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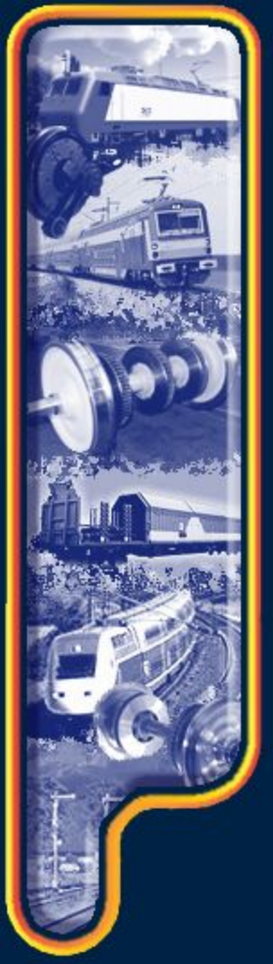

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THE COMPARATIVE ANALYSIS OF THE SURFACE ROUGHNESS OF THE ROLLING WHEEL PAIRS AFTER THEIR TRUEING ON KZ-20 MACHINE TOOLS

Summary. The comparative analysis of a surface roughness of the rolling wheel pair of the rail transport after regenerative repair on KZ-20 wheel milling machine tools by contour mills with DMetI profile was carried out. The parameter R_z is defined for all places of the surface profile of the rolling wheel pair, restored by contour mills, having 130 and 208 cylindrical cutters. The opportunity of holding of actions for all aspects of hardening for the rolling wheel pair surface was analyzed.

1. INTRODUCTION

The development of national economy causes the further growth of carriages by railway transportation. It is achieved, basically, by weight-lifting capacity and speed of trains driving increase. Railway wheel pairs are the important part of a carriage rolling stock substantially providing its effective operation and traffic safety. The increase of loading level at wheel pairs has stipulated increase an amount of repairs last years.

Outage of wheel pairs entails refusal in maintenance of the whole coach or the locomotive, calls increase of time of their idle time in Non-working Park.

Regenerative repair of wheel pairs during the process of exploitation in most cases carries on to cutting on 30-40 % of calculated life expectancy of wheel pairs because of uneconomical restoring of geometrical parameters of the profile of rolling wheel pair and wheel metal losses. Also significant losses of rim metal during the repair because of a super scheduled wear of wheel flanges are present [1].

Practically all turned wheel pairs have imperfections: fettled places, flats, and scaled places on surfaces of rolling wheel pairs, places of heightened hardness. It causes significant difficulties at restoring the profile of rolling surface. The turning of wheel pairs in these cases is accompanied by the big hardships negatively influencing cutting instrument and the equipment [2]. Wheel pairs restoring with such imperfections sharply reduces life expectancy of wheel pairs.

The heightening of an overall performance of transport, the further lowering of material inputs on regenerative repair, causes the researching of progressive technological methods of carriage rolling stock wheel pairs repair, and also perfecting operating with the purpose of their resource increase, improvement of serviceability, wheel pairs reliability. It is known,

that one-millimeter of width of wheel rim ensures 20…40 thousand km of run in dependence of diameter of wheel and conditions of maintenance.

The insufficient level of technological systems knowledge of wheel pair mechanical tooling, questions of wheel steel workability and reliability of the used instrument causes its breakages.

In the effective way of heightening of wheel pairs operation properties, in particular rolling surfaces, is heightening of wheel trueing quality during regenerative repair.

Regenerative repair of coaches and locomotives wheel pairs has one basic difference. The majority of locomotives wheel pairs are restored without their rolling-off. It is stipulated by the fact that the wheel pair is a part of wheel-motor block which disassembly is enough time-taking operation, which demands significant idle times of a carriage rolling stock. Handling of locomotives wheel pairs without their rolling-off is possible on machine tools KZ-20 by milling [3] for which special contour mill are applied.

2. CONSTRUCTIONAL FEATURES OF CONTOUR MILLS

Cutting elements of a contour mill (its body 1 is shown on fig. 1) are studded cylindrical cutters 3, which are interposed into holes of knifes 2 and fixed in them by means of screws 7 and nuts 6. Between nut 6 and knife 2, the elastic washer 5 protecting the screw from spontaneous unscrewing in case of vibrations of a contour mill is established. Compensating washers 4 of different widths are also established under cylindrical cutters. With their help the necessary exactitude of cylindrical cutter location is achieved at contour mills customization. The construction of the left and the right contour mills are similar.

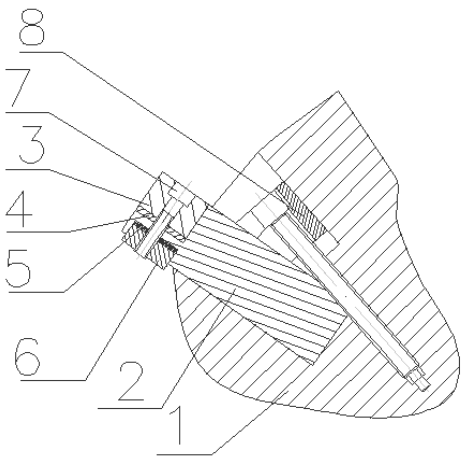


Fig. 1. Strengthening of cylindrical cutter in the knife body

The technology and repair of locomotive contour mills assumes holding its bench alignment at which depth of cutters installation is regulated with the purpose of execution of the profile appropriate to example. Thus the tolerance on beating sequentially working cylindrical cutters is 0,05 mm.

The construction of a mill assumes mutual overlapping cutters. Wheel trueing quality for wheel tread surface depends first of all on quality of the given overlapping, in other words the difference between envelope surface and the preset profile of wheel working surface. The height of ring asperities, made at handling wheel pair, should be minimum. It may be reached at an optimum positional relationship of cutters. In this case wheel trueing quality of handling raises, loading on each separate cutter is reduced if frequency of their installation is

augmented. However the construction of knifes does not allow to arrange on one knife more than 14 cutters of standard diameter of 12 mm, besides at width of partitions decreasing their operation stability is reduced, cutters break down its nests, that finally results in outage, both separate cutters, and knifes as a whole [4].

On fig. 2 the location of cylindrical cutters of the first knife, for a contour mill with sixteen knifes is shown. For lowering the loadings, operating on a barrier between adjoining cylindrical cutters, it is necessary to increase barrier width up to 2 mm.

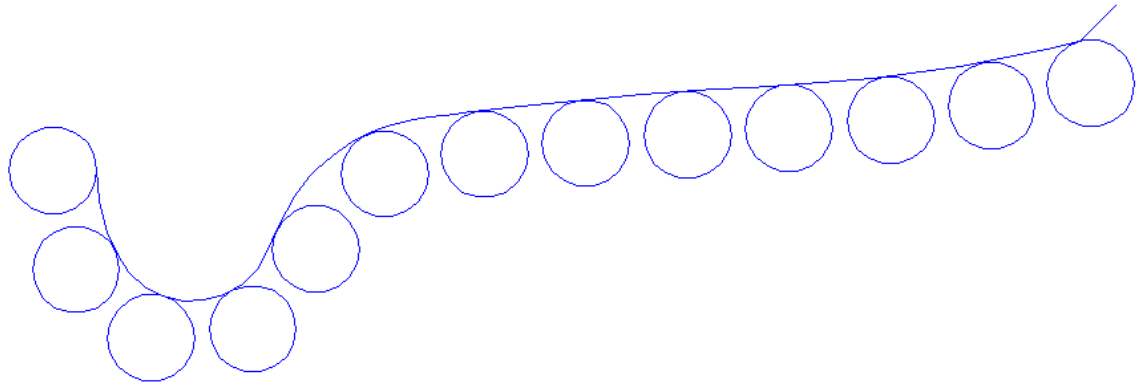


Fig. 2. Cylindrical cutters location of the first knife for contour mill with sixteen knifes

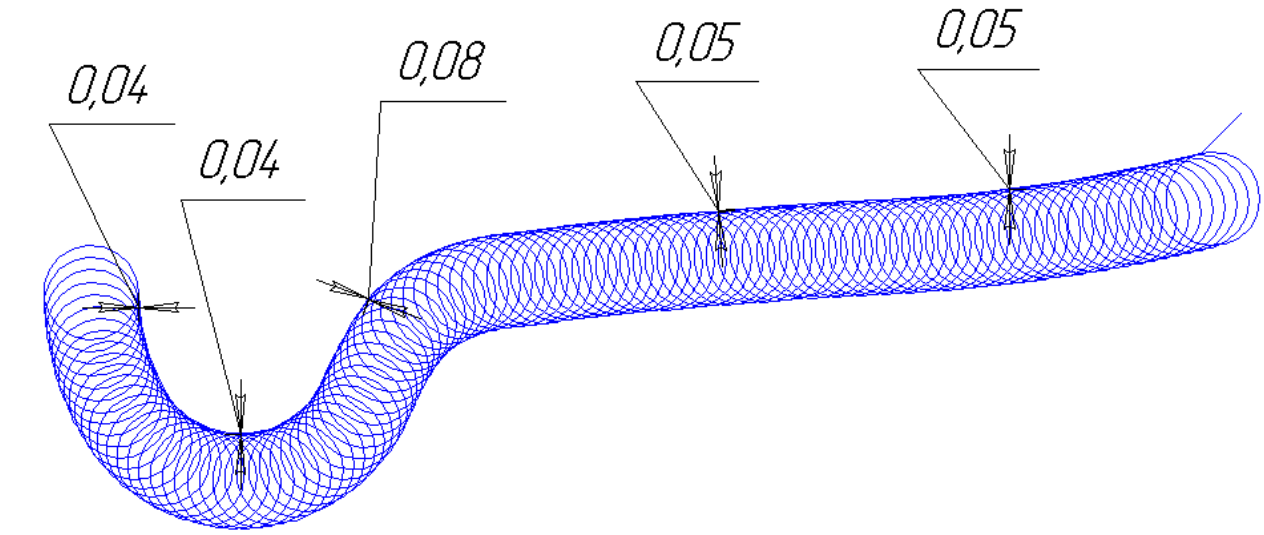
At knifes projection and contour mills it is important to set cylindrical cutters on all knifes uniformly, ensuring mutual overlapping on all places of the rolling surface profile of the wheel pair: a flange and circle of rolling. Execution of the given requirement allows doing turning of rolling surface with high exactitude. According to the Instruction on forming, repair and maintenance of wheel pairs for motive power of Ukrainian railways of 1520 mm track [20] (part 6.9.12) it is necessary, that wheel trueing quality of tooled wheel pair surface corresponds $R_z = 80$ micron [5].

3. THE GRAPHIC AND CALCULATED ANALYSIS

Let's carry out the analysis of influence of knifes increase of contour mills, and accordingly cylindrical cutters on wheel trueing quality of tooled surface, comparing contour mills with ten and sixteen knifes.

On fig. 3 modeling of mutual overlapping cylindrical cutters of contour mills having 10 and 16 knifes is shown. By heights (roughness) on different places of rolling surface of wheel pair, it is possible to make conclusion concerning quality of tooled surface.

Let's consider, what wheel trueing quality of locomotives wheel pairs handling on the example of designed contour mills for DMetI LR profile will be. Let’s assume, that customization is manufactured ideally, any of cylindrical cutters has no beating and only cylindrical cutters overlapping stipulate asperities. For profile peak height definition we shall use software COMPAS - 3D LT 5.10. Application of this software allows estimating wheel trueing quality of handling which will be an "ideal" contour mill at wheel pair handling. We shall consider area flange arc, which by virtue of design features has rather smaller wheel trueing quality of handling. Handling of this zone is done by cylindrical cutters of all knifes which have numbers 4, 5. According to coordinates of the holes centers for installation of cylindrical cutters we build circles in diameter of 12 mm on all knifes for contour mills with ten knifes and for contour mills with sixteen knifes.



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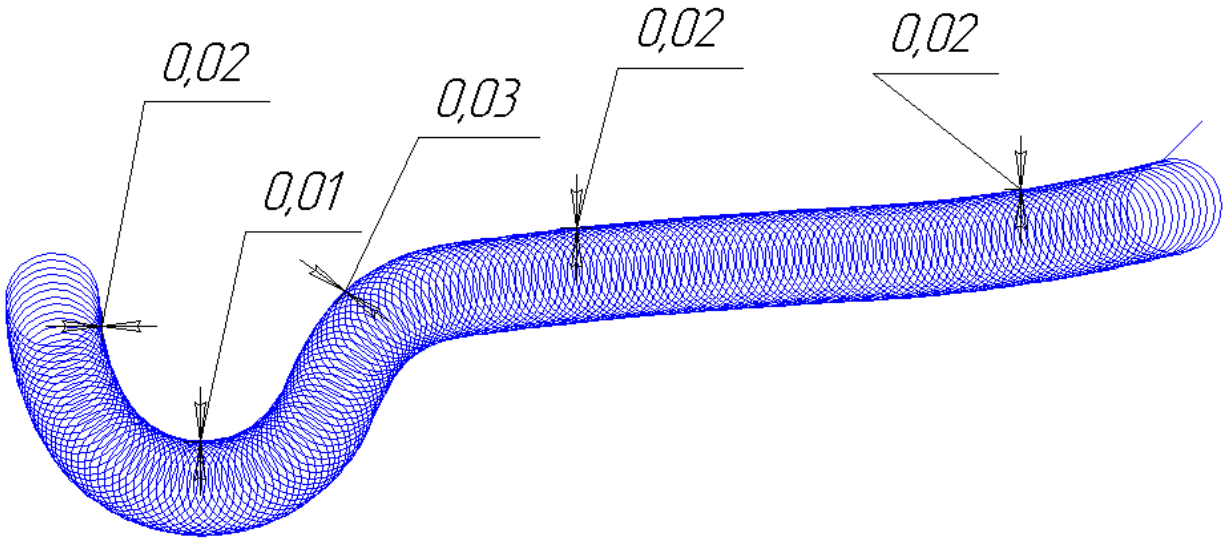

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Fig. 3. Modeling of mutual overlapping of cylindrical cutters of a contour mills at zero aberrations from the nominal sizes of their installation: a) for the mill with 10 knifes; b) for the mill with 16 knifes

On fig. 4 modeling of mutual overlapping of separate cylindrical cutters in flange arc zone of wheel flange by contour mills with 10 and 16 knifes is shown. Profile peak tops will be in cross points of circles, which for obviousness are enclosed. On each two neighboring tops, middle of profile valley, which also for obviousness are marked, were defined. These last points on conditions of mill projection belong to the preset profile of rolling surface of the wheel. Then on each three such points the arc of a circle, which will coincide practically under the shape with the profile of working surface of a wheel, may be constructed.

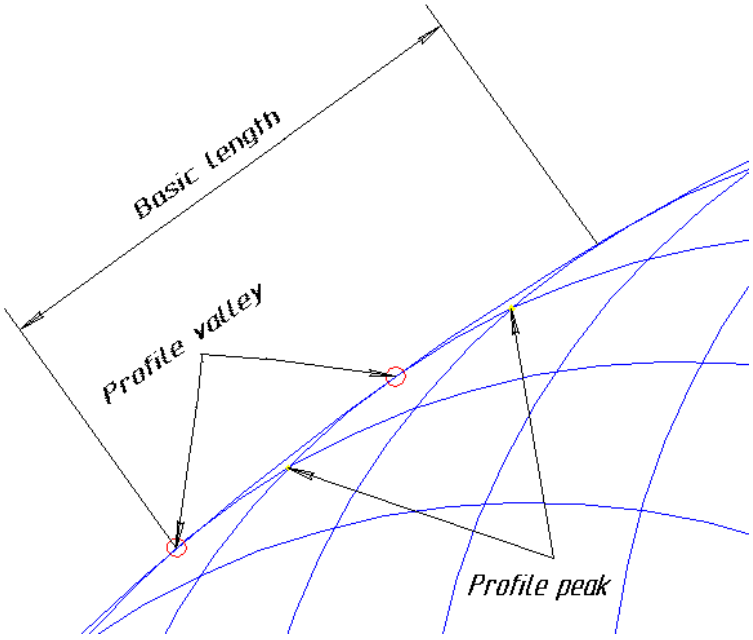
Analyzing heights of irregularities of the profile parameter, R_z may be defined as [6]

$$R_z = \frac{1}{5}\left(\sum_{i=1}^{5}\left|y_{pi}\right| + \sum_{i=1}^{5}\left|y_{vi}\right|\right) \quad , \tag{1}$$

where y_{pi} - an aberration from an average line of the profile of five greatest maximums of the profile, and y_{vi} - an aberration of five greatest minimums. In our case the profile is not the

average line, and the line, which has been carried out on cavities, in particular, approximation of the profile by separate arcs. Thus, without generality loss $y_{vi} = 0$ and then the formula (1) may be written down as

$$R_z = \frac{1}{5}\sum_{i=1}^{5}\left|y_{pi}\right|. \qquad (2)$$



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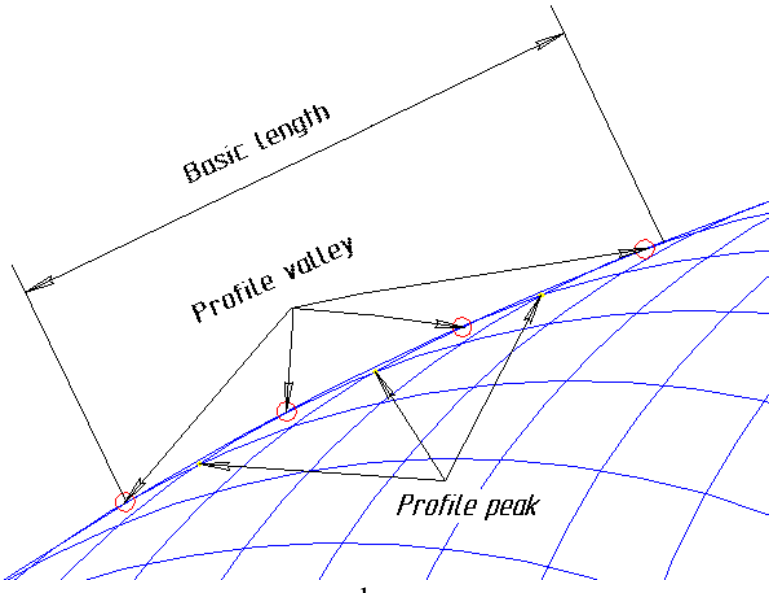

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Fig. 4. The analysis of wheel trueing quality of working surface handling of contour mills wheel at zero aberrations: a) for a mill with 10 knifes, b) for a mill with 16 knifes

Let's mark also, that the mentioned above profile peaks and valleys are selected on base length l, which for $R_z 80$ is equal 8 mm.

As a result of carried out graphic modeling and calculations parameters were defined R_z on base length. Results of research are written in table 1.

Table 1

Part of the wheel pair profile, on which measurements and calculations were carried	The contour mill with 10 knifes	The contour mill with 10 knifes
Roughness on an internal part of flange, R_z, micron	40	20
Roughness at flange top, R_z, micron	40	10
Roughness on the flange arc, R_z, micron	80	30
Roughness on a rolling circle, R_z, micron	50	20
The average roughness on rolling surface, R_z, micron	52	20

In the previous calculations ideally adjusted contour mill was considered. In practice it is impossible to realize the same. We shall consider a case when sequentially working cylindrical cutters; adjoining on figure 5, have as much as possible admissible beat of a mill - 0,05 mm.

As a result of carried out graphic modeling and calculations the case when sequentially working cutters, have as much as possible admissible beating - 0,05 mm is considered, parameters were defined R_z on base length. The most unfavorable is the case when specified "beating" of cylindrical cutter is located in flange arc area, and is sunk deep into a contour mill.

As one would expect, heights of irregularities are augmented, we shall get $R_z = 62$ micron for a contour mill with 10 knifes, $R_z = 38$ micron for a contour mill with 16 knifes. In other words even in the most unfavorable case if the contour mill is executed according to requirements of the instruction, it should ensure preset wheel trueing quality of handling surface during operation. Results of research are shown in table 2.

By results of the carried out comparative analysis of rolling surface roughness of wheel pairs after regenerative repair on wheel milling machine tools KZ-20 contour mills having 10 and 16 knifes it is possible to make conclusion, that both constructions of contour mills correspond all technical requirements presented in the Instruction on forming, repair and maintenance of wheel pairs for motive power of Ukrainian railways of 1520 mm track (part 6.9.12), wheel trueing quality of a handled wheel pair surface corresponds $R_z = 80$ micron.

As a result of the carried out scientific-research and development project essentially new contour mill of dismountable construction, for regenerative repair of rolling surface of wheel pairs on wheel milling machine tools KZ-20 has been developed. Its construction coincides with engineering, technological and operation requirements.

The number of knifes and, accordingly, number of cylindrical cutters is increased. Due to designer solutions the weight of construction does not exceed 100 kg. At increase of contour mill diameter the speed of cutting is increased, the time of wheel pair handling is diminished. Accordingly, productivity of wheel pairs profiles restoring raises during regenerative repair.

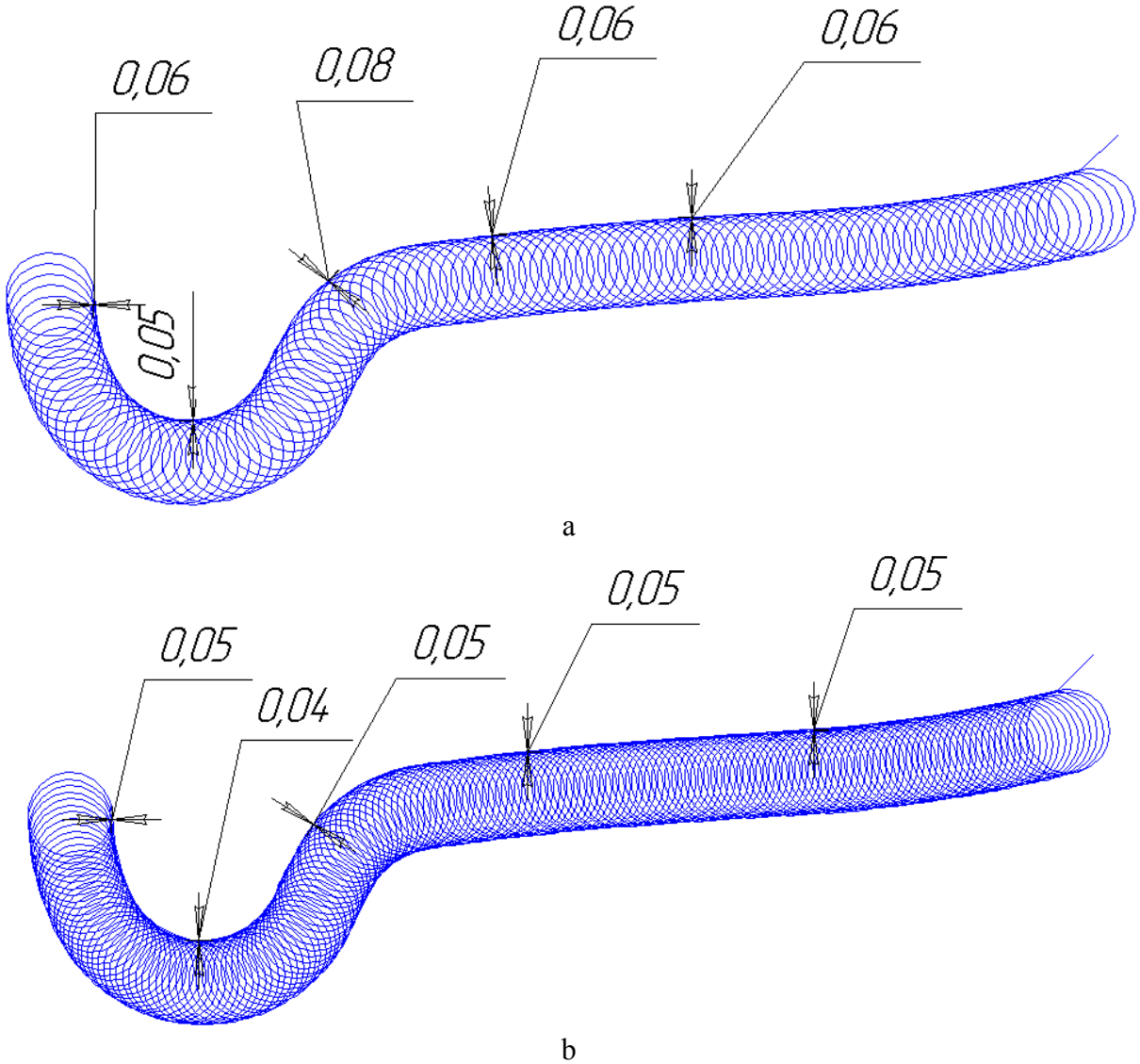

Fig. 5. Modeling of mutual overlapping of cylindrical cutters of contour mill at the maximal aberrations of sequentially working 0,05 mm chisels: a) for mill with 10 knifes (130 cutters); b) for mill with 16 knifes (208 cutters)

Wheel trueing quality of handled wheel pair surface, after handling by the improved contour mill, in comparison with Instruction on forming, repair and maintenance of wheel pairs for motive power of Ukrainian railways of 1520 mm track (part 6.9.12) is increased 2 times. After wheel pair surface handling it is possible to execute actions for all existing aspects of rolling surface hardening, including laser hardening. The service of contour mill construction is simplified during repair. The milling method is more acceptable technique for restoring the locomotives wheel pair profile of main and industrial transport, and does not demand the big technological and operation expenditures.

Таблица 2

Part of the profile on which measurements and calculations were executed	The mill of 10 knifes	The mill of 16 knifes
Roughness on an internal part of flange, R_z, micron	60	50
Roughness at flange top, R_z, micron	50	40
Roughness on the flange arc, R_z, micron	80	50
Roughness on a rolling circle, R_z, micron	60	50
The average roughness on rolling surface, R_z, micron	62	38

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Abstract

Проведен сравнительный анализ шероховатости поверхности катания колесных пар рельсового транспорта после восстановительного ремонта на колесофрезерных станках КЖ-20 фасонными фрезами с профилем ДМетИ. Определен параметр R_z для всех участков профиля поверхности катания колесных пар, восстановленных фасонными фрезами, имеющими 130 и 208 чашечных резца. Проанализирована возможность проведения мероприятий по всем видам упрочнения поверхности катания колесных пар.