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PROBLEMS OF THE MILLING HEAD FIRST CONTACT
PROBLEMATIKA PRVNÍHO ZÁBĚRU FRÉZOVACÍ HLAVY

Abstract

This article is deal with finding solutions for tool cutting geometry. Rising popularity of modern cutting materials (sintered carbide, ceramic...) using to milling brings some problems with their mechanical characteristics. In most events has banding resistance and impact value low for these materials. It is very important to set up the tool's geometry well to get the best results in stress deformations. To find a solution we can use mathematic model of tool cut.

Abstrakt

Neustále rostoucí obliba v používání výkonných řezných materiálů při frézování s sebou přináší určitá rizika spojená s jejich mechanickými vlastnostmi. Jedná se v převážné většině o materiály, které špatně snáší ohybové a rázové namáhání (slinuté karbidy, keramika...). Je proto důležité upravit parametry vstupu nástroje do záběru s ohledem na jeho nejvhodnější způsob zatížení. Toto je možné realizovat pomocí matematického modelování záběru nástroje, o kterém podrobněji pojednává následující článek. V článku jsou popsány základní způsoby styku nástroje s obrobkem a jejich matematické formulace.

1 Introduction

For working life of milling cutter is critical its first contact between cutting edge and milled part. If we want to find a place of the first contact between edge and work piece we have to start out from scratches, the plane of cut must be at line with feed and simultaneously parallel to axis of mill. We can vanish the curve of cutter tooth paths, because entering curve is short and we consider it like a linear. On figure, one and two are illustrations of situation between cutter and part. In plane of cut has chip profile of parallelogram allotted by 4 points, HBTV. The high of parallelogram is given by depth of cut a_p and feed s_z . HBTV parallelogram is made by cutting face continuous affecting to the milled part.

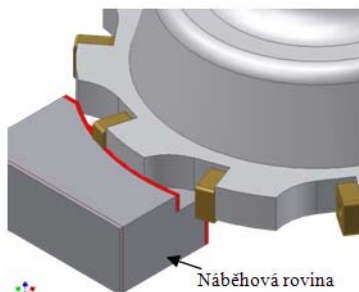


Fig. 1 Global situation

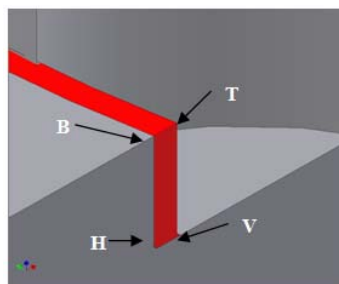


Fig. 2 HBTV parallelogram

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H point – is situated on the tool corner

B point – is the highest point of major cutting edge

T point – is situated on same high as the B point and translated by s_z distance.

V point – together with H point forms minor cutting edge

2 Mill cutter geometry

For finding a mathematic model of cutting edge entrance to part we have to defined the mill cutter geometry. Individual aspects of cutter geometry are described on next figure.

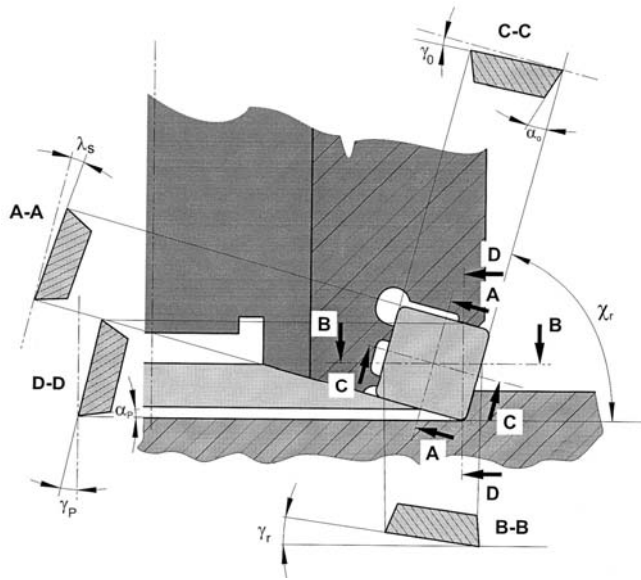


Fig. 3 Mill cutter geometry

γ_0 ... tool rake in orthogonal plane

γ_f ... tool rake in side plane

χ_r ... cutting edge angle

λ_s ... cutting angle inclination

γ_p ... tool rake in back plane

α_0 ... tool rake in orthogonal plane

α_p ... tool clearance in back plane

Primary influence, for the first contact between cutting edge and milled part, has a mesh angle ϵ . Setting possibilities of this angle are on fig. 4 and 5.

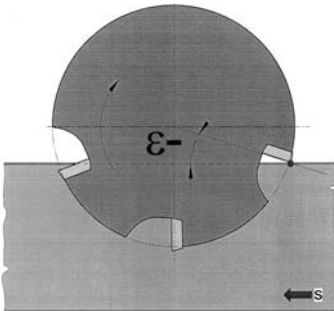


Fig. 4 Positive setting ϵ angle

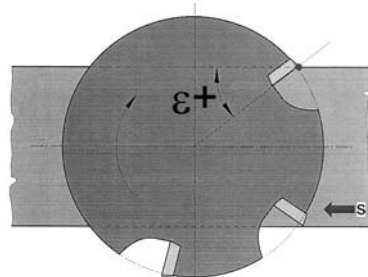


Fig. 5 Negative setting ϵ angle

3 Mathematic model of contac point

The first step of finding point of contact is a chosen random point (P) in a face plane. Then we solve their distance from the reference plane. From position of this point, we separately solve other points of contact. Mathematic solution of this problem is slightly long; therefore, I describe only final equations. Solutions after simplification are these substitution equations:

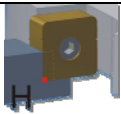
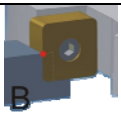
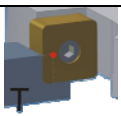
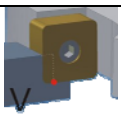
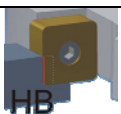


$$\begin{aligned}\psi_r &= 90^\circ - \chi_r \\ D &= a_p \cdot (\tan \psi_r \cdot (\tan \gamma_f - \tan \varepsilon) - \tan \gamma_p) \\ F &= s_z \cdot \cos \varepsilon \cdot (\tan \gamma_f - \tan \varepsilon)\end{aligned}$$



Where:

- ψ_r ... tool approach angle
- a_p ... depth of cut
- s_z ... feed of cut

Dependencies of the contact mill cutter and milled part are obvious from next table (tab.1). In table are graphic symbolization of contacts and relevant F and D substitution and relations between angles ψ_r , γ_p , γ_f a ε .

Tab. 1 Compendium of first contact possibilities

Type of entrance	The signs of F and D for current contact		Relationships between angles γ_f a ε for current contact	Relationships between angles ψ_r , γ_p , γ_f and ε for current contact
	F	D		
 H	+	-	$\gamma_f > \varepsilon$	$\tan \psi_r < \frac{\tan \gamma_p}{\tan \gamma_f - \tan \varepsilon}$
 B	+	+	$\gamma_f > \varepsilon$	$\tan \psi_r > \frac{\tan \gamma_p}{\tan \gamma_f - \tan \varepsilon}$
 T	-	+	$\gamma_f < \varepsilon$	$\tan \psi_r < \frac{\tan \gamma_p}{\tan \gamma_f - \tan \varepsilon}$
 V	-	-	$\gamma_f < \varepsilon$	$\tan \psi_r > \frac{\tan \gamma_p}{\tan \gamma_f - \tan \varepsilon}$
 HB	+	0	$\gamma_f > \varepsilon$	$\tan \psi_r = \frac{\tan \gamma_p}{\tan \gamma_f - \tan \varepsilon}$
 TV	-	0	$\gamma_f < \varepsilon$	$\tan \psi_r = \frac{\tan \gamma_p}{\tan \gamma_f - \tan \varepsilon}$
 HV	0	-	$\gamma_f = \varepsilon$	$\gamma_p > 0$

Type of entrance	The signs of F and D for current contact		Relationships between angles γ_f a ε for current contact	Relationships between angles ψ_r , γ_p , γ_f and ε for current contact
	F	D		
	0	+	$\gamma_f = \varepsilon$	$\gamma_p < 0$
	0	0	$\gamma_f = \varepsilon$	$\gamma_p = 0$

4 INDIVIDUAL ADVANTAGE OF CONTACT POINTS

Milling performance depends on durability cutting edge of mill cutter and vibrations of all milling system. From this case must be the point of entrance (contact) along from major edge. The quality of machined surface depends on tool corner sharpness and quality of minor edge. From this case should be contact point fare from minor edge. Sum of these cases is the ideal point in light of maximal durability and it is T point. In case we can not set up tool geometry well to reach T point contact, it is possible to use B point on major edge. Contacts by lines TB and TV are recommended but less suitable than previous contact palaces. First contact by tool corner (H point) is very unwanted. In this case is fraction of cutting edge highly possible. Contact by whole area HBTV is not recommended in consequence of high impact stress, all chip cross-section are made in one time.

Most influence to place of contact has a mash angle ε , which specify usability of mill cutters and position of cutter to work piece. This angle is influencing all of constructional cutter angles (γ_p , γ_f and χ_r).

5 THE CALCULATION PROGRAM

Aspiration of this mathematic formulation was creations of a computer program that will be able to easy calculate a point of entrance of cutting edge to work piece. Program has three main parts: calculation module, design module and module for estimate cutting parameters. The first one is designed to fast finding place of contact based on main cutting tool geometry; its interface is on figure 6.

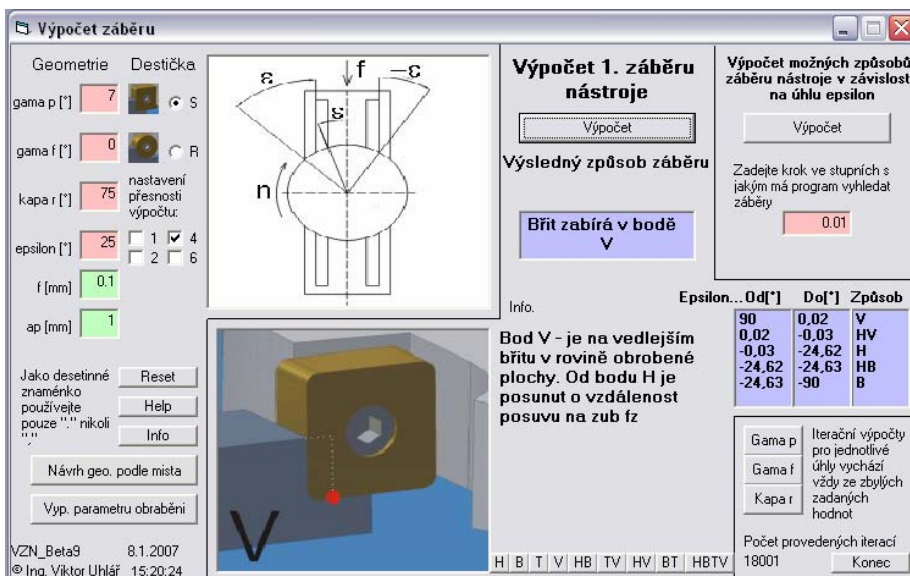


Fig. 6 Program calculation module

The second part of program is designed to finding of geometry parameters of mill cutter based on place of first contact entered by user. This part contains some predefined parameters which user can change. Computed results are recording to the table of solutions. This part screenshot is on fig. 7.



Fig. 7 Program design module

The third part of program is deal with computing of technological parameters milling process. These parameters are based on basic tool geometry, cutting parameters and position of mill cutter to milled part. Screenshot is on fig. 8.

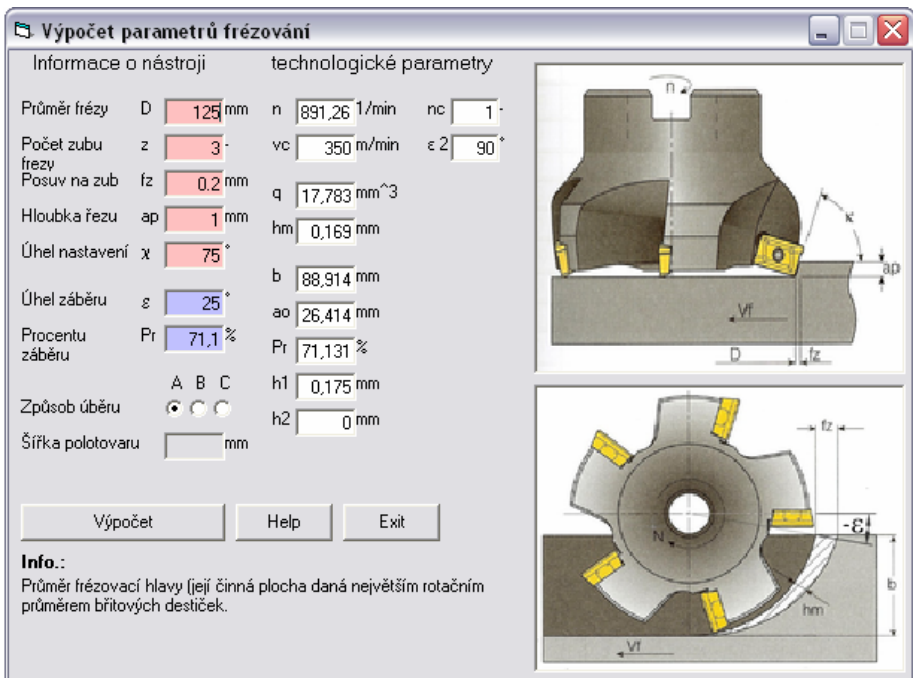


Fig. 8 Program technological module

6 CONCLUSION

In article was described mathematic model of the place of first contact between mill cutter and machined part. It is important to consider this aspect, in face of specific requirements of modern cutting materials. Mathematic model is easy to use and short way to finding solutions for first contact. My computer program, based on mathematic model, can fast and easily computation place of first contact, appear from basic tool geometry and position of mill cutter and work piece. Many modern CAD/CAM systems have a function that allows you to implement own modules to optimization of cutting process. This program, after some modification, can be suitable for CAD/CAM systems and may help to optimize cutting process.

7 REFERENCES

- [1] MRKVICA, M. *Přípravky a obráběcí nástroje I. Díl Řezné nástroje*. Ostrava: VŠB-TU Ostrava, 2001, 3. vydání, 192 s. ISBN 80-7078-941-7.
- [2] *Příručka frézování*, Walter, WALTER CZ s.r.o, 172 s.
- [3] MRKVICA, I. *Návody ke cvičení z obráběcích nástrojů I. část*. Ostrava: VŠB-TU Ostrava, 1999, 1. vydání, 148 s. ISBN 80-7078-624-8.
- [4] HALVORSON, M. *Microsoft Visual Basic 6.0 Professional*. Computer Press, 2001, 578 s. ISBN 80-7226-445-1
- [5] External informational materials, Pramet, PRAMET TOOLS s.r.o, 83 s.

Reviewer: doc. Dr. Ing. Josef Brychta