14th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2010, Mediterranean Cruise, 11-18 September 2010

CORRELATION RESEARCH OF CUTTING FORCES DURING TURNING

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ABSTRACT
In this paper are given experimental results during turning for material C45 and X12CrNi 18.8 (DIN). Turning has been made on a universal lathe PERVOMAJSKA NILES TVP-250 by using coated plates CNMG 12048 made in Sweden. The measuring has been done with dynamometer type FS1, where as a researching method was used a method of statistics with three factors.
Keywords: chip, lathe, forces and dynamometer

1. INTRODUCTION

In order to realize the processing with cutting it is necessary the cutting tool to act in the piece of processing material. During this activity, for the reason of chip plastic deformation, incoherence of chip from the material of processing piece, friction between front surface of cutting tool and chip as well as by friction between back surface of cutting tool and processed surface, appear cutting forces.
The resultant F_R in the common occasion of processing is spatial and it can be stripped in three normal components, one with the other Fig 1[2].

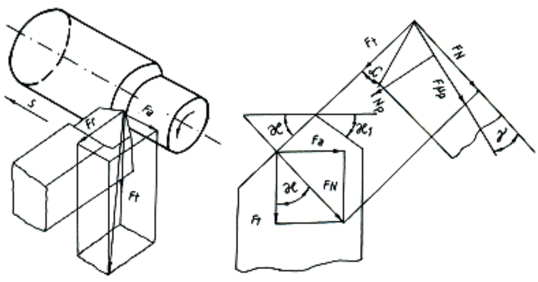

Figure 1. Cutting force during turning

These components are: tangential force Ft which acts on the front flat of surface and fits in the direction of cutting speed, tangential force Fr is perpendicular with the ax of processing piece and tangential force as well as axial force Fa that fits in the subsidiary movement direction with the

opposite direction. Except these, there are appeared other forces however experimentally are measured only in three directions, as Ft, Fa and Fr.
In this paper is researched the correlation of tangential cutting force Ft for steel X12CrNi 18.8 and steel C 45 according to DIN.

2. CONDITIONS FOR EXPERIMENT REALIZATION

Metal cutting Instrument: The research is done with cutting plates CNMG M3 120408 SEKO made in Sweden. Cutting plates are settled on the holder PCLNR 20 x20 made in Uzhica´s Prvi Partizan, which gives the cutting edge, this geometry $\chi = 90^0, \gamma = -6^0, \lambda = -6^0$ and $r = 0.8mm$.
Research material: The experiment is realized with steel X12 CrNi 18.8 and C 45 according to DIN with these dimensions dxL 100 x 400 mm.
Machine: The turning is processed in the lathe "PRVOMAJSKA" NILES TVP 250, with rotation numbers 16-2240 rotations/min, 18 scales, and feed 0,02 –1.2 mm/ rot. 48 scales figure 2.
Measure device: The measure of the cutting force is processed by three elements inductive dynamometer type FS1, where is done as well the calibration [1].
Processing parameters: The turning is done without utilizing cool means changing the cutting speed (V), cutting feed (s) and cutting depth (a) although as a scientific method is used the method with many factors ($2^3 + 4$), table1.

Figure 2. Machine NILES TVP 250

Table. 1 Conditions for experiment realization.

CHARACTERISTICS OF THE FACTORS					
Num.	Symbol	Level code	Maximum 1	Average 0	Minimum -1
1	V (m/min)	X_1	120.00	84.858	60.000
2	S(mm/rev)	X_2	0.200	0.141	0.100
3	a (mm)	X_3	2.000	1.414	1.000

3. ANALYSES OF THE RESEARCH RESULTS

Chosen plan and the derived research results are shown in table 2. During processing of the data in computer system are obtained mathematical models in four variants shown in table 3-4 [1]. Differences of cutting force in the function of processing regime is shown through mathematical model without reciprocal act and without factors valuation that are important as shown in table 3-4. Graphic interpretation of mathematical models 3.1-3.5 is shown in figure 3-4.
For analyze the cutting regime is used through mathematical model without reciprocal act and without factors valuation that are important. This is done with the intention that during research to participate all variable independent sizes (v, s, a) that makes possible qualitative determination of the change of cutting force.
In the sizes of cutting forces influence a great number of factors wherein are: physic-mechanical particularities of the processing material, chemical content, elements of cutting regime, geometry of cutting metal tool, cooling devices and tool wear. Mathematical models analyze 3.1 and 3.5 as well as their graphic interpretation, shown in figure 3-4 helps us to make the following conclusions

Table 2. Derived results during experiment realization

Nr rend.	V (m/min)	S (mm/rev)	a (mm)	X12 CrNi 18.8	C 45
				Ft (N)	Ft (N)
1	2	3	4	5	6
1	60	0.1	1	560	490
2	120	0.1	1	490	455
3	60	0.2	1	910	840
4	120	0.2	1	560	805
5	60	0.1	2	805	735
6	120	0.1	2	770	700
7	60	0.2	2	1400	1365
8	120	0.2	2	1365	1295
9	84.853	0.141	1.414	840	750
10	84.853	0.141	1.414	915	840
11	84.853	0.141	1.414	875	805
12	84.853	0.141	1.414	910	875

Table 3. Review of derived mathematical models for steel X12 CrNi 18.8

Review of mathematical models		
Type of mathematical model	Form of mathematical model	
Without reciprocal act and without factors valuation that are important	$Ft = 4940{,}937 \cdot v^{-0.102} \cdot s^{0.775} \cdot a^{0.624}$	3.1
Without reciprocal act and with factors valuation that are important	$Ft = 3138{,}410 \cdot \cdot s^{0.775} \cdot a^{0.624}$	3.2
With reciprocal act and without factors valuation that are important	$Ft = 2201{,}843 \cdot v^{-0.0637} \cdot s^{0.245} \cdot a^{1.224} \exp(0.1113 \cdot \ln v \cdot \ln s - - 0.052 \cdot \ln v \cdot \ln a + 0.5641 \cdot \ln s \cdot \ln a - 0.103 \cdot \ln v \cdot \ln s \cdot \ln a)$	33
With reciprocal act and with factors valuation that are important	$Ft = 3138{,}410 \cdot \cdot s^{0.775} \cdot a^{0.624}$	3.4

Table 4. Review of derived mathematical models for steel C 45

Review of mathematical models		
Type of mathematical model	Form of mathematical model	
Without reciprocal act and without factors valuation that are important	$Ft = 4687.441 \cdot v^{-0.078} \cdot s^{0.845} \cdot a^{0.648}$	3.5
Without reciprocal act and with factors valuation that are important	$Ft = 3305.374 \cdot \cdot s^{0.845} \cdot a^{0.624648}$	3.6
With reciprocal act and without factors valuation that are important	$Ft = 2486.600 \cdot v^{-0.0443} \cdot s^{0.508} \cdot a^{1.755} \exp(0.0656 \cdot \ln v \cdot \ln s - -0.192 \cdot \ln v \cdot \ln a + 0.602 \cdot \ln s \cdot \ln a - 0.1063 \cdot \ln v \cdot \ln s \cdot \ln a)$	3.7
With reciprocal act and with factors valuation that are important	$Ft = 3305.374 \cdot \cdot s^{0.845} 5. \cdot a^{0.648}$	3.8

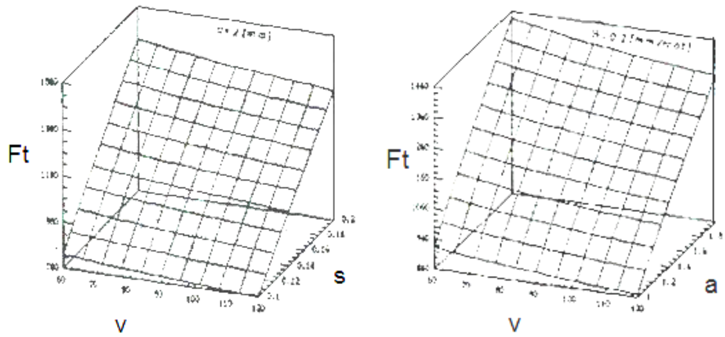

Figure 3. Graphic interpretation of mathematical models 3.1

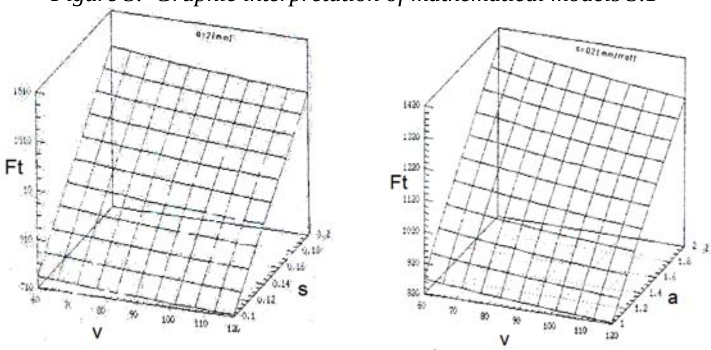

Figure 4. Graphic interpretation of mathematical models 3.5

- In derived mathematics models is seen that with the increase of cutting speed the force reduce because of material temperature increase which influence in reduction of friction force and persistence effect. This reduction phenomenon of cutting force occurs after friction forces predomination and persistence effect.
- Cutting feed and depth influence directly in increasing of cutting force

4. CONCLUSION

Derived mathematical models analyses as a result of experimental research make us possible to give the following conclusions:

- The difference of cutting force in the function of cutting parameters can be shown with gradual function.
- -During the same processing conditions processing tangential force is greater for steel X12 CrNi 18.8than for C 45.
- With the increase of cutting speed the cutting force reduce.
- Research results show the possibility of achieving the exploited characteristics utilized for cutting force whatever can influence evidently in machine ability of cutting material.

5. REFERENCES

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