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«Simulation of High-speed Machining Processes by Multi-edge Mills»

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Problem statement

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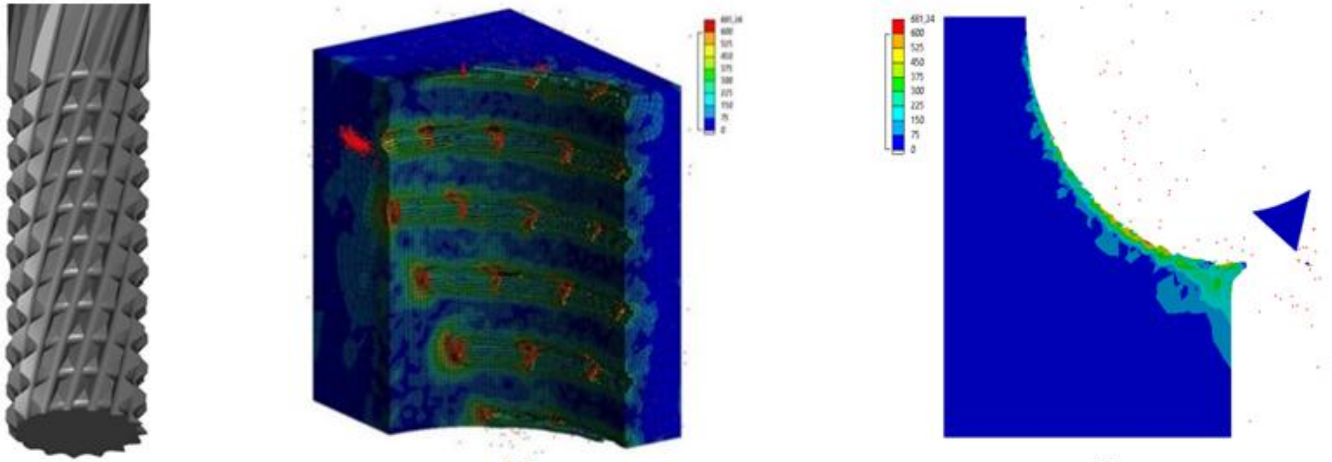
- Development of new designs of cutters and methods for the numerical assessment of deformation processes in the cut layer based on the FEA method is an urgent and practically significant task especially.

Solution methods

- Based on the results of the numerical experiment the mill design was created, optimized, having the initial tooth profile in the form of a trapezoid (Fig. 1a), located along two intersecting spiral lines with angles of inclination of 14 and 71 degrees. 3D models of various milling cutters were developed and the geometric parameters of the cutting part of the milling cutters were justified on the basis of stereological models: the angles of inclination of the screw grooves, the height and angular dimensions of the tooth.



a) b) c)

Fig. 1. Milling cutter model (a) and calculation results: (b) - cutting scheme and stresses in the contact zone; (c) - a single cycle of cutting with a cutter tooth and illustrated of chip formation

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Solution methods

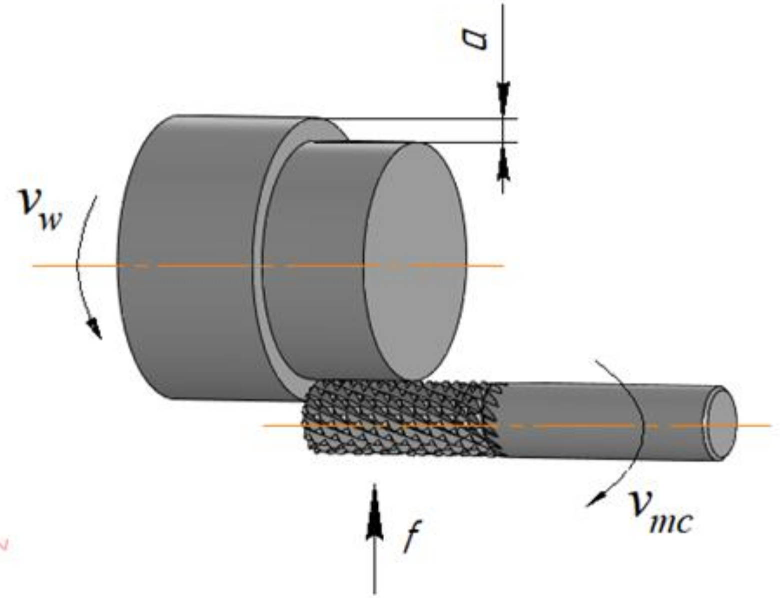


Fig. 2. Kinematics of shaping movements in turning milling

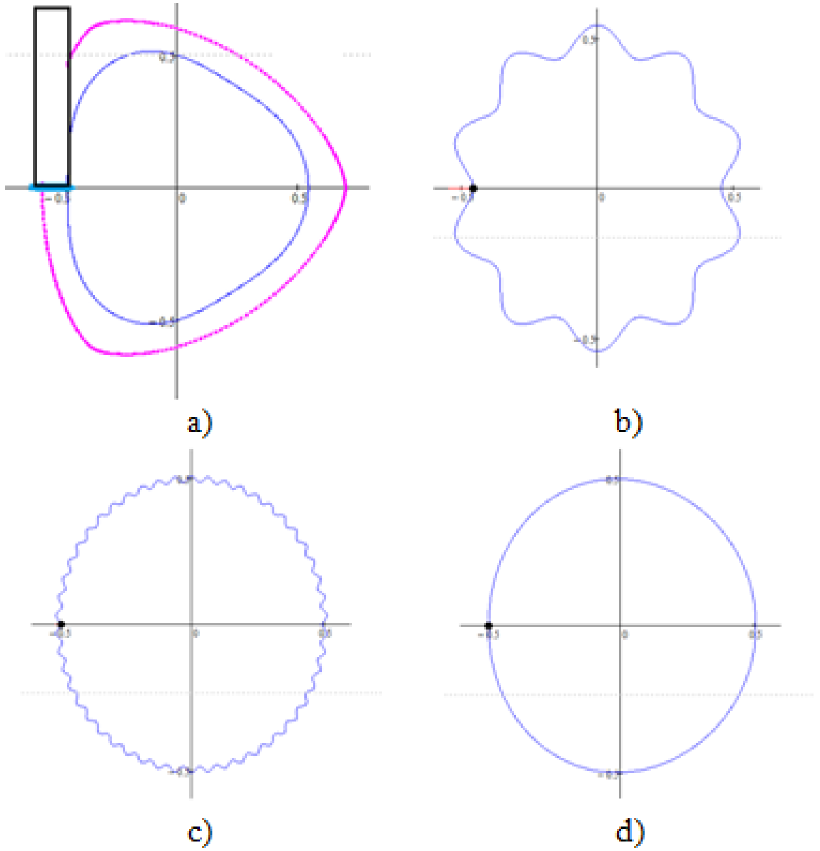


Fig. 3. Surface profiles of details obtained by turning milling

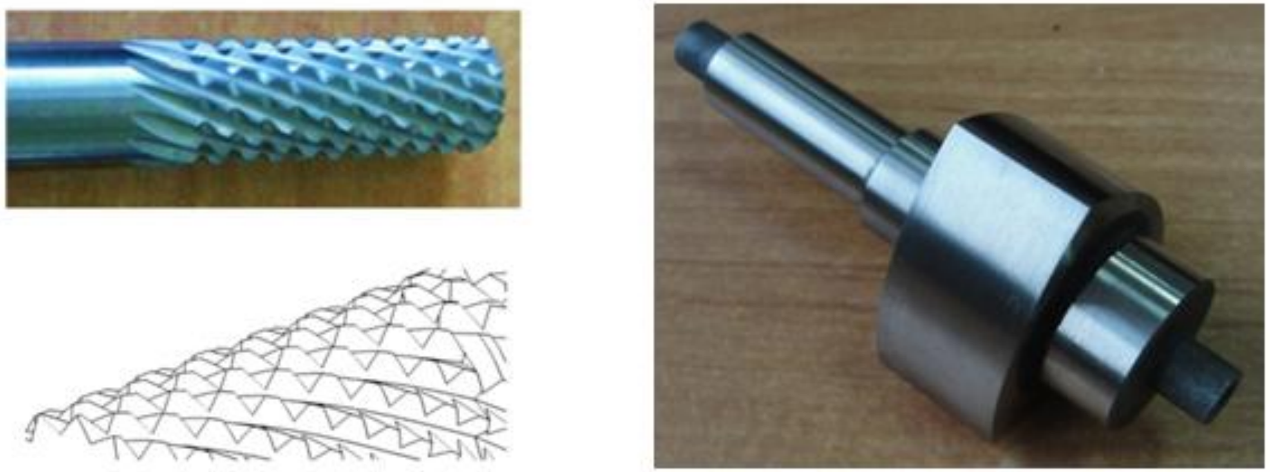
$$r_I(t,\delta\varphi) = \begin{pmatrix} r_{I0}\cos(\varepsilon_I t + \delta\varphi) + \varepsilon \\ 0 \\ r_{I0}\cos(\varepsilon_I t + \delta\varphi) \end{pmatrix}$$

$$r(t,\ \delta\varphi) = M_Z(t)\ r_I(t,\ \delta\varphi)$$

$$M_Z(t) = \begin{pmatrix} \cos(\omega_D t) & -\sin(\omega_D t) & 0 \\ \sin(\omega_D t) & \cos(\omega_D t) & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

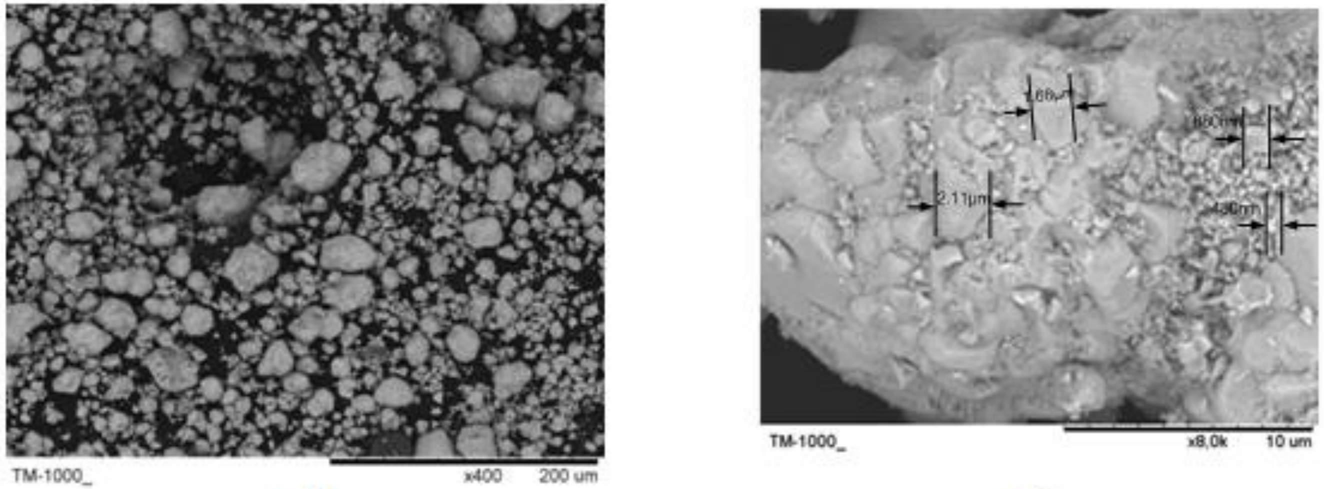
$$\delta\varphi_K = \frac{360\ deg}{N}\ K.$$

Solution methods



a) b)

Fig. 4. Hard metal tool's profile with cutter tooth in the form of "truncated pyramid" (a) and detail with surface in the form of an Reuleaux triangle profile manufactured by cutting milling (b)



a) b)

Fig. 5. Chip morphology obtained by cutting milling

Conclusions

- Using methods of finite element analysis studied the influence of the geometry of the cutting part of the multi-blades tool and cutting modes on the intensity of the deformation processes of high-speed milling. Additional studies made it possible to evaluate the effect of cutting modes, geometric parameters of the cutting part of the tool (profile and number of tooths), kinematics of relative displacement in the "tool - workpiece" system on the shape and sizes of surfaces obtained by cutting milling. On this basis determined the rational design of the mill, and the experimental studies confirmed the efficiency and increased productivity with simultaneous quality improvement when machining by the new multifaceted cutter.

Contacts

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