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MACHINABILITY OF MODIFY AUSTENTIC STELL 17 240 S

OBROBITELNOST MODIFIKOVANÉ AUSTENITICKÉ OCELI 17 240 S

Abstract

Contents of this article are above all the measuring results which processing allowed us to describe a re-developed material from the point of view of its machinability. Introduction of the report contains some important technical informations which are necessary for a wider understanding of this problem.

Abstrakt

Obsahem článku jsou především výsledky měření, jejichž zpracování umožní charakterizovat nově vyvinutý materiál z pohledu jeho obrobitelnosti. Úvod příspěvku obsahuje některé důležité technické informace nezbytné k širšímu pochopení řešené problematiky. Zásadní část práce pak tvoří výsledky zkoušek obrobitelnosti dodaných vzorků oceli.

1 INTRODUCTION – DEFINITION OF MATERIAL MASCHINABILITY

The "machinability" notion symbolizes an influence of mechanical and physical attributes of material, a chemical composition, a heat processing and a production way of half-finished product on qualitative and economic results of machining process. The machinability represents "the ability extended of material workpiece for machining". It impacts considerably a material removal rate and a machining production and besides it is an attribute of the same category like weldability, forgeability or castability.

The machinability is not described only by a maschined material but by a machining way and cutting conditions too. Theoretically you can´t separate the name "machinability" from the name "cutting property" because, the final economic, energy and qualitative machining result, does not depend only on the material of workpiece but on physical attributes of tool.

The machinability is often characterized by conditions of tool-wear and conditions of chip formation. A good machinable material is a material of parts which is cutted by a high cutting speed with a large cross sectional area of chips but with a small tool-wear. From chip formation point of view is a good machinable material of workpiece which is not "sticky" to the cutting edge, which does not built-up edge formation by material removal rat or spiral cutting and the final machinal surface is smooth and and without burres.

The most used evaluation in practise for a machinability assessment (a choice of cutting conditions for individual methods of machining including) is a relative evaluation, with a bearing to the kinematic criterion. This criterion applies according the cutting speed to the specific durability of cutting edge.

2 DETERMINATION OF MACHINABILITY COEFFICIENT

From the point of view of machining technology is the machinability one of the most important material properties and in a general meaning is defined "a capacity measure of a given specific property how to be worked by one of the machining methods" likes. The main factor which influents

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a choice of cutting conditions. Machinability depends on many factors which the most important of them are:

- ☐ Method of machining
- ☐ Working medium
- ☐ Tool geometry
- ☐ Sort and property of tool material

Machinability is also a a relative property and for the followed material it is determinated by a comparison with other material which is worked by the same tool under the same conditions. A comparison text then could be a cutting temperature, forming of chips, intensity of cutting force (resistance), surface machinability quality or cutting speed intensity by a chosen durability $\mathbf{v_T}$ which is the most often case.

If is the machinability assesses by value $\mathbf{v_T}$ (common values of durability are 15 minutes), it is about an evaluation of material removal rate by means of a given tool by a recommended constant theoretical cross section area of the cut (e.g. for turning depth of cut $\mathbf{a_p}$ = 2 mm, feed per revolution **f** = 0,25 mm) in a given working medium.

According the relative kinetic criterion of machinability are all machine materials in the Czech Republic put in order in "Machinability standard" – CNN 10-0-I/II to 9 groups and in every group of 20 classes of machinability according the coefficient of relative kinetic machinability $\mathbf{K_v}$ and they are ordered in geometric series with the coefficient $\sqrt[10]{10}$ (1,26).

Classes are marked with a number which is placed before a letter that determined a given group of material (e.g. 11a, 14b ...) Grading of the mean value of kinetic machinability coefficent means that the value of cutting speed $\mathbf{v_T}$ is a given class of machinability is everytime 1,26 times bigger (or smaller) than the value $\mathbf{v_T}$ in other class.

In particular cases is always the chosen one material that assists a machinability standard and the relation with this material is determined, then, in a relative machinability of all other materials of the whole group. Standard materials have a coefficients $\mathbf{K_v}$ = 1 ($1{,}26^0 = 1$) and they are for:

- ☐ cast irons – standard ČSN 42 2424, class of machinability 10a
- ☐ **steels - standard ČSN 12 050.1 (according the ČSN 41 2050), class of machinability 14b**
- ☐ heavy and non-ferrons metals – standard ČSN 42 3213.21, class of machinability 11c
- ☐ light and non-ferrons metals – standard ČSN 42 4380.11, class of machinability 10d

Value of machinability coefficient is:

$$K_V = \frac{v_{T/VB} \quad \textit{tested material}}{v_{T/VB} \quad \textit{standard material}} \quad , \tag{1}$$

where $\mathbf{v_{T/VB}}$ complies with $\mathbf{v_{15zk}}$ [m.min^{-1}] which is a cutting speed with a durability T = 15 minutes for a tested material $\mathbf{v_{T/VB}}$ complies with $\mathbf{v_{15set}}$ [m.min^{-1}] which is a cutting speed with a durability T = 15 minutes for a standard material, possibly

$$K_v = \frac{c_{v\,zk\,mat}}{c_{v\,et\,mat}} \cdot T^{\left(\frac{1}{m_{et}} - \frac{1}{m_{zk}}\right)} \tag{2}$$

where $\mathbf{c_v}$ are individual constans and **m** are exponents of tested and standard material.

Materials in the groups with a lower number than in the standard class, have worse machinability than standard material. Materials in the groups with a higher number have better machinability.

Relatively the worst machinability in a given group has always the material which is put into the class with the lower number. The best machinability has the material which is put into the class with the highest number.

3 METHOD OF MACHINABILITY TEST

The biggest sense for characterising machinability of materials has a tool durability T. It is the time-value in minutes during that a tool is taking away the cheep from the first engagement to the wear by the same cutting conditions. Removal is controlled by a chosen criterion of durability. Wear of cutting edge and tool is measured in different time intervals, cutting speed is constant. Usually is enough to know a width of wear of flank VB and a depth of chater wear KT.

For representation of dependence wear in time is used the Cartesian system with a logaritmic coordinates. Time is marked out into one coordinate system and a width of wear is marked out to second coordinate system. Shapes of measured value are by constant cutting speed almost straight.

For a chosen constant value of wear VB or KT, durabilities and relevant values of cutting speed are given into the coordinates $\mathbf{T_{VB} = f(v)}$ or $\mathbf{T_k = f(v)}$.

4 EXPERIMENTAL DETERMINATION OF MACHINABILITY CLASS OF A GIVEN

For machinability tests are possible to draw on from recommended tools and cutting conditions. For a turning is recommended a shank which is marked as PSBNR 2525 M12 (fig. 1) with a square section of shank 25x25 mm with a length 150 mm. In this shake is placed a square cutting insert with an opening SNMA 120408 (fig. 4) with a lenght of cutting edge 12 mmm width if insert 4,76 mm and with a rounded cutting edge radius 0,8 mm. By putting the insert to the shank of tool is resulted on the cutting edge a cutting geometry with angles: $\chi_r = 75°$, $\lambda_s = -6°$ a $\gamma_o = -6°$. Shank of tool and cutting inserts are from the Sandvik Coromant producer.

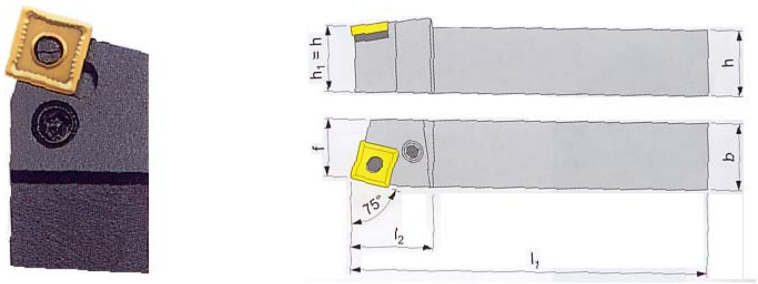

Fig. 1 Shank of turning tool

Maschined material was circle rod with a diameter 100 mm from material 17240S (X8CrNiS19-9, 1.4570). Chemical composition is showed in the following table:

Tab. 1 Chemical structure of assessing steel

C	Mn	Si	P	S	Cu	Ni	Cr	N	Al
0,02 0,07	1,40 1,50	0,4 0,6	0,030 0,045	0,10 0,25	1,4 2,5	8,5 10,5	17,2 18,2	0,05 0,10	0,010 0,050

All tests were performed by the same depth of a cut $\mathbf{a_p}$ = 2 mm and the same feed per revolution **f** = 0,25 mm. Standard material was a steel 12 050.1.

In the following text are compared the experimental results from laboratories of Deparment of Working and Assembly, Faculty of Mechanical Engineering, VŠB-Technical University of Ostrava. Over a period of the tests were studied a wear of cutting insert in dependence on the cutting time. For machinability criterium VB = 0,3 mm was marked out to graphs the values of durability and from them was stipulated speeds for reaching of durability 15 minutes. Comparison of these speeds allowed us to classify the examined material to a relevant class of machinability.

Standard – 12 050.1

Conditions of experiment: machine SU 3MM 500, shank PSBNR 2525 M12,
insert SNMA 120408 P10.

Cutting conditions: feed per revolution f = 0,25 mm, depth of cut a_p = 2 mm,
cutting speed v_C – fig. 2

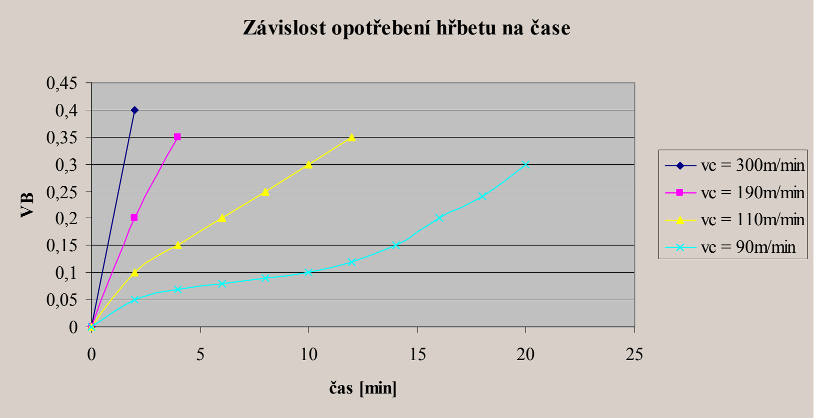

Fig. 2 Course of flank tool wear VB [mm] on time for a standard material

In other picture is marked out a dependence of durability of tool material on cutting speed for a chosen criterion of wear VB = 0,3 mm. For a chosen durability 15 minutes is a cutting speed v_{15} = 103 m.min^{-1}.

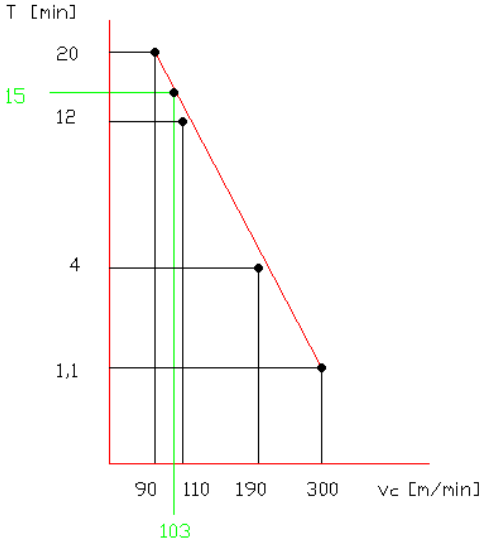

Fig. 3 Dependence of durability of cutting edge **T** on cutting speed $\mathbf{v_c}$

Comparision material – 17 140 S

Conditions of experiment: machine SU 3MM 500, shank PSBNR 2525 M12, insert SNMA 120408 P10.

Cutting conditions: feed per revolution f = 0,25 mm, depth of cut a_p = 2 mm, cutting speed – fig. 4

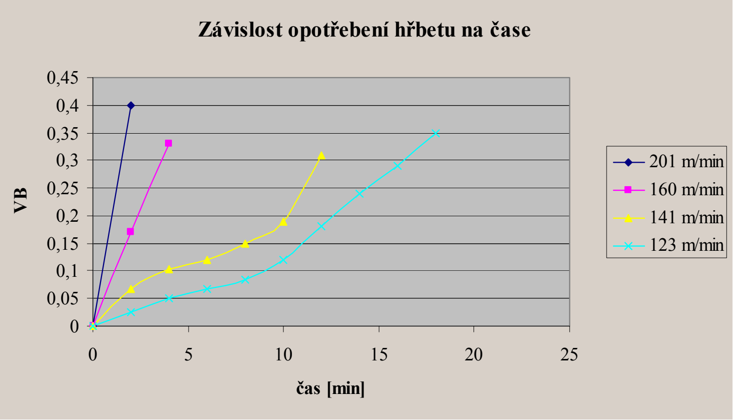

Fig. 4 Course of flank tool wear VB [mm] on time for a compared material

In other picture is marked out a dependence of durability of tool material on cutting speed for a chosen criterion of wear VB = 0,3 mm. For a chosen durability 15 minutes is a cutting speed **v_{15} = 125 m.min^{-1}**.

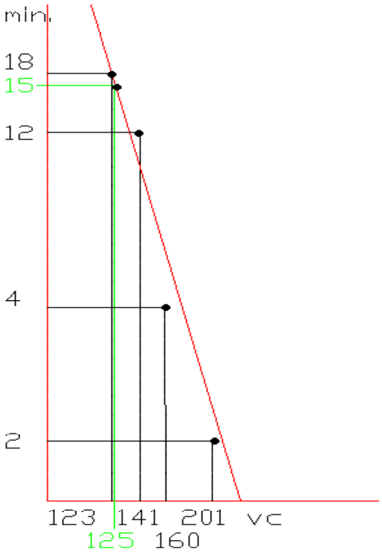

Fig. 5 Dependence of durability of cutting edge **T** on cutting speed **v_c**

5 CONCLUSIONS

From an accomplished measuring we can draw a lot of conclusions. Considering the reached cutting speeds which are 15 minutes for a durability by standard material 12050.1 for a chosen criterion of wear VB = 0,3 mm **v_{15} = 103 m.min^{-1}** and for a compared material 17 240 S **v_{15} = 125 m.min^{-1}** we can make a conclusion that for reaching a needful durability we can used higher cutting speed. This leads to the conclusion that material 17 240 S is **better** machinability than standard material.

This contention refills an coefficient of machinability **K_v** calcuted like a rativ of cutting speed of compared material for a reaching durability 15 minutes (**v_{15} = 103 m.min^{-1}**) and cutting speed of standard (**v_{15} = 125 m.min^{-1}**).

After division of these numbers we reach the value **K_v** = 1,21 that represents a class of machinability **15 b**. Theoretical and objectively measured values correspond to the shape of individual tests.

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