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Automatizatin of process design of cutting tool manufacturing for formation of grooved rolls

Razumov Mikhail

candidate of science, senior lecturer,
South-West State University, Kursk, Russia

Ponkratov Pavel

candidate of science,
South-West State University, Kursk, Russia

Grechukhin Aleksandr

candidate of science, senior lecturer,
South-West State University, Kursk, Russia

Ovchinkin Oleg

candidate of science, senior lecturer,
South-West State University, Kursk, Russia

Abstract
The advantages of profile connections are considered in the article. The possibility to produce this type of connection on the grooving equipment is described. The question concerning tool grinding is considered. The program, which allows to obtain vector image of adjusted sectional shape of a form cutter, is suggested. It allows to obtain base profile of cutting edge during overlapping of cutting work angle by means of grinding on the standard tool grinding machinery.
Key words: FORM CUTTER, GROOVED ROLL, DEFECT OF FORM, PROFILE CONNECTION.

At the present time profile moment transmitting rolls are of widespread occurrence. The most widespread types of profile rolls are shown in the figure 1.

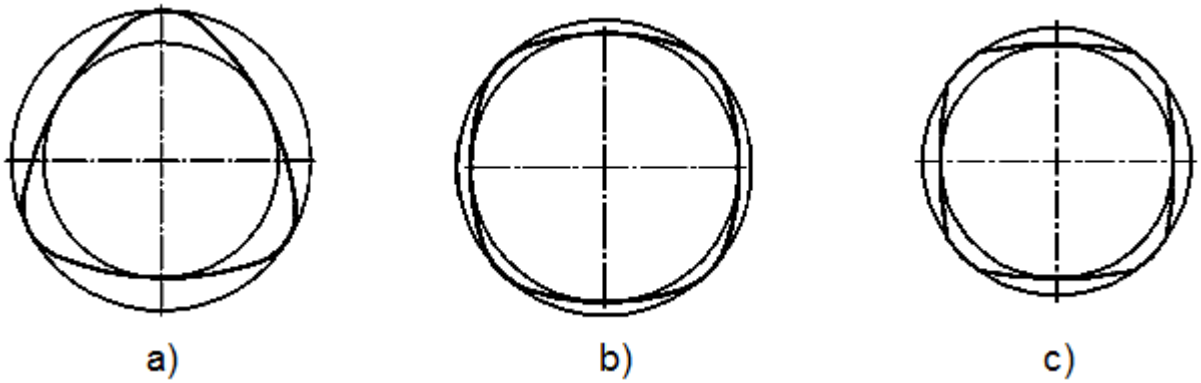

Figure 1. Types of curves of profile connections: a - continuous type RK; b- continuous type K; c – broken type K_s

In the work [1] there was a comparison of geometric and operating parameters of various rolls towards key-slotted roll. Total results are presented in the table 1.

Table 1 Total results

Type of profile	Performance criteria, %						
	K_q	K_I	K_ω	$K_{\lambda м}$	K_M	$K_{пм}$	K_F
RK-3	0	+18	+10	+10	+10	+10	0
K_s-4	0	+32	+45	+25	+27	+45	0
RK-5	0	+17	+14	+8	+10	+15	0
Spline	+3	+16	+12	+8	+10	+15	+3
Cotter	0	0	0	0	0	0	0

where K_q – correlation of mass per unit of length; K_I – correlation of roll deflection per unit length at single-sided support of a beam; K_ω – correlation of given roll strength; $K_{\lambda м}$ – correlation of bonding-stiffness coefficient; K_M – correlation of total moment; $K_{пм}$ – correlation of coefficient of reliability; K_F – correlation of section area.

Analysis of the table shows the doubtless advantage of profile rolls of K_s-4 type.

If one consider the given above parameters towards splined roll [1], the situation will be as follows (table 2):

Table 2 Total results

Type of profile	Performance criteria, %						
	K_q	K_I	K_ω	$K_{\lambda м}$	K_M	$K_{пм}$	K_F
RK-3	-2	-2	-3	+1.3	0	-4	-2
RK-5	-1.5	-1.3	-1	0	0	-1	-1.5
K_s-4	-2.4	-1.5	+28	+14	+15	+26	-2.4
Spline	0	0	0	0	0	0	0
Cotter	-2.6	-16	-12	-8	-10	-15	-2.60
Circular roll	-1.2	-1.3	+3.7	+1	+8	+3	-1.2

From this table one may see that profile of K_s-4 type may exceed in reliability the spline roll up to 26%. But if on the compared rolls there affects the similar force, then this type of rolls weights heavier then the fluted and spline rolls up to 12 and 32 % respectively. From researches [2] it is known that fatique strength of splined roll is 4.5 times lower then as for profile one of K_s-4 type. Nevertheless, such type of rolls is not popular nowadays in the native machine building [2]. With better quality factors profile rolls are considered to be not technological. Analysis of literary sources and patent search of the ways of formation

revealed the most acceptable ways for manufacturing of profile rolls (K-profile). Production of this type of pieces is possible with the help of profile milling cutter creation; on the CNC machines; with the help of polygonal sharpening [3,4,5].

But these ways are connected with large material costs for purchase of expensive equipment, tools and accessory etc. At the Southwest State University there was developed a methodology [6], which allows to manufacture such profiles. The difference of this method lies in cheap production accessories and high efficiency; and the matter lies in development of grooving instrument, which allows to realize forming of profile rolls on the grooving equipment. But during development of technological preparation for manufacturing of the tool there appeared the problem concerning finish grinding with overlapping of angle of cutting. Two variants of finish grinding were suggested (fig. 2).

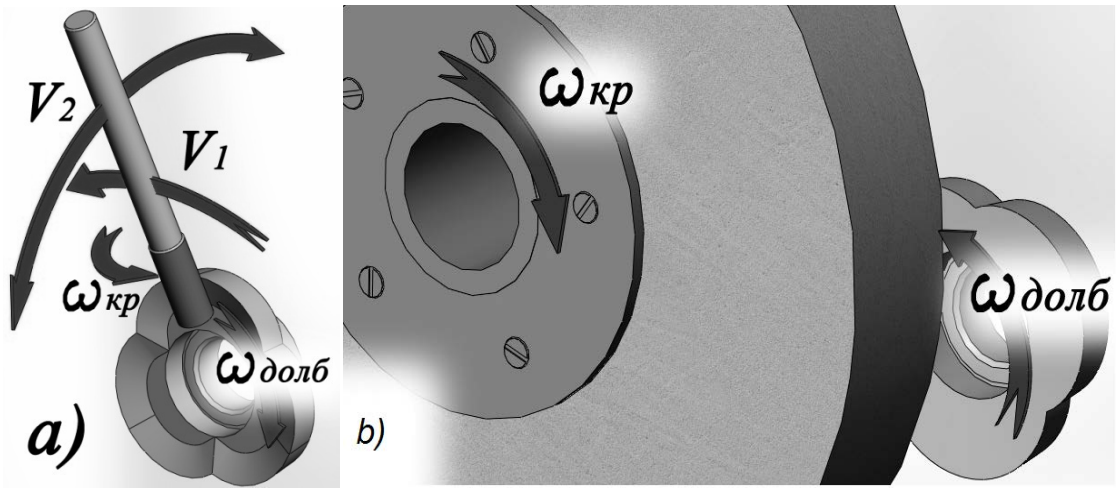

Figure 2. The ways of grinding of tool face: a) sector-wise grinding: V_1, V_2 – complex motions of polished head; b) grinding from the center.

Sector-wise grinding of the tool face excludes origin of an error of a form, but it is not expectable for the most of machine builders. This is connected with that during work grooving tool requires periodic regrinding of cutting edges, and for realization of sector-wise grinding there is a need in CNC grinding machines. In connection with this it was decided to grind with application of multifunctional tool grinding machinery, which is present at the most of enterprises and allows to realize this operation without retention of additional resources of an enterprise.

The figure 3 shows that at the chosen way of grinding there observed mismatch of theoric profile with obtained practically during design and overlapping of front and relief angles (figure) 3 difference *p* of forms projection 1 – calculation and 2 – real (with grinding) forms of cutting edges on the base plane [7].

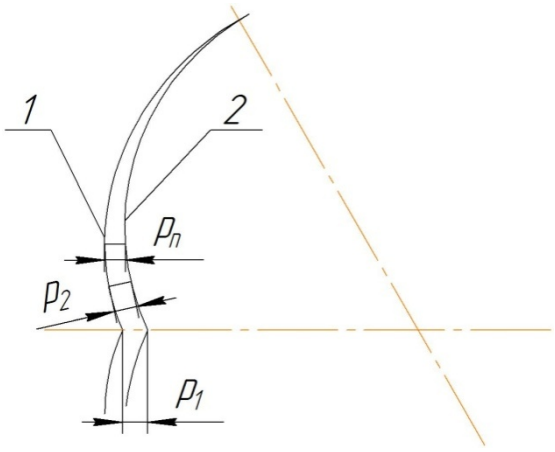

Figure 3. Overlapping of forms of calculated and grinded form cutters

That is why there was developed program product, which allows to eliminate this error on the stage of designing using computer-aided procedures.

Program product consists of information input unit where processing technological parameters are entered figure 4.

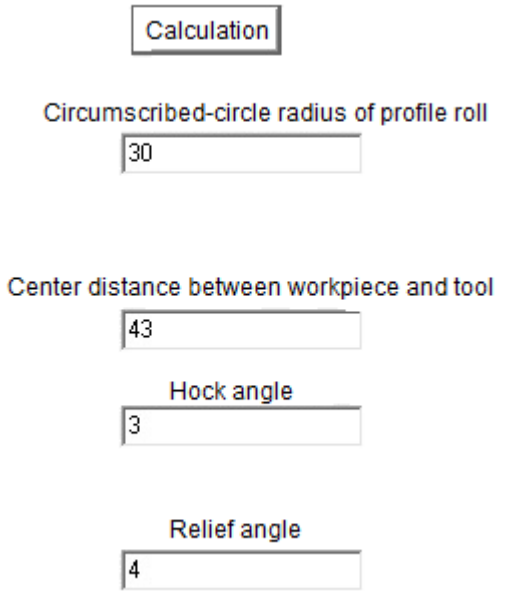

Figure 4. Data-input unit

Calculation unit, where the calculation of coordinates of initial and grinded profiles is fulfilled. Initial profile is obtained by approximation of cutting edge to the segment of a circle. The segment of a circle is approximated through three points, which are determined from the parameters of profile roll at the known diameter of circumscribed circle. The profile obtained during grinding may be calculated by solution the task of cone crossing by flat surface, as during approximation of cutting edge of shaping cutter by the circle and overlapping of relief angle, the profile may be presented as a cone, give that overlapping of front angle happens with face plane of cup grinder, which may be replaced with flat surface while calculation. Then adjustment unit calculates the difference between coordinates of initial and obtained profile after grinding. Hereafter adding the obtained difference to the initial profile, we will get the coordinates of adjusted profile of the shaping cutter piece (figure 5).

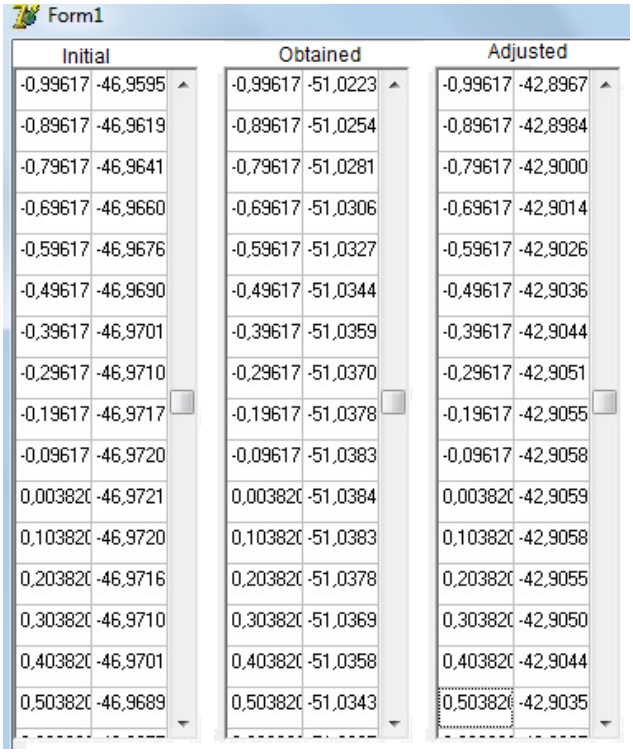

Figure 4. Calculation unit

End result of the program is the file changed to vector format, which may serve as the base for NC program during manufacturing of grooving tool piece.

In such a way suggested program will allow to obtain vector image of adjusted section shape of form cutter, which promotes to get the initial profile of cutting edges during overlapping of cutting work angels by means of grinding on the standard tool grinding machinery.

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