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RESEARCH OF FINISHING REAMING PROCESS OF SPHEROIDAL CAST IRON AT THE ASPECT OF THE QUALITY OF MACHINED SURFACE

VÝZKUM DOKONČOVACÍHO PROCESU VYSTRUŽOVÁNÍ TVÁRNÉ LITINY ZAMĚŘENÝ NA INTEGRITU POVRCHU OBROBENÉ PLOCHY

Abstract

In work some selected results of researches of surface layer formed in holes Ø 25H7 mm (accepted as representative diameter) in castings from a spheroidal cast iron ZsP50 have been presented. The research results allowed us on the determination of the most profitable parameters of finishing reaming. On diagrams one pictured influence of cutting depth, feed and speed on the surface roughness. Results of the increase of surface layer hardening after reaming have been also presented.

Abstrakt

Článek prezentuje selekci výsledků zkoumání povrchové vrstvy v dírách o Ø 25H7 mm (přijato jako reprezentativní průměr) v odlitcích z tvárné litiny ZsP50. Výsledky zkoumání umožnily stanovení optimálních parametrů pro dokončovací vystruhování. Na obrázcích je zachycen vliv hloubky obrábění, velikosti posuvu a řezné rychlosti na nerovnost povrchu. Rovněž jsou ukázány výsledky zkoumání zvýšení tvrdosti povrchové vrstvy po vystruhování.

1 INTRODUCTION

Most of bodies in present mechanical engineering are made from spheroidal cast iron. This material shows very good technological and using properties. Machine and device bodies have numerous holes, which will demand both drilling how as reaming. Many of holes in bodies of machines posses, given by designer, accuracy class IT6 – IT7, even lately IT5, and surface roughness R_a = 0,4 μm, often less 0,16 μm. Rough shaping of these holes is realized by drills and is burdened by definite defects both of hole surface how as of his shape (circularity and rectilinearity) [1, 2, 3, 5]. Therefore during forming of these holes it is used the several gradual machining, eliminating previously imperfections among other things by rough reaming, and especially by finishing reaming. Suitable selection of each degree is possible by accuracy forecasting of the following degrees [4]. Analysis of the hole diameters, stepping out in bodies, allowed on their scheduling i.e. on: little holes to diameter 12 mm executed only by drilling without definite accuracy class, average holes about diameters in section 12 mm < d < 35 mm (40 mm) in principle with definite accuracy class IT6 – IT7 and with roughness of line R_a = 0,16 – 0,4 μm of finishing reaming and greater holes executed by boring also with definite accuracy class and surface roughness as holes for bearings. In presented work one decided to undertake investigations connected with roughness and with hardening of holes from second group i.e. holes in the section of diameters 12 mm < d < 35 mm. As most typical hole

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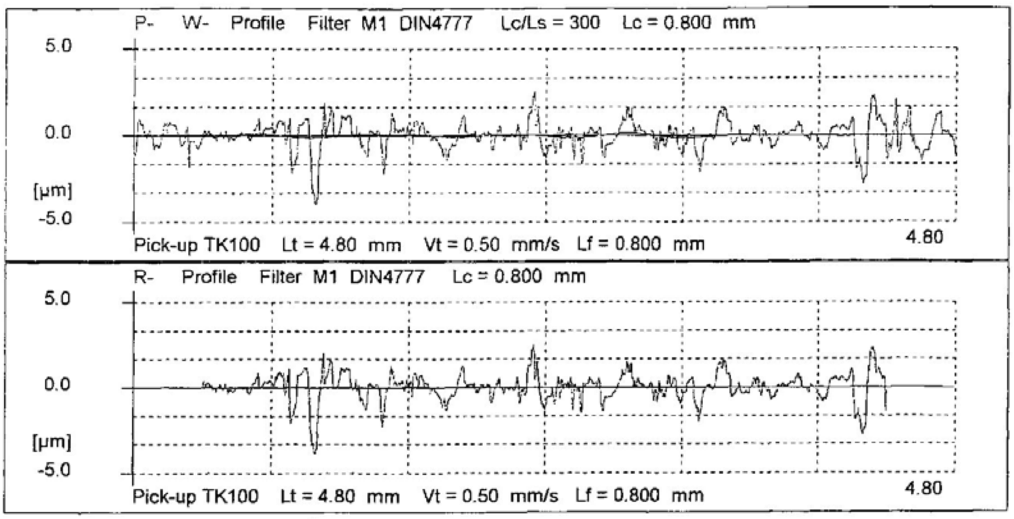
one accepted $d = 25$ mm to the investigations. Surface roughness after reaming is result of image of shape of reamer cutting edges connected with his turn and feed, and also with influence of kind of worked material, with vibrations of MWT (Machine-Work piece-Tool) system and with the other physical and technological factors of cutting process [6, 7]. Introduced set of factors putting into quality of executed hole demands in principle on realization of investigations in aim of qualification of characterization of surface roughness at initiation of new worked and tool materials.

2 CONDITIONS OF INVESTIGATIONS

Investigations of reaming were realized on castings from spheroidal cast iron named ZsP50 with hardness 220 – 260 *HB*, in form of shaft with diameter $d = 50$ mm and length 120 mm what has been compatible to the average thickness of body wall. Part of samples was intended to the strength investigations. External surface of samples has been turned before investigations on diameter $d = 40 + 0,1$ mm. To investigations one used finishing reamer NRTc 25H7 with blades from sintered carbide H10S coated by thin layer of TiN. The roughness measurements were executed on device of Hommel Tester T8000. Example picture of surface roughness has been given in Fig. 1. Measurement of roughness has been realized in 3 sections on reamer entry and 3 sections on reamer exit. Roughness results were average value from mentioned measurements with presenting of scattering of results. Investigations of reaming were realised on lathe TUM – 35 D1.



Roughness parameters

Ra	0,56 mm	RSm	0,0645 mm
Rz	4,49 mm	Da	0,051
Rmax	5,90 mm	Ir	0,8000 mm
R3z	2,34 mm		
Rz1	5,90 mm		
Rz2	3,63 mm		
Rz3	4,09 mm		
Rz4	3,72 mm		
Rz5	5,13 mm		

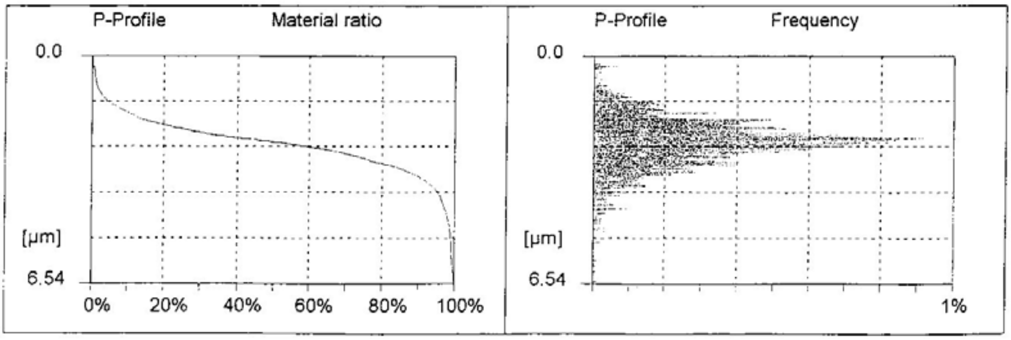


Fig. 1. Example picture of surface roughness after reaming

Investigations were realized in two stages. First stage of investigations was performed for the aim of distinctive with utilization of methods of planning of experiences [8]. Received results from first stage allowed on orientation of further works extending range of cutting speed, cutting feed and depth (a_f = 0,175 mm and 0,2 mm).

3 RESULTS OF INVESTIGATIONS

In Fig. 2 one introduced results of investigations of influence of thickness of cut layer cut by finishing reamer on surface roughness. In aim of maintenance of similar- identical conditions in finishing reaming process, both rough reamers how as finishing reamers possessed suitable dimensions assuring proper thickness of cut layer. In Fig. 2 it has been marked zone A, in of which there were situated thickness of cut layer for the normally practical conditions of finishing reaming. From given section it results that founded thickness of cut layer a_f = 0,125 mm for the finishing does not exist, what can cause that at non-rectilinear holes after drilling and rough reaming, certain fragments of layer become not worked – not finishing reamed.

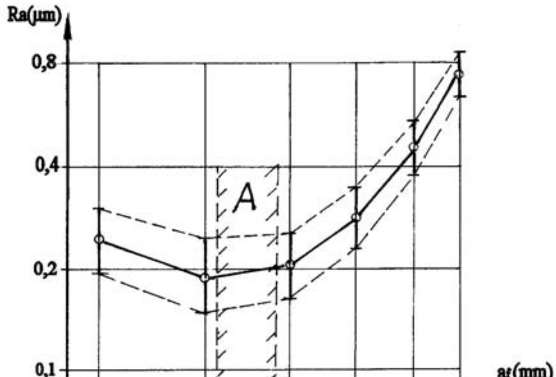


Fig. 2. Influence of cut layer thickness on the surface roughness of hole after finishing reaming

Fig. 2 shows that in due of thickness increase of cut layer, surface roughness grows up. Explanation of this occurrence is connected with vibrations of MWT system and with friction and chips led out from hole, and also with leading of reamer in hole.

In Fig. 3 one introduced the influence of cutting feed and cutting speed on the surface roughness. From the position of surface one can infer that large values of feed and little values of speed do not guarantee to receipt required roughness in the range R_a = 0, 63 µm.

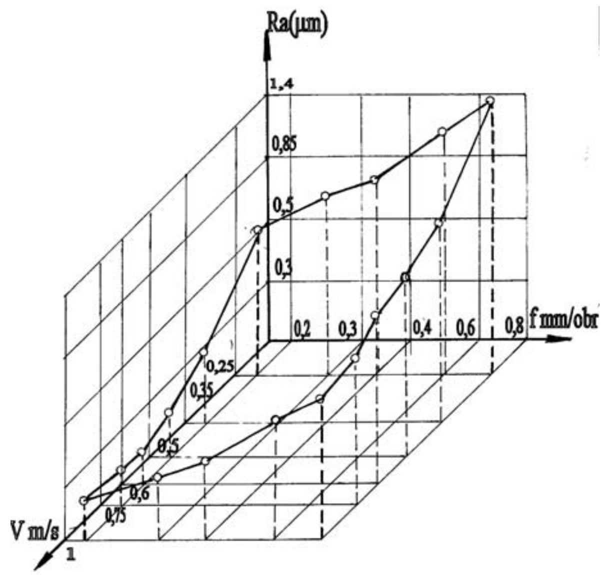


Fig. 3. Influence of cutting speed and feed on surface roughness of hole after reaming with normal thickness of cut layer a_f = 0, 125 mm

In Fig. 4 one gave the influence of cutting time on the changes of surface roughness of holes, reamed with the "normal" thickness of cut layer. After term of 20 min. of real work time of reamer the value of cutting edge wear occurred average *VB* = 0,5 mm at a_f = 0,125 mm, f = 0,5 mm/rev and v_c = 0,5 m/s. Further work of reamer in given conditions puts into formation of roughness changes, first of all, on entrance side. After offence of wear value *VB* = 0,5 mm follows distinct making worse roughness of surface.

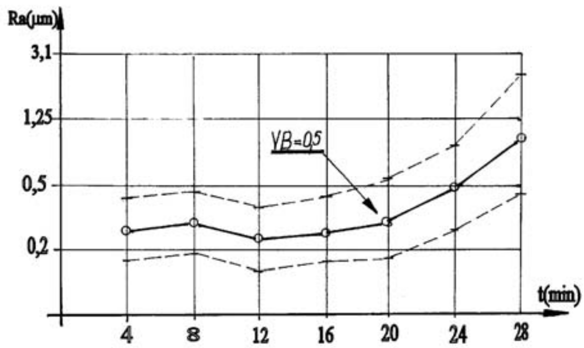


Fig. 4. Influence of cutting time of reamer work on the change of surface roughness a_f = 0,125 mm, f = 0,5 mm/rev, v_c = 0,5 m/s

In Fig. 5 one introduced example change of surface layer hardening of hole after finishing reaming according to the equation:

$$\Delta HV = \frac{HV_1 - HV_0}{HV_0} \cdot 100\% , \tag{1}$$

where: HV_1 – hardness after finishing reaming,

HV_0 - hardness before finishing reaming.

Fig. 5 shows, that on the depth greater than 100 µm do not exist the changes of surface layer hardening.

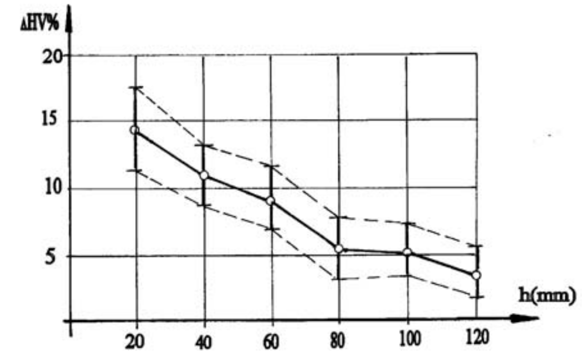


Fig. 5. The distribution of the hardening of surface layer after finishing reaming
a_f= 0,125 mm, f = 0,5 mm/rev, v_c = 0,5 m/s

4 CONCLUSIONS

Presented results of investigations of surface roughness after finishing reaming allow on choice of reaming parameters in the aspect of required surface layer roughness [7]. Besides, passed investigations permit on determination of influence of each of cutting parameters on the surface roughness. From estimation of influence of each parameter on surface roughness one can ascertain that greatest influence has reaming feed than cutting speed. Separate problem is connected with depth of cutting. According to the norms, depth of cutting results automatically from difference between diameter of finishing reamer and diameter of rough reamer and usually this difference carries out 0,25 mm. Thickness of layer carries out 0,125 mm – of this reason. In realities this thickness is smaller, and hesitates from 0,105 mm to 0,120 mm. This effect influences unfavourably on formed surface layer roughness from attention on fact rough reamer run-out. During steady distribution of layer the betterment of the roughness can be achieved.

REFERENCES

[1] MATUSZAK, K. WIECZOROWSKI, *Wpływ rozwiercania zgrubnego otworów na powiększenie otworu po rozwiercaniu wykańczającym*, ZN Mechanika, nr 46, Wyd. Politechniki Poznańskiej, Poznań 1999.

[2] K. WIECZOROWSKI, A. MATUSZAK, *Badanie prostoliniowości głębokich otworów wykonanych wiertłami lufowymi*, ZN Mechanika, nr 43, Wyd. Pol. Pozn., Poznań 1997.

[3] K. WIECZOROWSKI, A. MATUSZAK, *Wpływ zużycia wiertła na dokładność wiercenia głębokich otworów,* Arch. Bud. Masz. i Aut., Vol. 17 nr 2.

[4] K. WIECZOROWSKI, A. MATUSZAK, *Prognozowanie dokładności wykonania głębokich otworów*. Mat. Symp. pt.: „Automatyzacja Produkcji 97", Wyd. Pol. Wr., Wrocław 1997.

[5] K. WIECZOROWSKI, A. MATUSZAK, *Accuracy investigations of the reamed deep holes*, Mat. Konf. INGMEC 98 "*Classic technologies and machine tools*", Univ. of Craiova, Rumunia 1998.

[6] K. WIECZOROWSKI, A. MATUSZAK, A. A. RYŻKIN, *Wybrane aspekty technologii wykonywania głębokich otworów w klasie IT10 - IT11*, Mat. II Międz. Konf. pt.: „Projektowanie Procesów Technologicznych TPP 98", Poznań 1998.

[7] K. WIECZOROWSKI, H. ŻEBROWSKI, St. LEGUTKO, *Niektóre aspekty kształtowania charakterystyki warstwy wierzchniej części maszyn*, Mat. IV Międz. Konf. pt.: „*Wpływ technologii na stan warstwy wierzchniej*", Wyd. IBEN, Gorzów Wlkp. 1999.

[8] L. KUKIEŁKA, *Podstawy badań inżynierskich*, Wyd. Pol. Kosz., Koszalin 2000.

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