tool with two cutting inserts for making holes

Consecutively, all major and changing their positions working planes have been built as a result of the different working conditions of cutting. The modeling of the tool and the cutting process allows the angles to be measured at all

points of the cutting edge [5].

The position of the tangent planes varies according to the cutting mode parameters (parameters V - cutting speed [m / min], s - feed [mm / rev]), the geometric parameters of the tool and the radius r at any point of the active part of the cutting edge.

A major issue in the designing drills with standard disposable inserts is the determination of the spatial position of the cutting inserts overlapping the diameter of the machined hole [1, 3, 4].

It is necessary to minimize the bending moment that arises from the cutting forces in the cutting process. A certain influence in solving this task is the change in geometric parameters of the tool in the cutting process.

The spatial location of the cutting element is determined by the following parameters (Fig.3):

- Clearance angle – α ;
- Rake angle – γ ;
- Cutting edge angle – χ_r ;
- Cutting edge inclination – λ ;
- Distance of the initial diametrical plane of the tool to the researched point of the cutting edge.

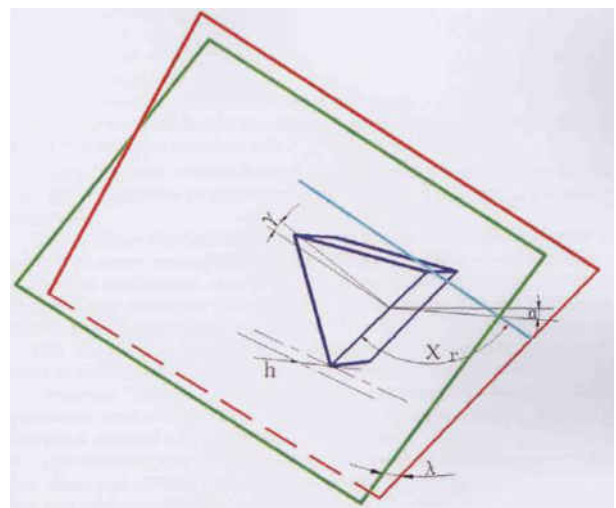


Fig.3 Spatial location of the cutting insert
 γ – rake angle; α – clearance angle; χ_r – cutting edge angle; h – distance from the cutting edge of the cutting insert to the tool axis, λ – cutting edge inclination

The angle λ , as well as the position of the inserts relative to the axis of rotation of the tool have a significant influence on the forces of chip formation, (parameter h)[2].

Taking into account the fact that in the cutting process the listed parameters influence each other and an analytical expression is not able to describe all the peculiarities that arise during the work. The most appropriate location of the cutting inserts can be determined only complex - in analytical and

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experimental method.

In the experimental research the influence of the parameter h in the cutting process has the following characteristics:

- The area of the standard central disposable insert overlapping the tool axis must always lie below the initial diametrical plane at a distance $h = 0.25 \div 0.5$ mm;
- At the value of $h < 0.25$ mm, due to the low cutting speeds, the cutting wedge breaks around the axis;
- At the value of $h > 0.5$ mm in the center of the drilled hole remains an unprocessed area, which is difficult to be removed after the machining

The area, which overlapping the tool axis, strives to move the cutting insert out of its bed and to destroy the elements that secure the standard disposable insert to the tool body [1].

In an experimental study, the influence of the cutting edge angle κ_r was found:

- At angle $\kappa_r < 45^\circ$ the cutting forces acting perpendicularly to the tool axes and the effective bending position greatly increase;
- At angle $\kappa_r > 85^\circ$ the cutting forces acting in the direction of the tool axis and loading the feed mechanism of the machine are greatly increased, as for drilling tools with larger diameters reaching unacceptable values.

III. EXPERIMENTAL RESULTS

Figures 4÷8 shows the results of the virtual measurement of angles α_{oc} and γ_{oc} at different conditions of the cutting process and different values of the static geometric parameters of the cutting part.

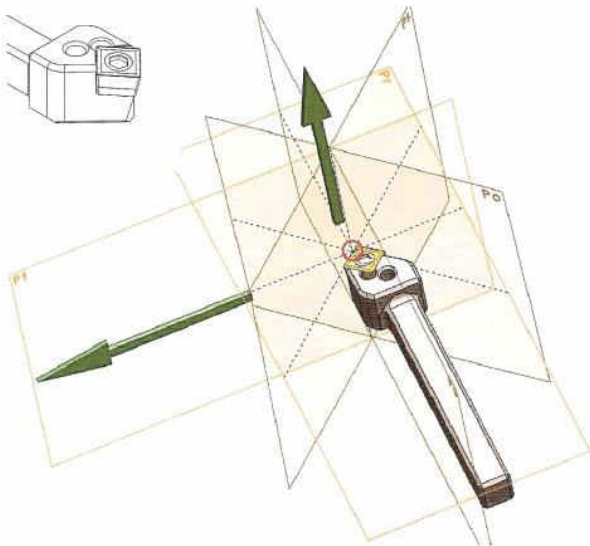


Fig.4. A system of secant and tangent planes of a turning tool

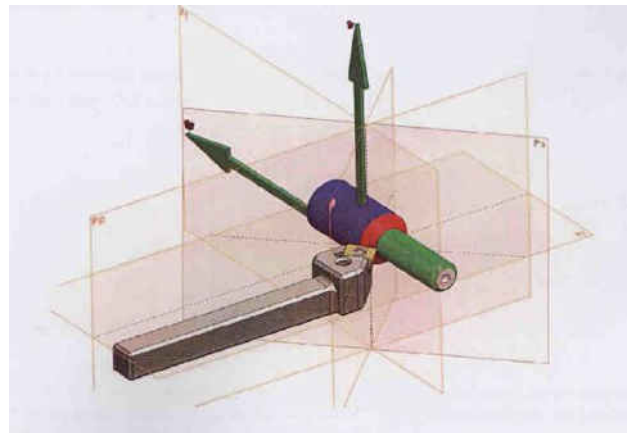


Fig.5. A system of planes in working position of the turning tool

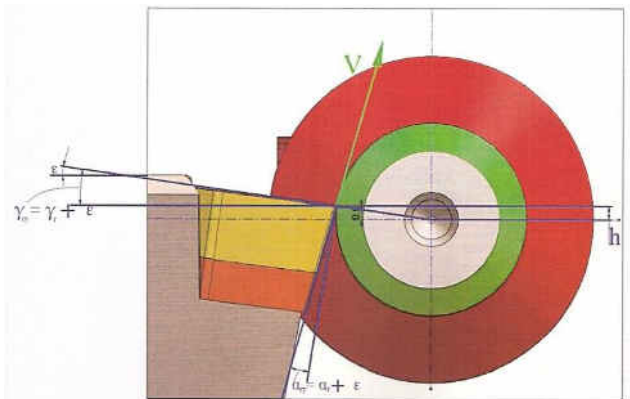


Fig.6. A scheme of change of rake angle and clearance angle of turning tool

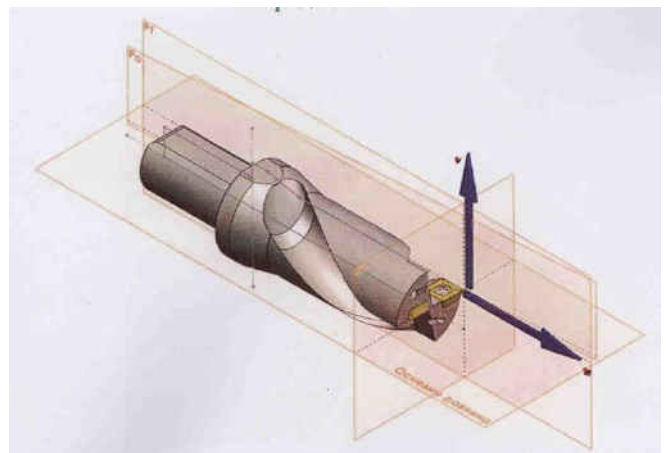


Fig.7 A system of secant and tangent planes of a drill

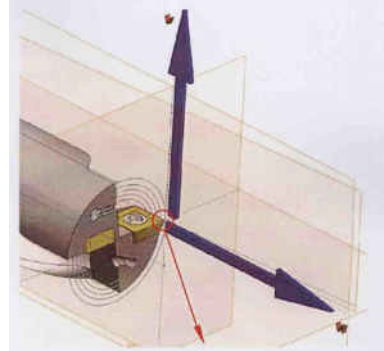


Fig.8. A system of planes in working position of the drill

In Fig. 9 are given values for measuring of the changeable clearance angle along the cutting edge (in function of r).

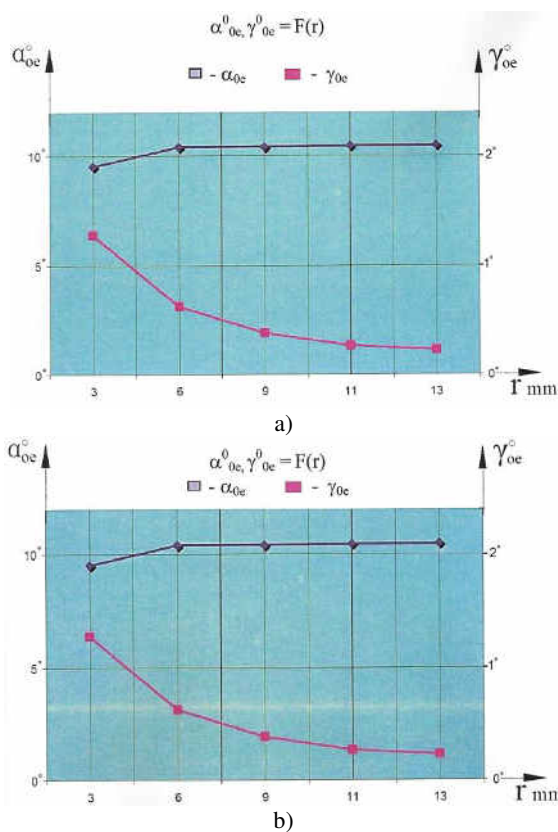


Fig.9 A changing of the working angles of the cutting inserts relative to r ($\kappa_r=80^\circ$; $s=0,1$ mm/rev)
 a) a peripheral cutting insert; b) a central cutting insert

The comparison between the theoretical results and the results obtained by modeling in SolidWorks environment is shown in Figures 10 ÷ 12.

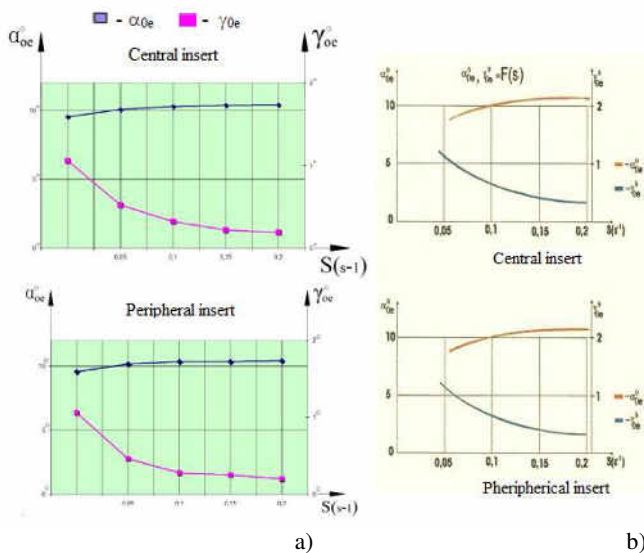


Fig.10 A changing of the working angles relative to s [mm/rev]
 a) researched by the new developed method (by object modeling); b) calculated by analytical dependencies

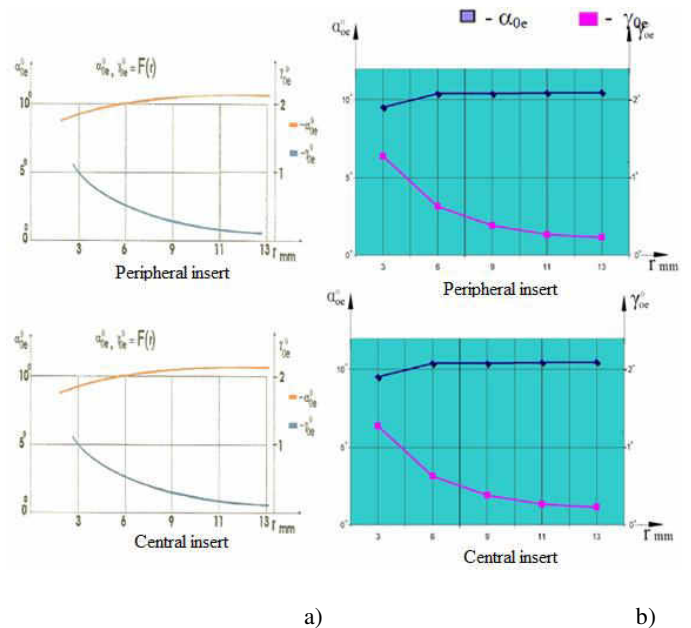


Fig.11 A changing of the working angles relative to r
 a) researched by the new developed method (by object modeling); b) calculated by analytical dependencies

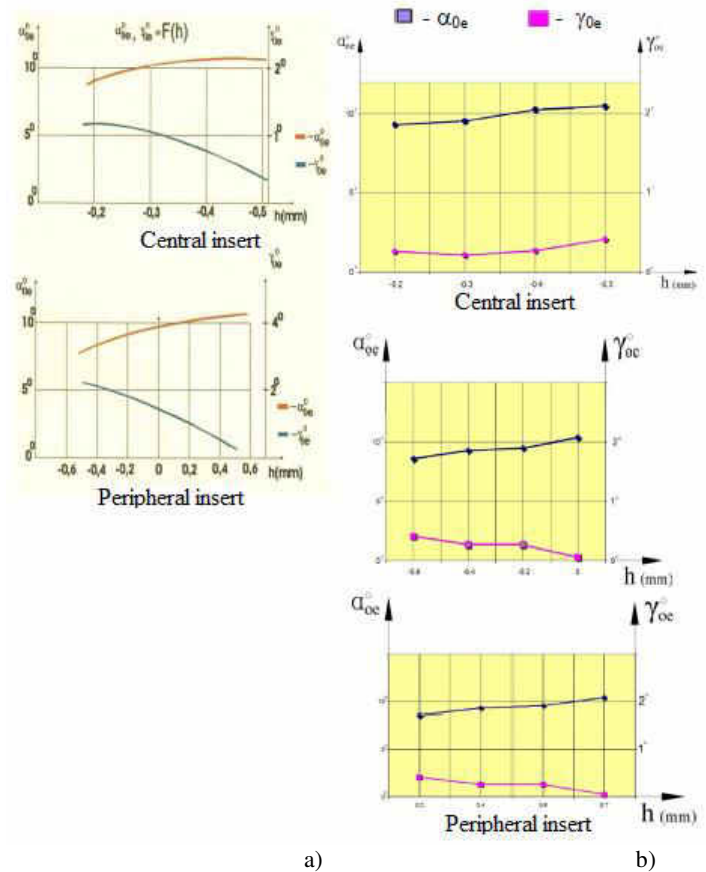


Fig.12 A changing of the working angles relative to h
 a) researched by the new developed method (by object modeling); b) calculated by analytical dependencies

IV. CONCLUSION

From the research that is done and the obtained results, the following summary can be made:

- The developed graphical-analytical method allows to visualize the work of different cutting tool designs and their condition in the cutting process.

- The used approach makes it possible to determine (measure) the working angles of the tool at different static angles and design parameters.
- A comparison between the developed method and the analytically obtained results give a difference of less than 2%.

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