TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 61, Issue Special, September, 2018

RESEARCH REGARDING A REDUCED CONTACT BETWEEN THE FLANKS SURFACE AND THE MATERIAL DURING TAPPING IN ORDER TO INCREASE MACHINING PRODUCTIVITY

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Abstract: *The tap geometry plays an important role in the tool's durability, influencing the forces during the tapping process and the way the chips are evacuated. This paper presents the geometry of a cutting tap that helps extend the cutting tool's life by reducing chipping, in C45 steel processing. The article contains details about: the geometry of the tap, the surface of the thread, the form of the chips, the forces that appear during machining and results obtained in this research. Based on the results, the objectives of this paper were achieved. The tap durability and the thread quality were improved, with the chip deposition on the rake surface reduced compared to the standard tap geometry.*

Key words: *tapping, threading, thread analysis, chips analysis, torsion moment.*

1. INTRODUCTION

Interest in the tapping process is increasing due to its importance in the industry, especially in the automotive industry. Thus, new and advanced research regarding this process are significant. [1]

Thread is a helical rib that is disposed on a surface that can be cylindrical or conical. This surface is external to bolts and internal in nuts and holes. There is also a particular case where the spiral is placed on a flat surface. The thread can be geometrically generated by a triangular, square, semi-circular or trapezoidal shape, which carries around a helical movement around the axis of the surface of rotation. [2]

In the last decade, to keep up with industry demand, researchers and cutting-tool manufacturers have focused on researching and developing the material from which the cutting tool, macro geometry, micro geometry, and chipping tools are made. Tap geometry plays an important role in the durability of the tool, influencing both the forces that appear on the chip in the type of chipping and the way the chips escape. [3]

This article aims to research the cutting tool geometry. The tap geometry is very important for the tool's life, influencing the forces that act upon the tap during cutting as well as the way the chips are removed. Chip removal is an important factor in the process of threading blind holes. The research aims to reduce the contact between the flank surface and the material during tapping in order to increase machining productivity, which is appropriate for cutting C45 material.

2. GEOMETRY MODIFICATIONS

For this scientific paper a tap drill with 5 geometry changes of the standard M8x1,25; DIN 371/376 tap with a tolerance class of 6HX from the cutting tool company Gühring was made. The changes that were done are the following: outside diameter reduced, two guide lands, no external relief, doubled relief on teeth flanks and increased core diameter.

2.1 Outside diameter reduced

By reducing the tap diameter, the arm strength shrinks but, more importantly, it decreases the amount of removed material [4].

2.2 Two guide lands

The guided land is carried out on the contact surface of the tap, as presented in figure 1, this being intended to reduce friction with the workpiece. reducing as much as possible the forces generated during processing due to friction with both the basic material and those that generate the torque moment. The two guide land do not allow the driving and ″galling″ of the chip between the front teeth and the processed material while withdrawing the tap. [4]

Fig. 1. The tap with a new geometry

2.3 Increased core diameter

The ascending core serves to deflect the chips without them being stuck on the guiding surface. Chips obtained after processing, tend to adhere to the surface of the guide land. The increased core determines directing of chips outwards, so after the withdrawal of the tap, the centrifugal force determines the chips to detach off the tap. [4].

2.4 No external relief

By increasing the clearance angle, the guiding properties of the tool are lowered, which is why cuts can occur in soft materials, when using compensation chucks. [3]

2.5 Doubled relief on teeth flanks

Axial resonance is favored by the use of taps with high clearance flank angles in soft materials or through improper treatment of the cutting edges. [3]

3. EXPERIMENTAL METHODS AND RESULTS

The workpiece material was Medium-Carbon-Steel C45 (1.0503) in the form of a rectangular block of 30x200x500 mm. The test was conducted on the machining centre „DMU 65 Monoblock” equipped with a „Spike tool” holder that allows us to measure the torsion moment and a Synchro chuck with compensation. The Synchro chuck allows compensation of axial forces resulting in a higher tool life and protects the spindle, because the direction of rotation of the chuck can be reversed.

The threading was performed with external cooling. Coolant is used in machining operations to reduce tool wear, to dissipate heat from the workpiece and machine, and to aid chip breaking as well as chip removal. [3]

The taps have standard coating (Hardlube) and the same cutting parameter (1,25 pitch; 3xD depth, coolant 12%). All the taps have been measured before testing in order to check the geometry. In order to obtain reliable results, two taps were tested for each geometry, with a third one being tested where large differences were observed.

During testing, at a certain interval of threads 3D scans on „Alicona Infinite Focus”, force measuring with „Spike tool”, pictures of tap, chips and threads were conducted on „PG2000” and „Keyence VHX-5000” and the electronic microscope „REM”.

3.1 Durability of cutting tools

Following the tests, the new tap has a 35% greater durability than the standard tap durability shown in Figure 2.

3.2 The analysis of the chips and surfaces

Figure 3 shows a great difference in thread quality after processing. The quality of the machined threads with the tap with the new geometry is higher compared to the standard tap, having much less deformation traces.

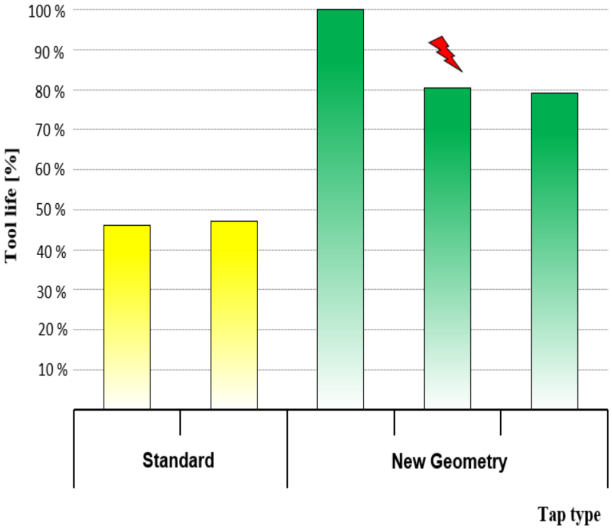
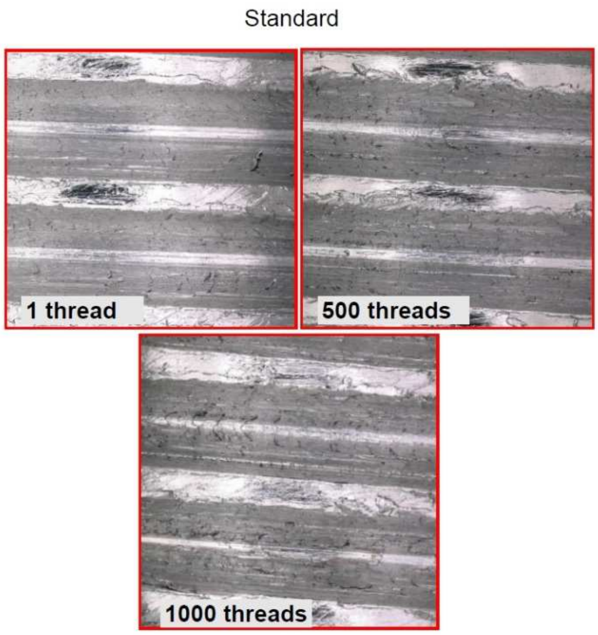


Fig. 2. Tool life in processing C45

These traces occur much later on the processed threads compared to the standard tap.

Chips and threads resulted after tapping, were analyzed using the "Keyence VHX-5000" microscope, at a certain interval of processed threads.



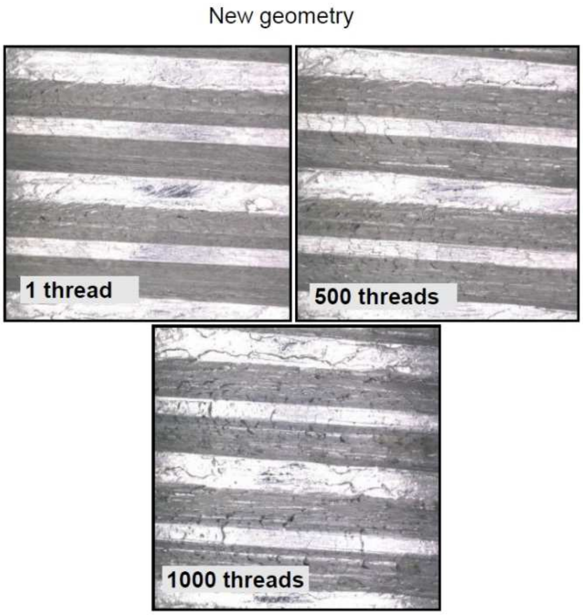


Fig. 3. The surface of the threads

Unlike standard taps, by having an increased core diameter, it shows more traces on the clearance surface of the cutting tool, made during chip evacuation when machining took place. After 10 also 1000 machined threads with the new tap geometry, the chips are shorter and thinner compared to the ones produced by the standard tap (See Figure 4).

This aspect has a major influence on chip evacuation during thread processing and also on cutting tool durability.

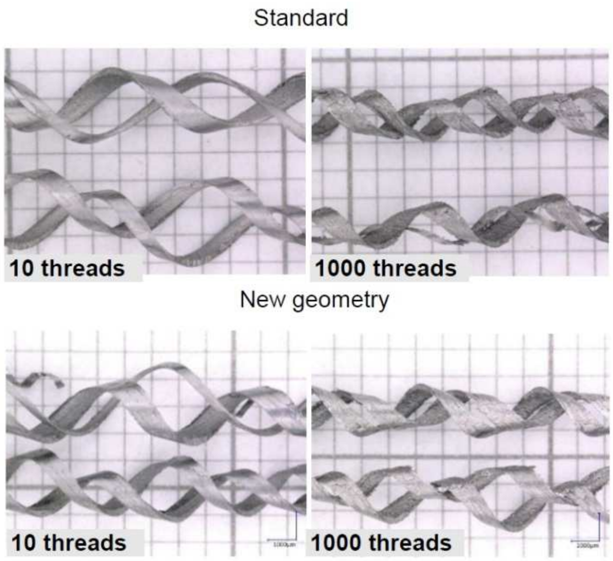


Fig. 4. Chips resulted after machining

After 10 processed threads, the chip spiral size is larger with the standard tap compared to the new geometry tap. After 500 and 1000 processed threads, the chips resulting from the standard tarp have a smaller spiral with larger deformation traces compared to the chips produced by the tap with this geometry.

Unlike the standard tap, in addition to a high durability, on the new geometry tap, chips deposition and chip formation is considerably smaller. It can be seen in Table 1 that the number of machine tool stops for removing the chips from the new geometry tap is three times lower than the standard one.

Table 1. Stop number for chip removal

Tap type	1%	2%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Standard	red	red	red	red	red	red	red	yellow	yellow	yellow	green	green	green	green
New geometry	yellow	yellow	yellow	yellow	green	green	green	green	green	green	green	green	green	green

yellow: Chip snarling between 11 - 30 threads; red: Chip snarling between 1 - 10 threads; green: No chip snarling

3.3 The analysis of the forces that appear during machining

Throughout the test torque moments were measured with the "Spike tool" device. Figure 6 shows the variation of the torque in relation to the durability of the cutting tool compared to the standard tap. At the first processed threads, the torque is lower at the new geometry tap. Having the higher torque on the last processed threads and increased durability, it proves that this type of tap can withstand higher torque moments than the standard tap.

Figure 5 shows the torsional moments obtained during the cutting after 1000 tapped tapes having new geometry and standard geometry. It can be seen both a difference in the magnitude of the measured value between the two types and the constant of the torque during the cutting process. This constancy is influenced by the vibrations that occur during machining, due to wear and tear on the teeth.

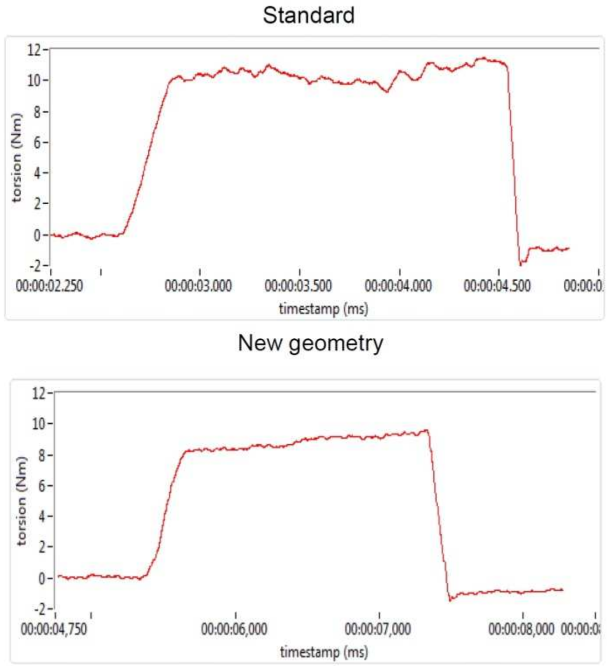


Fig. 5. Torque charts, measured during cutting, after 1000 processed threads

3.4 Tap wear analysis

At a certain range of processed threads, 3D models were scanned with the "Alicona Infinite Focus" machine. This has been done in order to track the wear and increase of chipping over time by overlapping the two models. Thus, in Figure 6 it can be seen the tap before machining and the tap after 1000 threads, for both types of taps researched in this article. The tap with a two guide land and an increased core diameter has small wear and no chipping, compared to the standard tap which has chipping of approximately 240 microns on the second tooth.

In order to be able to analyze the evolution of wear, material deposition and removal of the metal coating in certain areas of the cutting tool, was used the electron microscope „REM”. Figure 8 shows capture images, with the electron microscope, on the two types of taps, used for this article, after 1000 processed threads. In these images one can notice this interruption of the rank face, which results the wear, in this area of the tap, since there is no contact with the material during the processing, which leads to a higher durability of the cutting tool.

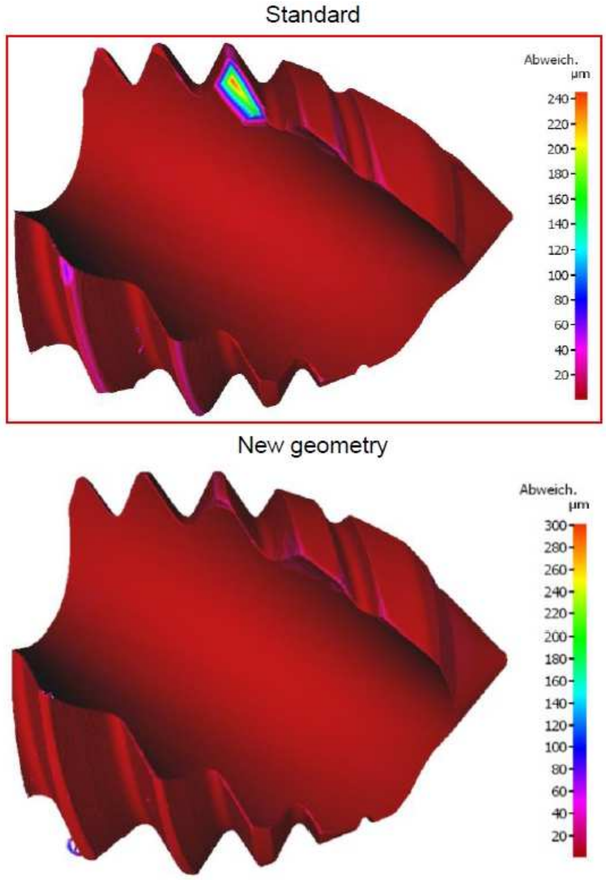


Fig. 6. Analysis of the most affected areas after 1000 processed threads

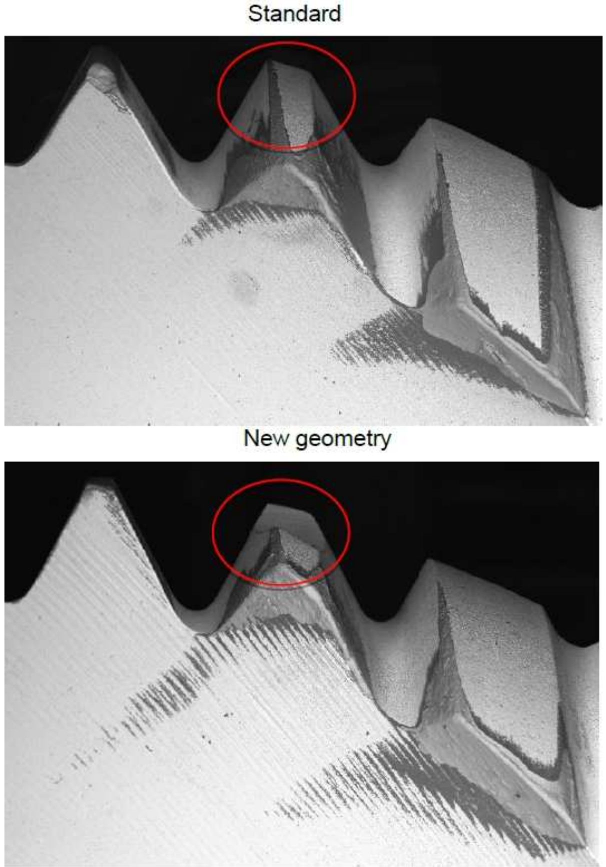


Fig. 8. Wear analysis after 1000 processed threads

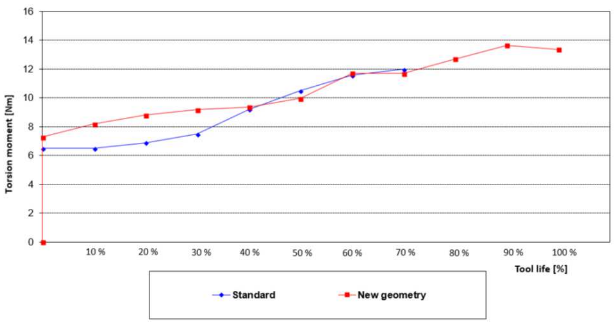


Fig. 7. Torque variation

4. CONCLUSIONS

The purpose of this research was to produce, analyze and test a tap type, with the best geometry, in C45 steel processing. After testing, the tap with new geometry has a longer tool life, with 35% longer than the tool life of the standard tap. Removal of chips from the tap with the new geometry is three times lower than from the standard tap.

Having higher torque during processing and increased tool life, proves that this type of tap resists higher torque than the standard tap. The thread quality, processed by the tap with the new geometry, is much better compared to the quality of the thread, processed by the standard tap, with far fewer signs of deformation.

5. ACKNOWLEDGMENTS

The authors would like to thank the Technical University of Cluj-Napoca for knowledge and especially to Gühring Company for the technical and material support.

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CERCETĂRI PRIVIND REDUCEREA CONTACTULUI ÎNTRE SUPRAFAŢA FLANCULUI ŞI A MATERIALULUI ÎN TIMPUL OPERAŢIEI DE GĂURIRE PENTRU CREŞTEREA PRODUCTIVITĂŢII DE PRELUCRARE

Rezumat: Geometria tarodului joacă un rol important în durabilitatea sculei, influențând forțele în timpul procesului de așchiere și modul în care așchiile sunt evacuate. Această lucrare prezintă geometria unui tarod prin aşchiere, care ajută la extinderea duratei de viață a sculei prin reducerea depunerii aşchiilor, în prelucrarea oțelului C45. Articolul conține detalii despre: geometria tarodului, suprafața filetului, forma aşchiilor, forțele care apar în timpul prelucrării și rezultatele obținute în cadrul acestei cercetări. Pe baza rezultatelor, obiectivele acestei lucrări au fost atinse. Durabilitatea tarodului și calitatea filetului au fost îmbunătățite, iar depunerea de așchii pe suprafața de degajare a fost redusă comparativ cu geometria standard a tarodului.

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