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MODELLING OF DISPLACEMENT PROCESSES AND FORCES IN THE THREADED CONNECTIONS OF BORING CUTTING TOOLS

ANDREW GERASIMOV, NIKOLAI POPOK
Polotsk State University, Belarus

Modeling of displacement processesin SolidWorks.Modelling of forces in the threaded connections of boring cutting tools.

Introduction. Mechanical engineering is a key industrial sector, because without the use of its capacity for the production of the necessary parts, products, equipment, etc. cannot do any other industry.

Compared with other methods of production of machine parts machining provides the greatest accuracy and highest production flexibility makes it possible to quickly move from one size machining workpieces to a different size.

Cutting tool, cutting relatively thin layers of material, gives the workpiece desired shape and size.The efficiency of the cutting tool, its reliability had a significant impact on the economic efficiency of the production process.

Quality and tool life in many ways determine the performance and effectiveness of treatment, and in some cases, and the possibility of gaining parts of required form, quality and accuracyin general.Improving the quality and reliability of cutting tools enhance productivity of metal cutting [1].

Oneoftheperspectivewaysofboringtoolsconstructionsdevelopmentisusingtheprinciplewhentheyaremadefro mdifferentmodules. Whenweusethisprinciple,weincreasethesafetyduringtheirworkandmaintenanceconditionsbyreducingtheamountof moduleconstructions. Inaddition,theusingofthese modulesinprojectingreducetimeandlaborcontentforengineer these constructions, give the opportunities for using new methods of engineering.

Specialattentionisgivenfortheconstructionsofmicrometer adjustment andmovement of cutting blades assemblies, cartridges and cutting blocks as well.

The disadvantages of modular tool units are their reduced stiffness and accuracy as compared with solid tools, and the lower, the more modular elements in the block. To increase the accuracy of blocks, resort to using elements for adjusting the size of the cutting tools [2].

In metal treatment of precise holes increasing application get boring heads. They allow to set the size of the tool with high precision and achieve high-quality and accurate processing. The ability to control the size of the tool can improve the processing efficiency by reducing tooling costs and improve performance through the use of cutting teeth made of modern instrumental materials (hard metal, mineral ceramics and super-hard materials), allowing the use of higher cutting data [3].

Boring heads have higher performance as compared to other boring tools.

Formulationofaproblem. There are many ways to make the preload in the micro metric threaded connection of microbores [4]. However, the easiest to manufacture of the resilient member is the form of a slotted spring.

During the design and development of a new boring tool with micrometric adjustment blades solved the problem of backlash sample (reduce it to the required value) in the threaded connection of the boring head.It was found that the amount of movement in the sample is affected by several factors: the parameters of the split grooves on the housing sleeve and the efforts of its pre-compression or wedging (to bring it to preload) [4].

Modeling and experiment.

One of the technical characteristics of boring heads with micrometric blades adjustment is discrete adjustment for the size of 0.005 mm in diameter.

The main element for the size adjustmentin the design of the boring head is the slide, displacement of which depends on the accuracy of the threaded connection M12x0,5–6H.

Therefore, it was analyzed the ability of using the spring washers to eliminate gaps during movement of the slider to a specific size in this compound. It should be noted that all of the leading manufacturers of boring heads with micrometric adjustment of the blades recommends to make the setting up the tools in one direction.For example, by sliding the slider one more time in order to increase the size of boring diameter, at first the slide must be retracted, and then the slider could be set up to the desired diameter.

After analyzing the structure of the sample of boring head with a spring and a lock nut in a slider design, that was proposed by RUE "Orsha Toolmaker" following should be noted:

1. Figure 1 shows the load diagram of turns of the screw shaft with preload via lock nuts and disk spring.Loaded hand turns in the thick line.Since the spring pushes the slider and the lock nut from each other, then the preload loaded the versatile surfaces of thread locknut and slider.

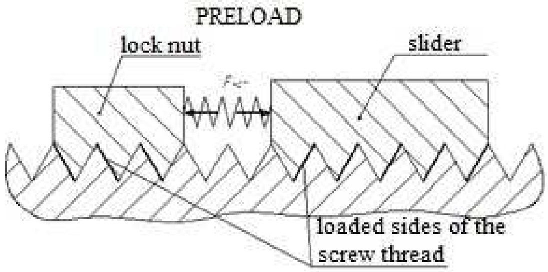

Fig. 1. The scheme of turns of the screw shaft with preload via lock nuts and disk spring

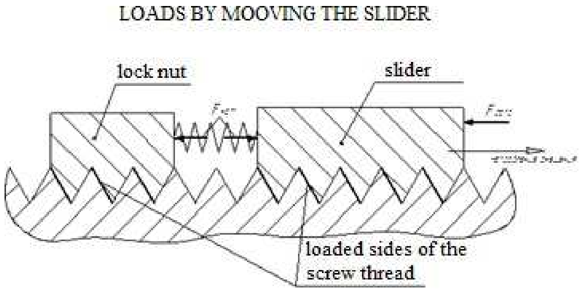

Fig. 2. The scheme of turns of the screw shaft with preload via lock nuts and disk spring (increase size)

When you move the slider for adjustment (increase size) in contact of screw and the slider should work the other side of the thread of the screw shaft (Fig. 2).However, since the preload occurred in the opposite direction, there is a load uncertainty.The gap in the connection of "screw - nut slide" will depend on the interference of force ratio$F_{нат}$and total resistance force$F_{сопр}$of the slider movement.

This uncertainty may be one of the reasons for the uneven displacement of the slider when setting up, and as a result, the bore size installation inaccuracies.

To minimize uncertainty of loading will allow the accommodation of locknut on the other side of the slide, or compression preload of lock nut and slider (at an invariance of their location).

Initially were created three-dimensional solid models of split bushings and screws in the program SolidWorks (Fig. 3).

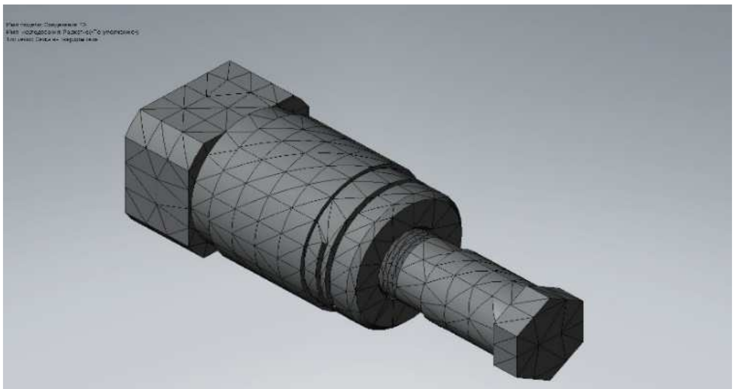

Fig. 3. Connection, broken into finite elements in SolidWorks

After analyzing the structure using FEM program SolidWorks (Fig. 4), we can make preliminary conclusions about the acceptability of this type of backlash in the threaded connection of cutting tools.

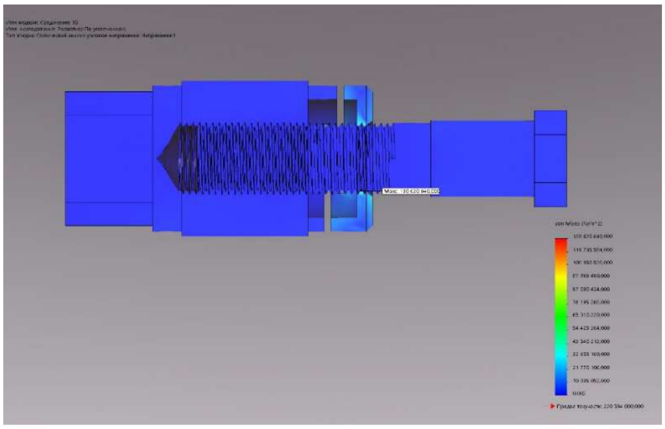

Fig. 4. Map of the distribution of stresses, resulting in the program SolidWorks

After conducting research and calculations using SolidWorks software, experiments were conducted on natural samples of split sleeves.

During the experiment, the split sleeve disjoining with measuring plates, and then when screwing and unscrewing the screw, was measured torque that occurs in the threaded joint. (Fig. 5).

Fig. 5. Measurement of torque with a torque wrench

The rigidity of sleeves is measured using the ЗИП 05-82 (Fig. 6).

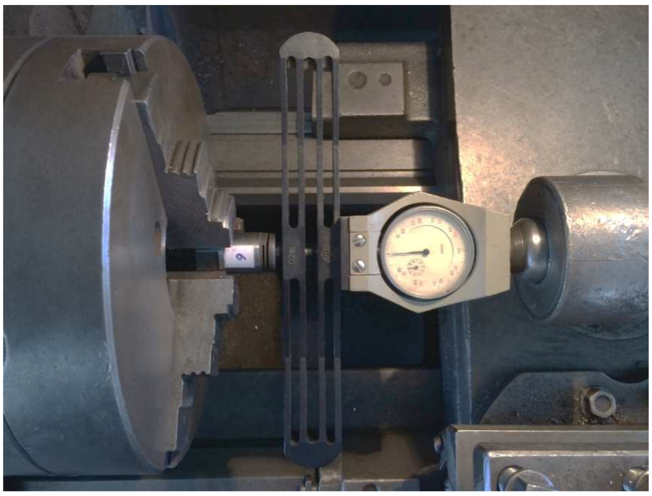

Fig. 6. Measurement of hardness using ЗИП 05-82

Conclusions. The most appropriate is the initial version of the design with cutting through slots in the slider - which allows to exclude the gaps in the transmission of the screw-nut. It is necessary to pay attention to the sequence of the assembly adjustment for appropriate the size.

When analyzing the structure using the finite element method in the program SolidWorks, we can draw preliminary conclusions on the admissibility of this type of gapscompensation in the threaded connection of micrometer screws in precision cutting tools. However, due to the nature of the calculations in SolidWorks Simulation it is not possible to situate the compression of split bushing and then screwing the screw. Thus, a further simulation carried out on real models. It turned out that there are moments when screwing screws into the sleeve cut with insufficient depth of the groove. Suitable torque observed when the width and step values of sleeve grooves are in the interval of one to two pitches of the thread. Rigidity of sleeves decreases with increasing of depth and width of the grooves in the sleeves.

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