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EXPERIMENTAL TESTING METHODS OF HARDOX 500 FACE MILLING BY PRAMET 8230 CARBIDE INSERTS

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ABSTRACT:
This article deal with the face milling proces of HARDOX 500. Material abrasion resistance HARDOX 500 have to discharge very hard inquires against mechanical wearing. Manufacturing process of this material is result of various factors effect as are combination of high strength, stiffness and toughness. The application in technical praxis is a result in general spectrum of usage e.g. working part of automatic feeder, jaws, crushers, stone crushers etc. The manufacturing process of HARDOX 500 sheets consists of hot sheeting between 900÷920 degrees in stabile austenite area and then directly hardened very fast in water shower. After low temperature annealing at 200÷300 degrees, then reaches the range 46÷50 Rockwell hardness. HARDOX is manufactured by SSAB Őxellősund (Sweden) and importer for Slovakia is WINFA Ltd. Trnava.
KEYWORDS: Hard face milling, PRAMET SNHF 8230 cutting inserts, cutting parameters, HARDOX 500, diagram of cutting tool wearing, milling cutter wear.

1. INTRODUCTION

HARDOX 500 – the abrasion resistance sheet verified the fundamental requirements for its hardness. It is important facility against mechanical wear. Very important basic factors from its production process result from high hardness, stiffness and toughness combination. Termo-mechanical heat treatment causes improvement and increase as physical-mechanic properties. All these positive facilities predestinated HARDOX 500 for large spectrum of application. Experimental testing methods of HARDOX 500 face milling (Fig.1a, b) were realized by PRAMET milling cutter with 8230 changeable inserts SNHF 1204EN-SR-M1 (Fig.2a, b).

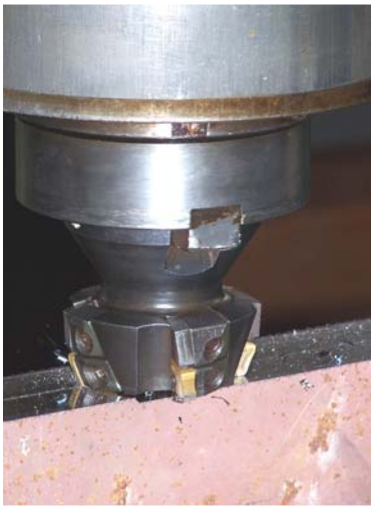

a.

b.

Fig. 1.a, b: Overall view for HARDOX 500 sheets clamping and face milling process at FA3V machine tool by PRAMET 8230 changeable inserts

2. WORKPIECE MATERIAL FOR EXPERIMENTAL FACE MILLING

Material: HARDOX 500 abrasion resistance sheet
Dimensions: 20x150x705mm created by laser (TRUMATIC L3030 – STELLIT Ltd.Trencin)
Hardness: 46÷50 HRC
Chemical composition: 0.29%C; 0.70%Si; 1.6%Mn; 1.0%Cr; 0.5%Ni; 0.3%Mo; 0.004%B; 0.025%P; 0.010%S
Manufacturing process: hot sheeting at 900÷920 degrees, then heat treatment in stabile austenite area, rapid hardening up to 1 min at water jet, low temperature annealing

3. EXPERIMENTAL MILLING PROCESS AND CUTTING CONDITIONS

Machine tool: FA3V vertical console milling machine, P = 45 kW
Cutting tool: NAREX milling cutter with changeable inserts, D = 50 mm, PN 222460.12, z = 4, K_r = 75 deg, rake angle γ = -7 deg, cutting clearance angle α = 7 deg, λ_s angle = -4 deg
Changeable cutting insert: SNHF 1204ENSR-M1-8230 PRAMET TOOLS (see on Fig.2a, b)
Workpiece material clamping: two pieces of sheet clamped in double grippers on machine tool support for 150 mm highness

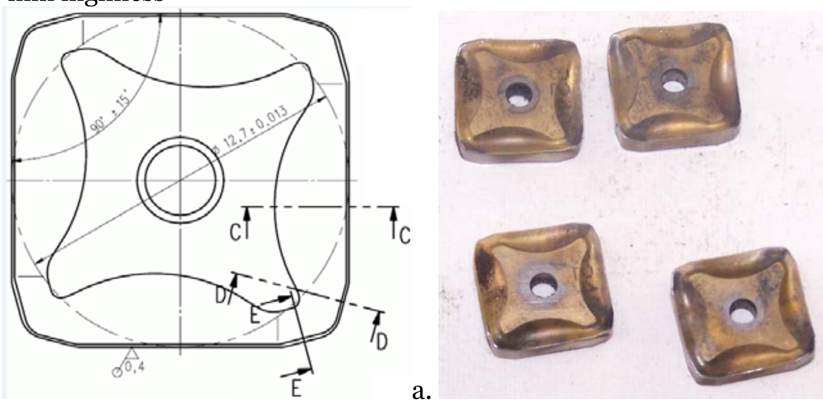


Fig.2 a, b: Applied cutting changeable inserts PRAMET, a) schematic image, b) real photo

Milling parameters: for T = f (v_c) – where T is a function of cutting speed to Taylors ratio
Constant parameters:
Depth of cut a_p = 2,0 mm
Width of cut a_e = B = 40 mm
Allowed wear estimation VB_k = 0,2 mm
Revolution feed f_o = 0,224 mm
Feed motion pre tooth f_z = 0,056 mm
Without coolant
Changeable parameters:
Cutting speed v_{c1} = 55,7 m/min
Spindle speed n_1 = 355 /min
Translation speed v_{f1} = 80 mm/min
Cutting speed v_{c2} = 78,5 m/min
Spindle speed n_2 = 500 /min
Translation speed v_{f2} = 112 mm/min
Cutting speed v_{c3} = 111 m/min
Spindle speed n_3 = 710 /min
Translation speed v_{f3} = 160 mm/min
Time of milling process and reached cutting durability:
t_{AS1} = 8,86 min, t_{AS2}= 6,29 min, t_{AS3} = 4,40 min
T_1 = 223 min, T_2 = 135 min, T_3 = 39,6 min
Milling time estimation: directly from formula $t_{AS} = L / n.f_z .z$
The graphs of wearing depending up of time you can see on (Fig.3a,b,c), where
a) v_{c1} = 55,7 m/min, b) v_{c2} = 78,5 m/min, c) 111 m/min.
Sequential relation T = f (v_c) acquired from graphs and processed by square method is displayed on Fig.5 in double logarithmic axis system. This acquired relation from cutting durability to cutting speed has the final form:

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$$T = \frac{2,4.10^4}{v_c^{2,1}}$$

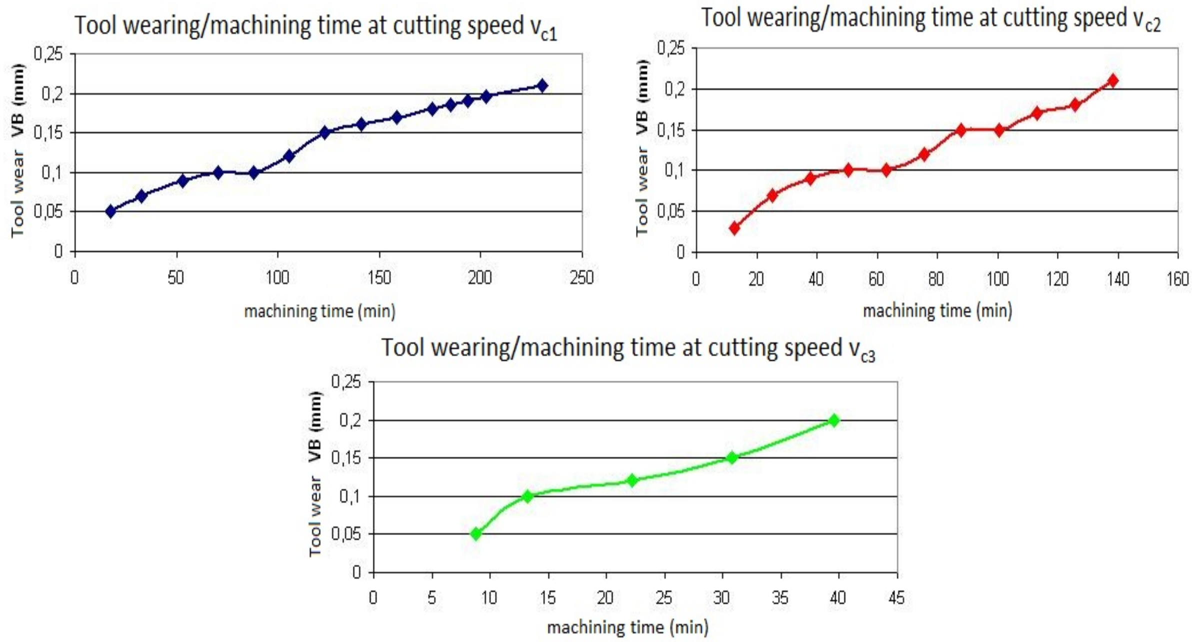

Fig.3 a, b, c: Generated graphs at various cutting speed during face millig process

4. THE FACE MILLING BY PRAMET 8240 WITH T = F(F) VERIFICATION

The face milling process with the same tool holder NAREX PN222460.12 with 4 inserts was realized by the PRAMET changeable inserts 8240 SNHF1204ENSR-M1. Cutting conditions during milling were sthe same as in the previous process. The overall results from measured cutting times, inserts durability but at various feed motions f_{z1} = 0.039 mm/tooth; f_{z2} = 0.056 mm/tooth; f_{z3} =0.078 mm/tooth; f_{z4}=0.112 mm/tooth; f_{z5} =0.15 mm/tooth were graphically executed. Then from these measured values at constant revolutions n = 355/min were designated T= f(f_z) by the square method to the final form: $T = C_T/ f_z^{\,y}$.$T = 7.551/f_z^{\,0,99}$. Reached surface roughness was reached by the feed motion growth in the range from R_a = 0.6÷0.95 µm to R_a = 1.2÷1.6 µm. The auxiliary cutting edge was also weared to VB = 0.1÷0.12 mm. See on Fig.4.

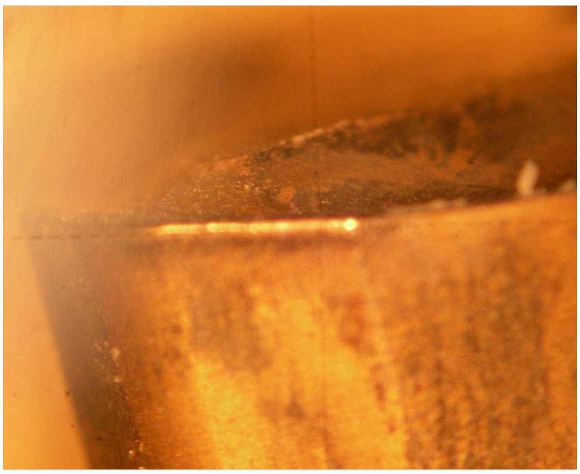

Fig.4: Tool insert wearing on auxilliary cuting side. Measured on MITUTOYO TM 500 microscope (extension 30x)

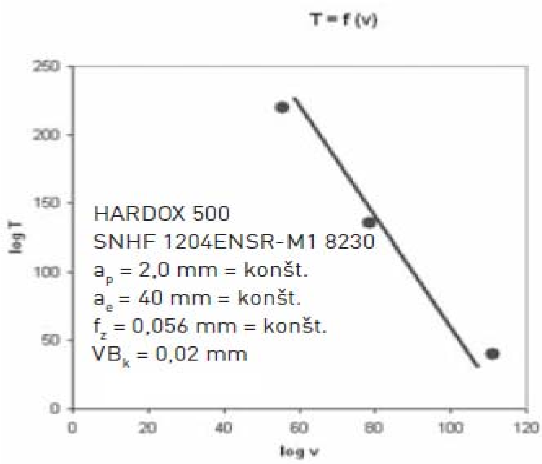

Fig.5: Sequential relation T = f (v_c) in double logarithmic axis system

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5. CONCLUSION

These experimental hard face milling process with PRAMET 8230 and 8240 show us that carbide insert 8230 has cutting durability T = 223 min whereas 8240 only T = 132 min, what is 68% more than with 8240. Both two types of coated cemented carbide inserts are desirable for hard machining technology application of HARDOX 500 with 46÷50 Rockwell hardness. 8240 is also desirable, but by lower cutting conditions. Face milling process is convenient without coolant in 8230 and 8240.

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