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PRELIMINARY RESEARCH OF CUTTING FORCES OF SHAFT PINS

One of the greatest problems of modern production techniques is the achievement of an appropriate quality at minimal costs and accompanied by the production efficiency increase. Therefore while designing the production process, the technology used should have a considerable influence on the durability and reliability of machine parts to be produced. During finish treatment the final dimensions as well as functional properties are imparted to a given element by application of proper treatment type. The engineer has a range of production techniques to choose for the proper surface layer formation. It is crucial to find a suitable solution which will meet the requirements as well as the work conditions of a given machine part.
The paper presents the first stage of cutting forces tests which was research for shaft made of steel normal quality. A roller made of S235JR steel was used for the research. The process of sample surface finish lathing was performed by a cutting tool provided with CCMT 09T304 PF plates type. During the research, the effect of changes in the depth of cut on the value of cutting forces and temperature was defined.

Keywords: *turning dynamometer, cutting forces, cutting temperature.*

INTRODUCTION

One of the most important stages of forecasting tasks for improving the quality of use of machinery and equipment is the development of methods to control their durable – reliable characteristics. The object must properly fulfill its tasks under certain conditions and time [6]. Research shows that nearly 80% of the damage of machine parts has its beginning in the surface layer, and 50% of the kinetic energy is lost to overcome the frictional resistance [7]. The manufacturing process of machine parts is related to formation of the technological surface layer.

Ensure appropriate design, materials and manufacturing technologies should provide the desired initial state of the workpiece [1, 2]. The most common and universal way to remove layers of abraded material is the process of cutting.

For the basic method of the surface layer forming of shaft pins is known lathing. Conventional machining accuracy is usually considered as a function of the characteristics of all the components of machine tool, fixture, object, tool. There are: accuracy performance, and the accuracy of static and dynamic determining and cutting parameters, which are associated with strength, temperature and wear of the cutting edge. Therefore, stock removal of high efficiency should be performed in a controlled manner which ensures the correct shape and size of the chip.

During the implementation of the research work entitled „Assessment of suitability of burnishing process that improve operating properties of marine pump shafts" [5], the use of fixed parameters of preliminary machining technology, resulted in a variety of measurements of surface roughness examined shafts. The shaft pins ϕ 39 mm in diameter, made of X5CrNi18-10 stainless steel was carried out on a universal CDS 6250 BX-1000 lathe centre. The preliminary lathing process was conducted by a cutting tool with WNMG 080408 WF removable plates by Sandvik Coromant. During the lathing the following machining parameters were used: cutting speed $V_c = 112$ m/min, feed f = 0.13 mm/rev, cutting depth $a_p = 0.5$ mm. The statistic analysis results of the obtained values of roughness factor measurements were presented in Table 1.

Table 1. The results of statistic analysis of roughness factor measurements (measurements number 48)

Mean	Median	Minimum	Maximum	Stan.Deflection	Stan. Error
0.83	0.79	0.50	1.18	0.14	0.02

The correct effect in the machining result of burnishing process depends on the primarily geometry, surface condition and hardness burnishing tool. However, the important factor is also suitable preparation of the surface shafts before burnishing process. Therefore, the research of influence of cutting parameters on the cutting forces, temperature and wear of the cutting edge to the process of lathing stainless steel X5CrNi18-10 are planned.

Machining stainless steels, especially austenitic steel, causes a lot of difficulty. On the machinability of austenitic steel has a negative impact high propensity to the deformation strengthening (Fig. 1), low thermal conductivity and good ductility.

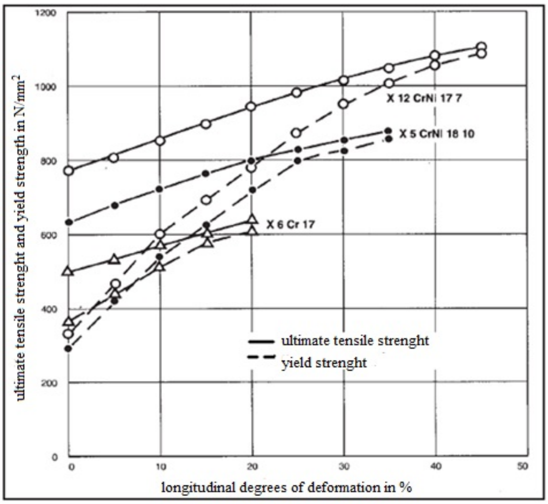

Fig. 1. Strengthen of some stainless steels [8]

Alloying element improves the machinability of stainless steels is sulfur. Sulfur in combination with manganese forms MnS manganese sulfide, whose positive influence on machinability is confirmed by the type of chips (short and brittle), smoother surfaces of workpieces and less tool wear.

The group of steels with improved machinability X5CrNi18-10. This steel is characterized by high resistance to intergranular corrosion (extremely low carbon content) and has been used: in engineering and nuclear, construction and architecture, transport devices, in contact with food, pharmaceutical and cosmetic industries, in the construction of chemical apparatus and vehicles, in the manufacture of surgical instruments, sanitation items and household goods and artistic products [3].

The article presents the preliminary results of measurements of the forces and cutting temperatures for turning shafts made of structural steel at normal quality. The aim of this study was to determine the repeatability and the possibility of measuring the gauge DKM 2010. The dynamometer is the equipment of Gdynia Maritime University. In addition, the effect of depth of cut on the value of the forces and cutting temperatures.

RESEARCH METHODOLOGY

The process of turning of shaft pins ϕ 39 mm in diameter, made of S235JR steel was carried out on a universal CDS 6250 BX-1000 lathe centre. The lathing process was conducted by a cutting tool with CCMT 09T304-PF removable plates. During the lathing (Fig. 2) the following machining parameters were used: cutting speed V_c = 150 m/min, feed f = 0.106 mm/rev, cutting depth a_p = 0.5; 0.75; 1.0; 1.25; 1.5; 1.75 mm.

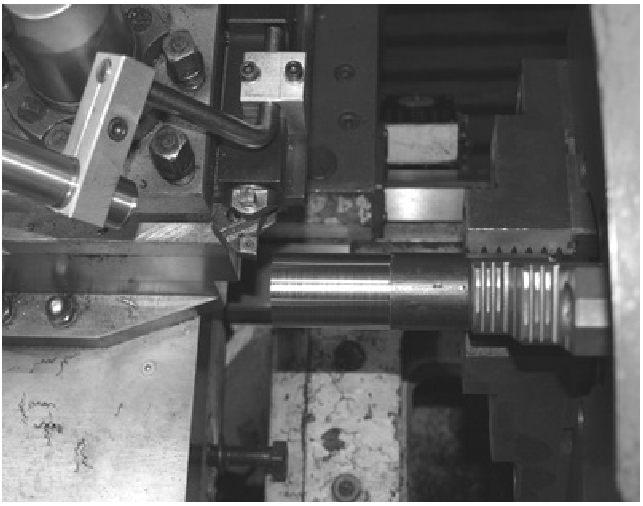

Fig. 2. General view of tooling system (machine, grip, object, tool)

DKM 2010 is a 5-components Tool Dynamometer for use on conventional or CNC lathe machines. It measures force on the cutting tool up to 2000 N with a resolution of 0.1% and as option also temperatures on the tool tip between 300 and 800°C. The temperature measurement is based on radiation principle on a spot not greater than 2 mm. DKM 2010 is equipped with adjustable inserts – holder to change side angle $\varkappa_r$ into 45, 60, 70, 90°. The complete equipment of DKM 2010 is presents to Figure 3.

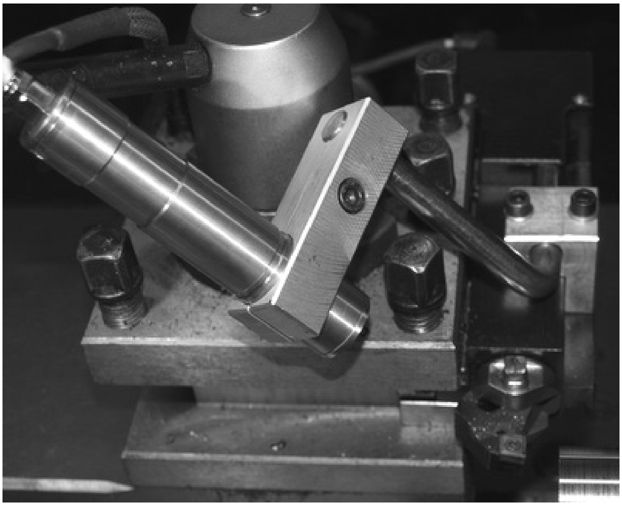

Fig. 3. Turning dynamometer DKM 2010

RESEARCH RESULTS

During the preliminary tests conducted longitudinal turning the shaft with a depth of cut ap = 0.50, 0.75, 1.00, 1.25, 1.5 and 1.75 mm. For each depth of cut made three attempts to turning with fixed parameters of cut. Figure 4 shows the effect of depth of cut on the change in the value of cutting force (F_c), feed force (F_f) and radial force (F_p). In contrast, in Figure 5 shows the effect of depth of cut on the change in temperature on the rake face plate removable cutting tool at a distance of 2 mm from the cutting edge. The cutting process was carried out dry.

Analysis of influence changes in the depth of cut on cutting forces showed that with increasing the value of a_p is an increase in the cutting force and feed force. Changing the depth of cut of 0.25 mm cause an average increase in force F_c and F_f the value of 100 N. At the same time, increasing the value of the parameter a_p leads to decrease in the value of the radial force of 25 N.

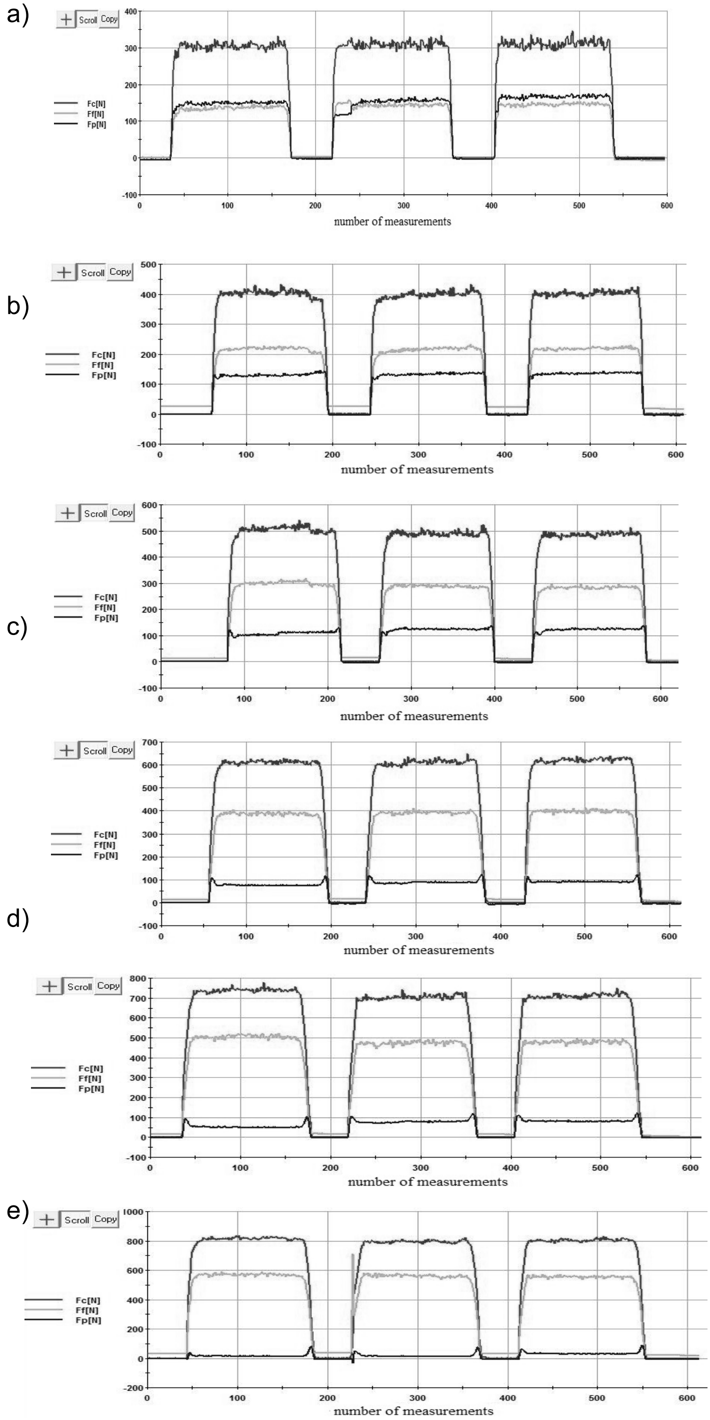

Fig. 4. Cutting forces for depth of cut: a) a_p = 0.50 mm, b) a_p = 0.75 mm, c) a_p = 1.00 mm, d) a_p = 1.25 mm, e) a_p = 1.50 mm, f) a_p = 1.75 mm

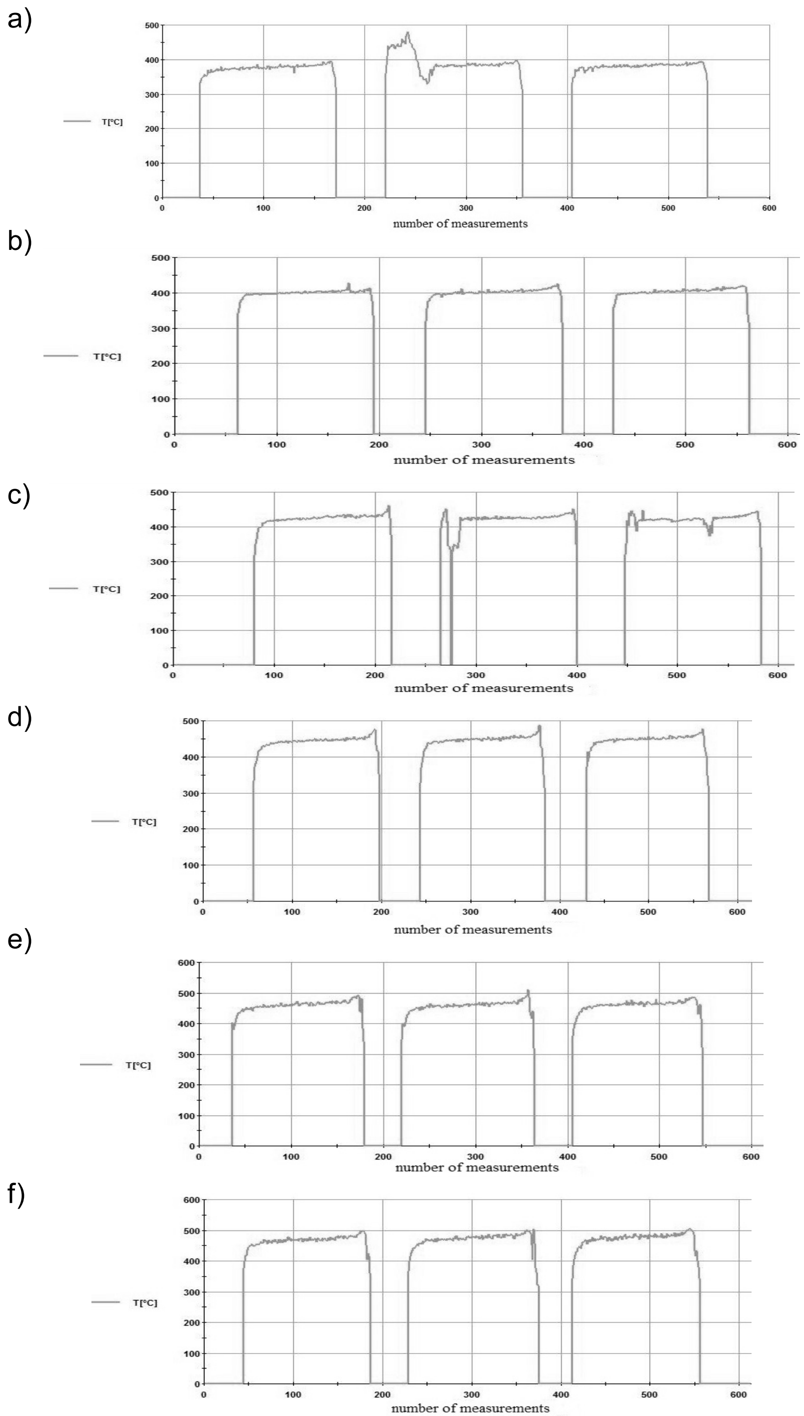

Fig. 5. Cutting temperatures for depth of cut: a) a_p = 0.50 mm, b) a_p = 0.75 mm, c) a_p = 1.00 mm, d) a_p = 1.25 mm, e) a_p = 1.50 mm, f) a_p = 1.75 mm

The temperature distribution on the rake face of the turning tool for the cutting depth analyzed ranged from 350 to 500°C. With increasing depth of cut of the increased temperature on the rake face. Disruption temperature measurement shown on Figure 5 a and 5 c were caused by the rise of continuous chip.

CONCLUSION

An analysis of the results of the influence of depth of cut on the distribution of forces and cutting temperature confirmed the reproducibility of measurements using a dynamometer DKM 2010. In order to eliminate interference temperature measurements important role is played geometry of the cutting plates, which will allow the formation of a discontinuous chip.

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BADANIA WSTĘPNE SIŁ SKRAWANIA CZĘŚCI TYPU WAŁEK

Streszczenie

Jednym z najważniejszych problemów współczesnych technik wytwarzania jest zapewnienie odpowiedniej jakości wyrobu, przy minimalizacji kosztów i jednoczesnym wzroście wydajności produkcji. Dlatego podczas projektowania procesów wytwarzania powinno się zastosować technologię, która ma istotny wpływ na trwałość i niezawodność części maszyn.

Podczas obróbki wykończeniowej nadawane są ostateczne wymiary i właściwości użytkowe danego elementu. Osiąga się to poprzez zastosowanie odpowiedniego rodzaju obróbki oraz dobór właściwych parametrów danego procesu. Technolog projektujący proces kształtowania warstwy wierzchniej ma do dyspozycji różne techniki wytwarzania. Konieczne jest znalezienie określonego rozwiązania, które będzie odpowiadać wymaganiom i warunkom pracy danej części maszyny.
W artykule przedstawiono pierwszy etap badań pomiarów sił skrawania dla części typu wałek wykonany ze stali S235JR. Proces toczenia powierzchni próbki wykonano nożem z wymiennymi płytkami CCMT 09T304 PF. Na podstawie uzyskanych wyników badań określono wpływ parametrów skrawania na wartość sił skrawania oraz temperatury. Podczas eksperymentu analizowano wpływ głębokości skrawania przy stałej prędkości obrotowej oraz posuwie.

***Słowa kluczowe**: toczenie, siłomierz, siły skrawania, temperatura skrawania.*