Jacek Makuch
Dr inż.
Politechnika Wrocławska, Wydział Budownictwa Lądowego i Wodnego; Katedra Mostów i Kolei
jacek.makuch@pwr.edu.pl

DOI: 10.35117/A_ENG_19_06_01

Measurements of transverse section wear of rails in tracks of tram-loop

Abstract: In article the problems of classical methods of transverse section wear of rails replacement with new techniques based on electronic devices was concerned. Reasons of rails shape section changes were defined. Principles of rails waste inspection resulting from regulations were reminded. Review of practical measurement methods and devices were made. Shapes of nominal sections of rails used in tram tracks were analyzed. Realization of measurements executed with mechanical-electronic profile gauge and mechanical track gauge on tram-loop Sępolno in Wrocław were described. Proposal of graphic manner analysis of rail wear measurements in connection with track width measurements were proposed. In summary conclusions from effected investigations were formulated.

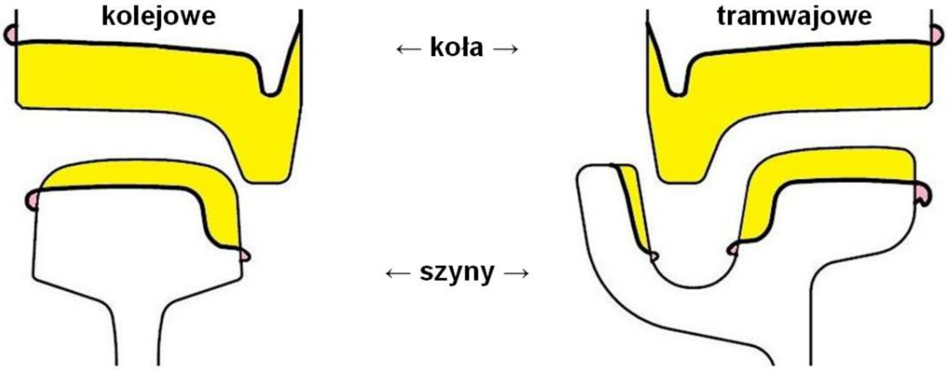
Keywords: Tram tracks; Diagnostics; Profile Gauge

Introduction

In August 2017, the exchange of tram switches at the intersection of Paderewski and Mickiewicz streets. At the time of these works, the Sępolno loop was excluded from streetcar traffic. The author of this article managed to obtain the infrastructure manager's approval (ZDiUM) for measurements of rail shape section wear on this loop at that time. These examinations were not the result of any order or grant but resulted only from the need to check the correct operation of diagnostic equipment used in teaching, before the beginning of the next semester of classes with students. The possibility of carrying them out, however, has become an opportunity to recognize some interesting problems that are the result of replacing the classic methods of measuring rail section wear with new techniques based on the use of electronic devices.

Reasons for changing the shape of the rail section

With the passage of time, differences in the shapes of wheel and rail sections appear in actual rail vehicles and tracks - actual compared to nominal. Fig. **1** presents the most common wear shapes on the rim and steel surface of the tracks - for both rail (head) and tram (grooved) rails).



1. The most common shapes of wheel and rail rim wear [1]

The most important reason is the friction wear on rolling surfaces, which is the result of friction and impact - steel wheels on steel rails. These are "losses" of material (highlighted in Fig. **1** in yellow). At the boundaries of the rolling surfaces, runoff may occur in the form of bulges, i.e. "excess" of the material (highlighted in Fig. **1** in pink) - resulting from displacements of plasticized steel, and if so - they are not only excess but also defects. The shape of the running surfaces of operated rails can also be changed as a result of deliberate actions such as reprofiling (grinding) or regeneration (surfacing and grinding).

Below the rolling surfaces, the rails may be subject to excessive corrosion. First, as a result of delamination and peeling, the surface of the rail is "swollen" - that is, excess occurs, although, of course, this is not a material in the form of homogeneous steel (as in runoff), then later delamination and scales begin to fall, which leads to cavities. A possible cause of a change in the shape of the rail section may also be foreign bodies that have adhered to them, resulting in excess.

The last two reasons do not apply to the rolling surfaces of the rails, which does not mean that they can be completely omitted in the analysis of the phenomenon of wear of their cross-sections. Most methods of measuring this wear are of indirect nature - refer to the so-called reference surfaces, i.e. those parts of the rail that have not worn. If their image is falsified, then the final results of the conducted analyzes become unreliable.

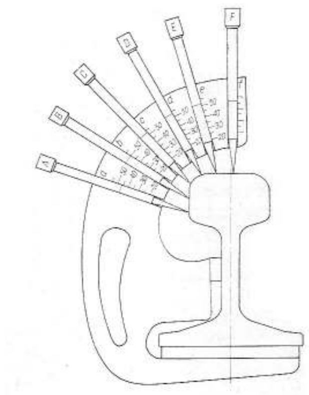
Principles of rail wear control resulting from regulations

In classic railways they are regulated by Annex 14 of Id-1 [2], in which, depending on the track class and rail type, the permissible values of headwear are given: vertical (from 8 to 28 mm) and side (from 12 mm to bottom) its edge) and the angle of the lateral surface (65, 60 or 55 degrees). Side wear is determined 15 mm below the upper level of the railhead, and the angle of inclination to horizontal. Unfortunately, the drawing illustrating the instructions for determining lateral wear is imprecise (the rail instead of inwards is inclined outside the track), which may cause its incorrect interpretation. While vertical and lateral wear has been checked for many years, the angle has been relatively recent (last version of the D1 instruction from 2002). In a slightly veiled way (in the first remark to Table **1**) the case of coincidence (simultaneous occurrence) of vertical and lateral wear is taken into account - in such situations the permissible vertical wear should be reduced by half of the actual side wear.

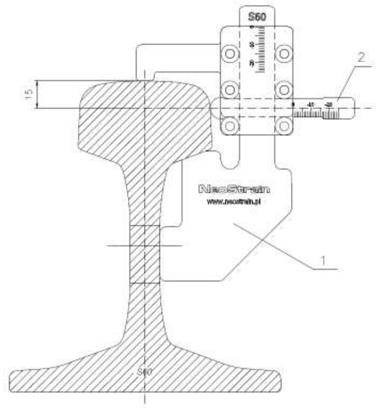
In the case of tram tracks, these issues are governed by much older regulations [3] of 1983, which do not distinguish track classes, but distinguish three cases of rails: grooved and rail (head) with a weight up to or over 422 N/m and gives corresponding the permissible headwear values: vertical P (18, 12 or 15 mm respectively) and side B (15 mm - for each of the three rail cases). The regulations also define simultaneous vertical and lateral wear as P+B/3 and give its permissible values (respectively 18, 12 or 15 mm - exactly the same as for vertical wear). However, the regulations do not require checking the angle of inclination of the lateral surface, and for grooved rails - wear the guide (side and inclination angle). It also does not specify at what depth the lateral wear of the railhead should be determined - whether the same as on the railway or maybe a little higher (taking into account the fact that the tram wheels have about 6 mm lower flanges).

Measurement methods and measuring devices

The oldest and at the same time the simplest are discrete measurement methods. Most often they are made with calipers. However, this is an indirect measurement - by measuring the height of the entire rail and subtracting from its nominal size, we determine its vertical wear, similarly to horizontal wear. To facilitate measurements, devices enabling direct measurement were developed – such graver device (Fig. **2**) and template profile gaugaes (Fig. **3**).



2. Graver device

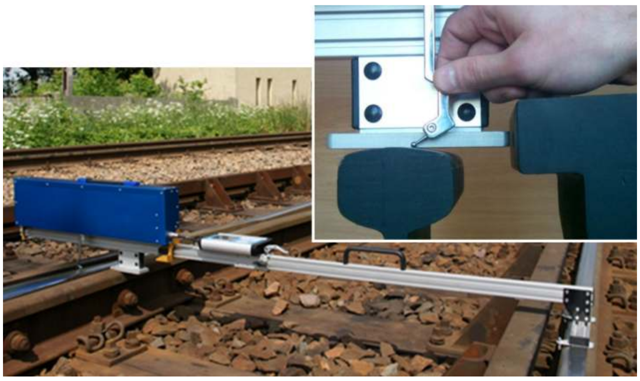


3. Template profile gauge [4]

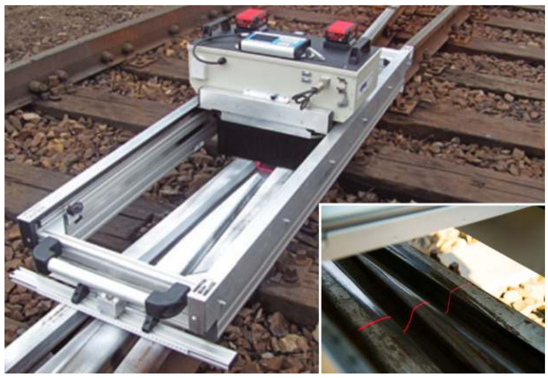
4. Mechanical profilograph [5]

Unfortunately, graver devices usually define "their" measuring places, not necessarily the same which the regulations require us to check. In turn, the template profile gauge presented in Fig. 3 determines vertical wear exactly in the middle of the rail head width - which in real measurements of heavily worn rails is not always the case.

Newer methods are continuous measurements. They are made possible by devices such as mechanical profilographs (Fig. **4**), in which the movement of the guide stick guided by hand on the rail surface causes the drawing of its section shape on paper. Much more modern devices enabling continuous measurements are mechanical-electronic profile gauge (Fig. **5**) in which we still have to manually outline the rail with a guide or optical-electronic (Fig. **6**) where the measurement takes place completely automatically, thanks to the use of laser scanning technique.



5. Mechanical-electronic profile gauge [6]

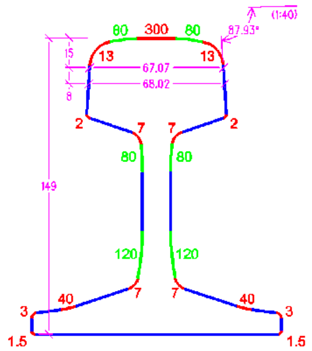


6. Optical and electronic profile gauge [6]

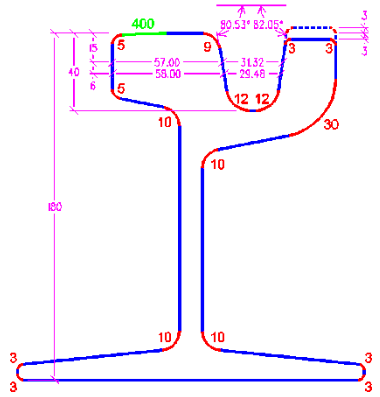
Only the last two devices allow measurement with an accuracy of 0.1 mm, all previously mentioned - only up to 1 mm. Although vernier calipers have vernier, it is necessary to take into account errors in applying the device when making measurements. On the other hand, the regulations do not require accuracy greater than 1 mm.

Nominal sections of rails used in tram tracks

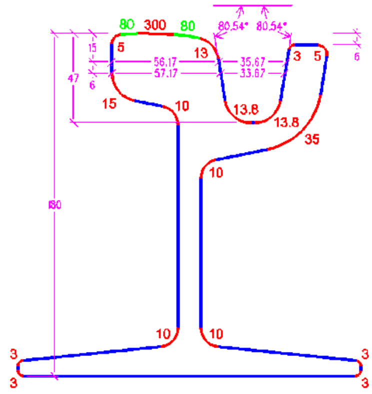
In the case of indirect measurements, the measured values should be referred to the nominal sections specified in the relevant normative documents [7, 8 and 9].



7. Rail 49E1 [7]



8. Rails 180S and 180P [8]



9. Rail 60R2 [9]

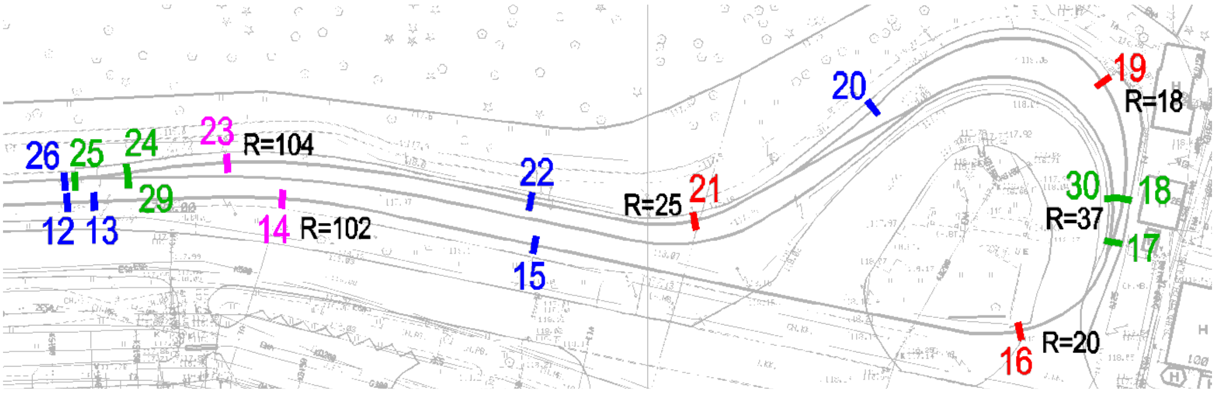
Figures **7**, **8** and **9** show such cross-sections, while the form of their presentation differs from the one presented in the standards, as they were modified by the author of the article for the needs of teaching. Colours indicate different cases of sectional curves: blue are straight sections, and red and green are arches. The numbers given are the values of the radius of the arcs. Pink dimension lines are nominal dimensions, but only some (there are many more in standard drawings). Only the dimensions needed to determine the wear of the rail section are shown, i.e., for example, the width of the railhead 15 mm below its upper level - however, it should be noted that with high vertical wear this dimension increases (by 1 mm for 8 mm of vertical wear of the 49E1 rail), which is sometimes reason for lowering the determined values of side wear if we do not take it into account. The angle of inclination of the lateral surface of the rail type rail head (49E1) is given for its inward tilt of 1 to 40.

For tram (groove) type rails - two older types are shown in one illustration (Fig. **8**) because they differ only in the upper end of the guide (the higher guide, shown in dashed line, is the 180P rail). The inclination angles of the side surfaces of the head and the guide are slightly different in the newer rail (Fig. **9**) than in the older ones (Fig. **8**), where they are additionally different for the head and guide, and generally (for the newer rail and both older ones) for the heads about 7 degrees smaller than in a rail (head) rail. In Fig. **8** and **9** there are much more pink dimension lines than in Fig. **7** - this is due to the fact that built-up structures are used much more often than in railway tracks, and then vertical wear can only be determined based on the location of the unused bottom groove or unused upper guide surface, while lateral wear - based on the location of the unused side guide surface. But if the bottom of the groove and the guide are worn - built-up tram tracks cannot be determined by caliper measurements for vertical and lateral wear. Figs. **8** and **9**, similarly to Fig. **7**, show the increase in the nominal dimension of the rail head width along with the increase in its vertical wear, which this time progresses at a faster pace, as 1 mm increase is obtained with only 6 mm vertical wear. With maximum vertical wear of 18 mm, we can, therefore, lower the specified side wear by up to 3 mm. If, however, we use the width of the groove as the nominal dimension - then the growth rate is twice as high (2 mm per 6 mm vertical wear).

Description of the loop and the measurements carried out on it

Over the last 30 years, three tram lines have terminated at the Sępolno loop, except for the period of 6 years (between autumn in 2011 and 2017), when only two lines reached Sępolno. The last renovation of the loop was over 30 years ago. In 2012, a section of the tram line was renovated directly before the loop (from the intersection of Paderewskiego and Mickiewicza streets), rails, sleepers, ballast, and traction network were replaced. At that time, by using the tram stop, some of the most worn switches, crossings and rails in the arches were replaced by new ones. The loop turns out to be a very "grateful" research object. In the geometrical arrangement (Fig. **10**) it has arches with both large, medium and small radii and straight inserts between compatible and inverse arches, short and long. Not renovated for many years, but with local replacements of selected, the most worn-out components, it is characterized by a large variety of types and ages of the track surface in use, and as a result a large variety of forms and volumes of rail cross-sections.

The measurements were taken on August 18, 2017, between 10 am and 1 pm, in nice sunny weather. At the beginning of the measurements, the air temperature was 23°C and at the end 30°C, while the rails - 36°C and 44°C, respectively. To measure the wear of the sections of the rails, 17 characteristic places (positions) were selected along the length of the loop (Fig. **10**): 6 - on a straight line, 2 - in gentle arches, 3 - in tight arches and 6 in turnouts (including both straight sections and arches).



10. Sępolno loop - measuring stations (colour: blue - straight sections, pink - gentle arches, red - tight arches, green - junctions) and radii of arches

At each of the stations, the shape of the wear of the left and right rails was measured with a mechanical and electronic profilometer by GRAW (Fig. **5**), and in addition to connect the measurements of the shape of the wear of both rails - width (clearance) and cant with a SOLA mechanical track gauge.

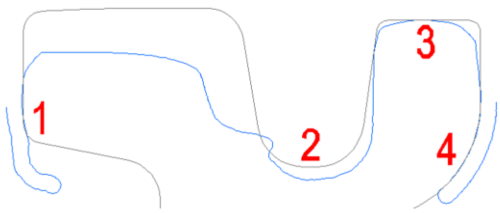
Analysis of test results

The profilometer used in the research had the software created by its manufacturer to analyze their results, however, due to the limited range of tools of this software and a rather unique way of working with drawings (different from that used in the most popular engineering graphics programs) the author of the article used this software only to convert files made measurements in the dxf format, and their further analysis was made in the most-known engineering graphics editor - the Microstation program.

For each position, the analysis was carried out in the following three stages. The first stage (Fig. **11**) consisted in applying a worn section to a nominal one, based on the reference surfaces - those parts of the section shape that should not have worn. In the case of grooved rails, these are (according to the designations in Fig. **11**):

– 1 - side and bottom of the rail head (on the outside of the track),
– 2 - bottom of the groove,
– 3 - guide bar top,
– 4 - side and bottom of the guide.

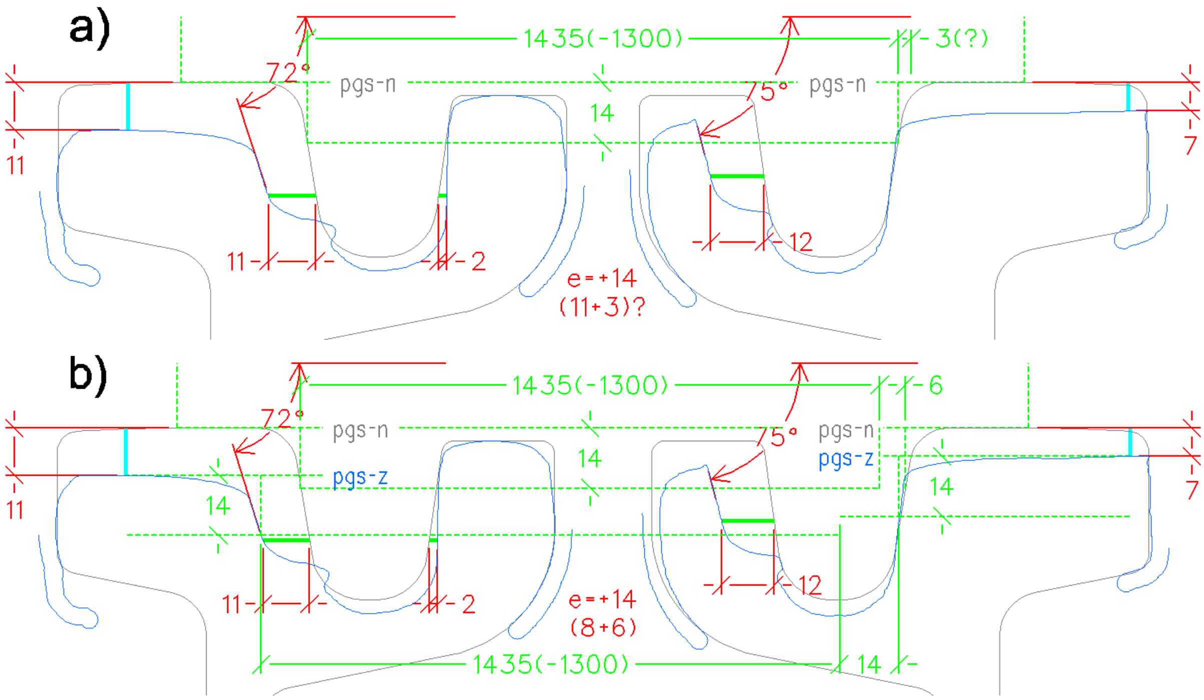
Application was carried out by the method of subsequent tests. One reference surface was fitted and the matching effect was checked for the others. To do this, close-ups of the drawing view were used as accurately as possible, and binding tools were used. Sometimes it was possible to get fit in all four checked places. Mostly, however, at least one or two of these places did not match the others. In the example analyzed in Fig. **11** (station 14, left rail) these were the bottom of the groove and the bottom of the rail head (although the side already fitted). It was therefore necessary to decide which of the matches are less reliable and should not be included. In the analyzed case, however, it was considered that the bottom of the groove was subject to wear as a result of corrosion, because the analyzed cross-section was in the place of the concave track bend and even during measurements in the "solid" groove, although rainfall occurred a few days earlier. Similarly, it was considered that the bottom of the head was distorted as a result of excessive corrosion or adherence of a foreign body, or the occurrence of both of these combined.



11. Application of the worn rail shape section (blue) on the nominal (gray) based on reference surfaces (red)

The second stage is the graphic identification of vertical and lateral wear places and their dimensioning. In the case of determining the angle of inclination of the lateral surface, it was necessary to construct a tangent line to the most protruding (inside the groove) broken vertices reflecting the shape of the worn lateral surface. At this stage, engineering graphics systems tools such as finding the minimum distance between elements, parallel copying, cutting, and automated dimensioning with rounding turned out to be very useful.

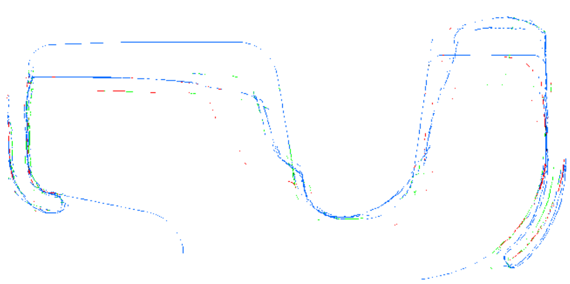
The third stage is setting the sections of the left and right rails relative to each other, first nominally (Fig. **12a**), then - taking into account the measured actual track width (Fig. **12b**). The case (station 14) analyzed in Fig. **12** is a track located in the right arc with a radius of R = 102 m, with rails over 30 years old. Therefore, it is not surprising that the lateral wear of the left railhead and right rail guide, as well as the lack of slight lateral wear of the right railhead and left rail guide, and relatively high vertical wear (greater in the outer arc). Inserting the right rail next to the left (Fig. **12a**), first, the mirror image of the first was made, then the railheads were leveled for nominal cross-sections (pgs-n), and then the cross-sections were removed so that the nominal width of the track 14 mm below pgs-n. However, for better readability of the graphic analysis, instead of 1435 mm, the dimension was 1300 mm smaller, i.e. 135 mm - then both rails in the drawing appeared next to each other. Finally, the rails had to be spread apart to match the actual track gauge (e) measured. In the analyzed case it was just +14 mm (i.e. 14 mm widening). Using the logic known from the measurements of rail wear made with a caliper, since the lateral wear of the left rail was 11 mm and the right rail did not occur (0 mm), the 14 mm widening consisted of: 11 mm resulting from side wear and only 3 mm caused by operating rail splits. In the analysis carried out, the rails had to be separated from their nominal position by 3 mm.



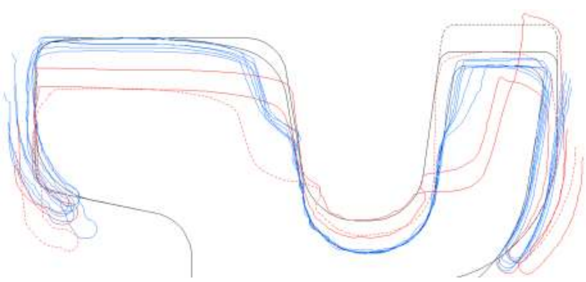
12. Shape sections of the left and right rails with specified wear values, oriented relative to each other based on a nominal (a) or actual (b) track gauge

Except that when measuring the width of the used track, the track gauge was applied not to the rails with nominal sectional shapes but used, therefore, returning to the graphic analysis (Fig. **12b**), the right rail was moved away from the left rail so that the real track width measured (1435 mm enlarged by the track gauge) by 14 mm widening) get 14 mm below levels of railheads for worn sections (pgs-z). It turned out then that the nominal cross-section of the right rail moved away from the left not by 3 mm but by 6 mm.

To sum up the considerations, in the track extension of 14 mm in the analyzed case: only 8 mm was the result of wear on the side rails, and as much as 6 mm was due to their mutual separation. It may seem a little illogical, but only a thorough graphical analysis allows you to understand the difference in this way of inference, compared to the analyzes carried out only computationally - used for measurements made with calipers. The reason for this discrepancy is the vertical rail wear in addition to the lateral ones. The larger they are, the greater the divergence of both methods of inference appears. Conducting the three stages of graphical analysis of the results of the measurements presented above is the starting point for further possible analyzes, which can be both graphical and purely descriptive (tabular, computational). After obtaining correctly applied sections used for nominal, we can compare them with each other - for example, different types of track geometry, but at the same age, or vice versa.



13. Comparison of rail wear shapes of the same age but for different cases of track



14. Comparison of rail wear shapes of the same age but for different cases of track geometry (description in the text) geometry (description in the text)

Fig. **13** presents a comparison of the shapes of rail wear at about 30 years of age for various cases of track geometry:

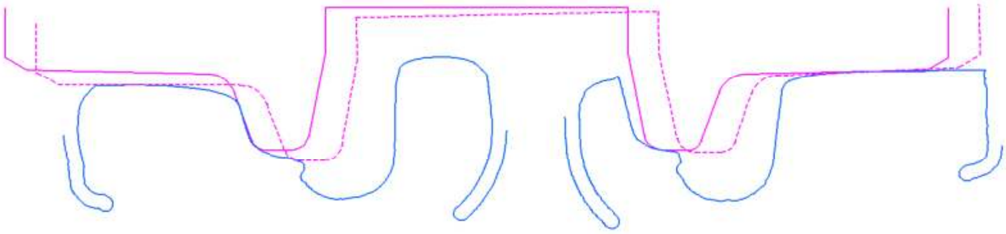
- outer rails in arches (red) - clearly the largest side wear of the heads; vertical wear mostly high; asymmetrical side wear (heads against guides),
- internal rails in arches (green) - here, in turn, the greatest side wear of the guides; whereas the vertical heads are usually small; side wear also unsymmetrical,
- rails in straight sections (blue) - average wear, both vertical and lateral, the latter rather symmetrical.

Fig. **14** shows a comparison of rail wear shapes in arches for different ages:

- rails around 5 years old (blue) - clearly much less wear,
- 30-year-old rails (red) - here much more wear, with lateral ones - interchangeably (i.e. if not the head, then the guides).

The nominal sections of the rails are shown in gray in both drawings. After obtaining correctly oriented used cross-sections of the left and right rails, we can "set" tram wheel rims on them - with nominal shapes (Fig. **15**) or with different degrees of wear, which gives the possibility:

- consideration of different cases of mutual positions,
- analyzing the causes of shape wear both rails and rims.
-



15. Analysis of cooperation between tram wheel rims and worn rails

Track measurements were also measured at each of the stations. Its values could have been included in the third stage of the graphical method of analysis of the measurement results presented above (analogously to the measured track gauge), which was not used, however, according to the author of the article, this would unnecessarily complicate the analyzes carried out, without obtaining any measurable benefits from this. Nevertheless, knowledge of the real values of cant remains valuable information. It can be helpful in interpreting the differentiation of obtained rail sections and in determining possible cases of mutual positions of the wheelset with respect to the track (as in Fig. **15**). Table **1** summarizes the results of the carried out tests. Since the selection of the location of the measuring stations was random, no statistical analyzes were carried out, but only limited (at the bottom of the table) to determine the extreme values, which were compared with the allowable values (only for those parameters for which such are generally determined).

Tab. **1** List of test results

nr sta-no-wis-ka	geometria toru, a dla rozjazdu - miejsce	szyna			zużycia kształtu przekroju						prze-chył-ka	szerokość toru (prześwit)					rozbieżność określenia rozsun. szyn (graf. - obl.)	śr. zuż. pion.
					główka				prowadn.			zmie-rzona	graficznie		obliczeniowo			
		str.	typ	wiek	pion. P	bocz. B	jedn. P+B/3	kąt α	bocz. Bp	kąt αp	h	e	zuż. bocz.	rozsun. szyn	zuż. bocz.	rozsun. szyn		
		-	-	[lat]	[mm]	[mm]	[mm]	[°]	[mm]	[°]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
12	prosta	L	60R2	5	1	1	1	76	0	-	-1	1	3	-2	2	-1	-1	1
		P	60R2	5	1	1	1	74	0	-								
13	prosta	L	180P	30	8	7	10	75	1	78	-1	10	2	8	7	3	5	10,5
		P	180P	30	13	0	13	76	11	79								
14	łuk prawy R=102	L	180S	30	11	11	15	72	2	-	31	14	8	6	11	3	3	9
		P	180S	30	7	0	7	-	12	75								
15	prosta	L	180P	30	8	3	9	75	2	75	21	9	3	6	6	3	3	8,5
		P	180P	30	9	3	10	73	2	76								
16	łuk lewy R=20	L	60R2	?	9	15	14	75	4	73	-58	15	25	-10	27	-12	2	9
		P	60R2	?	9	12	13	66	2	75								
17	prosta (tuż za R=20)	L	60R2	5	2	2	3	74	4	72	-4	14	8	6	7	7	-1	1,5
	początek zwrotnicy	P	60R2	5	1	5	3	69	0	-								
18	prosta	L	60R2	5	1	1	1	76	0	-	-13	3	3	0	3	0	0	0,5
	tor zasadniczy rozj.	P	60R2	5	0	2	1	73	0	-								
30	łuk lewy R=37	L	60R2	5	1	6	3	73	2	71	-10	14	12	2	12	2	0	0,5
	tor zwrotny rozj.	P	60R2	5	0	6	2	69	2	81								
19	łuk lewy R=18	L	60R2	5	1	5	3	73	5	68	-38	14	11	3	11	3	0	1,5
		P	60R2	5	2	6	4	66	1	80								
20	prosta	L	180S	30	5	0	5	-	1	76	14	2	7	-5	7	-5	0	4
	(tuż za R=18)	P	180S	30	3	7	5	74	0	-								
21	łuk prawy R=25	L	60R2	5	0	4	1	72	1	79	39	6	9	-3	9	-3	0	2
		P	180S	30	4	5	6	75	4	75								
22	prosta	L	180P	30	8	3	9	75	3	75	11	8	4	4	7	1	3	8
		P	180P	30	8	4	9	76	2	76								
23	łuk lewy R=104	L	180P	30	11	1	11	77	14	77	-40	12	3	9	5	7	2	7
		P	60R2	5	3	4	4	72	0	-								
24	prosta (tuż za R=104)	L	60R2	5	2	0	2	75	0	-	-10	1	3	-2	3	-2	0	1,5
	tor zwrotny rozj.	P	60R2	5	1	3	2	75	0	-								
29	prosta	L	180P	30	5	5	7	75	3	74	-10	4	3	1	5	-1	2	3
	tor zasadniczy rozj.	P	60R2	5	1	0	1	-	1	76								
25	prosta (tuż za R=50)	L	60R2	5	2	3	3	71	0	-	4	15	3	12	3	12	0	1
	początek zwrotnicy	P	60R2	5	0	0	0	-	8	73								
26	prosta	L	60R2	5	1	8	4	73	0	-	1	8	8	0	8	0	0	1
	(za łukiem R=50)	P	60R2	5	1	0	1	-	1	77								
				min:				66		68	-58			-10		-12	-1	
				max:	13	15	15		14		39	15	25	12	27	12	5	
				dop:	18	15	18	-	-	-								

In the right part of Table **1** (with a yellow background) methods of "separation" of the measured track gauge between lateral wear and rail, separation are compared - a graphical method (presented in this article) in relation to the computational method (used for caliper measurements). The penultimate column is the divergence of both methods, and the last - is the average vertical consumption. Of the 17 sites examined, only in the case of two (marked in red) the hypothesis stated earlier in the article was not confirmed that this discrepancy is greater, the greater the vertical wear of the rails. The remaining 15 positions confirmed the correctness of the hypothesis. An interesting observation from the research is the fact that in tramway curves with small radii, the inner railheads achieve lateral wear comparable to those found in the outer railheads (in Table 1 they are highlighted with a green background), and even at high track width extensions.

Summary

New methods of measuring rail section wear and analysis, based on the use of electronic devices, have a number of advantages. The most important of them are:

- greater accuracy,
- a wide range of possibilities of using engineering graphics editor tools (Autocad or Microstation),
- easier detection of unusual cases of use,
- the possibility of linking lateral wear measurements with track gauge measurements more realistically,
- possibility of analyzing the phenomenon of cooperation between wheel rims and rails,

- wider possibilities and more reliable assessment results of rail wear in built-in tram tracks.

Unfortunately, apart from the advantages, there are also some disadvantages:

- more expensive equipment, requiring additional software purchase,
- more data to be analyzed, and thus more labor-intensive and, as a result, more difficult to make final decisions,
- more difficult inference based on a larger number of reference surfaces.

Based on the analyzes carried out, the author of the article postulates the introduction of the following changes in applicable regulations:

- correction of the drawing illustrating the method of measuring the angle of the lateral surface of the rail head in Annex 14 of Id-1,
- clarification of the method of measuring lateral wear with high vertical wear at the same time (due to the risk of undercutting the determined side wear),
- determining in tram regulations the permissible values of lateral wear of the guide and the angle of lateral wear of the head and guide.

It is also necessary to solve the problem at what depth should the lateral wear be measured on the tram tracks - the same as on the railway or the shallow one (due to the lower rim of the tram wheel rim)? An important conclusion resulting from the conducted research is the conclusion that new electronic measurement methods and their analyzes do not release us from "thinking", the experience still plays an important role. Problems expose:

- make the right decision when applying the profile worn to the nominal (in a situation where different reference surfaces suggest different solutions),
- analyzing the links between lateral wear measurements and track width measurements (to what extent track extensions are the result of wear of the lateral rail heads, and how many changes of their position),
- analyzing cases of wheel-rail cooperation (selection of possible positions of the wheel set with respect to the rails).

Source materials

[1] Technische Regeln für die Spurführung von Schienenbahnen nach der Verordnung über den Bau und Betrieb der Straßenbahnen (BOStrab), Mai 2006
[2] Id-1 (D-1) Warunki techniczne utrzymania nawierzchni na liniach kolejowych - PKP PLK Warszawa 2005 - ze zmianami 2006, 2010, 2015
[3] Wytyczne techniczne projektowania, budowy i utrzymania torów tramwajowych, MAGTiOŚ 1983
[4] www.neostrain.pl/inspector.php?ins=7
[5] www.geismar.com/en/traditional-measurement/212-p110.html
[6] www.graw.com/pomiary-toru.html
[7] PN-EN 13674-1+A1:2017-07 Kolejnictwo - Tor - Szyna - Część 1: Szyny kolejowe Vignole'a o masie 46 kg/m i większej
[8] PN-H-93440:1992 Stal - Szyny tramwajowe z rowkiem
[9] PN-EN 14811+A1:2010 Kolejnictwo - Tor - Szyny specjalne - Szyny rowkowe i związane z nimi profile konstrukcyjne