Regarding the Choice of Tools for Machining of Parts with Complex Configuration

Tanya G. Avramova

Abstract— **The development is dedicated to a particular approach to developing a technological process for producing rotary parts with complex configuration by using metal cutting machines such as "machining center". The proposed method includes determine of the stresses and deformations emerging in the bodies of the cutting tools selected for the machining of relevant part, allowing to answer the following questions: Is the cutting tool suitable for the machining under the proposed cutting conditions; Is it properly chosen the instrumental material; Is it possible forecasting the accuracy of machining taking into account the deformation of the cutting tools.**

Index Terms— **Cutting tools, Machining, Rotary parts**

I. Introduction

Modern production based on automated machines requires high reliability of the technological process. The cutting tools are the weakest unit of the technological system.

This article gives a certain approach at choosing a tool group for machining of a particular part.

II. Essence of the Research

A. Description of the Surfaces of the Part "Pipe Flange for Soft-joint"

The purpose of the "Pipe flange" part (fig.1) is to make the connection between a metal or plastic pipe with a soft rubber hose by means of a bolt connection for reliable connection in the case of responsible pipe systems. It has the widest use in the shipbuilding at fire protection systems to connect the fire hose to the metal pipes that supply the foam for firefighting. It should be noted that the metal pipes for the firefighting system the welding of the connections between the pipes are not allowed.

Fig. 1 Pipe flange for soft-joint

Types of surfaces adjacent to the part with a complex configuration:

- Outer surfaces:
  - Cylindrical surfaces;
  - Forehead surfaces;
  - Forehead-cylindrical surfaces;
  - Forehead grooves;
  - Chamfers and roundings.
- Inner surfaces
  - Central cylindrical main hole;
  - Cylindrical holes with chamfer;
  - Cylindrical grooves.

B. Selection of Cutting Tools

From the analysis of the surfaces to be processed and allowance of machining is performed pre-selection of a group of tools, and then exploring their functional capability according to the following criteria [6-10]:

- Strength analysis;
- Determination of deformations under real load.

The first chosen tool is a milling cutter of stepped type using toroidal cutting inserts (Fig.2).When you submit your final version, after your paper has been accepted, prepare it in two-column format, including figures and tables.

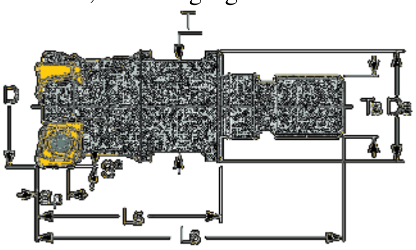


Fig. 2 Milling cutter for machining of stepped type surfaces

The second tool is a milling cutter for profiling of surfaces with round inserts for profiling and milling edges with roundings (Fig.3).

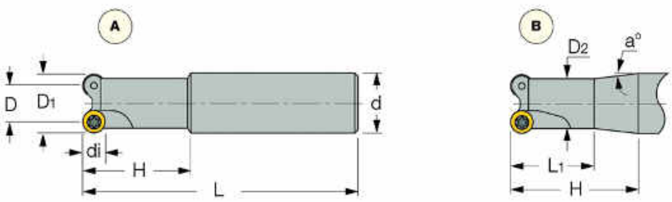


Fig. 3 Milling cutter for surface profiling

The third tool of the group is shank milling cutter designed for the processing of complex contours (Fig.4)

Manuscript received October 01, 2017
Tanya G. Avramova, Department "Manufacturing technologies and cutting machines, Faculty of Mechanical engineering and technologies, Technical University of Varna, Varna, Bulgaria

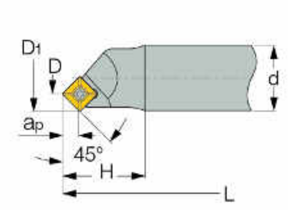


Fig. 4 Shank milling cutter designed for the processing of complex contours

Choosing a turning tool with a 45° angle of entry for complex internal contours is made (fig.5).

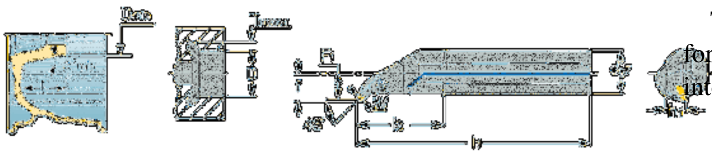


Fig. 5 Turning tool for complex internal contours

The choice of tools continues with a turning tool (Fig.6), characterized in that it is an adapter adaptable to different types of bodies, for making of internal and forehead grooves, as well as turning of internal surfaces.

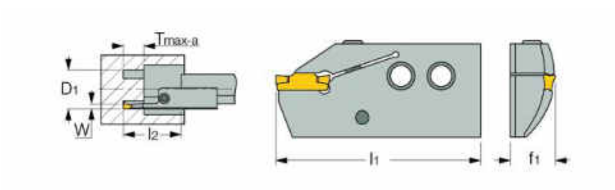


Fig. 6 Turning tool for internal grooves

The next tool in the group of selected tools is a turning tool designed for specially shaped inserts (fig.7) for machining of external and internal surfaces by copying the shape of the insert.

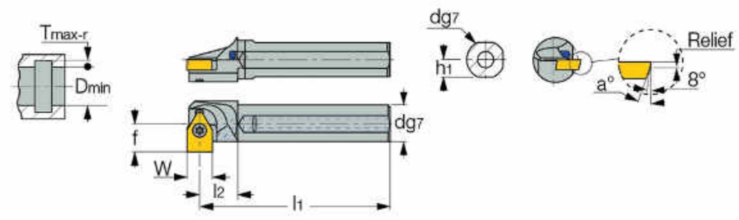


Fig.7 Turning tool for internal grooves and surfaces, working by copying

Follows a multifunctional tools for drilling, boring, facing and external turning (fig.8).

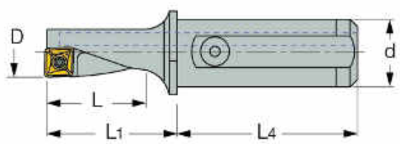


Fig. 8 Multifunctional tool for drilling, boring, facing and external turning

Tooling system for drilling and chamfering (Fig.9) in one operation is next in the list of selected for processing of the part (Fig. 1) with a complex surface instruments

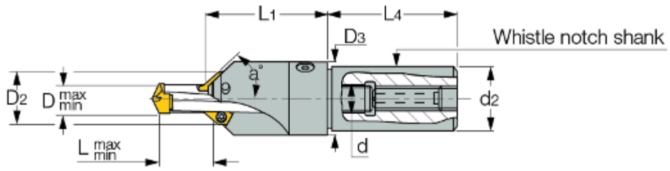


Fig. 9 Tooling system for drilling and chamfering

The last tool selected in the group is multifunctional tools for groove - turning and milling operations (fig.10) with interchangeable W - shaped drill inserts.

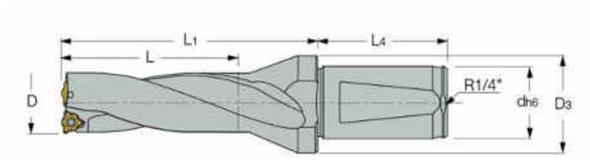


Fig. 10 Multifunctional tool for groove - turning and milling operations

C. Determination of stresses and deformations of the investigated tools

To perform the analyzes, computer simulations of the selected cutting tools were carried out, the calculated loads being set and for each of them the following are valid [1-3]:

- Determination of load patterns;
- Simulation analysis;
- Determination of stresses and deformations of cutting tools occurring in the processing processes.

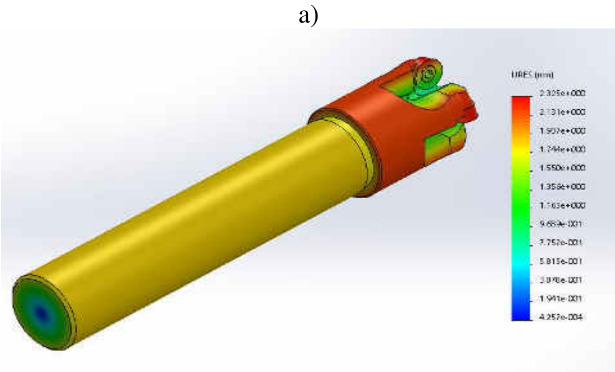
Studies were conducted under the following conditions:

- Cutting mode:
  - t =8 (mm) – cutting depth;
  - s = 0,3 (mm/rev) – feed;
  - V = 110 (m/min) – cutting speed;
  - z=4 – number of teeth (where applicable).
- Data on processed material (C30 EN 10250-2-2000):
  - R_m = 490 [MPa] – tensile strength;
  - R_e = 295 [MPa] – yield strength;
  - Amin = 21 % – relative elongation;
  - ψ = 50 % – relatively contraction;
  - HB = 179 – hardness in Brinell.

Cutting forces were obtained experimentally and after data processing from a planned experiment were proposed as step models. The tools are loaded with the maximum forces of cutting for particular processing at modes allowing maximum labor productivity [4,5].

Figures 11-14 shows the results obtained for the determined stresses and deformations after computer simulation of the instruments (results are shown only for the most critical tools of all tested).

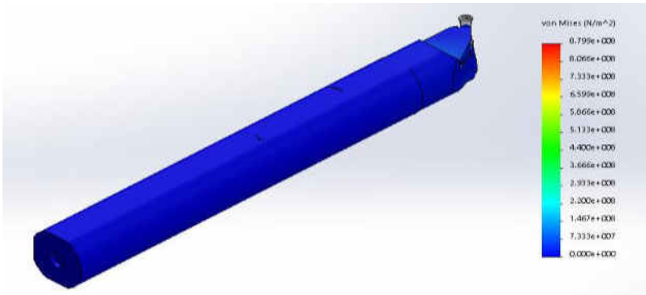
a)



b)

Fig.11 Results obtained after computer simulation for milling cutter for surface profiling

a) results of the resulting stresses; b) results of the deformations obtained



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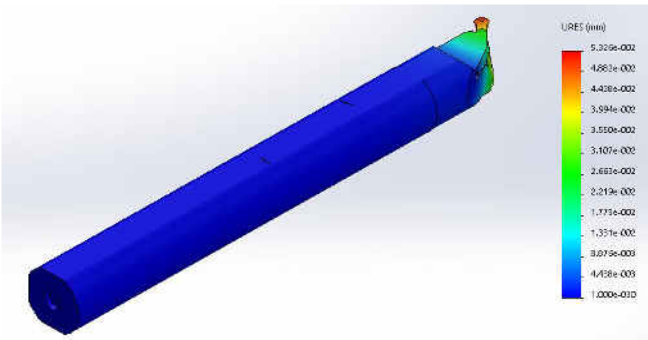
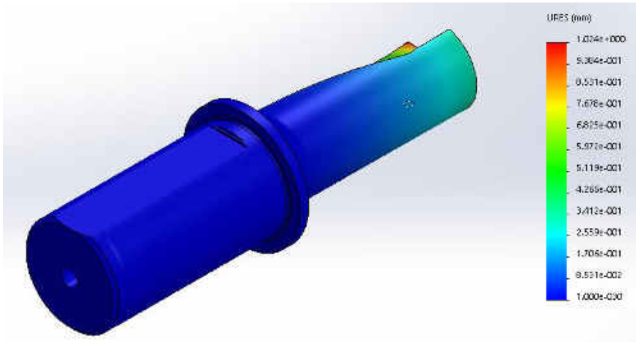


b)

Fig.12 Results obtained after computer simulation for turning tool for complex internal contours

a) results of the resulting stresses; b) results of the deformations obtained

a)



b)

Fig.13 Results obtained after computer simulation for turning tool multifunction tool for drilling, boring, facing and external turning

a) results of the resulting stresses; b) results of the deformations obtained

III. CONCLUSION

The following conclusions can be made from everything shown in this paper:

- An approach is proposed to select tools that allow the determining of their functional abilities.
- Determination of body deformations makes it possible to predict the accuracy of the processing, especially for designs with smaller body sections.
- The results obtained show that during loads and stresses occurring during processing, the selected tools show weaknesses at the sharp edges in the insert attachment area and in the tool attachment area to the machine (the shank of the tool) which can not be avoided due to limitations imposed by the machines and processes for making the bodies of the metal-cutting tools.
- For the most critical tools, maximum deformations were recorded with the following values: for milling cutter for surface profiling - 2.32 mm; For turning tool for complex internal contours - 0.05 mm; Multifunctional tool for drilling, boring, facing and external turning - 1.02 mm.
- The results allows to take measures to increase accuracy by a certain setting of tool and optimizing processing program in CNC machines.

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Ph.D. Eng. Tanya Avramova is graduated from the Technical University of Varna, Bulgaria. She is with Bachelor's degree and Master's degree in the specialty "Manufacturing engineering and Technologies". She successfully defended her PhD dissertation in 2014. She work as an Assist. Prof. in Faculty of Mechanical engineering and technologies at Technical University of Varna, Bulgaria since 2009 and give lectures of disciplines: Manufacturing technologies, Cutting Tools, Design Automation (AutoCAD), etc. Her professional development is in the field of the cutting tools.

Administrative activities: Person responsible for a specialty "Computerized Technologies in Mechanical Engineering"; Person responsible for learning activity of students and lecturers in the Master's degree; Organizer of the National Olympiad in Technical Drawing.