# TOOTHING KNIVES PROCESSED AFTER AN INVOLUTE SPIRAL

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**Abstract.** The paper presents the experimental research obtained while processing knives used for toothing bevel gears with curved teeth. The profile of these knives is made up of complex surfaces that are part of helixes. In this case, the lateral positioning surface of the knives has an involute spiral for a directing curve.

## 1. Introduction

The relieving technology used by manufacturers of machine tools and hardware for toothing bevel gears is unknown. Profiling these knives is difficult if not done properly because profile deviations appear after a number of re-sharpenings, deviations which influence the toothing process in a negative way.

The materialization of the imaginary generating plane gear by the tool is bound by a number of constraints regarding the necessity that the re-sharpened tool continue to describe a constant generating tooth for one, and that all the geometric parameters remain unchanged from the optimal values initially adopted [1]. These constraints are as follows:

I The main chipping edge of the exterior and interior knives must overlap the normal profile of the tooth of the imaginary generating gear;

II The exterior and interior generating diameters, $D_e$ and $D_i$, must remain constant;

III The positioning angles must have optimal values along the length of the profile (condition III, a), values which must remain constant after re-sharpening (condition III, b)

The optimal form of the positioning surfaces of the knives has to derive as a mathematical synthesis from the three above stated constraints.

## 2. The profile of the knives

After doing the research [3] regarding the simulation of the processing technology of toothing knives using the spatial gearing method, the work drawing was the designed for the geometric and constructive elements of a knife (fig.1). In order to mill the concave flank – the outer knife, the clamping part is processed using the Hardac model because the toothing attempts were done on the Gleason 516 toothing machine (Stimin Oradea), which is fitted with the ZH65 head.

The technical constraints imposed on these knives are the following:

1. Use of the material Rp 3 STAS 7682 - 91 forged, hardened and tempered before the rectification of the surfaces at their final levels, at 63-65 HRC.

2. The profile of the knife, the lateral positioning surfaces and the tip of the chipping part are relieved following an involute spiral (coincidental down-cut milling) in such a manner that any axial sections of the knife mounted in the cutter head maintains the following:

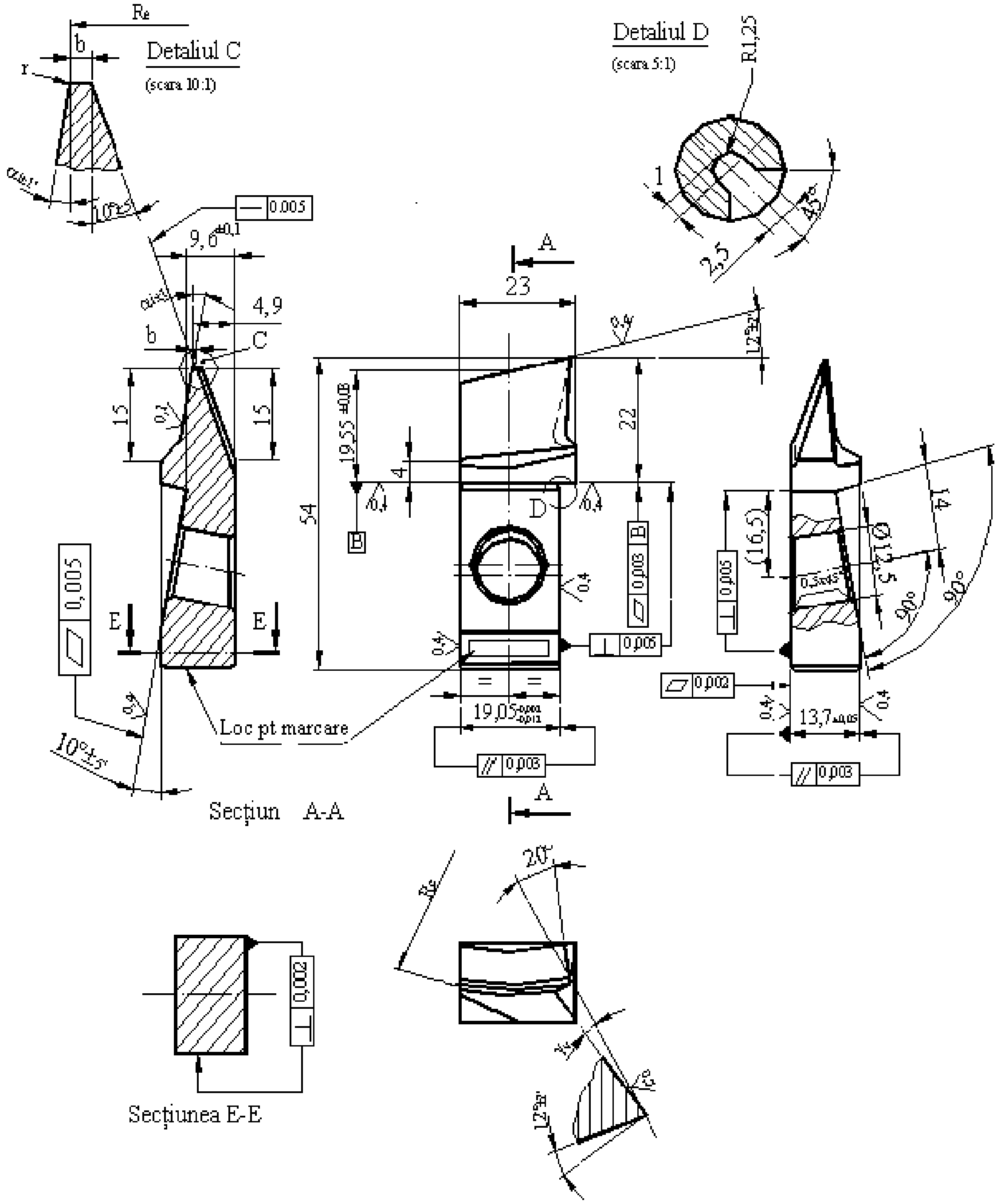


**Fig. 1** Exterior toothing knife

- the straightness of the chipping edge;
- the angle of the main edge's profile with a tolerance of ±1' ;
- the tip diameter $2R_e = D_e$ respectively $2R_i = D_i$,
- the tip positioning angle and the tip positioning angle with the nominal value for which it was designed;
- the positioning angles of the secondary chipping edges will be selected as low as possible in order to expand the

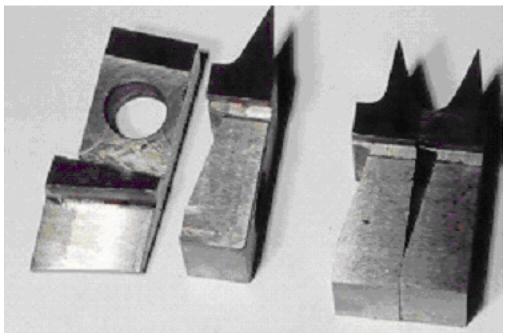

Fig. 2 Toothing knife

dimension range (the modules) of the head.

Figure 2 shows two pairs of knives after the profile rectification phase.

Measurements were done on the JCS-CLV 1086 machine for measuring coordinates in order to determine the control elements for toothing knives in parallel sections as well as in sections tangent to the base circle so that they could be positioned. The machine was mounted with an electronic dividing mass and the measurements were taken at STIMIN Oradea.

The measurements were done for knives which have an involute spiral for a lateral positioning surface and which are original Gleason knives.

The results of these measurements were processed in the program „*Calculus program for determining the deviations of the chipping edges in the generated knives*” and the deviations of the chipping edges were calculated for five re-sharpening sections.

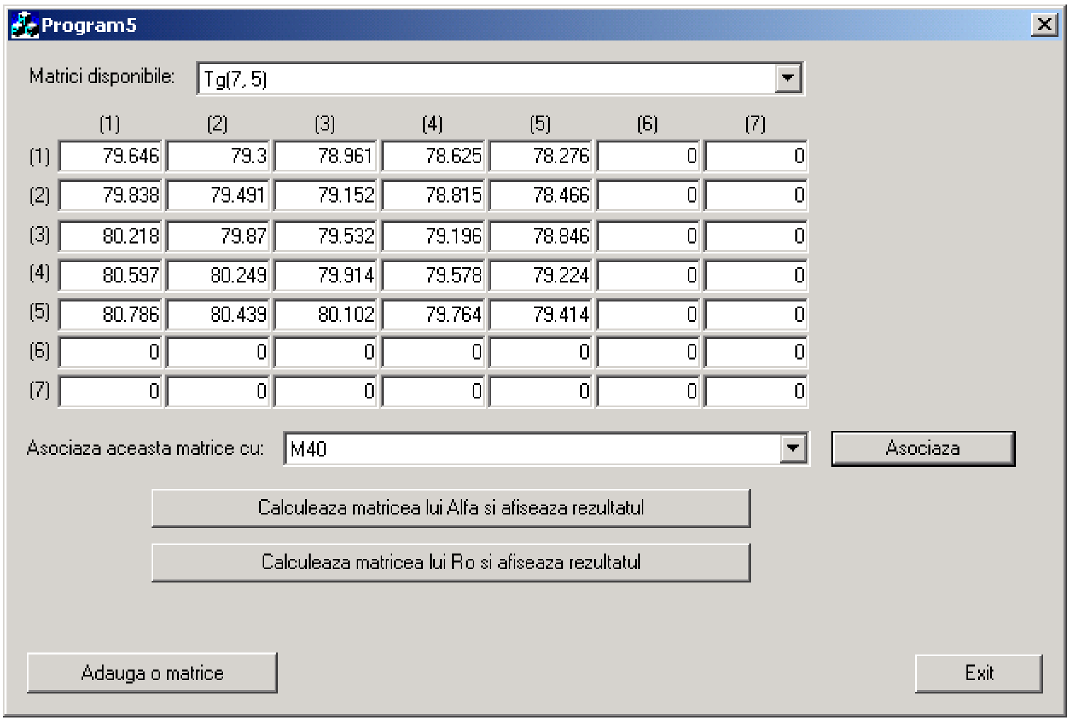


**Fig. 3** The program interface

The comparative analysis of the measurements regarding the coordinates of lateral positioning surfaces processed in the same conditions but after different directing curves is presented in table 3.

Table 3. The deviations of the chipping edges

| Evaluated section | The profile deviation for knives rectified after an involute spiral $\delta$ [mm] | The maximum deviation. $\Delta i$ [mm] | The profile deviation for Gleason knives $\delta$ [mm] | The maximum deviation. $\Delta i$ [mm] |
|---|---|---|---|---|
| 0 | 0.045 | | -0.012 | |
| 1 | 0.027 | | -0.025 | |
| 2 | -0.008 | 0.074 | -0.039 | 0.03 |
| 3 | -0.027 | | -0.023 | |
| 4 | -0.029 | | -0.009 | |

## 3. Conclusions

1. In order to determine the control elements for toothing knives in parallel sections as well as in sections tangent to the base circle, measurements were done on the JCS-CLV 1086 machine for measuring coordinates, which was mounted with an electronic dividing mass and these measurements were taken at STIMIN Oradea.

2. The measurements were taken for knives with lateral positioning surfaces done after an involute spiral as well as for original Gleason knives.

3. According to the comparative analysis of the measurements done for the coordinates of the lateral positioning surfaces processed under the same conditions but by different directing curves, the following can be stated:

- The geometric position of the chipping edges forms the lateral positioning surface of the knife;
- The maximum deviation of the chipping edge for a knife that has an involute spiral for a directing curve is $\Delta i$ = 0.074 mm;
- The maximum deviation of the chipping edge for a Gleason knife is $\Delta i$ = -0.038 mm;
- The maximum deviations for knives processed in this technology are well within the maximum admitted deviations for toothing knives: 0.08mm;
- The difference between the deviations of the experimental knives and the Gleason originals also comes from the extended wear of the Niles machine on which they were processed.

4. The secondary lateral positioning angles were shrunk, 5° for the interior knife and respectively 10° for the exterior, in order to expand the range of processed modules.

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