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SHARPENING TOOTHED CUTTING TOOLS DESIGN

Pantea Ioan
Universitatea din Oradea, ipantea@uoradea.ro

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Abstract: The most important element of the cutter holder support it is the cutter or the cutters which represent the active part of the tool. Providing the geometric shape of the cutting edges and of the proper profile after the reprofiling of the cutter represents the basic problem of the design and manufacture of the cutters. It is considered sharpening, the grinding of the cutters with straight cutting edges and curved seating surfaces, on the front face and only on their width. The numerical example refers to the sharpening of the bevel gear milling cutters on which experimental researches were made with the Hardac II type cutters holder support, having four interior cutters and four exterior cutters. Before being fixed on the machine, the abrasive disc is mounted on a suitable flange, then it is statically and dynamically balanced. The drawing up of the adjustment sheet for shaping and sharpening the cutters for the experimental researches on the execution of the wheel was done using the cumputer program for profiling and sharpening the tool.

1. INTRODUCTION

The sharpening/grinding of the toothed cutting tools is done usually on special machineries, which constitute the annexes of gear cutting machines. If there are no such machines available, the sharpening of the cutters can be done on universal grinding machines too, on the appropriate devices (fig.1). The regrinding of the heads must be done often, in order to remove through the grinding little material, about 0.15mm, thereby achieving a maximum length of use of the cutters. The paper distinguishes between the grinding and the profiling of the cutters. I consider sharpening the of grinding the cutters that have straight cutting edges and curved seating surfaces, on their front face and only on their width.

Fig. 1 Sharpening with the frontal side of the abrasive stone

2. THE SHARPENING/GRINDING OF THE TOOTHED CUTTING TOOLS ON THE FRONT FACE

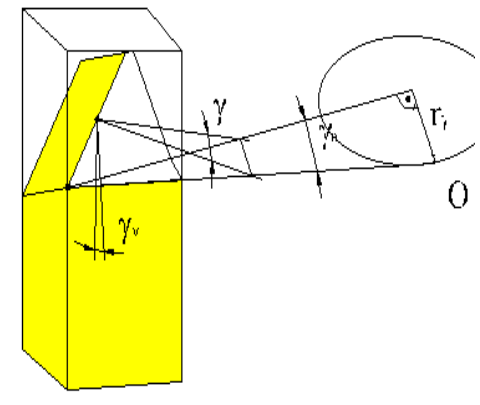

Fig. 2 Rake angles

The cutting edge geometry is determined from the cutting condition. The front rake angle γ results in a plane perpendicular on the cutting edge of the cutter and it is chosen depending on the quality of the processed material, recommending the following values:

- For medium-hard steels $\gamma = 20°$
- For tenacious/tough materials $\gamma = 27°$

To control the front face the angles γ^v and γ^h must be known, resulting in a plane passing through the axis of the cutter figure 3. The wearing of the milling cutters has a negative influence on the development of the milling process, on the

dimensional and surface quality of the machined flanks, and on energy consumption. As a result it is necessary to periodically, in a precautionary manner, regrind the cutters, which disrupts the process of gear cutting. Losses are considerably higher when there is not available another reserve set of knives, prepared in a cutter holder support and the stagnation is strictly related to the time necessary for regrinding. Due to these considerations results the necessity for preoccupations about choosing different parameters of the cutting process, in order to obtain the best durability between two regrindings of the tool [2]. The greatest influence on the wearing of the milling cutters it has the cutting speed and the advance (the thickness of the chip) in the conditions given by the properties of the gear cutting wheels material, the cutting environment, the front rake angle of the cutter. Depreciations occur on the sides of the cutting tool, or only on the main or secondary seating face (as a result of the contact between the tool and the surface of the piece), or only on the front face, as a result of the contact between it and the chip. Simultaneously the wearing can occur on the seating surface, rake surfaces and therefore the cutting edges, which are processing the flanks and the bottom of the tooth's gap. The grinding of the Hardac type milling cutters takes place only on the relief surfaces.

2. SOFTWARE FOR ADJUSTING THE SHARPENING MACHINE

The calculations of the adjusting elements of the sharpening machine presented in the calculation sheet, tab.1, were made with the use of a program*" Software for profiling and sharpening a tool"* implemented in a C++ programming environment. The numerical example refers to the sharpening of the milling cutters for the bevel gear-wheel on which were done experimental investigations with the cutter holder support type Hardac II, having four interior cutters and four exterior cutters. Before the fixing on the machine, the grinding wheel is mounted on a corresponding flange, and then it is statically and dynamically balanced. Between the body of the flange and the abrasive disc a gasket from special paper is fixed. The balancing of the assembly flange-abrasive body will be done by using a special mandrel. Along with other factors such as: the diamond milling manner of the abrasive disc, the cooling agent used, depth of cut, the balance will lead to the improvement of the sharpened surface quality of the cutters. When sharpening it is found that due to the cutting edge inclination angle different for the interior and exterior cutters, the angle adjustments are different, and the differences between them are big. From this wide gap will result in a deeper processing of the interior cutters. In order that the cutters in their turn remain at the same height and the numbers of regrinding to remain the same for the two cutters (for the interior cutters the depth of the cut is higher), at the processing and projecting the active part of the interior cutter, that should be higher with 1mm compared to the exterior cutter.

"Software for profiling and sharpening of the tool"

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//-------------------------------------

m_fN1 = ((m_iTeta1 + m_iTeta2) * sin(RadianDe(m_iBeta))) / 20;

//verificam valoarea cea mai apropiata

((m_fN[0] - m_fN1 < 0) ? m_fMin = (-1) * (m_fN[0] - m_fN1) : m_fMin =
m_fN[0] - m_fN1);

m_iPozMin = 0;

for(i = 0; i < 18; i++)
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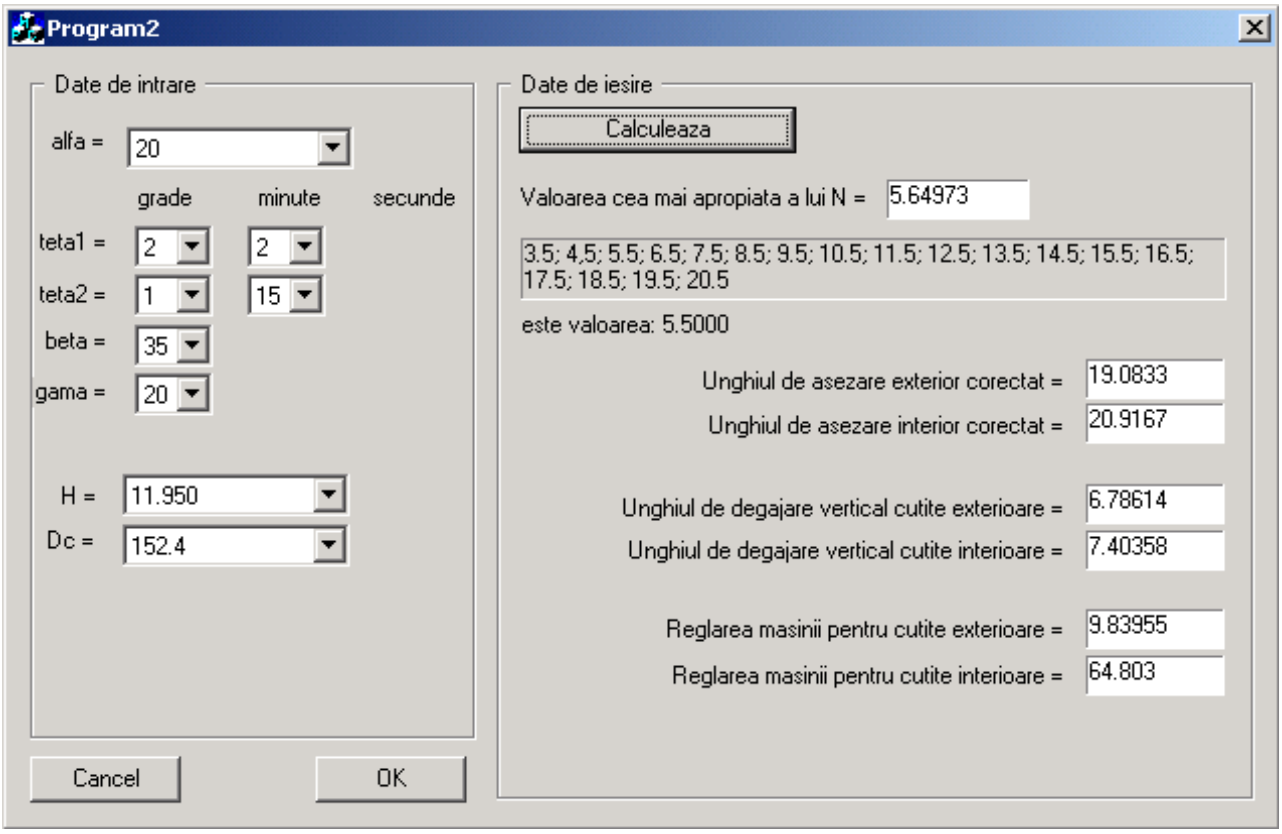

Fig. 3 Interface for determining the parameters in shaping and profiling the tool

Tab. 1 Calculation sheet

BEVEL GEAR-WHEEL WITH CIRCULAR TEETH CALCULATION SHEET for profiling the cutting tools and the adjusting elements of the Gleason Nr.13A sharpening milling machine			
Beneficiary: Univ.Oradea	Product:T.D	Reference: 2100.405.025	
Designation of the part: TOOTHED WHEEL/GEAR	Flank to be processed: BOTH		
Cutter holder support: type Hardac II; No.30.232.08;Diam.medium: 6" = 152,4mm			
Cutters: EC left; top width : 0,508; $\gamma = 20^{o}$			
No.	**Symbol**	**Exterior cutters**	**Interior cutters**
1	α_m -Gearing angle	20^{o}	20^{o}
2	Adjustments of the clearance angles	-1^{o}	$+1^{o}$
3	α -actual cutter angle	19^{o}	21^{o}
4	γ_v Angle adjustment	$6,71661387^{o}$	$7,47954007^{o}$
5	DC, the average diam. of cutter [„]	6"	6"
6	X_c The vertical gap/discrepancy (inches)	2,92918421	0,03256199

7	X_c The vertical gap/discrepancy (mm)	74,4012789	0,82707458
Notes: Z_d = no. of teeth of the divider disc Z_d = 48			
Valid for the the rake angle: $\gamma = 20^o$			

4. CONCLUSIONS

For simulating the technology for the execution of the toothed cutting tools for bevel gears with circular teeth it is necessary its identification, according to the relief-grinding methods, in the sense of establishing a connection as accurate as possible between the model and the process.

The theoretical research regardind the relief-grinding methods of the seating surfaces of the toothed cutting tools presented, was done with the purpose of determining the deviations of the cutting edge compared to a theoretical straight line which passes through its extreme points.

It was developed a program in C++ programming language for profiling the cutters and determining the parameters of profiling and sharpening (the setting of the Gleason 13A machine), „ Software for profiling and sharpening the tool".

With the aid of the program it was drawn up the adjustment sheet fot the profiling and sharpening of the cutters for the experimental investigations regarding the execution of the wheel.

References:

1. Litvin F. L., Gear Geometry and Applied Theory. University of Illinois, Chicago. PTR Prentice Hall, Englewood Cliffs, New Jersey 0763. ISBN-13-211095-4, 1994.
2. Guja, N. -Angrenaje conice şi hipoide. Elemente de calcul şi execuţie. Bucureşti, Ed. Tehnică 1980.
3. Minciu, C., Scule aşchietoare. Îndrumar de proiectare. Editura tehnică, Bucureşti, 1995.
4. Pantea I., Contribuţii privind tehnologia sculelor de danturat roţi dinţate conice cu dinţi curbi. Teză de doctorat, Universitatea din Oradea, 2004.