REPUBLIC OF SERBIA
CENTER FOR INVESTIGATION OF ACCIDENTS IN TRANSPORT
SECTOR FOR INVESTIGATION OF ACCIDENTS IN RAILWAY TRAFFIC
Nemanjina 11, 11000 Belgrade

No: ŽS - 01/24

No: 340-00-2/2025-02-1-79

Date: 21.05.2026.

FINAL REPORT ON ACCIDENT INVESTIGATION

Accident type:	Train derailment
Train No.:	51202
Place:	City of Belgrade, city municipality Voždovac, settlement Ripanj and city municipality Grocka, settlement Vrčin, open track between the junction Lipe and the station Vrčin
Date:	11.02.2025.
Time:	17:46

This Report presents the results of investigation of an accident, derailment of the train No. 51202 (railway undertaking „Srbija Kargo“a.d.), which occurred on 11.02.2025. at 17:46 at km 30+522 of the main railway line No.103 (Beograd Centar) - Rakovica - Jajinci- Mala Krsna - Velika Plana, between the junction Lipe and the station Vrčin.

The Working Group for investigation of this accident was formed by the Director of the Center for Investigation of Accidents in Transport of RS, by Decision No. 340-00-2/2025-02-1-10 of 21.02.2025. and by Decision No. 340-00-2/2025-02-1-45 of 29.08.2025.

In accordance with the Article 33 of the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic (“Official Gazette of RS” No. 66/15 and 83/18) and the Article 23 of the Directive 2004/49/EC of the European Parliament and of the Council of EU (Railway Safety Directive), the Center for Investigation of Accidents in Transport (hereinafter referred to as: CINS) drafted and published this Final Report.

In this report, all values are expressed as part of the International System of Units (SI).

The meaning of abbreviations used in the text is explained in the Glossary.

CINS has been established in accordance with the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15). The founder is the RS and the holder of founding rights is the Government of the RS.

Sector for Investigations of Accidents in Railway Traffic carries out tasks within the competence of the CINS in relation to rail traffic with the aim of possible improvement of safety on the railway by issuing safety recommendations. The investigative procedure in the field of railway traffic is conducted on the basis of the provisions of the Law on Investigation of Accidents in Air, Railway and Waterborne Traffic ("Official Gazette of RS" No. 66/15 and 83/18).

CINS conducts investigations following the serious accidents on the railway system with a view to possible improvement of railway safety and the prevention of new accidents caused by the same or similar causes. Serious accident in railway traffic means any train collision or derailment of trains, resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment, and any other similar accident with an obvious impact on railway safety regulation or the management of safety.

In addition to serious accidents, CINS may also investigate other accidents and incidents that could lead to a serious accident, including the technical failure of structural subsystems or interoperability constituents.

CINS has the discretion to decide whether to open an investigation of other accidents and incidents.

CINS is independent in its work and performs independent accident investigations. The aim of an investigation is to identify the causes and the possibility of improving safety on the railways and to prevent accidents by issuing safety recommendations.

Professional activities related to safety investigations are independent of judicial inquiry or any other parallel investigations whose objective is to determine responsibility or the degree of guilt. The investigation and discovery of the causes of accidents is not intended to determine criminal, economic crime, misdemeanour, disciplinary, civil or any other liability.

Glossary:

CINS	Center for Investigation of Accidents in Transport
RS	Republic of Serbia
MUP	Ministry of Interior
IŽS	Infrastructure Railways of Serbia
a.d.	Joint stock company
d.o.o.	Ltd.
ŽS	Railways of Serbia
JŽ	Yugoslav Railways
ZJŽ	Community of Yugoslav Railways
OJ	Organizational unit
ZOP	For track maintenance
TK	Telecommand
TT	Telegraph-telephone/Telephone-telegraph
SS	Safety signalling
RD	Radio dispatch
KM	Contact network, catenary
CDU	Center of remote control
TMD	Heavy motor vehicle
GHI	Emergency intervention limit
ECM	Entity in Charge of Maintenance
MMI	Man Machine Interface
RID	Rulebook on international rail transport of dangerous goods
VPI-EMG	European guide to freight wagon maintenance
PU	Police Department
PI	Police Unit
OJT	Basic Public Prosecutor
MGSI	Ministry of Construction, Transport and Infrastructure
NVR	National vehicle register

C O N T E N T:

1. Summary

1.1. Short description of the accident

On 11.02.2025 at 17:46, at km 30+522 of the main railway line No. 103 (Belgrade Center) - Rakovica - Jajinci - Mala Krsna - Velika Plana, during the movement of train No. 51202 (locomotive 193-910 and 15 (fifteen) wagon-tanks loaded with sulfuric acid (RID 80/1830), operated by "Srbija Kargo" a.d.), between the Lipe junction and Vrčin station, the eleventh wagon (wagon No. 33 87 7866 801-6) derailed with one bogie. After the derailment, train No. 51202 continued moving towards Vrčin station. In Vrčin station, while running on the second track, at switch No. 4L (the switch by which the first track branches off from the second track), the first (derailed) bogie of the eleventh wagon moved in the direction of the first track, while the second bogie of the eleventh wagon and the remainder of train No. 51202 continued moving along the second track. On that occasion, there occurred:

- decoupling of the train between the tenth wagon (wagon No. 33 72 7867 822-8) and the eleventh wagon (wagon No. 33 87 7866 801-6),
- the impact of the front end of the eleventh wagon against catenary support KM No. 26,
- derailment of the second bogie,
- the rotation of the derailed wagon by 180 degrees around its vertical axis,
- the overturning of the same wagon onto its side, to the left, viewed in the direction of travel of the train,
- the derailment of the twelfth wagon (wagon No. 33 72 7867 837-6) with one bogie (the first bogie, viewed in the direction of travel of the train), and
- the stopping of the train.

Sulfuric acid leaked from the tank of the overturned wagon at the cover.

Material damage was caused to the infrastructure, railway vehicles, and cargo.

There were no fatalities or injuries.

Material damage was caused to the infrastructure, railway vehicles, and cargo.

1.2. The accident causes determined by investigation

The direct and immediate cause of the accident was wheel climb on the rail in a sharp curve with a radius of 295 m, due to track twist over the relevant distance between the bogie centers axis, significantly exceeding the permissible limit of GHI, in combination with cant exceeding the GHI. The condition of the center bowl assembly of the leading bogie of the derailed wagon, most likely contributed, to a lesser extent, to an increase in the yawing/turning moment and, consequently, to an increase in the lateral (Y) force acting on the leading wheel and the Y/Q force ratio, which is decisive for this type of derailment.

Track maintenance in the derailment area was not carried out in accordance with the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023). The disturbed track geometry exceeding the GHI, which was the reason for the introduction of a restricted speed running in the derailment area, was not urgently

remedied; instead, this condition persisted for more than five months. The causes for the introduction of the restricted speed running should have been eliminated, and the restriction, in accordance with the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023), should have been lifted no later than 30 days from its introduction (see section 3.3.5.).

During the routine overhaul of the derailed wagon, which was carried out only four months prior to the accident, no defects were identified on the upper center pivot that would have required its replacement (see sections 4.2.12. and 4.2.13.).

The Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023) stipulates that, in cases where values of relative track geometry parameters exceed the emergency intervention limit, the possible measures include closure of the railway line, remediation of track geometry, or reduction of speed (see section 3.3.5.).

On the section of main railway line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana) between Vrčin station and the Lipe junction, a restricted speed running of 50 km/h was introduced due to poor track geometry. Based on the above, it can be concluded that, on this section, the measure of "speed reduction" was applied as a result of the poor condition of the track.

We note that the "speed reduction" measure, in cases where certain track parameters (twist and track gauge) exceed operational limits, is not adequate. This measure cannot reduce the risk of wheel climb (track twist) or the risk of wheel drop into the track (track gauge deviation), i.e., derailment the train. An urgent remediation of the track geometry is required (see section 4.2.4.).

1.3. Main recommendations and information on the entities to which the Report is submitted

Aiming to potentially improve railway safety and prevent the occurrence of future accidents, CINS has issued the following safety recommendations:

To the Directorate for Railways the following recommendations are issued: SR_01/26, SR_02/26, SR_03/26, SR_04/26, SR_05/26, SR_06/26, SR_07/26, SR_08/26, SR_09/26, SR_10/26, SR _11/26 and SR_12/26:

SR_01/26 The Directorate for Railways should carry out supervision over the safety certificate for the management of the railway infrastructure of "IŽS"a.d. and the implementation of the safety management system due to the lack of application of the criteria prescribed by the Instruction on Uniform Criteria for Track Condition Control on the JŽ Network ("Official Gazette ZJŽ" Nos. 2/2001 and 4/2004, "Official Gazette ŽS" No. 14/22) during the acceptance of works after the renovation of the section of main railway line No. 103 (Beograd Centar – Rakovica – Jajinci – Mala Krsna – Velika Plana), and to take measures within its competence in accordance with Article 15 of the Law on Railway Traffic Safety ("Official Gazette RS" No. 41/2018) (see sections 3.3.7. and 4.2.1.).

SR_02/26 The Directorate for Railways should carry out supervision over the safety certificate for the management of the railway infrastructure of "IŽS" a.d. and application of the safety management system due to the failure to apply the criteria prescribed in the Instruction on Amendments and Supplements to the Instruction on Uniform Track Condition Control on the JŽ Network ("Official Gazette ZJŽ", Nos. 6/01 and 4/04), No. 4/2022-3496-718 of 25.03.2022, during the acceptance of works after machine maintenance of the section of main railway line No. 103 (Beograd Centar – Rakovica – Jajinci – Mala Krsna – Velika Plana), and to take measures within its competence in accordance with Article 15 of the Law on Railway Traffic Safety ("Official Gazette RS" No. 41/2018) (see sections 3.3.6. and 4.2.3.1.).

SR_03/26 The Directorate for Railways should, through amendments and supplements of the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023) align the values for type C errors for track gauge twist given in the Annex of the Rulebook with the urgent intervention limit values from SRPS EN 13848-5, for which modern rail vehicles are designed (see sections 4.2.4.).

SR_04/26 The Directorate for Railways should consider the possibility, through amendments and supplements to the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023), of providing for the presentation of twist measurement results not only on a 3 m base, but also on a longer base, for example 8 or 10 m (see sections 4.2.4.).

SR_05/26 The Directorate for Railways should amend and supplement the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023), by abolishing, in Article 5, paragraph 2, item 1), the reduction of speed as a measure to mitigate the risk of train derailment in cases where the values of the parameters twist and track gauge exceed the limit for urgent (immediate) intervention (see sections 4.2.4. and 4.3.3.).

SR_06/26 The Directorate for Railways should amend and supplement Article 4, sub-item 5) of Annex 3 to the Rulebook on Brakes and Braking of Trains and Railway Vehicles ("Official Gazette of the Republic of Serbia", No. 68/2021), in accordance with the relevant requirements of IRS 40421, Issue 2 of 2025 (see sections 3.3.9. and 4.2.15.).

БП_07/26 "IŽS" a.d. should carry out a review of the causes leading to the recurrence of track geometry defects at the same location (see section 4.2.3.2.). Upon determining the causes and assessing the safety risks that have arisen as a result, it should take effective measures to eliminate the identified safety deficiencies, in accordance with the requirements of Article 5 of the Law on Railway Traffic Safety ("Official Gazette of the Republic of Serbia", No. 41/2018).

SR_08/26 "IŽS" a.d. should, through amendments and supplements, align the Instruction on Uniform Criteria for Monitoring the Condition of Railway Lines on the ŽS Network with the requirements of the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure with regard to the application of standard SRPS EN 13848-1 for the acceptance of works (see section 4.2.1.) and standard SRPS EN 13848-5 with respect to the GHI for twist (see section 4.2.4.).

SR_09/26 "IŽS" a.d. should adopt a decision on the use of the EM-80L track recording vehicle. In the event that "IŽS" a.d. decides to discontinue the use of this track recording vehicle, it is necessary, through amendments and supplements, to remove from the Instruction on Uniform Criteria for Monitoring the Condition of Railway Lines on the ŽS Network ("Official Gazette of ZJŽ", Nos. 6/01 and 4/04, and "Official Gazette of ŽS", No. 14/22) the sections relating to the EM-80L track recording vehicle (see section 4.3.4.).

SR_10/26 "IŽS" a.d. in the Rulebook on Organization and Job Classification of the Joint-Stock Company for the Management of Public Railway Infrastructure "Infrastruktura železnice Srbije, review the adequacy of the existing workforce and consider the possibility of providing an appropriate number of staff in the construction sector both on the section of the railway where the accident occurred and across the entire network, in order to ensure the safe operation of railway traffic. In accordance with the appropriate number of staff, it should plan the procurement of the necessary machinery and tools, all with the aim of ensuring the safe operation of railway traffic (see section 4.2.5.).

SR_11/26 *Elixir Group d.o.o. Šabac* should supplement its Instruction for the Proper Securing of Wagon-tanks after Loading and before Leaving the Factory Premises, in order to ensure the tightness of the tanks (checking the cleanliness and evenness of the seating surfaces, using undamaged prescribed gaskets, closing the openings with the designed number of bolts using a torque wrench with the torque specified by the manufacturer), provide the necessary conditions for its implementation, and additionally train the staff for correct handling (see section 4.2.11.).

SR_12/26 *Serbia Zijin Copper d.o.o. Bor* should supplement its Instruction "Loading of Sulfuric Acid into Wagon-tanks" in order to ensure the tightness of the tanks (checking the cleanliness and evenness of the seating surfaces, using undamaged prescribed gaskets, closing openings with the designed number of bolts using a torque wrench with the torque specified by the manufacturer), provide the necessary conditions for its implementation, and additionally train the staff in correct handling (see section 4.2.11.).

To the Ministry of Construction, Transport and Infrastructure the recommendations are issued: SR_13/26 and SR_14/26:

SR_13/26 **The** Ministry of Construction, Transport and Infrastructure, Inspectorate Sector, Railway Traffic Inspection Department, shall carry out supervision at "IŽS" a.d regarding the failure to take measures to obtain a permit for the infrastructure structural subsystem in accordance with the provisions of Articles 21 and 30 of the Law on the Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", Nos. 41/2018 and 16/2022 – Authentic Interpretation), or in accordance with the provisions of Article 24 of the Law on the Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", No. 62/2023), and shall take measures within its competence (see sections 3.3.3, 3.3.4, and 4.2.6.).

SR_14/26 The Ministry of Construction, Transport and Infrastructure, Inspectorate Sector, Railway Traffic Inspection Department, shall carry out an extraordinary inspection at the owners of wagons, Elixir Group d.o.o. Šabac and Serbia Zijin Copper d.o.o. Bor, as well as at the carrier "Srbija Kargo"a.d., regarding the use of railway vehicles that are not registered in the national vehicle register and/or do not have a Permit for use in accordance with the provisions of the Law on the Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", No. 62/2023), and shall take measures within its competence (see points 3.3.4. and 4.2.16.).

To *Autorité française de sécurité ferroviaire* the safety recommendation SR _15/26 is issued:

SR_15/26 *Atir-Rail SA*, should analyze the frequency of unacceptable damage to the center bowl inserts during regular maintenance, in order to assess whether the quality of the insert compromises the functionality of the center bowl until the next scheduled overhaul, and in its maintenance instructions, provide appropriate measures for quality control during regular overhauls, including verification that an original center bowl insert is used during replacement (see items 4.2.12. and 4.2.13.).

2. Direct facts on the accident

2.1. Basic data about the accident

2.1.1. Date, time and location of the accident

The accident occurred on 11.02.2025 at 17:46, within the territory of the City of Belgrade, on main railway line 103 (Belgrade Centre) – Rakovica - Jajinci - Mala Krsna - Velika Plana, between Lipe junction and Vrčin station, in a predominantly uninhabited part of the urban settlement of Ripanj (Voždovac municipality), on an open line section located near a local road (Bošnjaci road). Following the derailment, train No. 51202 came to a stop at Vrčin station, on track No. 2, in the inhabited area of the urban settlement of Vrčin (Grocka municipality).

The layout of the accident area is shown in Figure 2.1.1.1.

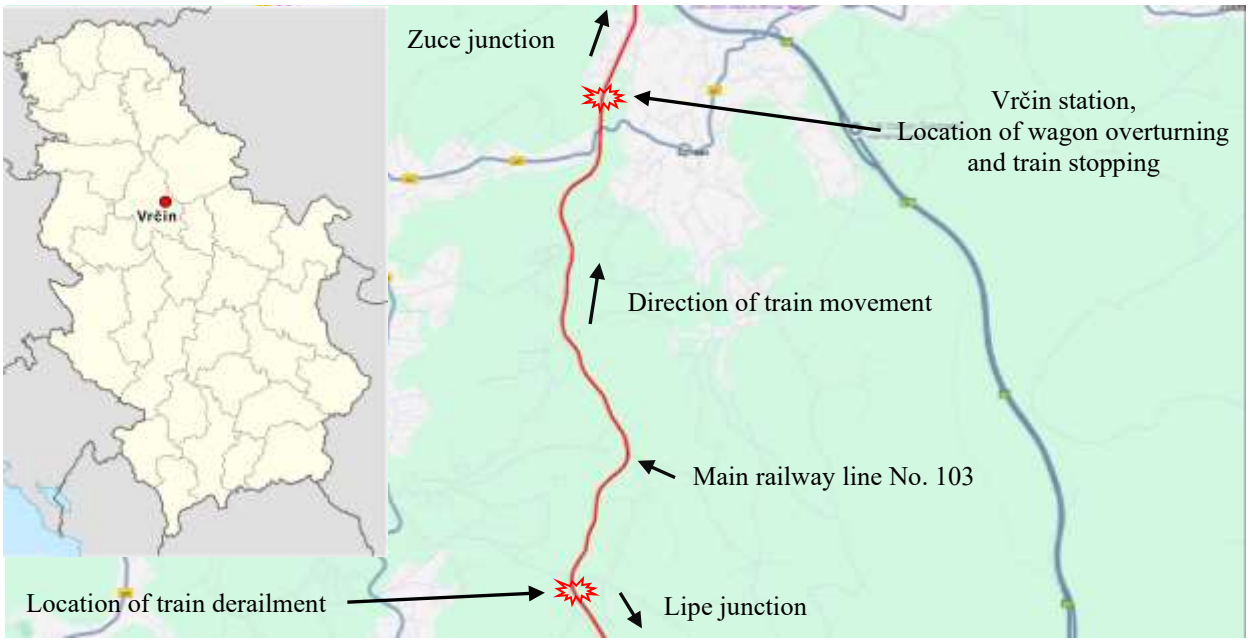


Figure 2.1.1.1: Cartographic representation of the accident area (*Google maps*)

The railway line designation was taken according to the Regulation on the categorization of railway lines belonging to the public railway infrastructure ("Official Gazette of the RS", No. 92/2020, 6/2021, 33/2022 and 63/2023).

2.1.2. Accident description, location description and the work of emergency and rescue services

On main railway line 103 (Belgrade Centre) - Rakovica - Jajinci - Mala Krsna - Velika Plana, between Vrčin station and Lipe junction, on the open line at km 30+522, train No. 51202, the eleventh Z series wagon with one bogie derailed (the front bogie, viewed in the direction of train movement).

The appearance of the derailment site of train No. 51202 is shown in Figures 2.1.2.1. and 2.1.2.2.

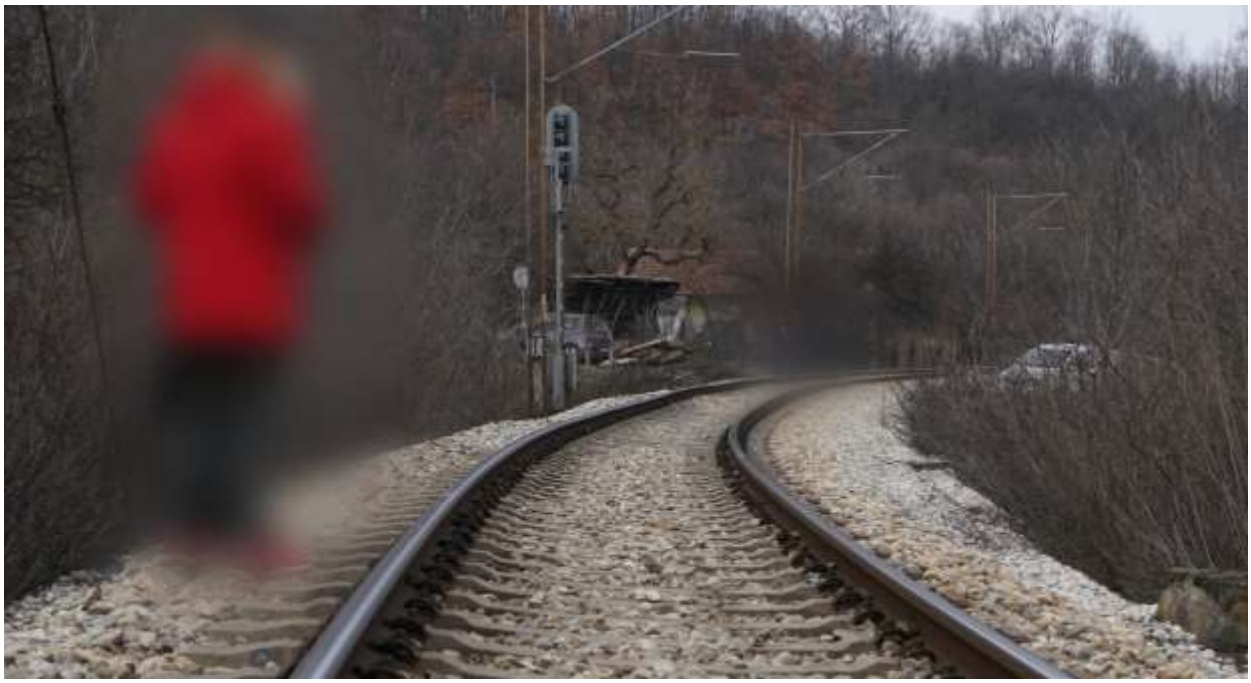


Figure 2.1.2.1: View of the derailment site (view in the direction of train movement)

Figure 2.1.2.2: View of the derailment site (view in the direction opposite to the direction of train movement)

Following the derailment, train No. 51202 continued moving to Vrčin station, where the train separation occurred, the eleventh wagon overturned onto its side, to the left-hand side, and the twelfth wagon derailed with its first bogie (viewed in the direction of train movement), after which the train came to a stop.

The appearance of the tank wagon overturning site is shown in Figures 2.1.2.3. and 2.1.2.4.

Figure 2.1.2.3: View of the wagon overturning site

Figure 2.1.2.4: View of the wagon overturning site

From the tank of the overturned wagon, leakage of sulphuric acid occurred at the tank lid.

Due to the resulting release (leakage) of sulphuric acid (according to RID classification: corrosive or slightly corrosive substance, containing more than 51% pure acid), members of the MUP RS, Police Directorate for the City of Belgrade, and members of the MUP RS, Sector for Emergency Situations attended the scene. Furthermore, upon becoming aware of the occurrence of the accident, special measures were also undertaken by the Ministry of Environmental Protection, Sector for Environmental Supervision and Preventive Action, and the City Institute for Public Health.

2.1.3. Decision to initiate the investigation, composition of the investigation team and conduct of the investigation

The Centre for Investigation of Accidents in Transport (CINS) was notified immediately after the occurrence of the accident. The Main Investigator in Railway Traffic received the initial notification about the accident on 11.02.2025 at 18:39 via phone from the main wagon dispatcher of "Srbija Kargo"a.d, and then at 18:59 via phone from the Head of Central Operations Department of "IŽS"a.d. Based on the information received and the facts established by the CINS during on-site examinations conducted on 11, 12. and 14. February 2025, CINS initiated an investigation of accident in accordance with the Law on Investigation of Accidents in Air, Railway and Water Transport ("Official Gazette of the Republic of Serbia", Nos. 66/2015 and 83/2018).

The composition of the Working Group for the investigation of the accident was determined by Decision No. 340-00-2/2025-02-1-10 dated 21.02.2025 and Decision No. 340-00-2/2025-02-1-45 dated 29.08.2025, issued by the Director of CINS, pursuant to Articles 6 and 32 of the Law on Investigation of Accidents in Air, Railway and Water Transport ("Official Gazette of the Republic of Serbia", Nos. 66/2015 and 83/2018).

2.2. Accident background

2.2.1. Involved railway staff, contractors, other persons and witnesses

The accident involved the driver of train No. 51202, who was employed by the railway undertaking Srbija Kargo a.d.

Employees of the infrastructure manager "IŽS"a.d. were not involved in the accident, nor were contractors, other persons or witnesses.

2.2.2. The trains involved in the accident and their composition

Train No. 51202 was involved in the accident. The train was operating on the route Požarevac - Šabac. The train consisted of a locomotive series 193-910, owned by the railway undertaking "Srbija Kargo" a.d. and 15 (fifteen) tank wagons of series Z, loaded with sulphuric acid (RID 80/1830), the railway undertaking "Srbija Kargo"a.d, with a total length of 228 m (64 axles) and a total gross mass of 1,245 t. According to data received from the railway undertaking "Srbija Kargo"a.d. (consignment note for the shipment submitted as an annex to letter No. 1/2025-1545 dated 3 June 2025), the net mass of the entire sulphuric acid shipment amounted to 833,570 kg.

An overview of the wagons forming part of train No. 51202 is provided in Table 2.2.2.1.

Table 2.2.2.1: Overview of Wagons in Train No. 51202 (viewed from locomotive 193-910)

Wagon Serial No.	Wagon Letter Code	Unique Wagon No.	Owner	Holder	ECM
1	Zacs-z	33 72 7867 865-6	-	-	-
2	Zacs-z	33 72 7867 855-5	-	-	-
3	Zacs-z	31 72 7865 000-5	ELIXIR Group d.o.o.	ELIXIR Group d.o.o.	ELIXIR Group d.o.o.
4	Zacs-z	33 72 7867 832-7	-	-	-
5	Zacs-z	33 72 7867 892-1	-	-	-
6	Zacs	33 87 7864 171-6	ATIR-Rail SA	ATIR-Rail SA	ATIR-Rail SA
7	Zacs	33 87 7847 014-0	ATIR-Rail SA	ATIR-Rail SA	ATIR-Rail SA
8	-	33 87 7839 023-1	ATIR-Rail SA	ATIR-Rail SA	ATIR-Rail SA
9	Zacs	33 87 7847 017-3	ATIR-Rail SA	ATIR-Rail SA	ATIR-Rail SA
10	Zacs-z	33 72 7867 822-8	-	-	-
11	Zacs	33 87 7866 801-6	ATIR-Rail SA	ATIR-Rail SA	ATIR-Rail SA
12	Zacs-z	33 72 7867 837-6	-	-	-
13	Zacs-z	33 72 7867 989-5	-	-	-
14	Zacs-z	33 72 7867 845-9	-	-	-
15	Zacs-z	33 72 7867 865-7	-	-	-

Note: In Table 2.2.2.1, data for the wagons forming part of Train No. 51202 are presented based on extracts from the European Virtual Vehicle Register (VVR). For wagons listed in the table under serial numbers 1, 2, 4, 5, 10, 12, 13, 14, and 15, data are not presented as these wagons are not registered in the National Vehicle Register of the Republic of Serbia (NVR). For these wagons, according to information provided by Elixir Group d.o.o., Šabac, based on the Sales Agreement for Technical Sulphuric Acid concluded on 20.12.2019. between Serbia Zijin Copper d.o.o., Bor (as seller) and Elixir Group d.o.o., Šabac (as buyer), valid until 31.12.2029 (registry numbers 10327 and 334/1), Serbia Zijin Copper d.o.o., Bor, as owner of the tank wagons for transporting sulphuric acid, leased them to Elixir Group d.o.o., Šabac for the duration of the agreement.

In accordance with the Law on Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", No. 62/2023) (see Section 3.3.4.), the holder of a railway vehicle is a natural or legal person, owner, or user of the railway vehicle, who uses the vehicle as a means of transport and is registered in the National Vehicle Register (NVR). Accordingly, it is required that Elixir Group d.o.o., Šabac, the legal entity using the vehicle as a means of transport, replace the owner code (F-ATIRR or SRB-BOR) with the holder code (SRB-ELIX) for the wagons leased from ATIR-Rail SA or Serbia Zijin Copper d.o.o., Bor, and register them accordingly in the NVR.

The appearance of the Z-series tank wagon intended for the transport of sulphuric acid is shown in Figure 2.2.2.1.

Figure 2.2.2.1: Appearance of the Z-series tank wagon for sulphuric acid transport

The wagons of the series *Z* that participated in the accident in question are four-axle special closed wagons for the transport of sulfuric acid with appropriate filling and dispensing systems.

2.2.3. Infrastructure and Signalling-safety system

The main line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana), on the section from km 12+045 to km 99+716, was constructed over various periods. The section from Jajinci Station to Mala Krsna Station was built in 1924, while the section from Mala Krsna Station to Velika Plana Station was built in 1886 as part of the Smederevo - Velika Plana line.

Between km 9+896 and km 67+800, the line underwent main repair from May 2019 to June 2022.

As part of this main repair, on the section from km 14+164 (entrance to Beli Potok tunnel) to km 31+581 (entrance to Lipe tunnel), the section where the accident occurred, rails, sleepers, and rail fastenings were replaced. Ballast supplementation was carried out on the open track and on main passing tracks at official locations. Additionally, turnouts on main and passing tracks, as well as rails, sleepers, rail fastenings, and ballast, were replaced on tracks 2 and 3 of Beli Potok Station and track 3 of Vrčin Station. At all level crossings, the drainage system was renewed, and roadways of rubber panels were installed.

After the completion of works on the main repair, the main line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana) was returned to service on 22.06.2022 at 08:00, according to telegram No. 107f issued by "IŽS"a.d. on 16 June 2022.

The section of main line No. 103 between Vrčin Station (km 24+900) and Lipe Junction (km 31+300) is a single-track, electrified line. According to its classification, the line belongs to Category D4 (maximum axle load 225 kN, load per metre 80 kN/m).

On the section of main line No. 103 between Vrčin Station and Lipe Junction, the superstructure on the open track and main passing tracks consists of 49E1 rails, B-70 concrete sleepers, and elastic fastenings Skl-14. Switches on main passing tracks are 49E1 type on concrete sleepers with Skl-12 elastic fastenings. The ballast is made of limestone origin. The design speed is 65 km/h.

On the section in question, the minimum curve radius is R = 275 m, and the maximum gradient is +10‰ (ascending 10‰ in the direction of increasing mileage). At the location where the derailment occurred, the gradient in the direction of increasing mileage is from km 30+420 to km 30+627, ascending 7.71‰ and from km 30+627 to km 31+128, ascending 8.7‰.

According to the timetable booklet 9.1/9.2 valid at the time of the accident, the maximum allowed speed between Vrčin station and Lipe junction was 65 km/h, with no additional speed restrictions introduced for this interstation section.

On the section of the railway between Vrčin station and the Lipe junction at the time of the accident in question, from km 30+100 to km 30+600, restricted-speed running with V_{max}=50 km/h was in effect, which was introduced on 28.08.2024 due to poor track geometry (telegram No. 231 of the "IŽS" a.d.).

On main line No. 103 between Jajinci and Mala Krsna stations, electro-relay interlocking devices of type SpDrS64-JŽ, manufacturer Siemens AG, Germany are installed at official locations and interstation sections. These devices operate within the CIW-CTC-FLEXICODE-560-JŽ.69 telecomand system, manufacturer Wabco Westinghouse, Italy, with the telecomand centre located in Makiš. Track section detection is realised via BO23 axle counter systems, manufacturer Altpro, Croatia. Main signals are equipped with LED modules and corresponding interfaces, manufacturer Thales AG, Austria. In all stations and junctions except in Vrčin station, signal interlocking devices (SS) are operated from interlocking control panels located in the station building in train dispatcher office. At Vrčin station, an EMMI "Signalling & Control", Belgrade type of MMI device is installed.

On the section between Mali Požarevac and Mala Krsna stations, single-track automatic block (APB) devices control interstation sections, while between Jajinci and Mali Požarevac stations, interstation dependency devices are installed.

Train traffic on the section between Jajinci and Mali Požarevac stations is regulated by the Jajinci station dispatcher and the responsible TK dispatcher in interstation sections, like one-track lines equipped with interstation dependency devices, in accordance with Articles 126 and 132 of the Railway Rulebook ("Official Gazette RS", Nos. 34/22, 107/22).

The railway line designation was taken according to the Regulation on the categorization of railway lines belonging to the public railway infrastructure ("Official Gazette of the RS", No. 92/2020, 6/2021, 33/2022 and 63/2023).

The description of the line and facilities is based on data provided by "IŽS"a.d. (submitted in attachment to "IŽS"a.d. letter No. 1/2025-1250 dated 05.05.2025 and email of 15.08.2025).

2.2.4. Means of communication

On the section of the main line No. 103 (Belgrade Center) - Rakovica - Jajinci - Mala Krsna - Velika Plana, when regulating train traffic between the stations Jajinci and Mala Krsna, for mutual agreement between the personnel regulating traffic, there is an OV (omnibus) line. All TT desks at the train dispatchers in all official locations from Jajinci to Mala Krsna are connected in the line. All conversations on this line are recorded on the recorders in the TT sections Belgrade Center and Mala Krsna.

On this section of the line for agreement there is also a CDS line, which connected the TK dispatcher in the TK center Makiš, TT desks at the train dispatchers and telephones at the exit and entry signals in all official locations. All conversations on this line are recorded on the recorders in the TT section Makiš.

Also, for communication between the personnel regulating traffic (TK dispatchers in the TK center Makis) and the train crew, there is a radio dispatcher connection. Communication is carried out via the RD switchboard and all radio locomotive devices in the traction vehicles that have them between the stations Jajinci and Mala Krsna. The radio dispatcher connection is recorded on a recorder in the TT section Makis.

For communication between the energy dispatcher in the CDU Topčider with the traffic crew, there is a CDeV line. All TT desks at the train dispatchers and all energy facilities in all official locations between the stations Jajinci and Mala Krsna are connected in the line. All conversations on this line are recorded on a recorder in the TT section Topcider.

The description of the means of communication is based according to data obtained from "IŽS"a.d. (data provided in the attachment to the letter of "IŽS"a.d. No. 1/2025-1250 dated 05.06.2025 and by e-mail dated 15.08.2025).

2.2.5. Works executed at or near the accident site

No works were carried out in the vicinity of the accident site.

2.2.6. Activation of the railway emergency plan and sequence of events

The railway undertaking "Srbija Kargo"a.d. immediately after the accident informed CINS, i.e, the Main Investigator in railway traffic accidents, and the same was done by the infrastructure manager "IŽS"a.d.

According to information provided in the email attachment of "Srbija Kargo"a.d. dated 03.06.2025, after stopping the train at Vrčin Station (due to loss of traction power and loss of air pressure in the main brake pipe), the driver noticed that a derailment had occurred and that one wagon was overturned, from which is leaking sulfuric acid. Upon becoming aware of the accident, the train driver immediately informed the TK dispatcher at Makiš TK centre and the train traction dispatcher in Belgrade. While awaiting the arrival of representatives of the infrastructure manager, undertaking, and emergency services, the driver warned the public not to approach the train.

According to data provided in the attachment to "IŽS"a.d. letter No. 1/2025-1250 dated 05.06.2025 and by email of 15.08.2025, the on-duty TK dispatcher at Makiš TK centre immediately notified all relevant services after receiving information about the accident.

After the accident, by "IŽS"a.d. telegram No. 74 dated 12.02.2025, due to track repair works, the section of main line No. 103 between Vrčin station and Lipe junction was closed to traffic.

The leakage of cargo (sulfuric acid) from the overturned wagon was treated by employees of "Elixir Group"d.o.o. (owner of the goods) by spreading lime on the leak areas (800-900 kg). Lime application was performed over several consecutive days starting from 11/12.02.2025.

The cargo owner, "Elixir Group"d.o.o., engaged "Patenting"d.o.o. Beograd, whose staff transferred sulfuric acid from overturned wagon No. 33 87 7866 801-6 into two tanker trucks (owned by LTH Šabac). A total of 14,220 kg of sulfuric acid was transferred.

In the period from 12.02. to 14.02. 2025., by engaging the equipment and personnel of the Center for Emergency Train Operations, the Kraljevo Emergency Train Operations Unit, the derailed tank wagon No. 33 72 7867 837-6 was lifted and returned to the track, and the overturned tank wagon No. 33 87 7866 801-6 was moved to the side.

Repair and restoration of the track for traffic was performed using personnel and machinery from "IŽS"a.d., as well as contracted companies "ZGOP"d.o.o. Novi Sad, "ATM BG"d.o.o. Novi Beograd, and "Galeb signalizacija"d.o.o. Šabac.

After completion of the track repair works, the Commission for Control and Acceptance of Executed Works, in Report No. 20/2025-1653 dated 13.10.2025, concluded that there were no conditional objections and that all safety conditions for D4 category track, for axle load 225 kN, and for train operation at regular timetable speeds were met.

By "IŽS"a.d. telegram No. 116f dated 15.10.2025, on 20.10.2025 at 08:00, the section of main line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana) between km 25+000 and km 30+550 was reopened to traffic.

2.2.7. Activation of emergency plan of public rescue services, police and medical services and sequence of events

Due to this accident, members of the MUP RS, the Police Directorate for the City of Belgrade, and the members of the MUP RS, Sector for Emergency Situations were engaged. Additionally, after becoming aware of the accident, special measures were taken by the Ministry of Environmental Protection, Sector for Supervision and Preventive Action in the Environment, and the City Institute for Public Health.

According to MUP RS Secretariat letter No. 020-4-1/25-3 dated 09.06.2025, the Vrčin Police Department was informed by telephone about the accident. Upon notification, two traffic police officers and two general jurisdiction officers from PI Grocka were dispatched to the scene. Following additional data received from the on-duty railway dispatcher, a total of 26 police officers from the Belgrade City Police Directorate were deployed: 6 officers from PI Grocka, 2 officers from the Traffic Police Department for Motorways, 16 officers from the Special Police Unit Police Brigade, 2 officers from PI Beli Potok. The police personnel secured and blocked the wider accident area, informed residents living nearby not to leave their homes and to keep windows closed, and collected necessary information for reporting purposes. Additionally, two emergency medical service teams and responsible personnel from the public health protection service were present at the scene.

According to MUP RS, Emergency Situations Sector 07 No. 217-937/25 dated 03.06.2025, after receiving the report, the necessary vehicles and equipment for working with hazardous materials (command vehicle, technical vehicle, fire tanker, vehicle for working with hazardous materials, decontamination vehicle, mobile storage and bulk vehicle) were sent to the site, as well as the required number of firefighters-rescuers. A total of seven vehicles and 22 (twenty-two) firefighters-rescuers from the Fire and Rescue Units of Zvezdara and Savski venac arrived at the site. During the intervention, members of the Fire and Rescue Units secured the accident site and performed measurements with a dosimeter. During the measurements, no elevated values of hazardous materials were detected. Upon a report from the Emergency Situations Sector, Mobile Teams of the City Institute of Public Health arrived at the scene, and based on their own measurements, they determined that no elevated values of hazardous substances were detected.

The site investigation was conducted by the Public Prosecutor of the Second Basic Prosecutor's Office in Belgrade and the investigation team of the Eighth Department of the Criminal Police Administration, Police Directorate for the City of Belgrade.

2.3. Fatally injured, injured and material damage

2.3.1. Passengers, third persons and the railway staff including contractors

There were no fatalities in this accident.

2.3.2. Goods, luggage and other assets

In this accident, part of the cargo (sulfuric acid) was lost due to spillage from tank of the wagon No. 33 87 7866 801-6 (the eleventh wagon counting from the locomotive).

Based on data provided by "Elixir Group"d.o.o. Šabac, via email dated 10.09.2025, the mass of lost cargo amounted to 24.9 t, with a value of 14,165.92 RSD.

According to the official middle exchange rate of the National Bank of Serbia on 11.02.2025, which was 1 EUR = 117.0683 RSD, the total material damage to the cargo (sulfuric acid) in this accident amounts to 121.01 EUR.

2.3.3. Railway vehicles, infrastructure and the environment

In this accident, railway vehicles and infrastructure were damaged. No material damage occurred to the property of third parties.

The structure of the material damage is as follows:

Damage to railway vehicles (wagons in the train composition):	3,411,752.55	RSD
Costs of lifting derailed wagons:	3,791,820.00	RSD
Damage to the track (rack superstructure):	223,073,261.55	RSD
Damage to KM facilities:	13,850,911.86	RSD
Damage to SS facilities:	12,801,600.48	RSD
Total direct material damage:	**256,929,346.44**	RSD

The damage is expressed in the official currency of the RS (Dinar - RSD).

According to the official middle exchange rate of the National Bank of Serbia on 11 February 2025, which was 1 EUR = 117.0683 RSD, the total material damage to infrastructure and railway vehicles in this accident amounts to 2,194,696.14 EUR.

The material damage presented in this report is based on pro forma invoices, estimates, or documents confirming the listed damage amounts, provided by "IŽS"a.d. and "Srbija Kargo"a.d. which were available by the time of finalizing this report.

2.3.4. External circumstances - weather conditions and geographical features

The accident site is located in the urban settlements of Ripanj and Vrčin. The site of the train derailment (first traces of derailment) is located between the Lipe crossing and Vrčin station, in a predominantly uninhabited part of the Ripanj settlement (Municipality of Voždovac), on a section of the track on an embankment, in a right-hand curve with a radius of R = 295 m and a gradient of -7.4‰ (downhill), considering the train's direction of travel. The site of the overturning of the eleventh wagon and the stopping of the train is located in the Vrčin station area on the second track, in the inhabited part of the Vrčin settlement (Municipality of Grocka).

The geographical coordinates of the train derailment site are: 44° 37' 31.1'' N and 20° 34' 35.0'' E.

The geographical coordinates of the train stopping site are: 44° 40' 13,2" *N* and 20° 34' 53,5" *E.*

The letter of the Republic Hydrometeorological Service of Serbia No. 925-1-131/2025 dated 13.05.2025 provided data that the following meteorological data were recorded on 11.02.2025, in the area between the Lipe crossing and Vrčin station: maximum air temperature: 7.6 °C, minimum air temperature: -2.0 °C, minimum air temperature at 5 cm above the ground: -4.0 °C. Hourly air temperature values were: at 17:00 4.5°C, at 18:00 2.5°C and at 19:00 1.6°C.

A moderately strong wind blew from the east-southeast, with maximum gusts of 8.0 to 10.7 m/s. Meteorological visibility was approximately 20 km (meteorological visibility is the transparency of the atmosphere, expressed as the greatest distance at which an observer with normal vision can distinguish familiar objects in the environment, when observing during the day, and light sources when observing at night.). The ground was frozen from 00:00 to 07:00 and wet from 07:00 to 24:00. There was no precipitation occurred during the day.

At the time of the on-site investigation by the CINS on 11.02.2025., it was night. The weather was cloudy, without wind. Visibility was good. There was no precipitation. The ground was dry. The air temperature was approximately 0°C.

3. Minutes on investigation and examination

The data, facts, and evidence regarding the occurrence of the accident were collected and verified based on:

- The on-site investigation conducted by the CINS,
- Material provided by the infrastructure manager "IŽS"a.d,
- Material provided by the railway undertaking "Srbija Kargo"a.d,
- Material provided by *„Elixir Group"d.o.o. Šabac*,
- Material provided by *„ATIR-RAIL SA",*
- Material provided by *„Zijin coper Serbia"d.o.o.* and
- Material provided by the MUP RS.

For the accident in question, on-site investigation were conducted by the joint investigative committee, composed of the infrastructure manager "IŽS"a.d. and the railway undertaking "Srbija Kargo"a.d.

Members of the MUP RS, the Belgrade City Police Department, and representatives of the Second Basic Public Prosecutor's Office in Belgrade also conducted an on-site investigation.

3.1. Summary of testimonies

On 15.09.2025 the Working Group, in the premises of the CINS, conducted hearing of the train driver employed by "Srbija Kargo"a.d, who was on duty on train No. 51202 at the time of the accident.

From "Srbija Kargo"a.d, the Record of the hearing and the Report of the train crew on irregularities on the route (S-5) concerning the driver of train No. 51202 were obtained.

The summary of the testimony of the train driver on duty with train No. 51202 is based on the hearing conducted by the CINS working group.

3.1.1. Railway staff

The train driver stated that on 11.02.2025, at approximately 13:00, he received locomotive 193-910 at Mala Krsna station. He then travelled with the locomotive to Požarevac station, where he took over train No. 51202. When he received the locomotive at Mala Krsna, he experienced an issue with the auto stop device, which he successfully resolved. He reported no further problems with the locomotive. During the journey of train No. 51202, he did not notice any unusual events with the train, no jerking, and described it as a normal ride. He did not see or notice any track deformation. He first became aware of the accident at Vrčin station, when he had to stop the train due to loss of air pressure in the main air line and loss of power in the traction unit. In coordination with the TC dispatcher, he left the locomotive to inspect the situation and reported it to the dispatcher, who contacted the fire department and the police. He then returned to the locomotive to wait for the arrival of emergency services and representatives of the infrastructure manager and railway operator. He observed a few people nearby and warned them not to approach, as the hazard involved sulfuric acid.

3.1.2. Other witnesses

CINS has no information regarding witnesses to this accident.

3.2. Safety management system

3.2.1. Organizational Frame and Method of Issuing and Executing Orders

In accordance with the current Safety Management System Rulebook, "IŽS"a.d. notified CINS about the accident.

In accordance with the current Safety Management System Rulebook, "Srbija Kargo"a.d.. notified CINS about the accident.

The infrastructure manager "IŽS"a.d. and railway undertaking "Srbija Kargo"a.d, in accordance with the Law on Railway Traffic Safety ("Official Gazette of the RS" No. 41/18), formed a joint investigation committee that conducted the accident investigation. Upon completion of the investigation, an Investigation Report was compiled (document No. 15/25-15-210 of 31.07.2025 "IŽS"a.d.).

3.2.2. Requirements that railway staff must meet and the manner they are applied

"Srbija Kargo"a.d. has ensured the management of competencies through the Safety Management System (SMS) Rulebook, i.e. processes to ensure that all employees directly involved in the conduct of railway traffic are trained and competent, as well as the planning of workload.

In relation to the accident involving the train driver employed at „Srbija Kargo"a.d, all activities related to professional training, competence, and working time planning were carried out in accordance with applicable regulations.

"IŽS"a.d. has ensured the management of competencies through the Safety Management System (SMS) Rulebook, i.e. processes to ensure that all employees directly involved in the conduct of railway traffic are trained and competent, as well as the planning of workload.

3.2.3. Procedures for internal audits and controls and their results

"IŽS"a.d. as the infrastructure manager, has established the Safety Management System (SMS) Rulebook. The Safety Management System encompasses the organization and all procedures and processes established within "IŽS"a.d. for the safe conduct of railway traffic.

Risk control related to the maintenance of railway infrastructure (subsystems of infrastructure, energy, control, management, and signalling - trackside) and railway vehicles used for maintenance by "IŽS"a.d. is based on the implementation of defined activities for regular and extraordinary maintenance and their monitoring and control. Regular and extraordinary maintenance includes continuous supervision, controls, inspections, repairs, and overhauls.

The requirements, standards, and procedures for maintenance at "IŽS"a.d. are established based on legal regulations, general and specific company acts, manufacturer instructions, and standards.

Regarding the accident in question, maintenance of the track was not performed in accordance with the applicable regulations.

3.3. Relevant international and national regulations

3.3.1. Law on Railways ("Official Gazette RS" Nos. 41/2018 and 62/2023)

II Railway infrastructure

...

1. Public railway infrastructure management

...

Obligations of the infrastructure manager

Article 10 (excerpt)

The infrastructure manager is obligated to ensure the safe and uninterrupted organization, regulation, and management of railway traffic, unobstructed access to and use of public railway infrastructure, and access to service facilities entrusted to their management and the services they provide in those facilities to all interested applicants for the allocation of infrastructure capacity, under equal, non-discriminatory, and transparent conditions, as well as the continuous, uninterrupted, and high-quality maintenance and protection of railway infrastructure

...

IIIA Construction, Reconstruction, Renovation, and Maintenance of Public Railway Infrastructure

...

2. Maintenance of Public Railway Infrastructure

Article 55. (excerpt)

Public railway infrastructure must be maintained in a state that ensures safe and uninterrupted railway traffic, as well as high-quality and orderly transport, and in accordance with the regulations governing railway traffic safety and technical regulations and standards.

...

The infrastructure manager by a special act approves the introduction of any restricted speed running or permanent speed limit in relation to the projected parameters of the railway line, with an explanation of the reasons for reducing traffic speeds and reducing the capacity of the railway, prescribing technical measures for their reconstruction, as well as the planned deadline, which he submits to the Republic Inspector for Railway Traffic.

3.3.2. Law on Railway Traffic Safety ("Official Gazette RS" No. 41/18)

III. Safety Management in Railway Traffic

1. Guaranteeing safety in railway traffic

Article 5. (excerpt)

The Ministry in charge of transport affairs (hereinafter: the Ministry), the Directorate, the Center for Investigation of Accidents in Transport (hereinafter: the Center), the infrastructure manager (hereinafter: the manager) and the railway undertaking, each in accordance with the tasks it performs, provide:

1) that the safety of railway traffic in the railway system is preserved, and where practicable, constantly improved, with priority being given to accident prevention;

2) that safety regulations and safety are applied transparently and non-discriminatory;

3) to accelerate the development of a unified railway system.

The manager and the railway undertaking are responsible for the safe operation of the railway system and the control of risks associated with it, by implementing the necessary risk control measures, in cooperation with each other, applying national safety regulations and standards and establishing safety management systems in accordance with this law.

…

6. Safety Management System

Article 14 (excerpt)

The Infrastructure manager and the railway undertaking are required to establish a Safety Management System (SMS) aimed at least achieving the CST (Common Safety Targets) for the railway system as a whole. The Safety Management System must be aligned with the national safety regulations for the safety and with safety requirements set out in the TSI (Technical Specifications for Interoperability), and the relevant provisions of the Common Safety Methods (CSM) must be applied.

...

Supervision over safety management systems

Article 15 (excerpt)

The Directorate supervises the safety management systems of the infrastructure manager and railway undertaking, after issuing safety certificates for the management of railway infrastructure and safety certificates for transportation.

Through the supervision outlined in paragraph 1 of this Article, it is verified whether the infrastructure manager and railway undertaking are implementing their safety management systems, and, if necessary, appropriate measures are ordered to be taken.

The decision to implement appropriate measures as stipulated in Paragraph 2 of this Article is finally determined through an administrative procedure, and a dispute regarding it can be brought before the Administrative Court.

On-site supervision, as referred to in paragraph 1 of this Article, is conducted by authorized persons of the Directorate, at least once a year.

...

V. Infrastructure Subsystem

...

Maintenance of infrastructure subsystem

Article 28 (excerpt)

The infrastructure manager is obliged to maintain the super and substructure of the railways in a condition that ensures safe and regular railway traffic.

The Directorate prescribe the method and deadlines for the maintenance of the super and substructure of the railways referred to in paragraph 1 of this Article.

...

3.3.3. The Law on Interoperability of the Railway System ("Official Gazette of RS", No. 41/2018 and No. 16/2022 - Authentic Interpretation)

Note: The Law on Interoperability of the Railway System ("Official Gazette of RS", No. 41/2018 and No. 16/2022 - Authentic Interpretation) was in force at the time of the reconstruction of the section of main railway line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana). With the entry into force of the Law on Interoperability of the Railway System ("Official Gazette of RS" No. 62/2023 of 27.7. 2023), this Law ceased to be valid.

III License for use

1. General provisions on License for use

Article 21 (excerpt)

In order to put structural subsystems into operation and use them in the railway system of the Republic of Serbia, structural subsystems must have a licence for use, issued by the Directorate on the prescribed form and in the form of a decision.

...

4. License for use of Subsystems not compliant with TSIs

...

Renovation or improvement of the structural subsystem

Article 30 (excerpt)

In the case of renewal or improvement of the structural subsystem, the contracting authority or manufacturer submit to the Directorate documentation containing a description of the project, and the Directorate decide, taking into account the TSI implementation plan for the Republic of Serbia, whether the scope of the works requires a new licence for the use of the structural subsystem or a new licence for the use of the vehicle.

...

3.3.4. Law on Railway System Interoperability ("Official Gazette of RS" No. 62/2023)

Meaning of Certain Terms

Article 2 (excerpt)

Certain terms used in this law have the following meanings:

...

12) The holder of a railway vehicle is a natural or legal person, owner or user of a railway vehicle, who uses that vehicle as a means of transport and who is registered in the National Register of Railway Vehicles;

...

III License for use

1. Licence for use of Stable Subsystems

Article 24 (excerpt)

Stable subsystems can be put into operation only if they are designed, constructed and installed in such a way that the basic requirements are met and if they have a licence for use issued by the Directorate in the form prescribed by the act referred to in paragraph 12 of this Article, as well as in the form of a decision.

...

2. Licence for use of mobile subsystems

...

Article 25.

Mobile subsystems can only be put into operation if they are designed, constructed, and installed in such a way that the essential requirements are met and if they have a licence for use.

…

Licence for use of vehicles not compliant with TSIs

Article 29 (excerpt)

The Directorate issues an licence for use of vehicles that are not compliant with TSIs, on the form prescribed by the act referred to in paragraph 6 of this Article, and in the form of a decision.

...

Exception to paragraph 1 of this Article, for vehicles that were in operation until 5 May 2005 and owned by a business entity registered in the Republic of Serbia, and for which the owner or holder cannot obtain a licence for use for the purpose of registering the vehicle in the National Register of Railway Vehicles, the Directorate issue a licence for use if the applicant has submitted:

1) Proof of ownership;

2) Technical documentation including:

(1) Technical description with a layout drawing of the vehicle,
(2) Basic technical and operational characteristics,
(3) Construction drawings necessary for maintenance,
(4) Instructions for use and maintenance,
(5) Spare parts catalog;

3) Proof that the vehicles have been maintained:

(1) Report from the last regular repair and report from the highest-level periodic inspection conducted every 12 months, carried out in accordance with the deadlines prescribed in the maintenance file,

(2) If a maintenance file was not formed - a report from the last regular repair not older than five years and a report from the still valid highest-level periodic inspection according to the documentation under point 2), subpoint (4) this paragraph,

(3) If less time has passed since the last regular repair than required for the next highest-level periodic inspection – report from the last regular repair;

4) A report on the technical inspection carried out, which contains a positive opinion on the functional correctness and ability of the vehicle for safe use in traffic.

…

V Vehicle and Infrastructure Registers

Register of Railway Vehicles

Article 47 (excerpt)

The Directorate maintains the National Register of Railway Vehicles.

Holders of vehicles of all types for which a licence for use has been issued are obliged to submit to the Directorate, without delay, a request for entry in the register referred to in paragraph 1 of this Article, prior to the first use of the vehicle.

...

Holders of a vehicle must immediately notify the Directorate of any changes to the data entered in the National Register, vehicle destruction, or a decision to terminate vehicle registration.

The vehicle holder, without delay, reports to the Directorate any changes in data entered in the National Register of Railway Vehicles, destruction of the vehicle or decision to terminate the vehicle registration.

...

3.3.5. Rulebook on Railway Lines Super and Sub Structure Maintenance ("Official Gazette of RS" No. 39/23)

Note: Rulebook on Railway Lines Super and Sub Structure Maintenance ("Official Gazette of RS" No. 39/23) is applicable as of May 20th, 2023.

II. Inspection of the Infrastructure Subsystem Condition

...

Measurement of Track Geometry on Mainline and Regional Tracks

Article 5.

For new, upgraded, and rehabilitated mainline and regional tracks, relative track geometry measurements are carried out based on parameters defined by standard SRPS EN 13848-1, using measurement systems and track recording vehicles defined by standard SRPS EN 13848 (parts 2 to 4).

The limit values for parameters of relative track geometry, as defined by standard SRPS EN 13848-5, are:

1) Emergency Intervention Limit (hereinafter referred to as GHI) - pertains to the parameter value that, if exceeded, requires taking measures to reduce the risk of derailment to an acceptable level, which can be achieved through track closure, track geometry rectification, or speed reduction;

2) intervention Limit (hereinafter referred to as GI) - refers to the parameter value that, if exceeded, requires extraordinary maintenance to ensure that the indicator value does not reach the GHI before the next measurement;

3) warning Limit (hereinafter referred to as GU) - pertains to the parameter value that, if exceeded, requires an analysis of the track geometry condition and inclusion in regular maintenance if necessary.

Tolerances for GHI parameters are defined by standard SRPS EN 13848-5, while tolerances for GI and GU parameters are defined within the Safety Management System of the infrastructure manager.

The determination of track geometry quality is defined by standard SRPS EN 13848-6.

Measurement of Track Geometry on Local Tracks, Industrial Railways, and Industrial Tracks

Article 6.

For railways not covered by Article 5, paragraph 1 of this Rulebook, instead of the full track geometry measurement prescribed in Article 5, the following parameters are allowed to be measured:

1) Track gauge;
2) Track stability;
3) Versine;
4) Cant of the outer rail in curves;
5) Twist.

The limit values of the track geometry parameters on the railways referred to in paragraph 1 of this Article are given in the Annex - Limit values of the track geometry parameters, which is printed with these regulations and forms an integral part thereof.

All track errors are classified into three groups:

1) Type A errors - values according to parameters up to which it is not require to plan and carry out works;

2) Type B errors - errors that require planning regular or extraordinary works to correct them;

3) Type C errors - errors that are over operational limits and that require measures to be taken to reduce the risk of derailment to an acceptable level, which can be done by closing the line, repairing the track geometry or reducing the speed.

The condition of the track geometry is assessed based on the total length of errors in groups B and C over a length of one kilometer.

The condition of the track geometry of one kilometer of track can:

1) Very good when is ≤ 10 m errors in group B and 0 m in group C;

2) good when is ≤ 50 m errors in group B and ≤ 10 m errors in group C;

3) Satisfactory when is ≤ 250 m errors in group B and ≤ 25 m errors in group C;

4) Unsatisfactory when is > 250 m errors in group B and > 25 m errors in group C.

...

IV Carrying out maintenance works

...

Restricted-speed runnings

Article 49 (excerpt)

The maximum lengths of restricted-speed runnings during works are defined within the infrastructure manager's Safety management system.

Restricted-speed runnings may be moved daily, but shall not exceed the lengths defined in accordance with paragraph 1 of this Article.

Restricted-speed running is being canceled, and the track is being restored for the maximum permitted speed prescribed for the section of track, within the following deadlines:

1) Restricted-speed runnings from 20 to 50 *km/h* - 20 days after implementation;

2) Restricted-speed runnings at speeds ≥ 50 *km/h* on single track and double track lines on which it operates 60 or more trains in 24 hours - 20 days after implementation, and on lines with lower traffic volumes - 30 days after implementation;

...

VI Acceptance of works

Track works on the track that requires acceptance

Article 67 (excerpt)

Track works followed by acceptance of the work includes:

...

2) Renewal or partial renewal and maintenance of rails, sleepers, switch sleepers, ballast and other elements of the superstructure;

5) Works on regulating the track in terms of width, height, and direction

...

Activities prior to Acceptance of Track works

Article 68. (excerpt)

Before accepting track works, the following measurements and inspections are carried out and documented, as defined by SRPS EN 13231-1 standard:

- Relative track geometry, including switches and crossings;

...

Tolerances for track geometry parameters upon acceptance of works

Article 70. (excerpt)

Tolerances for geometry parameters upon accepting works on the track in the ballast, on the open line section, switches and crossings, as well as expansion joints are defined by the SRPS EN 13231-1 standard.

...

Appendix

Limit values of track geometry parameters

Max. permitted speed on the line (km/h)			V > 100			100 ≥ V > 80			80 ≥ V > 60			V < 60		
Parameter		Error group	A	B	C	A	B	C	A	B	C	A	B	C
			mm											
1.	Track gauge	Track widening	3	10	20	3	25	30	5	25	30	8	25	35
2.		Track narrowing	3	3	3	3	4	6	3	4	8	3	5	10
3.	Twist on 3,5 m base		4	7	10	6	8	12	7	10	15	9	14	18
4.	Versine		2	5	10	5	10	20	8	20	30	10	15	40
5.	Cant		2	4	8	4	6	10	5	8	15	5	8	15
6.	Stability		2	5	10	4	8	15	5	8	15	5	10	20

3.3.6. Instruction on Amendments and Supplements to the Instruction on Unified Criteria for Track Condition Monitoring on the JŽ Network (Official Gazette of ZJŽ, Nos. 6/01 and 4/04), No. 4/2022-3496-718 of 25.03.2022

Apendix XXIII

Limit values of track geometry parameters

Limit values of track geometry parameters during line operation (mm)
(SRPS EN 13848-5)

Line category		I			II			III			IV		
Parameter	Speed	V < 80			80 < V ≤ 120			120 < V ≤ 160			160 < V ≤ 230		
	Category	GU	GI	GHI	GU	GI	GHI	GU	GI	GHI	GU	GI	GHI
Track gauge	Narrowing	-7	-9	-11	-7	-9	-11	-6	-8	-10	-4	-5	-7
	Widening	25	30	35	25	30	35	25	30	35	20	23	28
Twist on 3 m base (mm/m)		4	5	7	4	5	7	4	5	7	3	4	5
Cant		6	11	15	5	9	13	4	8	11	3	6	9
Versine D1		12	16	22	8	12	17	6	9	14	5	8	12
Stability D1		12	19	28	10	16	26	8	14	23	7	12	20
Versine D2		-	-	-	-	-	-	-	-	-	10	14	18
Stability D2		-	-	-	-	-	-	-	-	-	12	17	24

Limit values of track geometry parameters during acceptance of maintenance works (mm)
(SRPS EN 13231-1)

Line category		I	II	III	IV
Parameter	Speed	V < 80	80 < V ≤ 120	120 < V ≤ 160	160 < V ≤ 230
	Category	G	G	G	G
Track gauge	Narrowing	-3	-3	-2	-2
	Widening	7	5	5	5
Twist on 3 m base (mm/m)		4.5	4.5	4.5	3
Cant		5	4	4	3
Versine D1		5	4	4	3
Stability D1		5	4	4	3
Versine D2		-	-	-	4
Stability D2		-	-	-	4

Limit values of track geometry parameters
during acceptance of works after track renewal and construction of new track (mm)
(SRPS EN 13231-1)

Line category		I	II	III	IV
Parameter	Speed	V < 80	80 < V ≤ 120	120 < V ≤ 160	160 < V ≤ 230
	Category	G	G	G	G
Track gauge	Narrowing	-3	-3	-2	-2
	Widening	4	4	4	4
Twist on 3 m base (mm/m)		4.5	3	3	3
Cant		3	3	3	2
Versine D1		4	2	2	2
Stability D1		4	3	3	2
Versine D2		-	-	-	3
Stability D2		-	-	-	3

...

3.3.7. Instruction on Amendments and Supplements to the Instruction on Unified Criteria for Track Condition Monitoring on the JŽ Network ("Official Gazette of ŽS", No. 14/22) of 19.04.2022

Appendix XIII (excerpt)

...

Limit values of track geometry parameters during acceptance of maintenance works (mm)
(SRPS EN 13231-1)

Line category		I	II	III	IV
Parameter	Speed	V < 80	80 < V ≤ 120	120 < V ≤ 160	160 < V ≤ 230
	Category	G	G	G	G
Track gauge	Narrowing	-3	-3	-2	-2
	Widening	7	5	5	5
Twist on 3 m base (mm/m)		1.5	1.5	1.5	1
Cant		5	4	4	3
Versine D1		5	4	4	3
Stability D1		5	4	4	3
Versine D2		-	-	-	4
Stability D2		-	-	-	4

Limit values of track geometry parameters
during acceptance of works after track renewal and construction of new track (mm)
(SRPS EN 13231-1)

Line category		I	II	III	IV
Parameter	Speed	V < 80	80 < V ≤ 120	120 < V ≤ 160	160 < V ≤ 230
	Category	G	G	G	G
Track gauge	Narrowing	-3	-3	-2	-2
	Widening	4	4	4	4
Twist on 3 m base (mm/m)		1.5	1	1	1
Cant		3	3	3	2
Versine D1		4	2	2	2
Stability D1		4	3	3	2
Versine D2		-	-	-	3
Stability D2		-	-	-	3

...

3.3.8. Law on the Transport of Dangerous Goods („Official Gazette of RS”, No. 104/2016, 83/2018, 95/2018 - other law and 10/2019 - other law)

I Powers and Obligations of Authorities, Organizations, as well as participants in dangerous goods transport

...

2. Obligations of participants in transport

...

Obligations of the filler

Article 21 (excerpt)

The filler in road, rail, and inland water transport is required to comply with the obligations prescribed in subsection 1.4.3.3 ADR/RID/AND.

In addition to the obligations from paragraph 1 of this Article, the filler is required to:

…

6) ensure that after filling the tanks, the tightness of valves and equipment is checked in accordance with the applicable provisions of chapter 3.3 ADR/RID/ADN and subsection 4.2.4.5.5, as well as that valves are in the closed position and there is no leakage, in accordance with 4.3.2.3.3 ADR/RID;

...

Obligations of the unloader

Article 25 (excerpt)

The unloader in road, rail, and inland water transport is required to comply with the obligations prescribed in subsection 1.4.3.7 ADR/RID/ADN.

In addition to the obligations from paragraph 1 of this Article, the unloader is required to:

…

3) In accordance with subsection 1.4.3.7.1 ADR/RID/ADN, immediately after unloading a tank, vehicle, wagon, transport unit, or container:

(1) remove dangerous residues that may have left traces on the external surface of the tank, vehicle, wagon, transport unit, or container during unloading,

(2) ensure closure of valves and control openings

...

3.3.9. Rulebook on Train and Vehicle Brakes and Braking ("Official Gazette of RS", No. 68 of 07.07.2021.)

Appendix 3. Train Composition and Brake Type Selection for Freight and Passenger Trains

...

4. Inclusion of wagons and Brake Type Selection for Passenger and Freight Trains

...

5) Wagons of the SS mode (with automatic continuous brake force adjustment) for speeds up to 120 km/h, the P braking mode is functional on all vehicles and without exception on the last vehicle.

In the case of a towed mass greater than 800 t and less than or equal to 1,200 t, the active locomotive at the front of the train brakes in mode G.

In the case of a towed mass from 1,200 t to 1,600 t, in addition to the locomotive at the front of the train, the first five towed vehicles in the train brake in mode G. This braking mode is also known as "long locomotive" (marked as LL).

If the G braking mode is not possible for a particular vehicle, the brake of that vehicle is deactivated.

In the case of a towed mass exceeding 1,600 t, all vehicles in the train brake in mode G.

3.4. Functioning of the railway vehicles and technical installations

3.4.1. Control, management and signalling

On the section of the main railway line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana), between Vrčin station and Lipe junction, traffic is regulated by the TK dispatcher at workplace Jug 2 in the TK center Makiš in the interstation spatial sections.

A review of the malfunctions database maintained by the technical dispatcher in the TK hall at the TK center in Makiš (data provided in the attachment to the letter of "IŽS"a.d. No. 1/2025-1250 dated 05.06.2025) shows that at the time of the accident, on the section between Vrčin station and Lipe junction, no malfunctions were reported on the SS devices, i.e., the devices for control, management, and signaling were fully operational.

3.4.2. Infrastructure

The location of the accident is on a 7.4‰ gradient and in a right-hand curve when viewed in the direction of train travel (or a left-hand curve when viewed in the direction of increasing mileage), with a radius R=295 m and a length l=350 m (PPK: km 30+336.64; PKK: km 30+396.64; KKK: km 30+746.83; KPK: km 30+781.83). The accident (derailment) occurred on the circular curve section at km 30+522.

A sketch of the derailment site of train No. 51202 is shown in Figure 3.4.2.1.

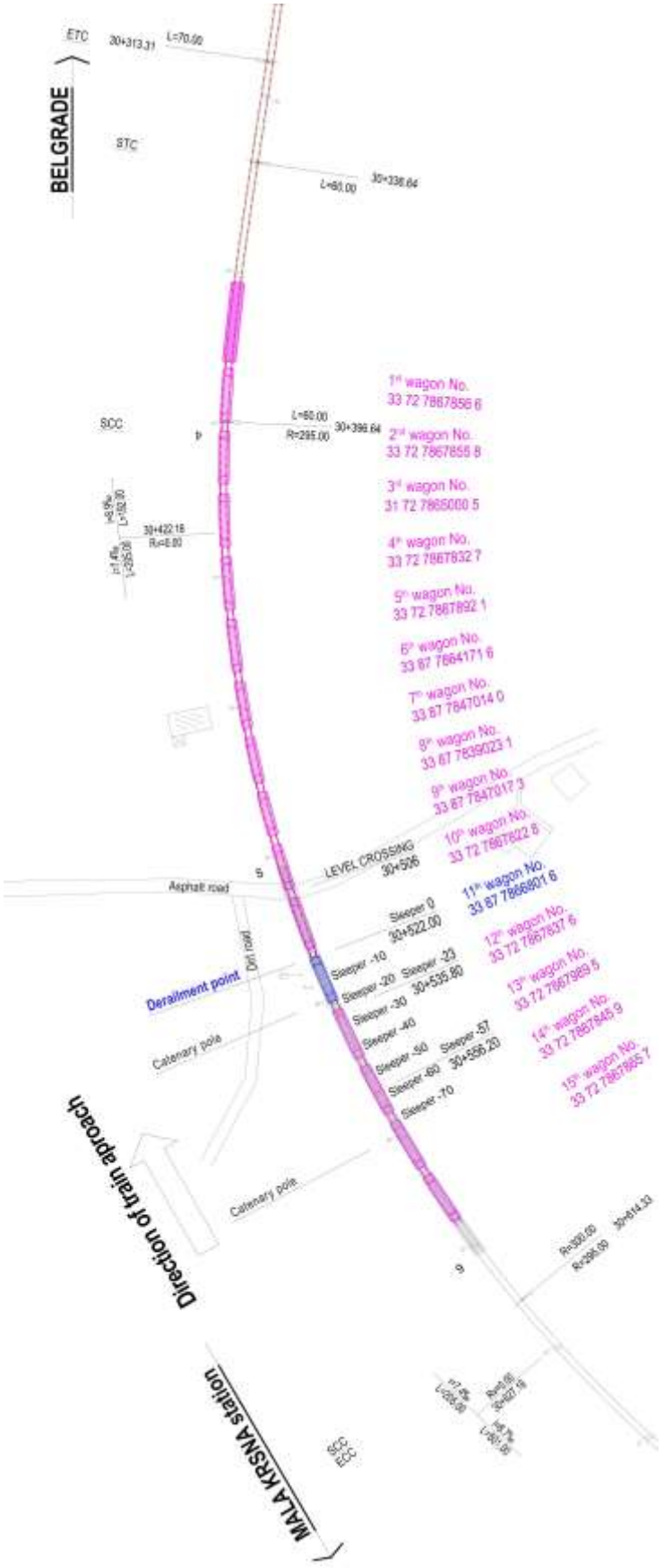


Figure 3.4.2.1: Sketch of the derailment location of train No. 51202

On the section of main railway line No. 103 between Vrčin station and the Lipe junction, new B-70 concrete sleepers have been installed with Skl-14 type elastic fastening systems. The track grid is laid on a ballast bed that is not dirty.

Devices against lateral track displacement were installed throughout the entire curve on every second sleeper, in accordance with applicable regulations.

The track section from km 30+510 to km 30+650 is located on a high embankment. During the main repair, the elements of the track superstructure were replaced, without any work on the track substructure.

At the location, the insufficient width of the subgrade is noticeable, causing the ballast chips to spill down the slopes of the railway embankment. The slopes of the railway embankment are overgrown with bushes.

The appearance of the subgrade in the derailment zone is shown in Figure 3.4.2.2.

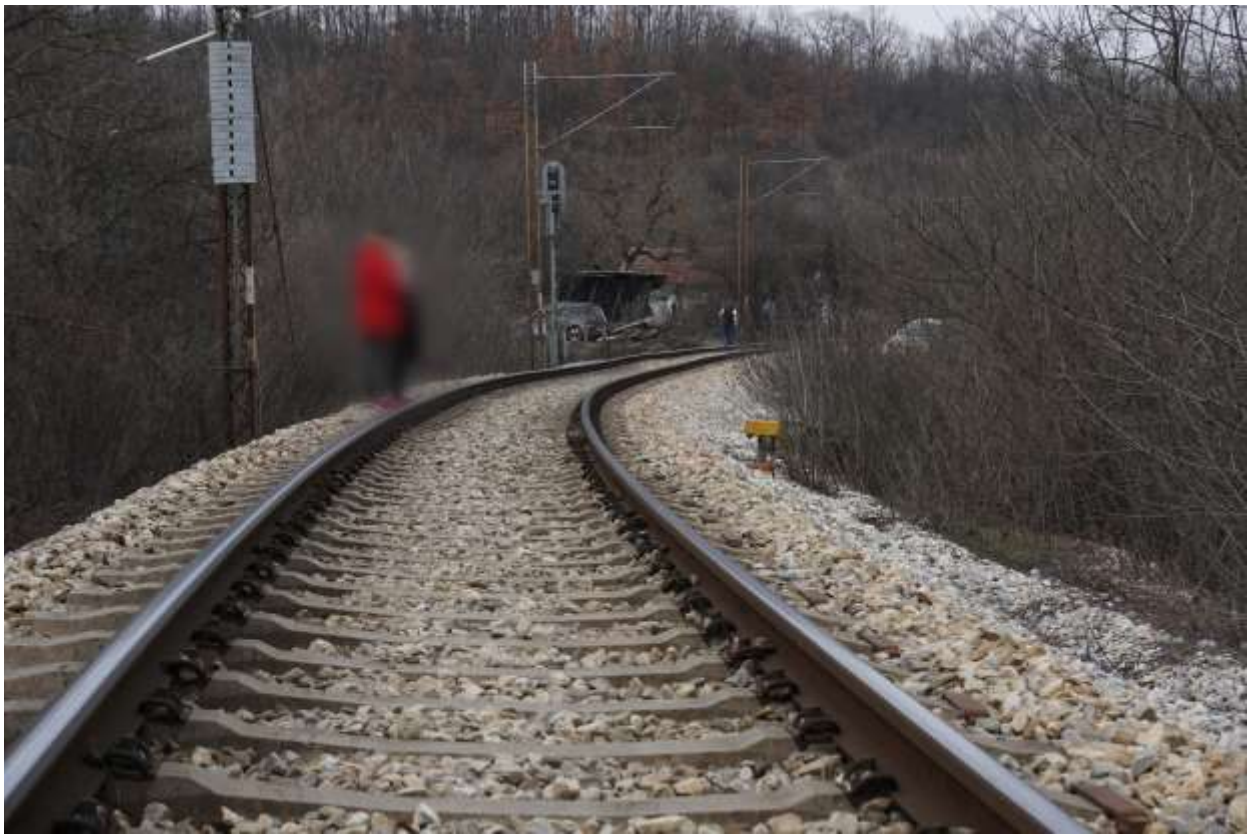


Figure 3.4.2.2: Appearance of the track in the derailment zone of train No. 51202

Sketch of the overturning of the eleventh wagon, derailment of the twelfth wagon, and stopping location of the train at Vrčin station is shown in Figure 3.4.2.3.

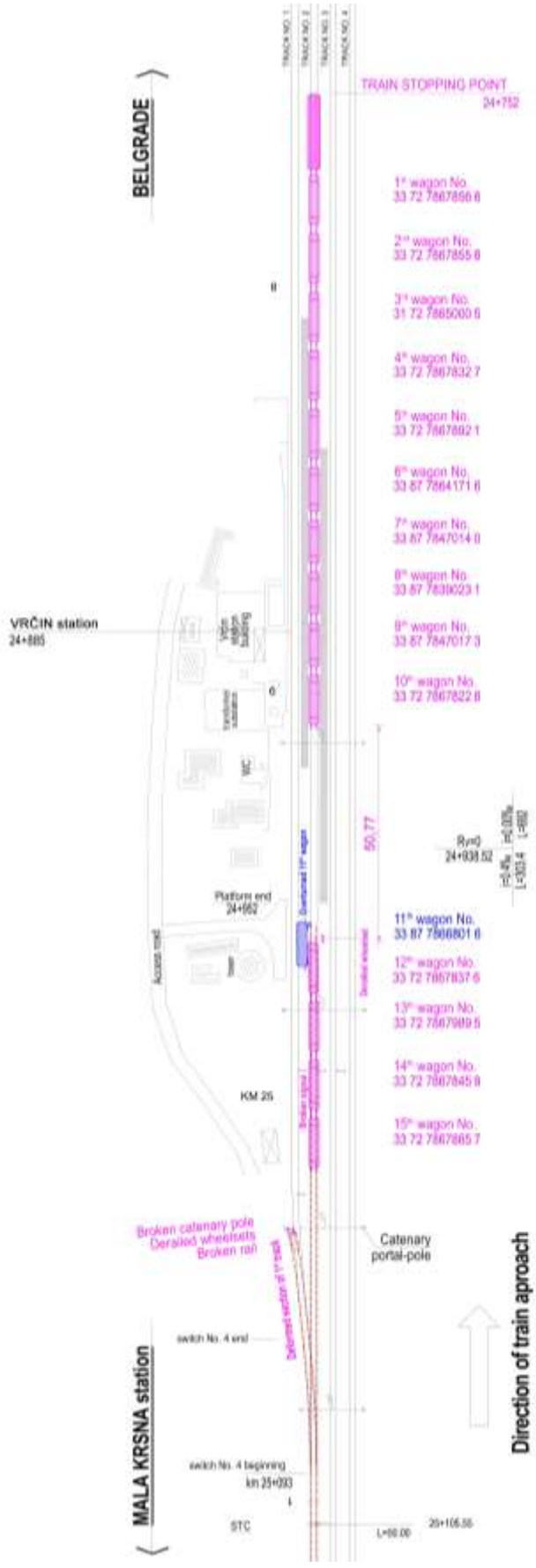


Figure 3.4.2.3: Sketch of the overturning of the eleventh wagon and the stopping location of train No. 51202

3.4.3. Means of communications

At the time of the accident, on the section of main railway line No. 103 between Vrčin station and the Lipe junction, the communication means were functioning properly and operational. No malfunctions or disturbances were recorded on the communication devices.

3.4.4. Railway vehicles

At the time of the accident, train No. 51202 was traveling from the Lipe junction toward Vrčin station (from the end of the line to the beginning, in the direction of decreasing mileage).

At the site, in Vrčin station, the locomotive 193-910 and all tank wagons of train No. 51202 were found.

From the overturned 11th wagon, the cargo (sulfuric acid) leaked occured.

The appearance of train No. 51202 at Vrčin station is shown in Figures 3.4.4.1. and 3.4.4.2.

Figure 3.4.4.1: Appearance of the rear part of train No. 51202

Figure 3.4.4.2: Appearance of train No. 51202

The locomotive series 193-910 is a four-axle, multi-system electric locomotive “Vectron” X4-E-LOK-AB, version A26, manufactured by Siemens Mobility GmbH, Austria, built for standard gauge tracks (1435 mm) and intended to haul all types of trains on all categories of railway lines.

From “Srbija Kargo”a.d., via email dated 14.02.2025, it was provided data that locomotive 193-910 is equipped with devices for recording relevant data on the locomotive called TRU. The HASLER type speed sensor is used for providing information about the speed, and all speed information is stored in the TRU device, and the stored data can be read using the appropriate software. Locomotives of series 193 are equipped with safety systems ETCS, LZB, TZB, and MIREL. Each of these systems has its own speed sensor. The data they record is systematically compared with GPS data, and in case of any discrepancy, the system indicates an error. There is no provision for certification of speed sensor devices and devices for checking the authenticity of records.

Processing of the data stored on 11.02.2025 in the Alstom TRU device installed on locomotive 193-910 of train No. 51202 was carried out by “Srbija Kargo”a.d, in the Train traction and TKP Sector, and a document titled Data recorded by the electronic speedometer device No. 17/2025-59 dated 14.02.2025 was issued.

By reviewing the document in question, it can be concluded that the train’s speed on the section between the Lipe junction (at 17:44:19) and the train's stopping point at the Vrčin station (17:53:59) was between 33.50 km/h and 50 km/h. At a speed of 50 km/h, the speed begins to decrease sharply and after approximately 135 m, the train stops.

3.5. Traffic management and regulation

3.5.1. Action undertaken by the staff that manages the traffic regulation and control and signaling

The traffic of train No. 51202 between the Lipe junction and Vrčin station occurred within a station section. The passage of the train through the Lipe junction towards Vrčin station was carried out normally, by issuing route-setting commands from the central signal at the TK Center Makiš.

Train personnel received all necessary orders and information regarding the traffic of train No. 51202 on this section of the railway via accompanying documents.

3.5.2. Exchange of the voice messages related to the accident

Immediately before and during the accident, there was no communication between the train crew (locomotive drivers) of train No. 51202 and the personnel managing traffic (TK dispatcher at work position Jug 2 in the TK Center Makiš).

Communication between the traffic control personnel and the locomotive driver was established after the accident in order to inform them about the accident. The driver of train No. 51202 notified the TK dispatcher at TK Center Makiš via a mobile phone operator.

3.5.3. Measures undertaken to secure the accident site

After the accident, the section of main railway line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana) between Vrčin station and the Lipe junction was closed for traffic by telegram by “IŽS”a.d. No. 74 dated 12.02.2025.

Given that train No. 51202 had breakdown at Vrčin station, the locomotive driver, on the first part of the train, closed the main brake pipe valve on the tenth wagon (at the point of breakdown) and applied the automatic air brake to that part of the train. Considering that the train stopped on a section of track with a 0.4‰ gradient (in the direction of train travel) and that two wagons derailed in the second part of the train, no special measures were taken to secure the second part of the train against unintended movement.

Given that train No. 51202 carried a substance which, if released uncontrolled from tank of wagons, could endanger human health and potentially harm the environment, and that some of this substance was released from the overturned wagon, the MUP of the RS was notified about the accident. Personnel from MUP RS secured the accident site.

3.6. Interface between people, machines and organization

3.6.1. Work time of the staff involved

According to data provided by "Srbija Kargo"a.d. (attached to the email of 03.06.2025), the locomotive driver of train No. 51202 completed his previous work assignment on 08.02.2025 at 21:40, and started his next assignment on 11.02.2025 at 13:00.

Up to the occurrence of the accident, the locomotive driver of train No. 51202 had been working in accordance with the law.

3.6.2. Health and personal circumstances that have effect on the accident, including the presence of physical or psychological stress

According to data provided by "Srbija Kargo"a.d. in the email of 03.06.2025, the locomotive driver on duty on train No. 51202 was professionally qualified and medically fit to perform his duties. The driver of train No. 51202 holds a Driving License for traction vehicles No. RS 71 2017 1168 issued by the Railway Directorate on 10.01.2017, valid until 10.01.2027, and an Additional Certificate for operating certain types of traction vehicles on specific infrastructure No. 00033035 issued by "Srbija Kargo"a.d. on 10.01.2017, valid until 10.01.2027.

After the accident, on-site alcohol testing of the locomotive driver of train No. 51202 was conducted twice by police officers: first by the traffic patrol of PI Grocka using an "Alco True P" breathalyzer, type GM-1-21, serial No. 23430818, and second by the traffic patrol of the Traffic Police Department, Highway Traffic Police Substation, using an "Alko-Kvant" breathalyzer, type A 114626. In both cases, the breathalyzer display showed a value of 0.00 mg/l of alcohol.

3.6.3. Manner of design of equipment that has an effect on the interface between the user and the machine

The section of main line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana), between Vrčin station and the Lipe junction, was designed for speeds up to 65 km/h and maximum loads of 225 kN/axle.

Due to poor track geometry between km 30+100 and km 30+600, a restricted-speed running with V_{max} = 50 km/h was imposed.

Operation of the series 193 locomotive is carried out by the driver using controls in the cab, designed during the locomotive's production. On locomotive 193-910, no complaints or deficiencies were recorded in the control systems and devices.

Regarding the designed technical and operational characteristics of the Z series wagons that were part of the train, no objections or deficiencies were registered in the designed technical - operational characteristics that would have an impact on the interface between the user and the machine.

3.7. Previous accidents of similar character

Based on data obtained from "IŽS" a.d. (provided in the attachment to letter No. 1/2025-1250 dated 05.06.2025), for the period from the reopening of the railway after the main repare until the occurrence of the accident, on main railway No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana), there was one accident: a train derailment.

On 25.07.2025 at 04:23, at Lozovik-Saraorci station, at km 82+800, an accident occurred, when train No. 51322 (undertaking "Srbija Kargo"a.d.) derailed with wagon (unique No. 31 65 5980 023-0) with both bogies. Due to a fault in the station interlocking panel, it was not possible to operate the entry signals, so the driver of train No. 51322 requested entry to the station on track 3, through switches No. 5 and 6, via telephone by entry signal Nu 91.

Also, due to this failure and after reporting from the Mu 92 input signal by the train driver of train 73371, was provided a path for entry to track 2 via switch No. 2 by the train dispatcher using the TIS button. Seeing that entry path for train No. 51322 was already given, the dispatcher used the TIS button to change switch No. 6 right in front of train No.51322, which led to the derailment of the mentioned wagon (the seventh wagon from the locomotive) with both bogies.

From 01.01.2014 until the occurrence of the accident in question, 14 (fourteen) accidents occurred on the network of "IŽS"a.d. in which tank wagons loaded with sulfuric acid derailed. Out of the total number of accidents, in three accidents, acid leaked from the tank wagon.

An overview of accidents in which tank wagons loaded with sulfuric acid derailed is provided in Table No. 3.7.1.

Table 3.7.1: Overview of accidents involving derailment of tank wagons loaded with sulphuric acid that occurred in the period from 01.01.2014 to 11.02.2025

No.	Date	Time	Short description	Cause
1	22.03.2014.	18:15	At Prahovo station, in the area of switch No. 3, derailment of three wagons of train No. 53729 occurred. No leakage of cargo occurred	Poor track condition
2	29.01.2018.	14:57	At km 174+385, in Negotin station, derailment of train No. 63729 (undertaking "Srbija Kargo" a.d.) involving five wagons, two of which overturned. **Leakage of cargo occurred from the overturned wagons.**	Technical defect of a wagon; undertaking responsibility.
3	23.11.2018.	17:00	At km 22+287, at Ostrovica station, on switch No. 1, derailment of train No. 45022 (undertaking "Srbija Kargo" a.d.) involving two wagons. No cargo leakage occurred.	Poor track condition
4	18.11.2019.	06:00	At km 129+720, between Trnavac and Brusnik stations, derailment of train No. 53726 (undertaking: "Srbija Kargo" a.d.) involving nine wagons. No cargo leakage occurred.	Improper train composition and inadequate braking (undertaking dissenting opinion)

No.	Date	Time	Short description	Cause
5	28.11.2020.	19:27	At km 123+670, between Bagrdan and Jagodina stations, derailment of train No. 45022 (undertaking "Srbija Kargo" a.d.) involving eight wagons, five of which overturned. **Cargo leakage occurred.**	The rupture of the track which was not maintained in accordance with Articles 74 and 76 of the Rulebook on technical conditions and maintenance of railway lines superstructure
6	14.07.2021.	14:50	At km 235+190, between Bor Teretna and Zagrađe stations, derailment of train No. 53753 (undertaking "Srbija Kargo" a.d.) involving one wagon, which overturned. **Cargo leakage occurred.**	Failure to comply with reduced speed limit and poorly visible mileage markings
7	14.08.2021.	17:40	At km 237+300, between Bor Teretna and Rgotina stations, derailment of train No. 53753 (undertaking "Srbija Kargo" a.d.) involving one wagon. No cargo leakage occurred.	Track deformation due to high daily temperatures.
8	13.08.2021.	21:50	At km 136+000, between Trnavac and Brusnik stations, derailment of train No. 52731/73373 (undertaking "Srbija Kargo"a.d.) involving three wagons. No cargo leakage occurred.	Investigation commission has no unified conclusion.
9	20.03.2022.	01:20	At km 197+200, at Vlaole station, derailment of train No. 61751 (undertaking "Srbija Kargo" a.d.) involving four wagons. No cargo leakage occurred.	Investigation commission has no unified conclusion.
10	30.04.2023.	04:50	At km 124+600, at Trnavac station, derailment of train No. 51753 (undertaking "Srbija Kargo" a.d.) involving two wagons. No cargo leakage occurred.	Investigation commission has no unified conclusion.
11	02.09.2023.	12:45	At km 233+852, between Bor Teretna and Rgotina stations, derailment of train No. 51753 (undertaking "Srbija Kargo" a.d.) involving one wagon. No cargo leakage occurred.	Investigation commission has no unified conclusion.
12	01.04.2024.	05:50	At km 125+200, between Trnavac and Brusnik stations, derailment of train No. 51755 (undertaking "Srbija Kargo" a.d.) involving one wagon. No cargo leakage occurred.	A combination of circumstances where none can be individually identified as the cause of the derailment.
13	22.06.2024.	17:02	At km 233+900, between Bor Teretna and Rgotina stations, derailment of train No. 51753 (undertaking "Srbija Kargo" a.d.) involving one wagon. No cargo leakage occurred.	Track deformation due to high daily temperatures.
14	28.07.2024.	14:20	At km 126+003, between Trnavac and Brusnik stations, derailment of train No. 51753 (undertaking "Srbija Kargo" a.d.) involving one wagon. No cargo leakage occurred.	Track deformation due to high daily temperatures.

In the forementioned accidents, there were no fatalities or injuries.

3.8. Previous accidents investigated by CINS

According to the Law on Investigation of Accidents in Air, Railway, and Waterborne Transport ("Official Gazette of RS" No. 66/15 and 83/18), CINS conducts investigations after serious accidents in the railway system with the aim of possible safety improvement on the railways and prevention of new accidents caused by the same or similar causes.

Although CINS is obligated to conduct investigations after serious accidents in the railway system, for the purpose of improving railway safety and preventing the occurrence of new accidents caused by the same or similar causes, CINS has also conducted investigations of accidents related to train derailments, including:

1. On 16.08.2017. at 15:30 on the main line: Belgrade Marshalling Yard "A" - Junction "B" - Junction "K" - Resnik, between Junction "B" and Junction "K", there was a train derailment of train No. 62946 (ŽS - 02/17, Final Investigation Report No. 33, No. 340-8059/2017-16 dated 05.01.2018);
2. On 03.11.2017. at 15:25 at km 33+150 of the local railway line Markovac - Resavica, between the stations Svilajnac and Despotovac, there was a train derailment and separation of train No. 56990 (ŽS - 06/17, Final Investigation Report No. 33, No. 340-00-10982/2017-16 dated 14.08.2018);
3. On 23.12.2017. at 13:15 at km 122+250 of the regional railway line Pančevo Main Station - Zrenjanin - Kikinda - (Jimbolia), in the area of the station Novi Bečej, there was a train derailment of train No. 53527 (ŽS - 07/17, Final Investigation Report No. 33, No. 340-00-13136/2017-19 dated 26.11.2018);
4. On 28.11.2020. at 19:27 between km 123+600 and km 123+670 of the main railway line 102: Belgrade Center - Junction "G" - Rakovica - Mladenovac - Lapovo - Niš - Preševo - state border - (Tabanovce), between the stations Bagrdan and Jagodina, on the left track of the double-track railway line, there occurred a train derailment of train No. 45022 (ŽS - 03/20, Final Investigation Report No. 340-00-2/2020-02-1-53 dated 17.11.2021) and
5. On 25.12.2022. at 16:45, at km 67+244 of the main arterial line No. 106: Niš - Dimitrovgrad - state border - (Dragoman), between the crossing point Staničenje and the station Pirot, there occurred a derailment of the train No. 45010 (ŽS - 01/22, Final Investigation Report No. 340-00-2/2022-02-1-120 dated 12.10.2023).

In order to enhance safety in the railway system and prevent the occurrence of new accidents caused by similar or the same causes, CINS has issued the following safety recommendations among others:

1. To the Directorate for Railways, concerning "IŽS"a.d. Safety Recommendations: SR_03/17, SR_05/17, SR_24/18, SR_25/18, SR_28/18, SR_29/18, SR_13/21, SR_14/21, SR_04/23, SR_05/23, SR_06/23, and SR_07/23;
2. To the MGSI, Inspection Supervision Sector, Department for Railway Traffic Inspection, Safety Recommendations: SR_07/17, SR_26/18, SR_31/18, SR_22/21, and SR_08/23 were issued.

None of the mentioned safety recommendations were implemented, except BP_22/21, which was partially implemented, and BP_08/23, which was fully implemented.

4. Analysis and conclusions

4.1. Final review of the course of events and drawing conclusions about the accident based on the facts established during the investigation and examination

On 11.02.2025, train No. 51202, consisting of locomotive 193-910 and 15 (fifteen) wagon-tanks loaded with sulfuric acid (RID 80/1830), operated by "Srbija Kargo" a.d., was traveling between the Lipe junction and Vrčin station on main railway line No. 103 (Beograd Centar – Rakovica – Jajinci – Mala Krsna – Velika Plana).

At 17:46, at km 30+522, two wheelsets of the front bogie of the eleventh wagon (counting from locomotive 193-910) derailed.

The train driver did not notice any disturbance in the drive, so the train continued to travel for approximately another 5.6 km after the derailment until Vrčin station, where the eleventh wagon that had derailed overturned, two wheelsets of the front bogie of the twelfth wagon derailed, and the train came to a stop, with the front of the train at km 24+753. According to the locomotive clock, the train stopped at 17:54.

Sulfuric acid leaked from the overturned wagon- tank. Material damage occurred to the railway vehicles, infrastructure, and cargo. According to information submitted by email on 10.09.2025 by the cargo owner ("Elixir Group" d.o.o. Šabac), the mass of the leaked acid amounts to 24,940 kg. The track was damaged over a length of approximately 5.6 km, with over 9,000 broken or damaged concrete sleepers. At Vrčin station, two switches, parts of the electrical SS system, and sections of the track were partially deformed. One wagon-tank was scrapped due to the consequences of the accident, and the other sustained damage. The railway line between Vrčin station and the Lipe junction was closed for repairs for a period exceeding eight months.

4.2. Discussion – analysis of the facts established during the investigation and examination, aimed at drawing conclusions regarding the causes of the accident and the performance of the rescue services

4.2.1. Analysis of Track Geometry Data from Track Recording Vehicle

According to data obtained from "ŽS" a.d., between the reopening of the renewed railway on 22.06.2022 and the occurrence of the accident, in the section of the track where the derailment occurred, one local mechanized track adjustment and one manual track adjustment were performed.

On the section of the railway between Jajinci and Mala Krsna stations, track parameters were measured using the track recording vehicle of type SEVER 1435. Since the reopening of the renewed railway for operation, measurements were conducted twice a year (06.04.2022, 06.10.2022, 10.04.2023, 07.10.2023, 04.03.2024, and 10.12.2024). Data from these measurements were provided by "IŽS" a.d. in both graphic and analytical report formats.

In the attachment to "IŽS" a.d. letter No. 1/2025-1250 dated 05.06.2025, measurement reports from the Track Recording Vehicle were provided, without evidence that IAL type errors were delivered to the track section, and without evidence that the responsible track section carried out urgent removal of identified IAL group errors, particularly twist and cant errors. No data is indicating that the management of "IŽS" a.d. analyzed why the procedure was not followed. Similarly, there is no information on any corrective measures taken. This phenomenon has been observed in previous CINS investigations, and related safety recommendations have already been issued (see section 3.8.).

Software for analyzing track geometry recalculates measured parameters and compares them with the permissible error limits according to the SRPS EN 13848-5 standard.

This standard defines three threshold levels:

- AL (Warning Limit - WL): Indicator of the need for increased surveillance.

- IL (Intervention Limit - IL): Requires planning of corrective maintenance activities.

- IAL (Immediate Action Limit - IAL): Requires immediate measures to be taken to ensure traffic safety.

The registration of a parameter that exceeds the IAL requires urgent repair work, temporary speed restrictions, or complete closure of the track until the defect is corrected.

It should be noted that the limit values relate to individual parameters and do not consider the cumulative effect of overlapping errors on track safety or the degradation of track geometry due to dynamic loads. Therefore, quality analysis must also consider the impact of excessive cant on the rate of track degradation. Imposing a speed limit when twist exceeds IAL, combined with high cant, increases the probability of derailment due to the leading wheel climbing the rail and it is not a solution for such a situation. The defect must be corrected immediately. This is because reducing speed decreases centrifugal force, which relieves the vertical load on the outer rail wheels (reducing Q force) while guidance force (Y) remains approximately the same, thus increasing the Y/Q ratio and the likelihood of derailment. Previous CINS investigations have already issued safety recommendations regarding this (see section 3.8.).

The analysis of the quality of track geometry on the rate of track geometry degradation must also include the influence of excess cant, when it exists.

According to the Instruction on Amendments and Supplements to the Unified Criteria for Track Condition Control on the JŽ Network ("Official Gazette of ŽS", No. 14/22), which was valid at the time of track acceptance (see section 3.3.7.), permissible deviations from designed parameters are given by SRPS EN 13231-1:2014.

In the graphical and analytical report of the track recording vehicle from 08.04.2022, incorrect limit values for track geometry were used. Instead of the limits for acceptance of work on renewed and upgraded tracks, the limits from SRPS EN 13848-5, which relate to in-service track geometry, were applied. Table 4.2.1.1. presents an excerpt from the "IŽS"a.d. report of 08.04.2022 for the section of track from km 30+000 to km 30+998, where the track condition was assessed as very good.

Table 4.2.1.1: Excerpt from the Summary Overview of Deviations from km 30+000 to km 30+998

Region JK 30.000 – 31.000 (998 m)

Measurement 08.04.2022.

Summary:

Param	*GU*		*GI*		*GHI*	
	Len, m	*Count*	*Len, m*	*Count*	*Len, m*	*Count*
CANT	2.70	2	0.00	0	0.00	0
VERTICAL RAIL WEAR L	1.60	1	0.00	0	0.00	0
Total	**4.30**	**3**	**0.00**	**0**	**0.00**	**0**
Track condition assessment	***Very good***					
TQC_STD	***D***					

However, when these measurements are analyzed based on the acceptance limits from the SRPS EN 13231-1 standard, Table 1, or the Guidelines on Unified Criteria for Track Condition Control on the JŽ Network, which were in effect at the time of track acceptance, it is concluded that the cant at the time of the track opening did not meet the criteria set by the standard.

Figure 4.2.1.1. shows the measurement results in the zone where the derailment occurred, with acceptance limits for track works (for $v \leq 80$ km/h) of ±3 mm for cant and ±4.5 ‰ for twist (measured over a 3 m base).

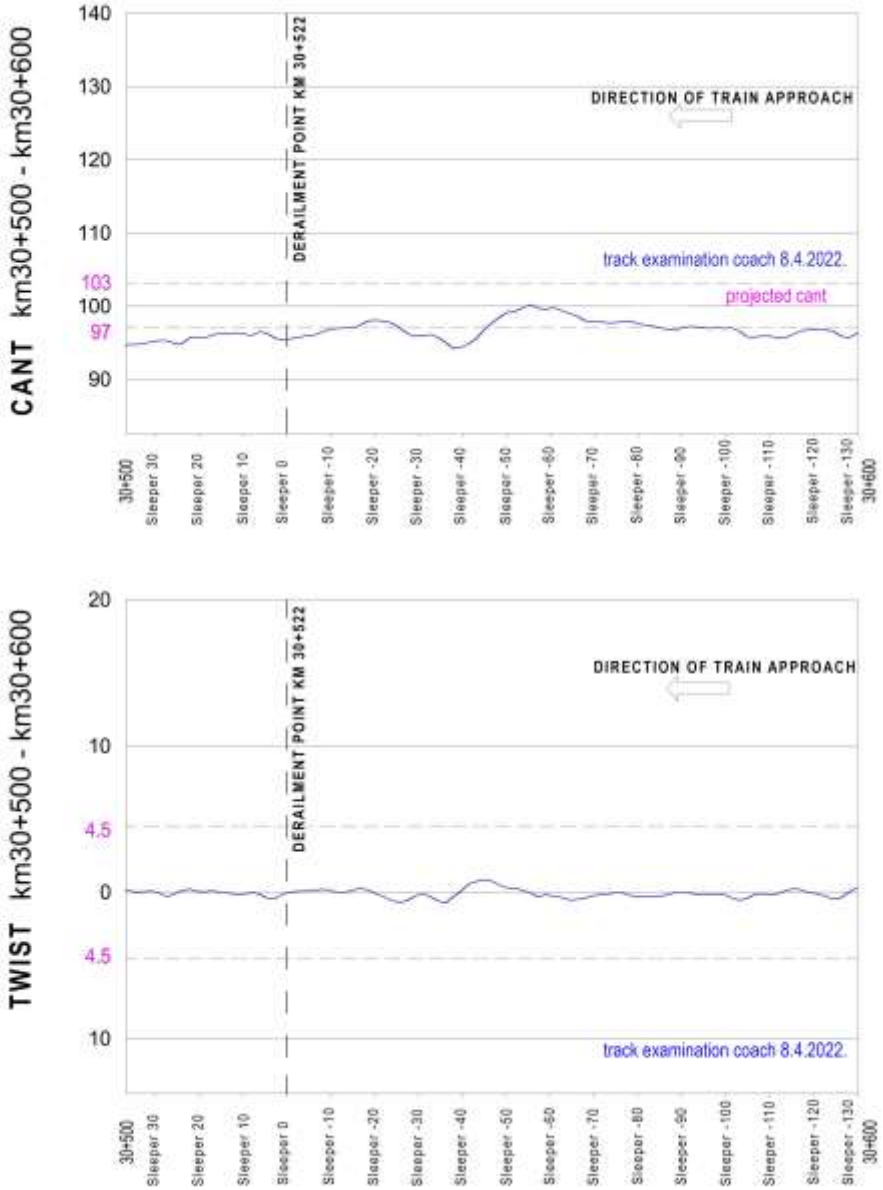


Figure 4.2.1.1: Track geometry measurement results obtained with the track recording vehicle on 08.04.2022, with limits for acceptance of works after renovation from the version of the Regulations that is in force on 08.04.2022

On the next measurement, carried out on 06.10.2022, two and a half months after the railway was put into operation, the summary report found that the cant exceeded the emergency intervention limit at the same mileage (Table 4.2.1.2.).

Table 4.2.1.2: Extract from the summary overview of deviations for km 30+000 to km 30+998

MEASUREMENT 06.10.2022.

Region JK 30.000 – 31.000 (1000 m)

Defects:

#	Param	Start	End	Threshold	Extremum	Length	Degree
1	*CANT*	30.115	30.120	-15.00	-16.97	5.10	***GHI***
2	*CANT*	30.137	30.141	15.00	17.53	4.10	***GHI***
3	CANT	30.542	30.551	15.00	18.13	9.20	**GHI**

Summary:

Param	*GU*		*GI*		*GHI*	
	Len, m	*Count*	*Len, m*	*Count*	*Len, m*	*Count*
D1 STABILITY D	3.00	1	0.00	0	0.00	0
CANT	297.85	28	46.90	9	18.40	**3**
TWIST	7.70	3	0.00	0	0.00	0
VERTICAL RAIL WEAR D	134.60	5	0.00	0	0.00	0
LATERAL RAIL WEAR D	0.20	8	0.00	0	0.00	0
Total	**443.35**	**45**	**46.90**	**9**	**18.40**	**3**
Track condition assessment	***Satisfactory***					
TQC_STD	***E***					

Figure 4.2.1.2. shows the results of cant and twist measurements in the zone where the derailment occurred, with the maintenance limits. For the observed curve, the relevant IAL of 6 ‰ was entered for the twist, which is explained in chapter 4.2.4.

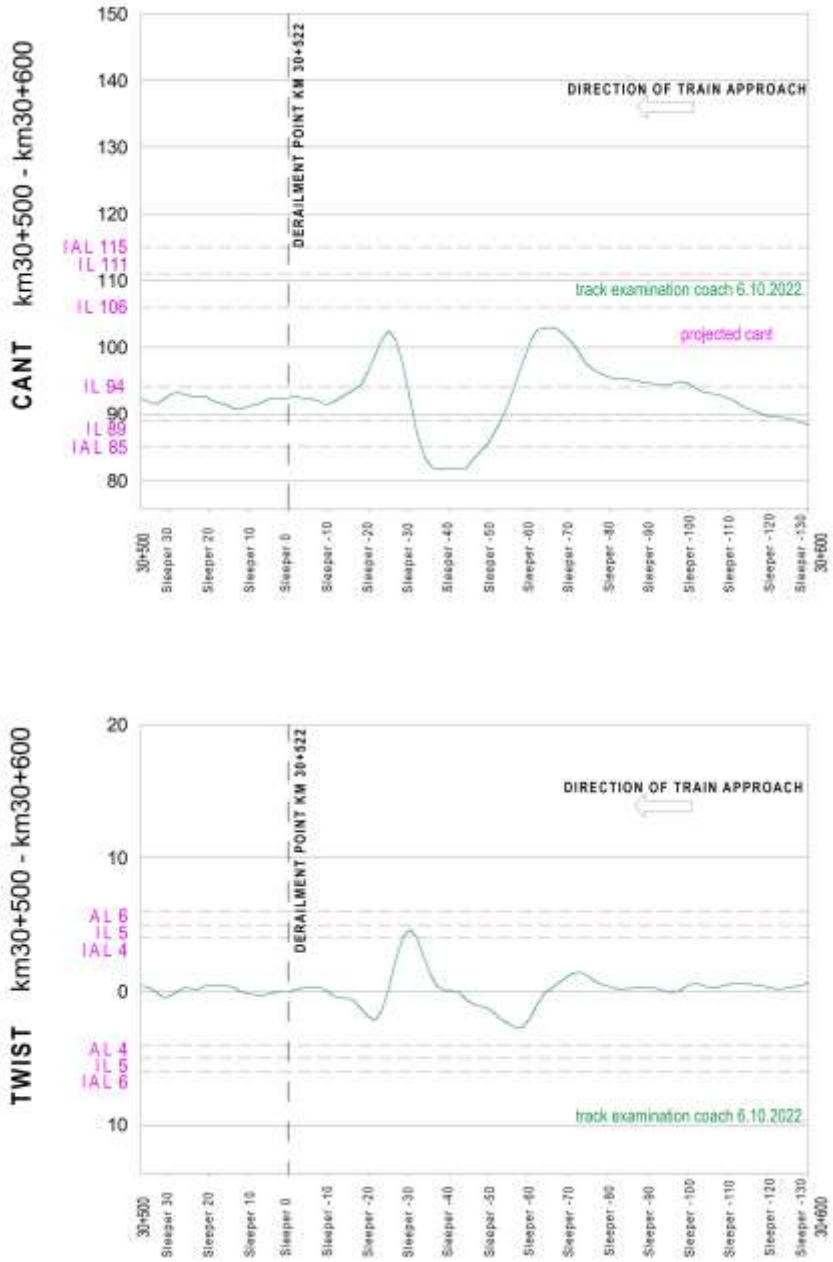


Figure 4.2.1.2: Track geometry measurement results obtained with the track recording vehicle on 06.10.2022. with limits for maintenance

Table 4.2.1.3. provides an excerpt from the summary report following measurements conducted on 10.04.2023. Figure 4.2.1.3. shows cant and twist in the derailment zone. Considering that machine-based track alignment was performed on this section during spring 2023, the applicable acceptance limits after track adjustment are those from SRPS EN 13231-1:2014, Table 2 (for $v \leq 80$ km/h) ±5 mm for cant and ±4.5 ‰ for twist deviation (measuring base 3 m), rather than the values from SRPS EN 13848-5, which were used in the report from "IŽS" a.d.

Table 4.2.1.3: Extract from the Summary Overview of Deviations from *km* 30+000 to *km* 30+998

Region JK 29.999 – 30.999 (1000 m)

MEASUREMENT 10.04.2023.

Defects:

#	Param	Start	End	Threshold	Extremum	Length	Degree

Summary:

Param	GU		GI		GHI	
	Len, m	Count	Len, m	Count	Len, m	Count
D1 VERSINE L	4.40	2	0.00	0	0.00	0
D1 VERSINE D	3.00	3	0.70	1	0.00	0
CANT	55.50	12	0.00	0	0.00	0
Total	**62.90**	**17**	**0.70**	**1**	**0.00**	**0**
Track condition assessment	**Very good**					
TQC_STD	**E**					

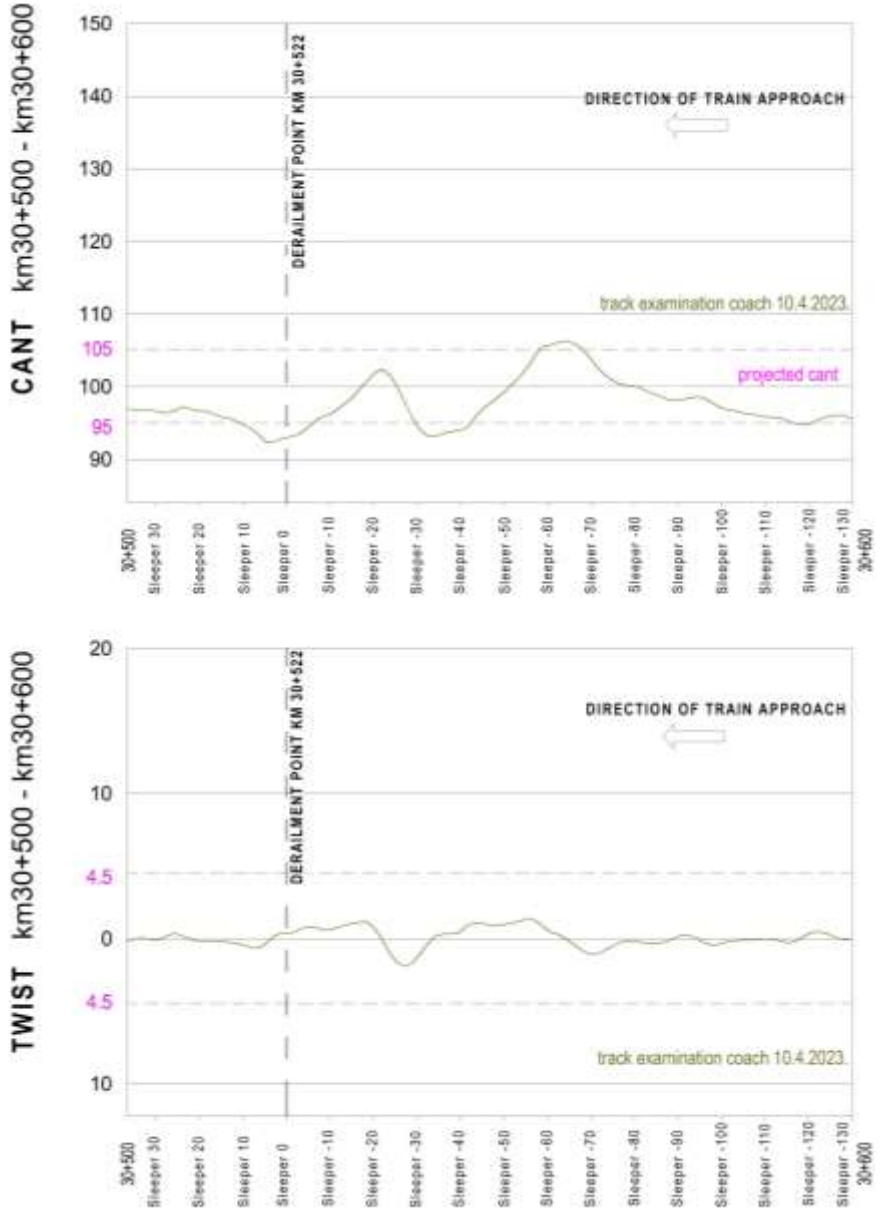


Figure 4.2.1.3: Track geometry measurement results obtained with the track recording vehicle on 10.04.2023. with maintenance acceptance limits, according to the applicable SRPS EN 13231-1 standard.

The figure shows that the works were not executed in accordance with the requirements of the Regulation, i.e., the standard, as the cant limit of ±5 mm was exceeded in multiple locations.

Tables and figures 4.2.1.4. to 4.2.1.6. show extracts of summary results and graphical representations of cant and twist in the derailment zone from other measurements by the track recording vehicle until the accident occurrence.

Table 4.2.1.4: Extract from the Summary Overview of Deviations from *km* 30+000 to *km* 30+998

MEASUREMENT 07.10.2023.

Region JK 29.999 – 30.999 (995,983 m)

Defects:

#	Param	Start	End	Threshold	Extremum	Length	Degree
1	CANT	30.130	30.111	-15.00	-49.57	18.70	**GHI**

Summary:

Param	GU		GI		GHI	
	Len, m	Count	Len, m	Count	Len, m	Count
D1 STABILITY L	3.30	1	0.00	0	0.00	0
D1 STABILITY D	3.90	1	0.00	0	0.00	0
CANT	95.00	27	11.10	6	18.70	**1**
TWIST	9.80	8	10.50	4	0.00	0
VERTICAL RAIL WEAR L	7.70	3	0.00	0	0.00	0
LATERAL RAIL WEAR L	0.80	1	0.00	0	0.00	0
Total	**120.50**	**41**	**21.60**	**10**	**18.70**	**1**
Track condition assessment	**Satisfactory**					
TQC_STD	**E**					

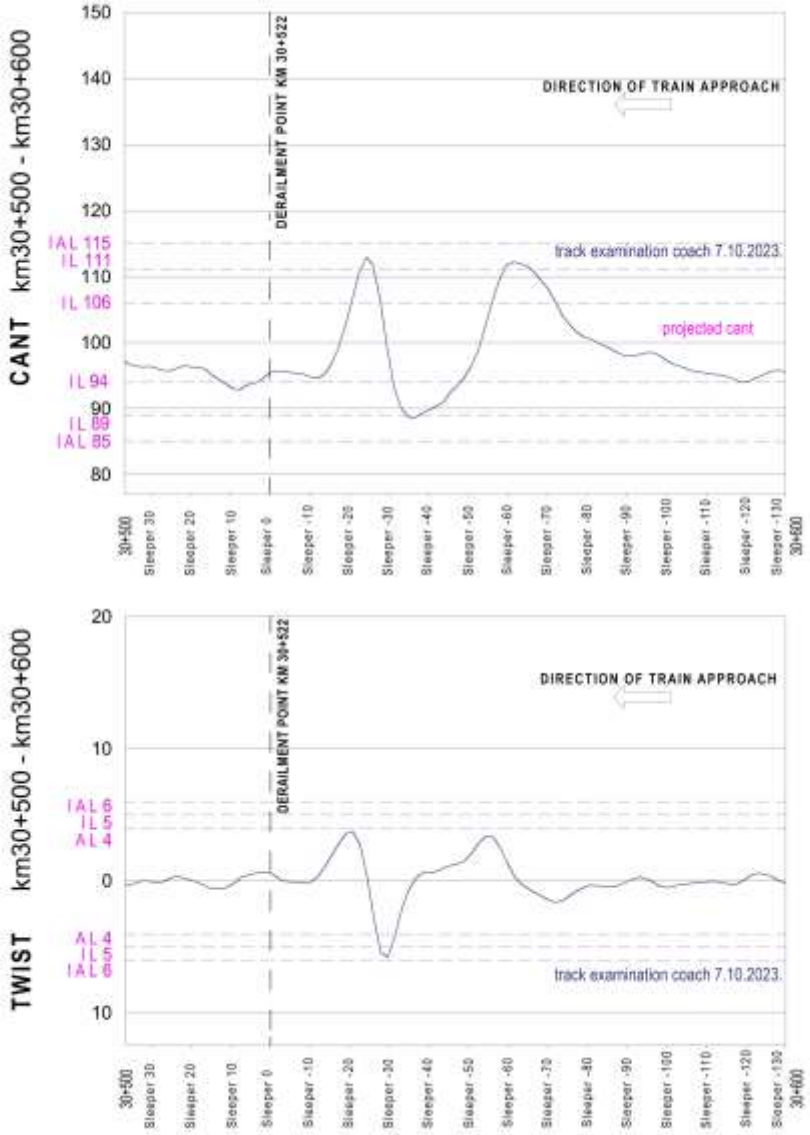


Figure 4.2.1.4: Track geometry measurement results obtained with the track recording vehicle on 07.10.2023. with maintenance limits.

Table 4.2.1.5: Excerpt from the Summary of Deviations from *km* 30+000 to *km* 30+998

Region JK 29.999 – 30.999 (1000 m)

MEASUREMENT 04.3.2024.

Defects:

#	Param	Start	End	Threshold	Extremum	Length	Degree
1	CANT	30.536	30.530	-15.00	-24.36	6.20	**GHI**
2	CANT	30.560	30.546	-15.00	-22.67	13.90	**GHI**

Summary:

Param	GU		GI		GHI	
	Len, m	Count	Len, m	Count	Len, m	Count
CANT	87.20	19	19.50	4	20.10	**2**
VERTICAL RAIL WEAR R	89.80	44	0.00	0	0.00	0
LATERAL RAIL WEAR L	0.50	1	0.00	0	0.00	0
LATERAL RAIL WEAR R	0.70	2	0.00	0	0.00	0
Total	**224.10**	**89**	**19.50**	**4**	**20.10**	**2**
Track condition assessment	**Satisfactory**					
TQC_STD	**E**					

#	Param	Start	End	Threshold	Extremum	Length	Degree
1277	VERTICAL RAIL WEAR R	30.502	30.500	12.00	16.71	2.30	GU
1278	VERTICAL RAIL WEAR R	30.505	30.503	12.00	16.48	2.00	GU
1279	VERTICAL RAIL WEAR R	30.509	30.506	12.00	16.09	2.50	GU
1280	VERTICAL RAIL WEAR R	30.523	30.523	12.00	12.65	0.90	GU
1281	VERTICAL RAIL WEAR R	30.526	30.525	12.00	16.06	1.20	GU
1282	CANT	30.529	30.528	-6.00	-10.91	1.10	GU
1283	VERTICAL RAIL WEAR R	30.530	30.529	12.00	14.00	0.50	GU
1284	CANT	30.530	30.529	-11.00	-14.80	0.70	GI
1285	TWIST	30.531	30.528	4.00	4.70	2.50	GU
1286	CANT	30.536	30.530	-15.00	-24.36	6.20	**GHI**
1287	CANT	30.546	30.536	-11.00	-14.93	9.10	GI
1288	VERTICAL WEAR R	30.551	30.551	12.00	12.79	0.20	GU
1289	VERTICAL WEAR R	30.555	30.551	12.00	16.22	3.10	GU
1290	VERTICAL WEAR R	30.558	30.556	12.00	16.38	1.90	GU
1291	CANT	30.560	30.546	-15.00	-22.67	13.90	**GHI**
1292	CANT	30.561	30.560	-11.00	-14.83	1.20	GI
1293	VERTICAL RAIL WEAR R	30.562	30.559	12.00	16.46	2.30	GU
1294	CANT	30.563	30.561	-6.00	-10.96	1.80	GU
1295	VERTICAL RAIL WEAR R	30.566	30.565	12.00	12.93	0.40	GU
1296	VERTICAL RAIL WEAR R	30.567	30.566	12.00	14.62	0.70	GU
1297	VERTICAL RAIL WEAR R	30.572	30.569	12.00	15.99	2.80	GU
1298	VERTICAL RAIL WEAR R	30.575	30.572	12.00	15.93	2.30	GU
1299	VERTICAL RAIL WEAR R	30.581	30.577	12.00	16.07	4.40	GU
1300	VERTICAL RAIL WEAR R	30.599	30.594	12.00	16.21	5.50	GU

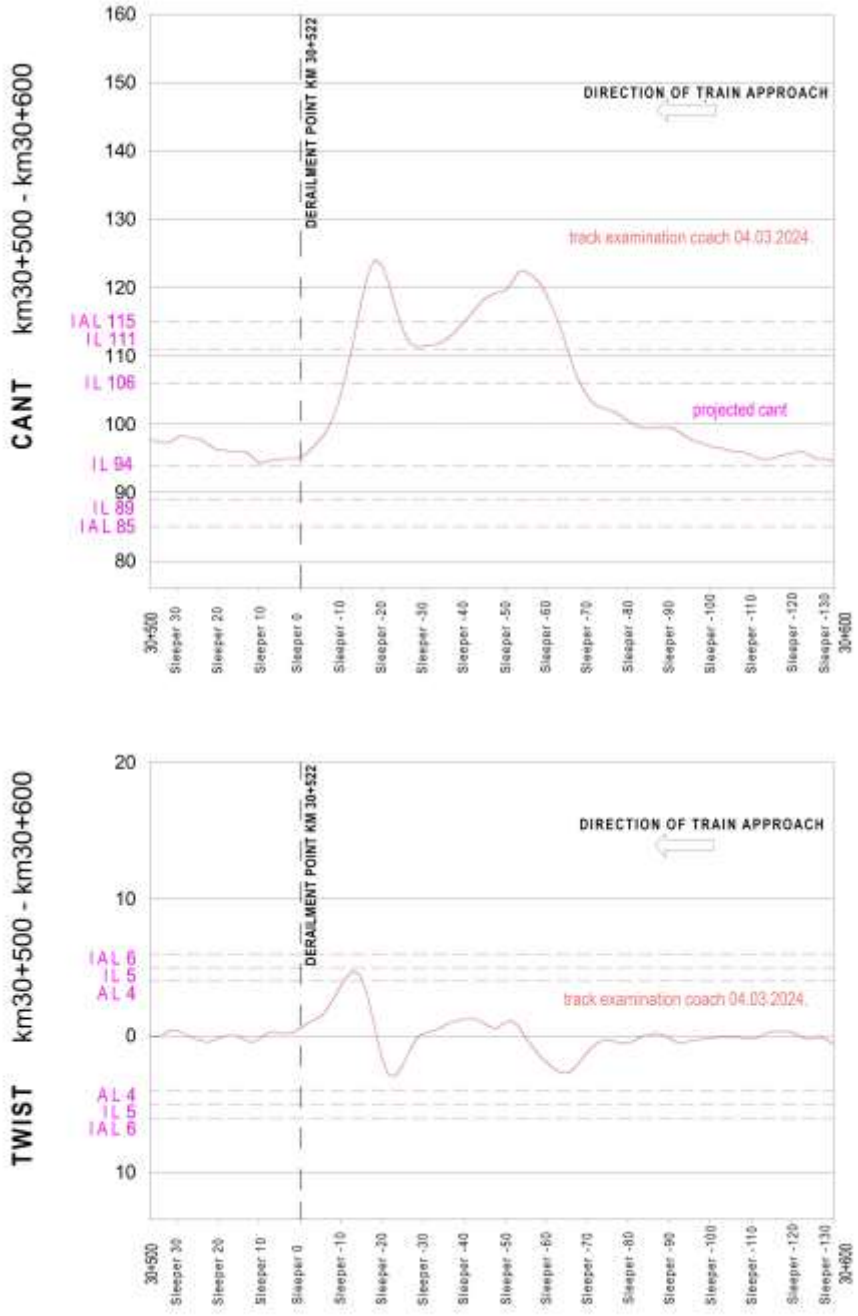


Figure 4.2.1.5: Track geometry measurement results obtained with the track recording vehicle on 04.03.2024. with maintenance limits.

Table 4.2.1.6: Excerpt from the summary of deviations from km 30+000 to km 30+998

MEASUREMENT 10.12.2024.

Region JK 30.000 – 31.000 (998,938 m)

Defects:

#	Param	Start	End	Threshold	Extremum	Length	Degree
1	CANT	30.108	30.113	-15.00	-23.56	5.30	**GHI**
2	CANT	30.131	30.138	15.00	23.20	7.10	**GHI**
3	CANT	30.141	30.147	15.00	16.79	6.00	**GHI**
4	CANT	30.168	30.182	15.00	16.75	13.50	**GHI**
5	CANT	30.529	30.536	-15.00	-31.32	7.20	**GHI**
6	CANT	30.549	30.560	-15.00	-28.00	10.70	**GHI**
7	CANT	30.636	30.639	15.00	16.26	2.80	**GHI**
8	CANT	30.670	30.674	-15.00	-15.72	3.60	**GHI**
9	CANT	30.939	30.939	-15.00	-15.02	0.30	**GHI**

30 km 963 m CANT: 65. Transition Start: 65 -> 0

Summary:

Param	GU		GI		GHI	
	Len, m	Count	Len, m	Count	Len, m	Count
D1 STABILITY R	6.10	2	0.00	0	0.00	0
D1 SMER D	4.10	2	0.00	0	0.00	0
CANT	191.26	35	58.20	22	56.50	**9**
TWIST	9.80	7	8.30	3	0.00	0
VERTICAL WEAR L	70.20	40	0.00	0	0.00	0
VERTICAL WEAR R	40.20	13	0.00	0	0.00	0
LATERAL WEAR R	4.60	5	0.00	0	0.00	0
Total	**326.26**	**104**	**66.50**	**25**	**56.50**	**9**
Track condition assessment	**Unsatisfactory**					
TQC_STD	**E**					

#	Param	Start	End	Threshold	Extremum	Length	Degree
1509	D1 STABILITY R	30.523	30.525	-12.00	-16.00	2.30	GU
1510	D1 VERSINE R	30.524	30.527	12.00	13.79	2.80	GU
1511	TWIST	30.527	30.528	-4.00	-4.98	0.80	GU
1512	CANT	30.527	30.528	-6.00	-10.59	0.80	GU
1513	TWIST	30.528	30.531	-5.00	-5.93	2.70	GI
1514	CANT	30.528	30.529	-11.00	-14.86	0.60	GI
1515	CANT	30.529	30.536	-15.00	-31.32	7.20	**GHI**
1516	D1 STABILITY R	30.530	30.533	12.00	16.55	3.80	GU
1517	TWIST	30.531	30.531	-4.00	-4.89	0.50	GU
1518	D1 VERSINE R	30.533	30.534	-12.00	-12.70	1.30	GU
1519	TWIST	30.534	30.535	4.00	4.93	0.40	GU
1520	TWIST	30.535	30.537	5.00	5.79	1.90	GI
1521	CANT	30.536	30.537	-11.00	-14.62	0.70	GI
1522	TWIST	30.537	30.537	4.00	4.86	0.50	GU
1523	CANT	30.537	30.547	-6.00	-10.94	10.30	GU
1524	CANT	30.548	30.549	-11.00	-14.90	1.70	GI
1525	CANT	30.549	30.560	-15.00	-28.00	10.70	**GHI**
1526	VERTICAL WEAR R	30.550	30.580	12.00	18.76	30.10	GU
1527	CANT	30.560	30.561	-11.00	-14.89	1.00	GI
1528	LATERAL WEAR R	30.561	30.561	6.90	6.61	0.20	GU
1529	VANT	30.561	30.563	-6.00	-10.79	1.60	GU
1530	LATERAL WEAR R	30.562	30.564	6.20	6.87	1.80	GU
1531	LATERAL WEAR R	30.574	30.575	6.90	6.59	1.60	GU
1532	LATERAL WEAR R	30.578	30.579	6.90	7.15	0.80	GU
1533	LATERAL WEAR R	30.580	30.580	6.90	6.64	0.20	GU
1534	CANT	30.584	30.594	6.00	7.70	9.70	GU

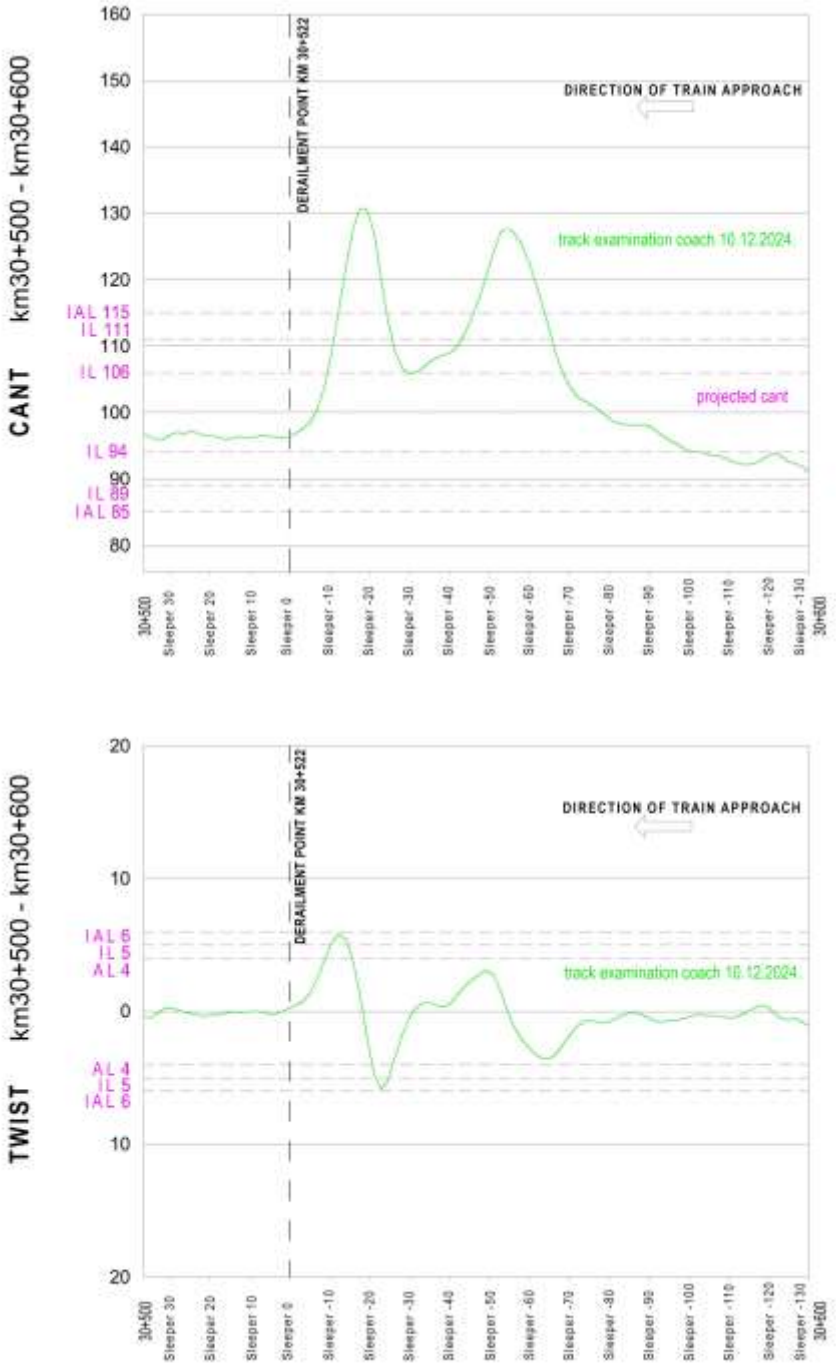


Figure 4.2.1.6: Track geometry measurement results obtained with the track recording vehicle on 10.12.2024. with maintenance limits.

The results of the measurements using the track recording vehicle showed that rail wear values along the track were within the allowed limits.

"IŽS" a.d. provided the "Rail Wear Record for 2024". The measurement was carried out on 30.10.2024. The measured rail wear values were within the permissible tolerances.

The vertical and lateral wear tolerances of the rail head are defined by SRPS EN 13674-1.

4.2.2. Manual measurement of track parameters conducted by CINS after the Accident

On-site, on 12.02.2025, CINS carried out measurements of track gauge and cant in the derailment zone. The measurements were performed using a manual track gauge measurement device, Robel brand, owned by CINS. The zero reference sleeper was marked at km 30+522, at the point where the trace of derailment was observed. Measurements were taken on sleepers 0 to -130 in the direction of increasing mileage (from km 30+522 to km 30+600, opposite to the direction of train No. l51202 travel) where the derailment trace was identified, and on sleepers 1 to 15 (from km 30+522 to km 30+513) in the direction of train travel.

The survey of track gauge and cant is presented in Table 4.2.2.1.

Table 4.2.2.1: Results of measurements on 12.02.2025 in the derailment zone, conducted by CINS, using a manual track gauge measurement device

Sleeper No.	Mileage (km)	Deviation from track gauge (mm)	Cant (mm)
15	30+513.00	-8.9	-97.3
14	30+513.60	-7.5	-97.2
13	30+514.20	-3.0	-96.9
12	30+514.80	-8.0	-96.2
11	30+515.40	6.2	-95.4
10	30+516.00	6.5	-95.0
9	30+516.60	4.6	-94.9
8	30+517.20	3.7	-94.7
7	30+517.80	3.8	-94.5
6	30+518.40	3.5	-94.2
5	30+519.00	4.1	-94.7
4	30+519.60	3.6	-96.0
3	30+520.20	3.7	-97.1
2	30+520.80	5.7	-97.6
1	30+521.40	7.3	-97.2
0	**30+522.00**	**8.3**	**-96.0**
-1	30+522.60	9.0	-95.3
-2	30+523.20	10.1	-94.8
-3	30+523.80	10.8	-94.4
-4	30+524.40	11.2	-94.6
-5	30+525.00	11.6	-95.4
-6	30+525.60	11.9	-96.5
-7	30+526.20	12.7	-98.0
-8	30+526.80	13.0	-100.1
-9	30+527.40	12.9	-102.5
-10	30+528.00	12.4	-105.4
-11	30+528.60	12.1	-109.2
-12	30+529.20	11.9	-112.9
-13	30+529.80	11.8	-117.3
-14	30+530.40	11.4	-121.8
-15	30+531.00	10.7	-126.1
-16	30+531.60	10.1	-129.7
-17	30+532.20	9.0	-132.7
-18	30+532.80	8.0	-135.0
-19	30+533.40	7.9	-137.0
-20	30+534.00	8.0	-138.6
-21	30+534.60	8.5	-139.6
-22	30+535.20	8.3	-140.3
-23	30+535.80	7.2	-140.6

Sleeper No.	Mileage (km)	Deviation from track gauge (mm)	Cant (mm)
-24	30+536.40	6.4	-140.5
-25	30+537.00	6.1	-139.3
-26	30+537.60	7.0	-137.2
-27	30+538.20	8.4	-134.2
-28	30+538.80	8.8	-130.6
-29	30+539.40	8.3	-127.0
-30	30+540.00	9.1	-123.7
-31	30+540.60	10.3	-120.9
-32	30+541.20	10.6	-119.3
-33	30+541.80	10.3	-118.3
-34	30+542.40	9.3	-118.4
-35	30+543.00	8.7	-118.8
-36	30+543.60	8.6	-119.0
-37	30+544.20	8.8	-119.2
-38	30+544.80	9.2	-119.1
-39	30+545.40	9.9	-119.2
-40	30+546.00	11.2	-119.2
-41	30+546.60	12.2	-119.2
-42	30+547.20	12.4	-120.0
-43	30+547.80	12.4	-120.2
-44	30+548.40	12.0	-120.3
-45	30+549.00	11.1	-120.7
-46	30+549.60	10.5	-121.6
-47	30+550.20	10.0	-122.9
-48	30+550.80	9.6	-124.3
-49	30+551.40	9.2	-125.7
-50	30+552.00	9.2	-126.6
-51	30+552.60	9.0	-127.8
-52	30+553.20	8.9	-128.7
-53	30+553.80	9.7	-129.5
-54	30+554.40	9.9	-130.2
-55	30+555.00	10.0	-130.8
-56	30+555.60	10.1	-131.8
-57	30+556.20	10.0	-132.1
-58	30+556.80	10.3	-131.9
-59	30+557.40	11.3	-130.8
-60	30+558.00	11.7	-129.6
-61	30+558.60	11.5	-128.7
-62	30+559.20	7.1	-127.4

Sleeper No.	Mileage (km)	Deviation from track gauge (mm)	Cant (mm)
-63	30+559.80	11.1	-126.1
-64	30+560.40	10.9	-124.6
-65	30+561.00	10.9	-122.6
-66	30+561.60	10.7	-120.7
-67	30+562.20	11.7	-118.4
-68	30+562.80	11.2	-116.2
-69	30+563.40	10.6	-113.8
-70	30+564.00	10.4	-111.1
-71	30+564.60	10.6	-108.8
-72	30+565.20	11.1	-107.0
-73	30+565.80	11.8	-105.5
-74	30+566.40	12.1	-104.1
-75	30+567.00	12.6	-102.9
-76	30+567.60	12.2	-102.1
-77	30+568.20	12.2	-101.3
-78	30+568.80	12.1	-100.8
-79	30+569.40	12.1	-100.5
-80	30+570.00	12.0	-100.0
-81	30+570.60	11.3	-99.8
-82	30+571.20	10.1	-99.5
-83	30+571.80	9.3	-99.1
-84	30+572.40	9.7	-98.8
-85	30+573.00	11.1	-98.1
-86	30+573.60	11.8	-97.7

Sleeper No.	Mileage (km)	Deviation from track gauge (mm)	Cant (mm)
-87	30+574.20	11.9	-97.3
-88	30+574.80	11.9	-97.0
-89	30+575.40	12.0	-97.2
-90	30+576.00	12.0	-97.1
-91	30+576.60	12.2	-97.2
-92	30+577.20	12.5	-97.1
-93	30+577.80	12.6	-97.2
-94	30+578.40	11.9	-97.2
-95	30+579.00	10.6	-96.9
-96	30+579.60	9.6	-96.6
-97	30+580.20	9.9	-96.0
-98	30+580.80	9.6	-95.5
-99	30+581.40	9.6	-95.3
-100	30+582.00	10.5	-94.8
-103	30+583.80	11.6	-93.9
-106	30+585.60	11.2	-93.0
-109	30+587.40	10.5	-93.0
-112	30+589.20	11.0	-92.5
-115	30+591.00	10.7	-91.8
-118	30+592.80	10.8	-91.3
-121	30+594.60	10.1	-91.5
-124	30+596.40	10.7	-92.0
-127	30+598.20	10.6	-92.1
-130	30+600.00	12.1	-90.8

4.2.3. Track condition analysis

4.2.3.1. Superstructure

Based on the records from the track recording vehicle since the line was put into service, as provided by "IŽS"a.d, and the manual measurements conducted by CINS the day after the accident, it is evident that the derailment occurred on a section of track where the track cant and twist exceeded the emergency intervention limit (IAL).

On main line No. 103, from km 12+045 to km 99+716, the only mechanized maintenance was performed at the beginning of 2023, following supervision by the Internal Control Center of "IŽS"a.d. The Internal Control Center Report dated 05.03.2024 notes that mechanized track adjustment was carried out over a length of 7,790 m, partially prioritized in certain areas. The improvement results for the section from km 30+500 to km 30+600 can be seen in the overlaid diagram of twist and cant (Figure 4.2.3.1.), but these results did not meet the acceptance limits for maintenance works according to the SRPS EN 13231-1 standard, as specified in the Instruction on Amendments and Supplements to the Instructions on Uniform Criteria for Track Condition Control on the JŽ Network ("Official Gazette ZJŽ", Nos. 6/01 and 4/04), document No. 4/2022-3496-718 dated 25.03.2022 (see Section 3.3.6.).

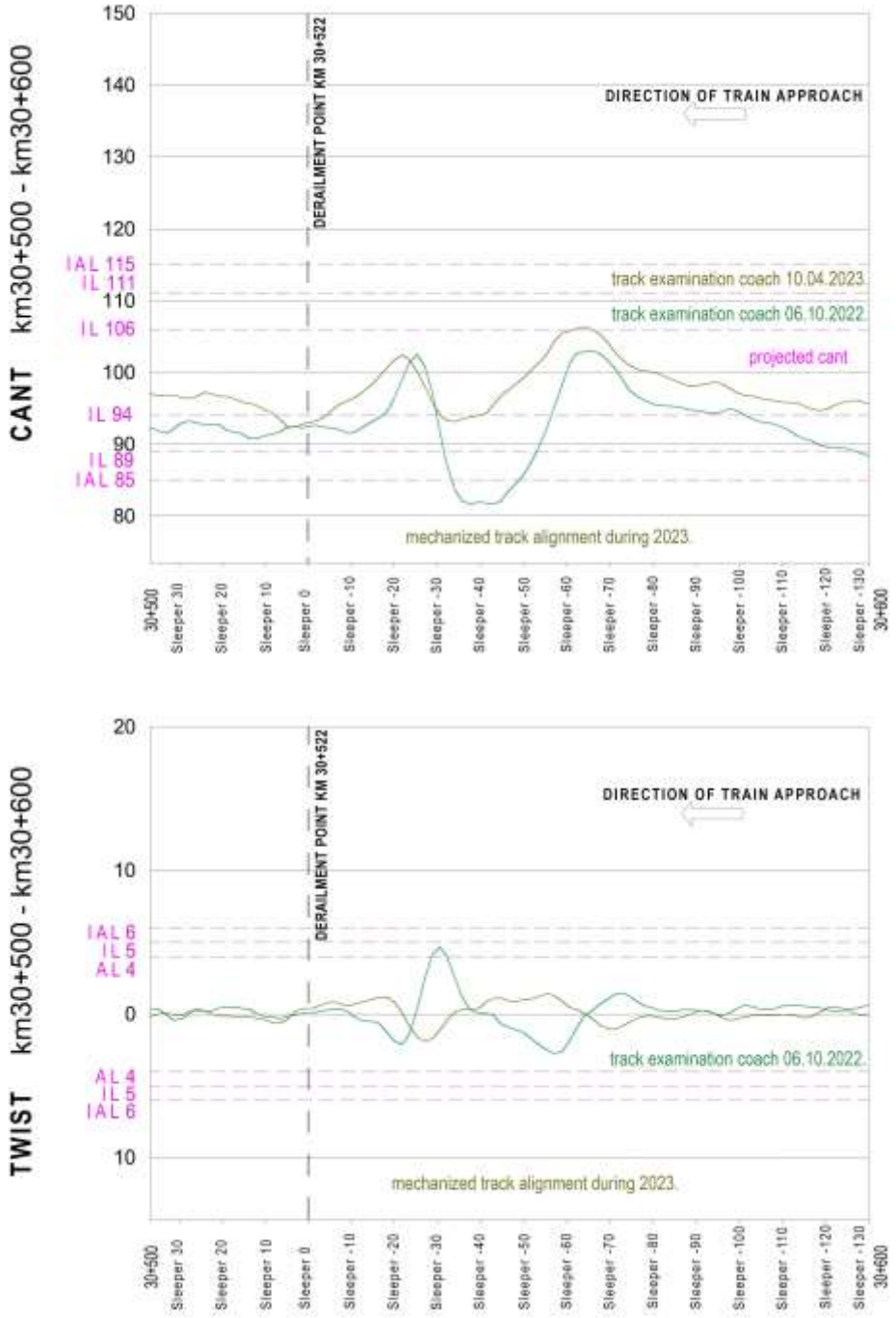


Figure 4.2.3.1: Cant and twist variation in the derailment zone
before and after mechanized track alignment at the beginning of 2023

Except for a single mechanized track adjustment performed in 2023, the track geometry parameters have been in continuous decline (Figure 4.2.3.1.), as evidenced by the number of UIC urgent (IAL), intervention (IL), and warning (AL) errors, as well as the track condition assessments for each measurement conducted.

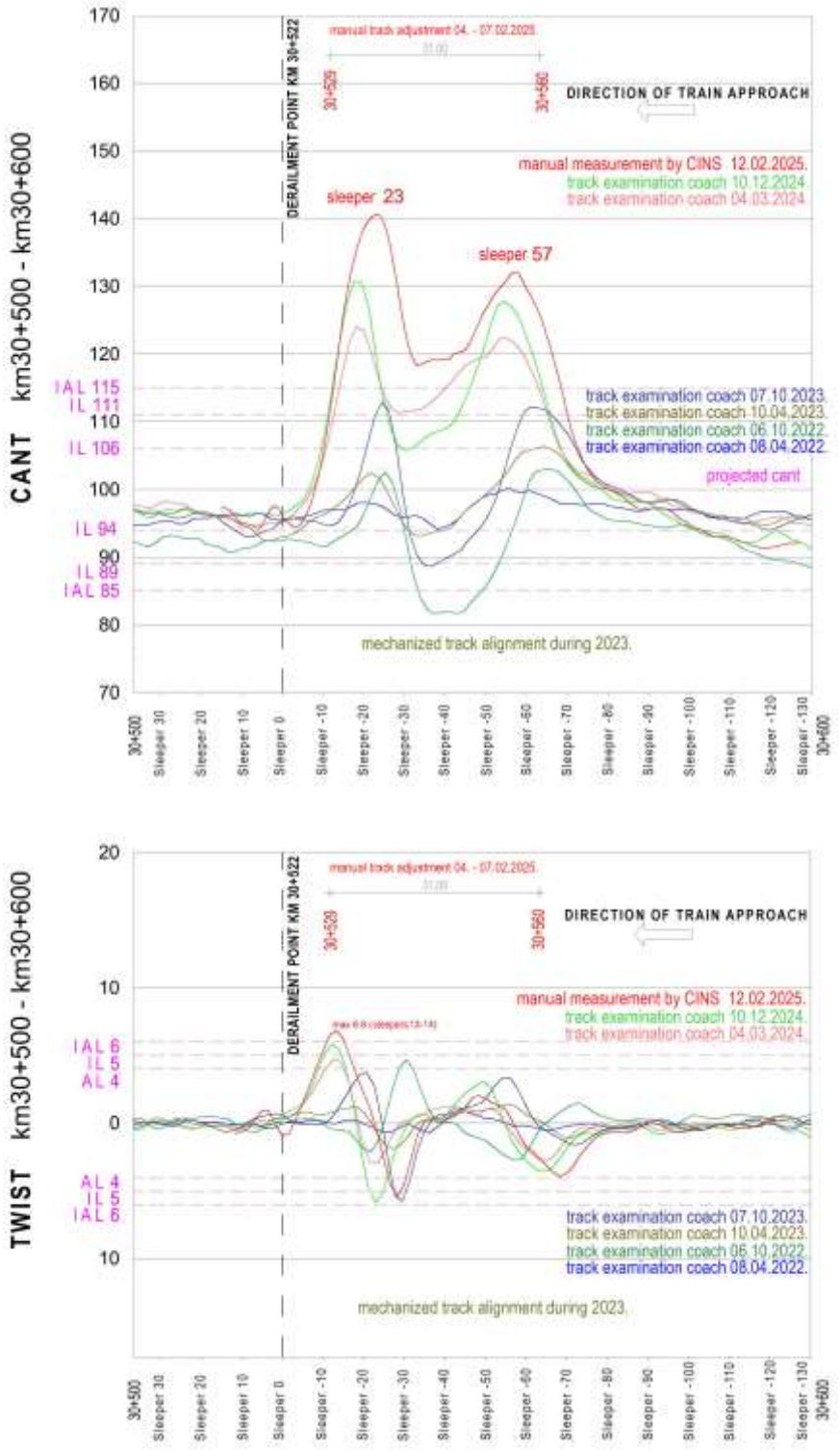


Figure 4.2.3.2: Overview of cant and twist from the commissioning of the line up to the derailment

A poor practice is observed whereby track maintenance is carried out only following inspection by the Internal Control Center. For example, manual track adjustment on the section from km 30+529 to km 30+560, where temporary restricted-speed running was imposed on

28.08.2024, was initiated only after the inspection by the Internal Control Center, which commenced on 03.02.2025. On the overlaid diagram of cant and twist from 10.12.2024 and the CINS manual measurement taken the day after the accident (Figure 4.2.3.3.), no correction of the track geometry is visible, although such an adjustment should have been carried out via manual regulation and, according to the provided documentation, was completed four days before the accident (07.02.2025).

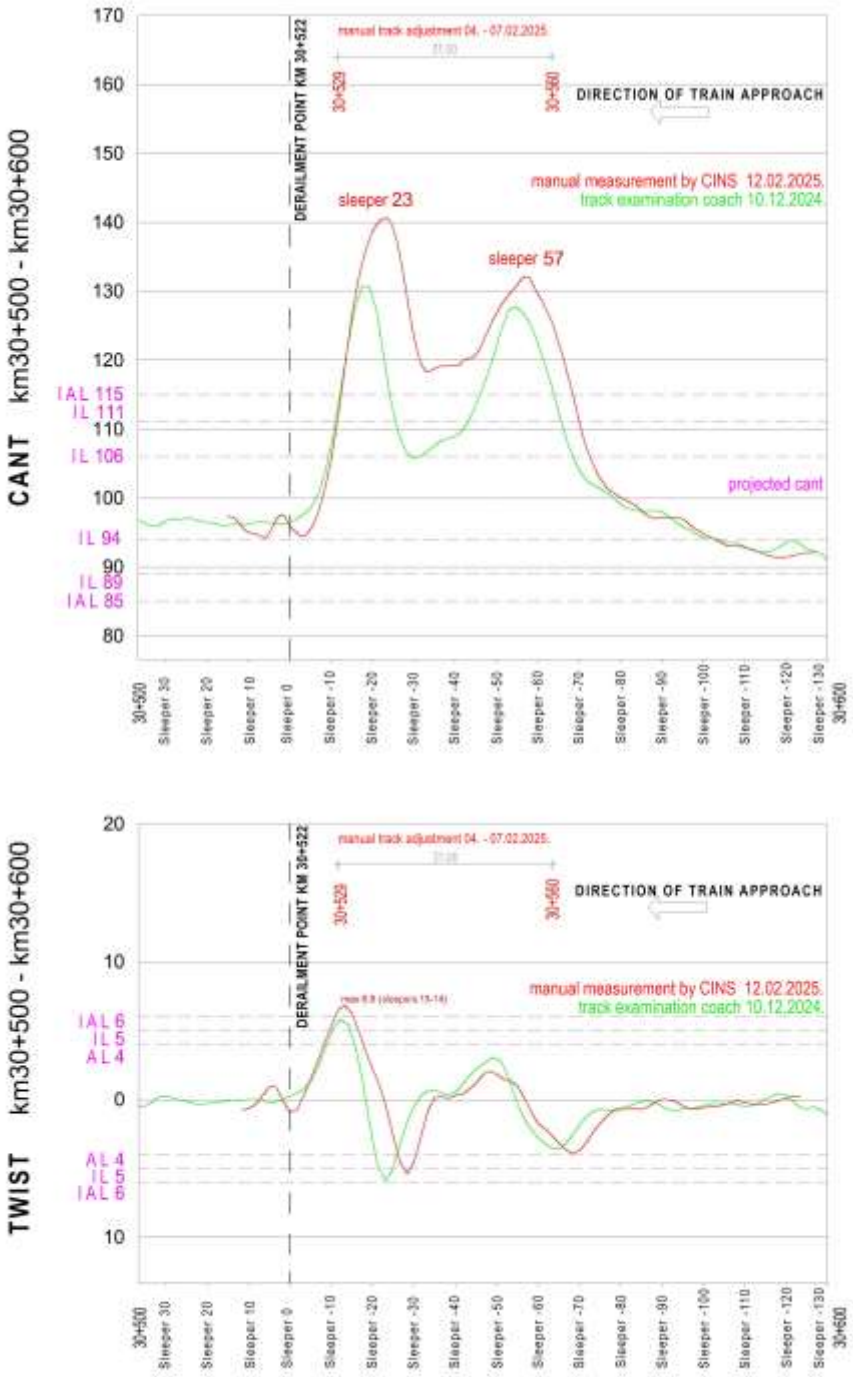


Figure 4.2.3.3: Comparison of measurement results obtained by the track recording vehicle on 10.12.2024 and manual measurements carried out after the accident on 12.02.2025

In the operational plan received from "IŽS"a.d., mechanized track adjustment was scheduled to correct the deficiencies identified in the Internal Control Center report, with a completion deadline of 31.12.2024.

It can be concluded that, on the section exhibiting a constant decline in track geometry quality, manual adjustment did not yield results.

The intervention limit (IL) refers to the parameter value that, if exceeded, requires extraordinary maintenance to ensure that the indicator value does not reach the immediate action limit (IAL) before the next measurement. Measurement results indicate that the IL for both cant and twist was exceeded already on 04.03.2023, at which point adjustment should have been planned and executed.

According to the track recording vehicle diagrams and CINS manual measurements, the maximum track twist was observed between sleepers 12 and 15 (between 7 m and 9 m) in front of the wheel climb point.

Due to poor track geometry, a restricted-speed running of 50 km/h was imposed on 28.08.2024 from km 30+100 to km 30+600 (the timetable-prescribed speed at that location was 65 km/h).

From the imposition of the restricted-speed running, until the first maintenance work on the problematic section, five months elapsed, which is contrary to Article 49 of the Rulebook on Maintenance of the Superstructure and Substructure of Railway Lines ("Official Gazette of RS" No. 39/23), according to which temporary speed restrictions must be removed within a maximum of 30 days on lines with lower traffic volumes (see section 3.3.5.). Additionally, under the Railway Law ("Official Gazette of RS" Nos. 41/2018 and 62/2023) (see section 3.3.1.), the infrastructure manager is obliged to notify the Republic Inspector for Traffic of the introduction and planned removal of speed restrictions.

4.2.3.2. Substructure

During 2024, settlement of embankment was observed from km 30+100 to km 30+600 (Report No. 14/2025-2.1-2/1 dated 25.02.2025, inspection conducted at OC ZOP Požarevac, Section 5.3.13). The section where restricted-speed runnings were imposed twice due to disturbed track geometry coincides with the section where track settlement was observed.

It is unacceptable to correct sections where the same errors in track geometry have occurred since the moment the line was opened by manual adjustment.

At the same location, repeated geometry disturbances occur even after mechanized adjustment. The consistent recurrence of the same type of irregularity indicates that the problem is not caused by insufficient machine processing but stems from deeper structural factors within the substructure.

Potential causes may include:

- Local soil settlement,
- Lateral or longitudinal embankment slippage
- Inadequate or non-functional drainage
- degradation of the protective layer or embankment material,
- Problems with the track foundation (e.g., weak bearing layer, variable moisture, organic material, etc.).

These processes result in track geometry returning relatively quickly to a state of deviation even after proper adjustment, as the root cause lies below the sleeper level - in the supporting structure that fails to provide stability.

While the actual cause within the substructure remains unresolved, disturbances in track geometry will continue to occur, regardless of the frequency and quality of mechanized adjustment. Therefore, it is necessary to shift from a reactive to a root-cause-oriented approach - first identifying and then permanently eliminating the structural problem.

4.2.4. Analysis of track twist management

Twist is a track characteristic important for safety against derailment. The safety against derailment of railway vehicles is verified during type approval according to the SRPS EN 14363 standard, and originally in reports.

In the SRPS EN 13848-5 standard, the twist is defined as: “The algebraic difference between two cants, taken at a defined distance, usually expressed as the gradient between two measurement points. It is expressed in ‰ or mm/m”. Therefore, the twist **g** for different measurement bases can simply be obtained as the difference in cant (D - the designation for cant in the standard) expressed in mm in two sections at a distance ℓ, divided by that distance in m: $g = (D_2-D_1)/\ell$.

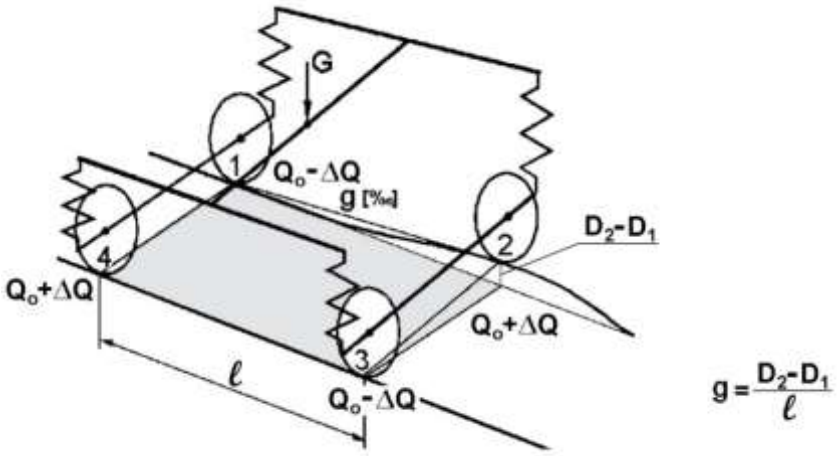


Figure 4.2.4.1: Influence of twist on wheel unloading

Figure 4.2.4.1. illustrates the influence of track twist on the distribution of vertical loads on the wheels of a railway vehicle. In practical terms, twist represents the deviation (D_2 - D_1) of support point 2 in the figure from the plane defined by the other three points (1, 3 and 4). As a consequence, taking into account the suspension effect, the wheels on one diagonal become unloaded relative to the static load Q_0 on flat track, while the wheels on the opposite diagonal become additionally loaded.

In an equivalent manner, for vehicles with two bogies, the wheels on one vehicle diagonal are unloaded, while those on the opposite diagonal are additionally loaded. For unloading within a single bogie, the governing parameter is the track twist based on the distance between wheelsets in the bogie. For unloading along the vehicle diagonals, the governing parameter is the track twist based on the distance between bogie centres. Both unloading effects are superimposed. Therefore,

for each derailment case, the governing parameters are the track twist based on the distance of wheelsets in bogie and the track twist based on the distance between bogie centres of the specific wagon.

For this reason, standard SRPS EN 13848-5 presents a diagram of limit values for twist depending on the measuring base (Figure 4.2.4.2.). Another track parameter which, in combination with twist at reduced speeds in curves, affects derailment safety is cant. Therefore, two limit curves are specified in the standard. Curve "A" applies to values of outer rail cant in curves, denoted as "D" and expressed in millimetres, which satisfy the condition: $D \leq (R-100)/2$ (where the curve radius R is expressed in metres).

The limit values of twist requiring immediate intervention according to Curve A are determined using the expression: $IAL = ((20/\ell) + 3)$, with a maximum value of 7 mm/m for lines with speeds below 200 km/h, and 5 mm/m for lines with speeds above 200 km/h.

Curve "B" applies to values of outer rail cant in curves, denoted as "D" and expressed in millimetres, which satisfy the condition: $(R-100)/2 < D < (R-50)/1,5$.

If the twist exceeds (R-50)/1.5, in addition to the track twist limitations according to Curve "B", additional derailment prevention measures are required, such as installation of a check rail, lubrication of the outer rail gauge face, etc.

The limit values of twist requiring immediate intervention according to Curve "B" are determined using the formula: $IAL = ((20/\ell) + 1,5)$, with a maximum value of 6 mm/m and a minimum limit value of 3 mm/m.

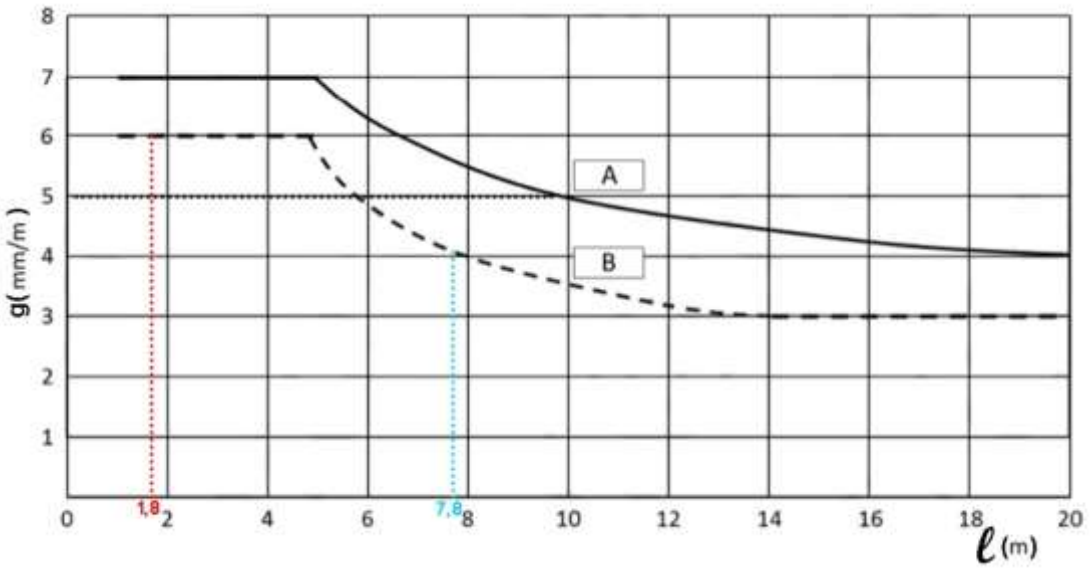


Figure 4.2.4.2: Limit values of twist

The curve in which the derailment occurred has a radius R=295 m and a designed cant D=100 mm.

Since: D = 100 mm > (R-100)/2 = (195-100)/2 =97,5 mm,

Curve “B” is governing for this curve. For a measuring base of 3 m, the IAL value is therefore 6 mm/m, instead of 7 mm/m.

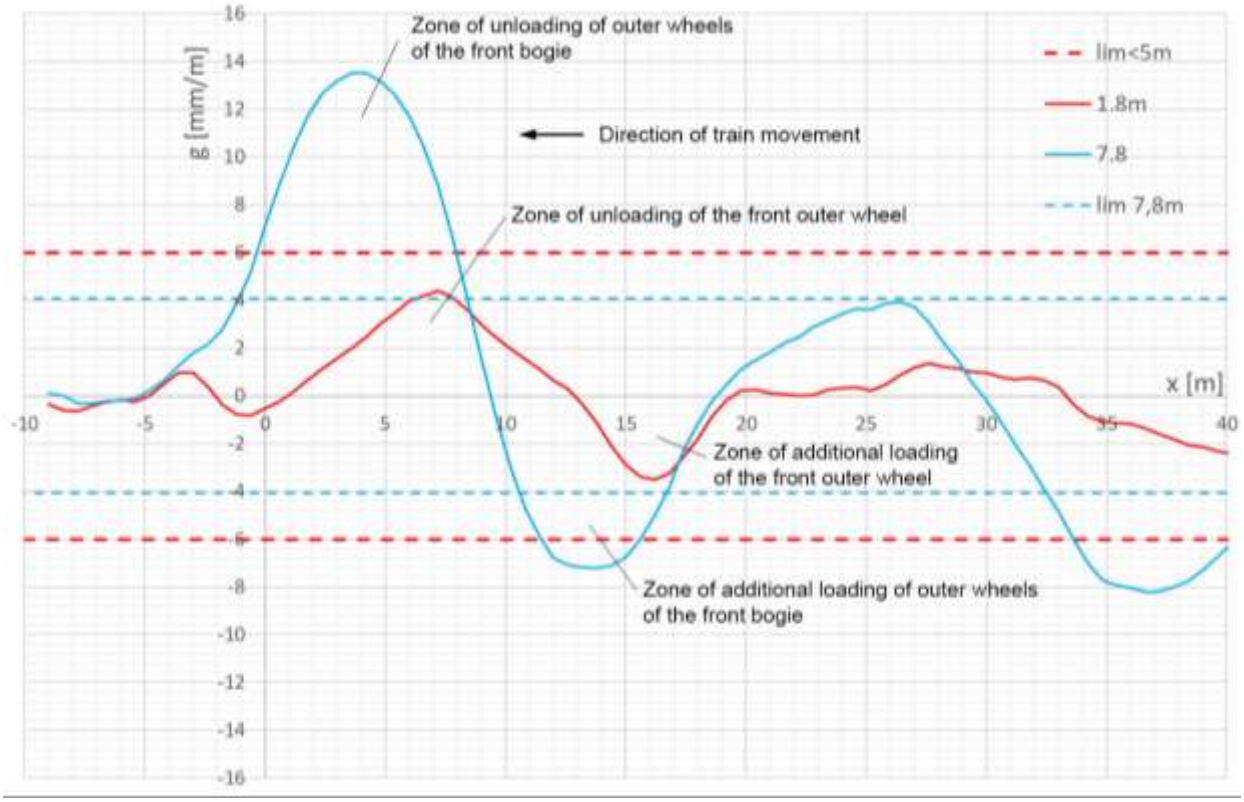
In the reports of “IŽS”a.d. concerning track geometry defects, the same IAL value of 7 mm/m is used for all curve radii, regardless of cant. In the analysis of track geometry condition records, for all curves that do not meet the cant condition for Curve “A”, the IAL value corresponding to Curve “B” must be applied; therefore, for a measuring base of 3 m, 6 mm/m should be used instead of 7 mm/m.

It should be noted that IAL values for twist refer to the total twist value (designed value + deviation), as measured, for example, by the SEVER 1435 track recording vehicle.

According to the Instruction on Amendments and Supplements to the Instruction on Unified Criteria for Track Condition Monitoring on the JŽ Network (“Official Gazette of ŽS”, No. 14/22), dated 19.04.2022 (see section 3.3.7.), limit values for twist are specified for the acceptance of works on renewed and new tracks, as well as for the acceptance of maintenance works. **The stated values are given without clarification that they refer to the maximum deviation from the designed track twist** (see standard SRPS EN 13231-1:2023, Table 1), rather than to total track twist values. It should be noted that the designed twist on straight track and in full curves is 0 mm/m, while on transition ramps the track twist corresponds to the ratio of designed cant to the length of the transition ramp (transition ramp gradient in mm/m). It is necessary to add a note to the values for acceptance of works as in the standard SRPS EN 13231-1:2023, Table 1.

It should be noted that the 3 m measuring base, for which IAL values are specified in SRPS EN 13848-5, and acceptance values in SRPS EN 13231-1, was selected as representative of typical distances between the outer wheelsets in a bogie, which range from 1.8 m for freight wagons to more than 4 m for three-axle locomotive bogies.

With regard to the specific derailment, the governing parameters are the track twist based on the distance between wheelsets in bogie, which for the derailed wagon was 1.8 m, and the track twist based on 7.8 m, corresponding to the distance between bogie centres. Based on the cant data measured in the derailment zone immediately after the accident by CINS, as presented in Table 4.2.2.1, the calculated twist values are shown in Figure 4.2.4.3. The figure also shows the limit values according to the Curve “B” from the SRPS EN 13848-5 standard for measuring bases of 1.8 m and 7.8 m (see Figure 4.2.4.2.).



Слика 4.2.4.3: Twist based on the dimensions of the derailed wagon

It is observed that the twist based on the distance of wheelsets in the bogie is within acceptable limits. However, the twist based on the distance between bogie centres, within the derailment zone, is several times greater than the permitted 4.06 mm/m for a base of 7.8 m. Considering that unloading effects on the leading wheel are superimposed, the cumulative effect, at approximately 7 to 8 m before of the zero sleeper, led to wheel climb onto the rail. It should be noted that the conditions for unloading of the leading wheel and its climbing onto the rail occur in zones of decreasing cant, i.e., they depend on the direction of transition of twist. Therefore, in Figure 4.2.4.3, the zones of vertical unloading and zones of additional loading for the leading wheel are indicated, corresponding to the actual direction of movement.

Based on this, it follows that at locations with disturbed height track geometry, it is necessary to consider not only the track twist on a 3 m base, as presented in measurement results, but also on longer bases typical of distances between bogie centres. As previously stated, track twist on any measuring base can be calculated from measured cant values.

On local lines, industrial railways and industrial sidings, as well as on non-renewed lines, Article 6 and the Annex of the Rulebook on Railway Lines Super and Sub Structure Maintenance (“Official Gazette of RS”, No. 39/23) (see section 3.3.5.) define parameters and limit values for errors (Type A, Type B and Type C), as well as instructions for evaluating the track geometry condition of one kilometre of line.

The table contains limit values for track geometry parameters, where it can be observed that the values for Type C errors (defects exceeding operational limits) are excessively relaxed and inconsistent with the maximum values specified in standard SRPS EN 13848-5.

Limit values for twist, even for Type A errors, are specified above the theoretically maximum track twist limit of 7 (6) mm/m. It should be taken into account that SRPS EN 14363 prescribes verification of derailment safety during type testing of railway vehicles using a maximum track twist of 7 mm/m (‰) on bases up to 5 m in length. This means **that existing railway vehicles are not designed for twist values exceeding 7 mm/m, such as those specified in the table contained in the Annex of the Rulebook on Railway Lines Super and Sub Structure Maintenance ("Official Gazette of RS", No. 39/23).**

Unlike IAL, i.e., Type C errors, which take into account the interaction between vehicle and track, as well as the risk of undesired events, the other quality levels are mainly related to maintenance policy.

The alert limit (AL) and the intervention limit (IL) may be adjusted by national regulations, as they are closely linked to maintenance policy. **The immediate intervention limits (IAL - Type C errors) are defined in standard SRPS EN 13848-5, and increasing these limits leads to an unacceptable level of derailment risk.**

4.2.5. Line Maintenance Resources

According to data provided by "IŽS"a.d, OC ZOP Požarevac maintains: 282.79 km of open line and main running tracks, 68 km of other station tracks, 292 switches and crossings on open lines, main running and other tracks, 51 bridges with a total length L=1.71 km, 20 tunnels with a total length L=11.68 km, 432 culverts, 213 level crossings, 34 service locations, as well as a significant number of retaining walls, lining walls, drainage and protective channels. The number of operational staff includes a total of 23 employees (track workers, operators of light track machinery, and auxiliary workers).

OC ZOP Požarevac has the following machinery available:

- One road-rail excavator (VAIA CAR) - operational,
- Two TMD units - non-operational.

According to Norms I - IV for routine maintenance of standard-gauge track superstructure per governing kilometre (Traffic Institute CIP Study: Methodology for Calculating Costs of Routine and Investment Maintenance of Track Superstructure for Speeds up to 160 km/h, Belgrade, April 1997), for OC ZOP Požarevac, assuming that all 282.79 km of open line and main running tracks belong to Category I, 0.211 workers per kilometre are required for superstructure maintenance, i.e., a total of 59.67 workers. For other tracks and switches, an additional number of workers would be required.

Application of the above study indicates an insufficient number of operational staff at OC ZOP Požarevac for maintenance of the railway track superstructure to ensure safe and orderly railway traffic. Consequently, the number of operational staff is also insufficient for maintenance of the railway track substructure.

4.2.6. Infrastructure usage permit

Based on the Law on Interoperability of the Railway System (see sections 3.3.3. and 3.3.4.), infrastructure components, as structural subsystems of the railway system of the RS, must possess an permit for use. In the case of renewal of the railway line, the contracting authority is obliged to

submit documentation to the Railway Directorate, based on which the Directorate decides whether a new authorization for use is required.

Following a second reminder request for submission of data, a notification was received from "IŽS"a.d. by e-mail dated 17.09.2025, that "IŽS"a.d. does not possess a Permit for Use, nor has it submitted documentation to the Railway Directorate regarding the renewal of a section of Main Line No. 103 between Jajinci and Mala Krsna stations.

4.2.7. Inspection supervision

On Main Line No. 103 (Belgrade Center) - Rakovica - Jajinci - Mala Krsna - Velika Plana), between Jajinci and Mala Krsna stations, the Section for Inspection Affairs of Railway Traffic, Sector for Inspection Supervision, Section for Inspection Affairs of Railway Traffic of the Ministry of Construction, Transport and Infrastructure, conducted 16 inspections (regular, extraordinary, and control) related to the line during the period from 01.01.2022 until the occurrence of the accident. During these inspections, no irregularities in the superstructure or substructure that would endanger traffic safety were recorded.

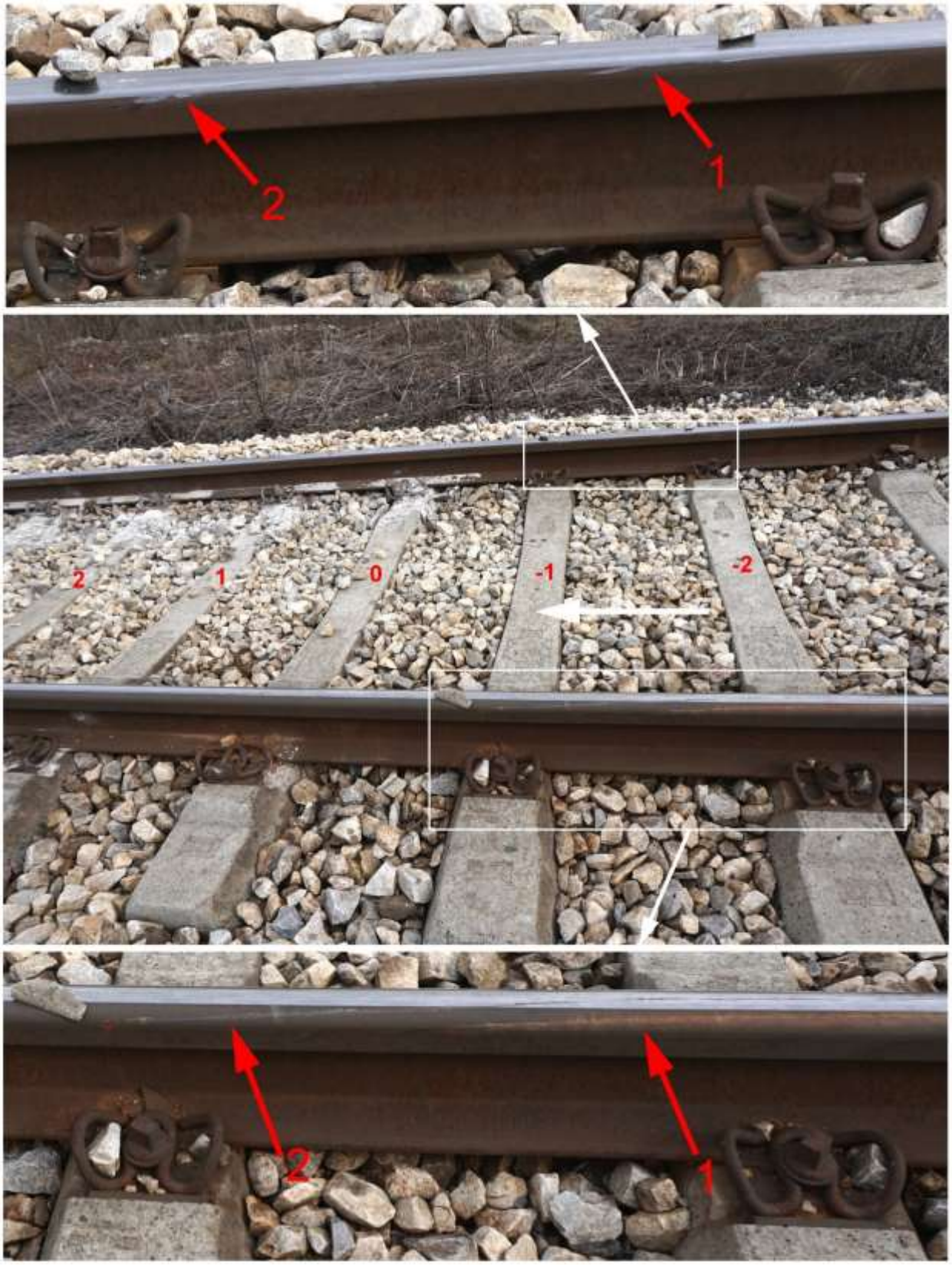
4.2.8. Inspection at the site of the derailment

Representatives of CINS attended the accident site on 11.02, 12.02 and 14.02.2025. The inspection was carried out in the zone of the initial derailment and in the Vrčin station area, where the eleventh wagon, No. 33 87 7866 801-6, rotated and overturned, and the twelfth wagon, No. 33 72 7867 837-6, derailed with its first two wheelsets.

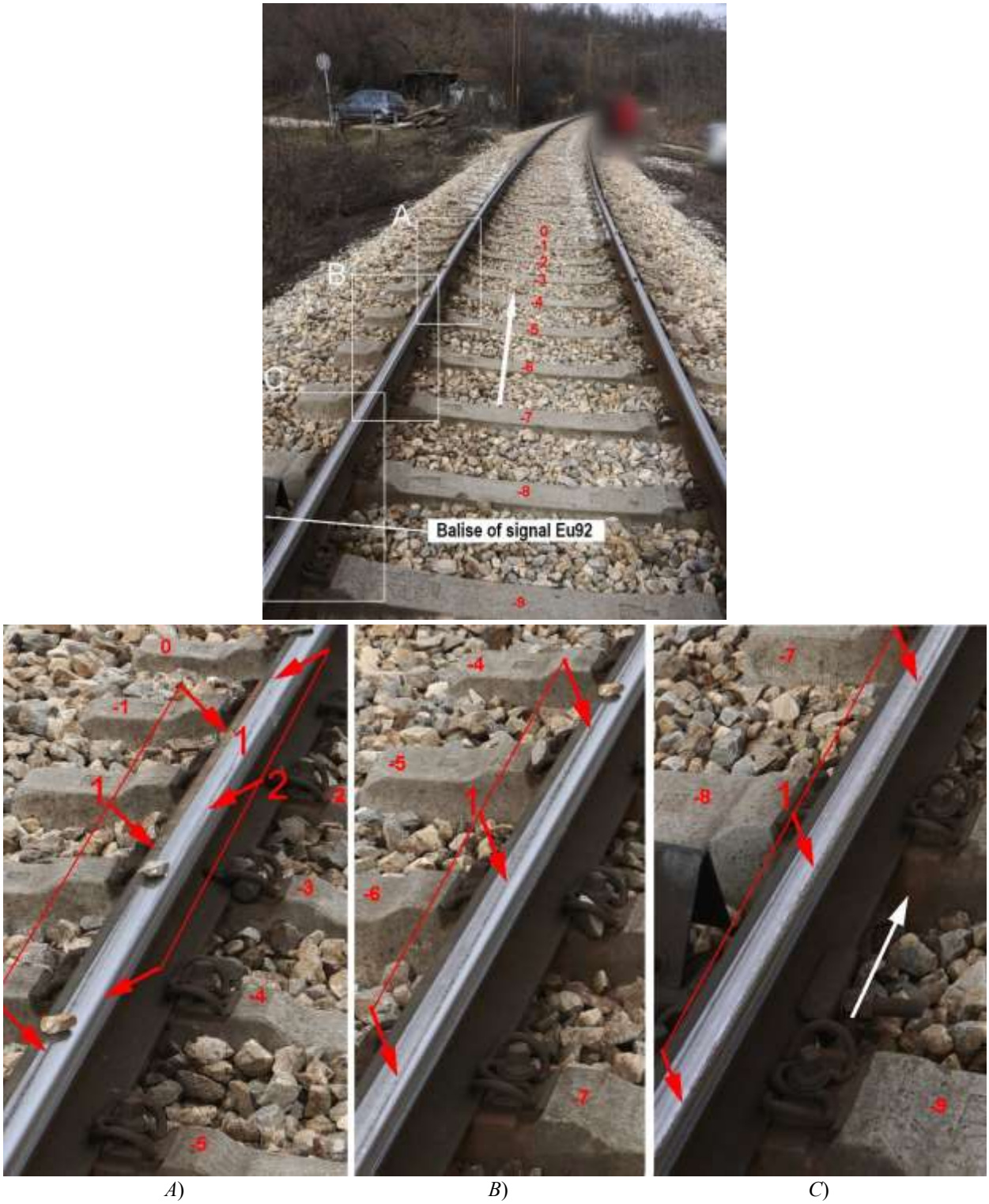
Observed in the direction of train movement, the derailment location is situated in a right-hand curve with a radius of 295 m and a designed cant of 100 mm. According to the documentation provided by "IŽS" a.d., a restricted-speed running of 50 km/h was in force from km 30+100 to km 30+600, with the stated reason for its imposition being "poor track geometry".

At km 30+522, a mark was observed on the fastening system and sleeper, indicating fall of the right wheel into the track and simultaneous derailment of the left wheel from the track. This sleeper is marked as No. 0 in Figure 4.2.8.1. and in the subsequent figures. The following sleepers, in the direction of movement, are marked with increasing numbers (1, 2, 3, etc.), while sleepers before of the derailment point are marked with numbers -1, -2, etc.).

The direction of train movement is indicated by a white arrow. Details relevant to the investigation are indicated by red arrows and, where necessary, numbered. Enlarged details are shown in the upper and lower parts of Figure 4.2.8.1, where marks on the rails caused by derailment of wheels from two wheelsets are visible.



Слика 4.2.8.1: Point of the derailment of Train No. 51202



A) *B*) *C*)

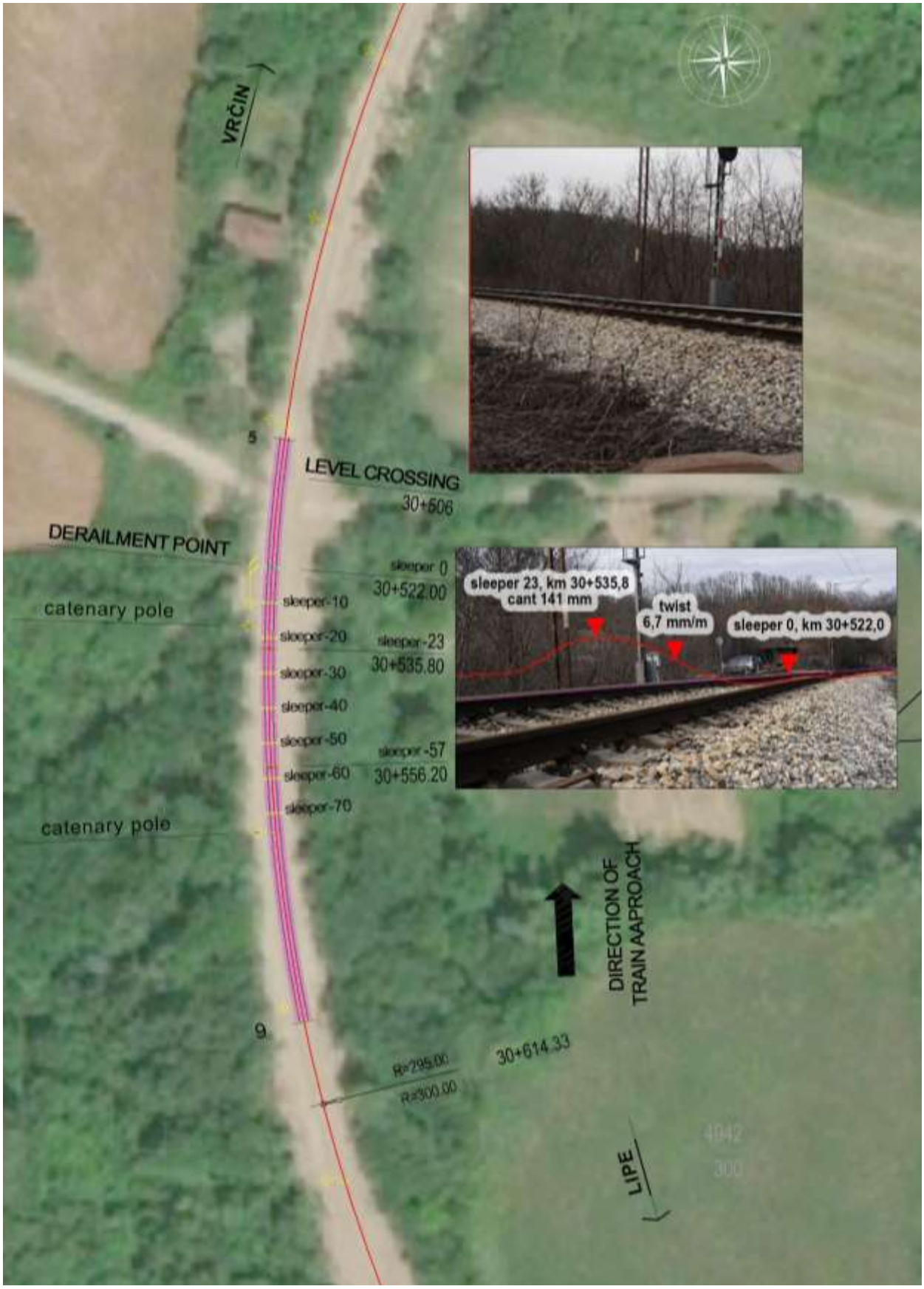
Слика 4.2.8.2: Wheel flange marks of the first and second wheelset on the outer rail

Figure 4.2.8.2. shows a wider derailment zone with enlarged details A), B) and C). By tracing backwards, the wheel flange marks on the running surface of the outer rail, it can be observed that the flange of the outer wheel of the second wheelset climbed onto the rail at sleeper -5, and the flange of the wheel of the first wheelset between sleepers -9 and -10, which is approximately 6 m before of sleeper 0. Due to partial side wear of the outer rail, it was not possible to determine the

exact point of the beginning of wheel climb. It can be estimated that this point for the first wheelset was approximately two sleepers before, i.e. about 7 m before sleeper 0.

The track in the derailment zone has a visibly disturbed geometry, as illustrated in Figures 4.2.8.3. and 4.2.8.4. CINS representatives measured the track width and cant in the derailment zone, as shown in point 4.2.2.

In Figure 4.2.8.4, the measuring device is positioned above sleeper 0. Climb of the outer wheel of the first wheelset of wagon No. 33 87 7866 801-6 began approximately at sleeper -12. The wheel flange climbed onto the rail between sleepers -10 and -9, began descending towards the outer side of the rail at sleeper -2, and struck sleeper 0 from the outer side, as shown in the previous figures.



Слика 4.2.8.3: Derailment zone

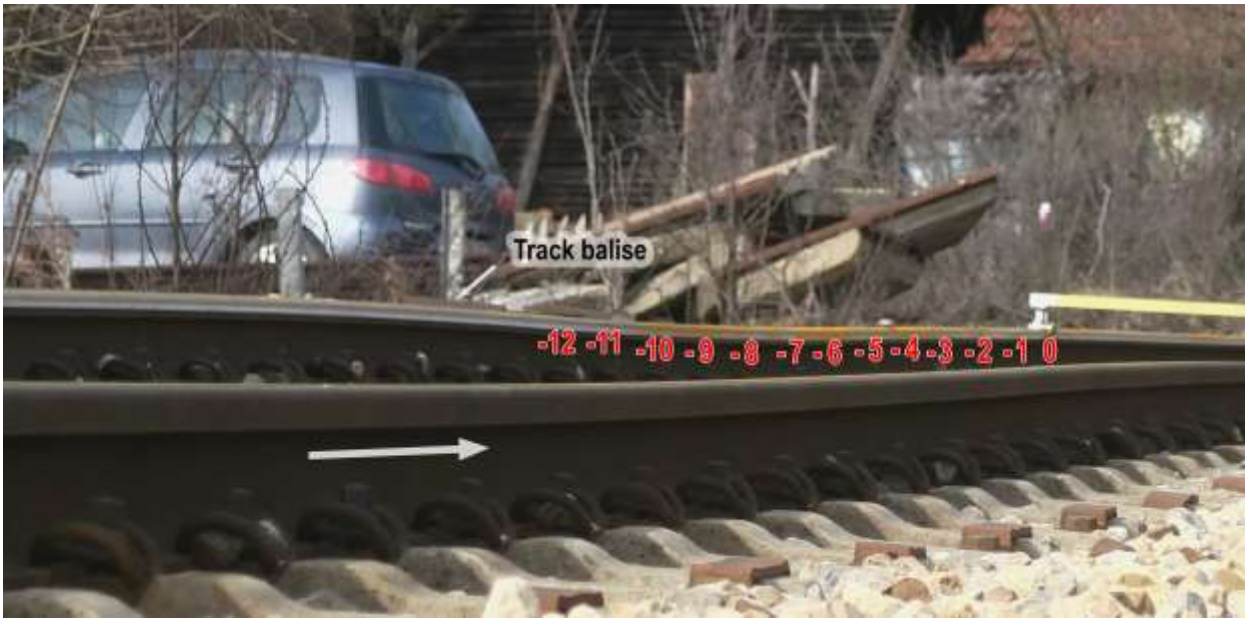


Figure 4.2.8.4: Track layout in the derailment zone

4.2.9. Inspection of the line section from the derailment location to Vrčin station

From sleeper 0 to Vrčin station, marks of derailed wheelsets and broken or damaged sleepers can be traced, as illustrated in Figure 4.2.9.1.

Figure 4.2.9.1: Damaged and broken sleepers

Figure 4.2.9.2. shows a frame from a CCTV camera at level crossing PBE-1 (Vrčin 2). Intense sparking caused by impacts of the wheels of the leading bogie of the eleventh wagon against sleepers and ballast can be observed.

Figure 4.2.9.2: Sparking caused by impacts of derailed wheels of the eleventh wagon against the track structure (source: "IŽS"a.d.)

In the track area between the derailment site and Vrčin station, some suspension components of the front bogie of wagon No. 33 87 7866 801-6 became detached. One suspension link was found at km 25+800, Figure 4.2.9.3. Several broken parts were located between the entrance signal Eu 91 and the entrance switch No. 6 at Vrčin station. The front bogie's broken headstock of the eleventh wagon was found approximately 50 m before switch No. 4 at Vrčin station. All these components detached as a consequence of impacts with sleepers and ballast over a distance exceeding 5 km, from the derailment site to Vrčin station.

Figure 4.2.9.3: Fallen out suspension link

4.2.10. Inspection at the Vrčin station

At the entry of Vrčin station, on the right-hand entrance switch No. 6, which was set in straight position, the derailed right wheel impacted the right switch blade base and broke it (Figure 4.2.10.1.a). Subsequently, the right wheels of the first and second wheelset impacted the switch point base and climbed onto the right stock rail (Figure 4.2.10.1.b)). Beyond the switch, the derailed wheelsets continued moving so that the left wheels left a mark along the outer side of the left rail and the right wheels along the inner side of the right rail in the direction of travel. At the end of the switch, in the welded rail joint zone, both left and right rails fractured.

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Figure 4.2.10.1: Broken switch blade and wheel marks on the switch point of switch No. 6 at Vrčin station

Upon reaching the left-hand switch No. 4, set in straight position, the derailed right wheels struck the right switch blade, which was in an offset position from the rail (Figure 4.2.10.2.), and climbed onto the displaced right stock rail of the switch.

Figure 4.2.10.2: Broken switch blade and wheel marks on the switch point of switch No. 4 at Vrčin station

After approximately 2.5 m, one wheel and then the other fall into the track to the left and the entire front derailed bogie of the eleventh wagon starts to turn towards the first track. Figure 4.2.10.3. shows the traces of this fall. In this case, the rail foot broke in the area where the switch rail connects to the switching mechanism (detail on the right, above, in Figure 4.2.10.3.).

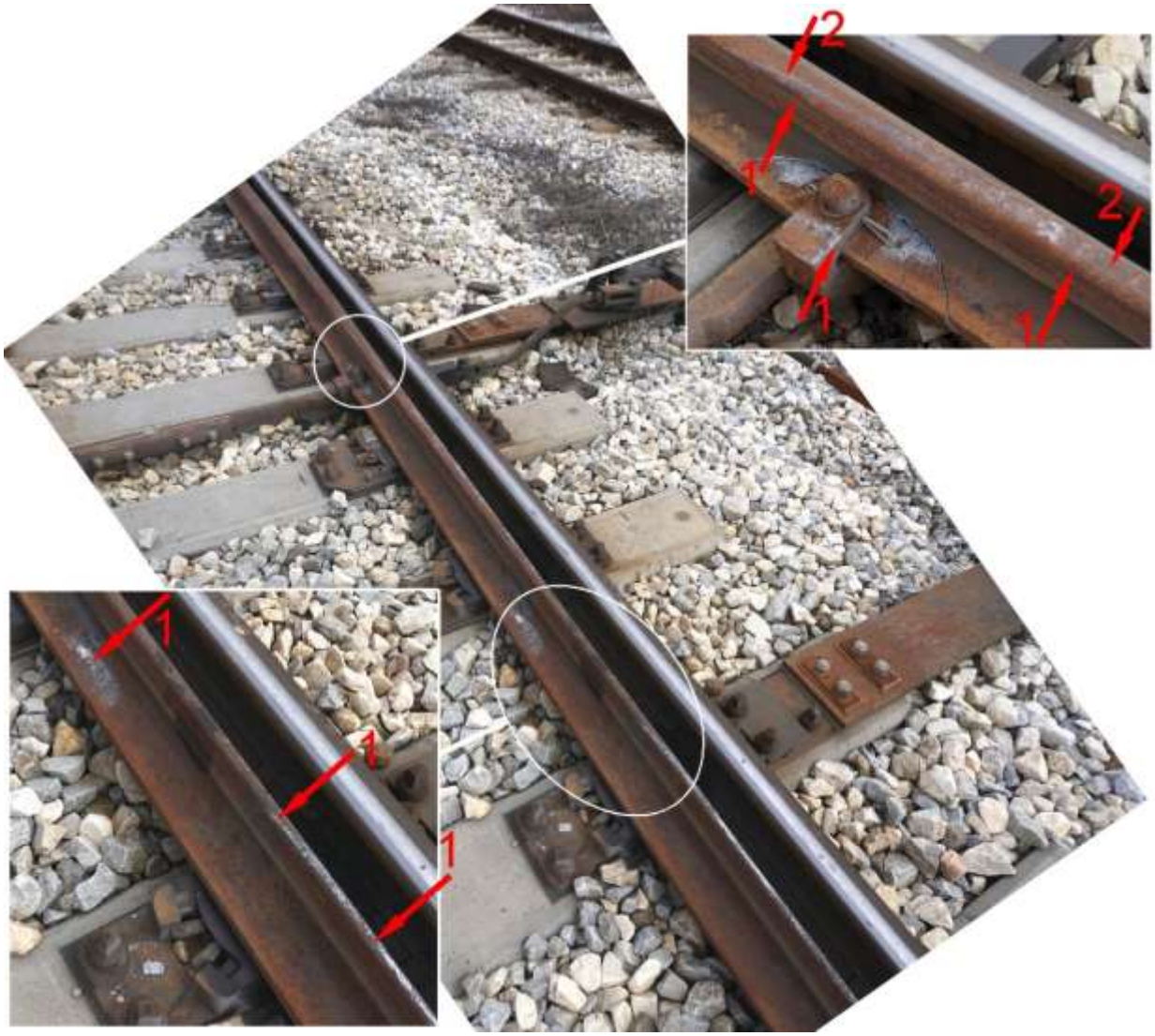

Figure 4.2.10.3: Traces of movement of the right derailed wheels on the right rail of the switchgear of switch No.4

The rear bogie of the eleventh wagon continued straight along the second track of Vrčin station. Due to the front bogie turning left onto the first track, the coupler between the tenth and eleventh wagons detached. Simultaneously, the main brake pipe ruptured, activating the emergency pneumatic brake. Part of the first track with wooden sleepers was damaged over a length of approximately 15 m, while the second track was slightly displaced sideways.

The eleventh wagon, likely, struck the KM portal post No. 26 with its left front buffer, viewed in the direction of travel, causing deformation. The buffer, together with the two detached wheelsets of the front bogie, was found next to the deformed KM post (Figure 4.2.10.4.). The wagon rotated 180° about the vertical axis, overturned onto its side, and slid approximately 40 m

along the ballast between the first and second track. During this movement, shunting signal KE 02 and the repeating signal PPEo2 located between the first and second tracks were knocked down.

While overturning, the eleventh wagon dragged the front of the twelfth wagon sideways, causing transverse displacement of the rails of the second track to the left. The front bogie of the twelfth wagon derailed on both wheelsets, the coupler between the eleventh and twelfth wagon detached, and the front right buffer of the twelfth wagon (viewed in the direction of travel) was torn off. This buffer was found approximately 15 m to the right of the second track.

Figure 4.2.10.4: Detached wheelsets and buffer of the eleventh wagon

In the overturning zone, several springs were scattered, the rear coupler of the eleventh wagon was torn off, along with other detached wagon components, as shown in Figure 4.2.10.5. The transverse displacement of the second track is indicated by the red arrow in the figure.

Figure 4.2.10.5: Position of detached wheelsets and overturned tank wagon

In Figure 4.2.10.6.a), the right bearing housing of the first detached wheelset of the eleventh wagon is shown. On its upper surface and the rear wear plate, deformation marks and bluish discoloration are visible, indicating elevated temperatures developed during movement of the derailed wheelset. On the front wear plate of the left housing, as well as on the housings of the second wheelset, no such intensive material discoloration is observed. This suggests that on this housing, the suspension links and springs likely detached first, causing the longitudinal and vertical impacts of the wheel on the sleepers to be transmitted directly to the vertical stop and the contact of the rear wear plate with the bogie jaws. Due to the high number of strong impacts and surface friction, elevated temperatures developed, causing material discoloration.

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Figure 4.2.10.6: Right bearing housing and left wheel of the first wheelset of the eleventh wagon

The left wheel of the first wheelset has shifted approximately 15 mm outward from the axle (Figure 4.2.10.6.b)). A very high force is required to displace a wheel from the axle. Such a force

could occur during the final impact, wheelsets detachment, and track damage. This is further indicated by the clean surface of the seat of the displaced axle.

Figure 4.2.10.7: Position of the eleventh and twelfth wagon

Figure 4.2.10.7. shows the overturned eleventh wagon, the twelfth wagon with a derailed front bogie, and the detached third wheelset of the eleventh wagon.

On 27.02.2025, the collected parts were inspected at the workshop in Velika Plana. A total of six external suspension springs were found (five scattered at Vrčin station and the sixth on the bearing housing of the second wheelset of the overturned eleventh wagon), six internal suspension springs, and one spring cap. The three detached wheelsets contain a total of 12 spring sets (external plus internal) and six caps. Six spring sets and five caps that were not found may have detached during movement from the derailment site or were displaced further into the area beside the track during overturning at Vrčin station.

4.2.11. Acid leakage from the overturned wagon

Sulfuric acid leakage occurred from the tank of the overturned wagon No. 33 87 7866 801-6 (Figure 4.2.11.1.). As visible in the figure, on the filling lids from which the acid is leaking, only three of the designed eight bolts are present, one of which is completely loose. On the gas-phase lid, only two of four bolts are present, and on the liquid-phase lid, only three of eight. Missing bolts on the lids were also noted on other wagons in the train set. This indicates shortcomings during tank filling and venting, i.e., non-compliance with the design specifications for pressure vessel lids.

Figure 4.2.11.1: Acid leakage at the filling lid

Law on the Transport of Dangerous Goods (see section 3.3.8.) obliges the shipper and the consignee to ensure the closure of valves and openings, i.e., the tightness of the tank, after filling or unloading.

In the document “Sulfuric Acid Filling” No. P031.23402-25.013 dated 04.01.2025, provided by the shipper “Serbia Zijin Copper” d.o.o, Bor, regarding lids closure, the following instruction is given:

“When the pipe is removed, place the lid on the opening and tighten all screws.”

The consignee, “Elixir Group” d.o.o, provided the document “Instructions for Proper Securing of Tanks Containing Sulfuric Acid After Filling and Before Leaving the Plant Premises,” No. RU.2200.IMS.35 dated 05.04.2022. The document illustrates, in detail, prohibited practices regarding the condition of bolts. Judging by the condition of the bolts on the tanks in the train set, there is a high likelihood that these instructions were not followed over an extended period.

However, both instructions contain deficiencies.

In the original wagon documentation, the manufacturer, **based on the design pressure, specifies the number, dimensions, and quality of bolts, the dimensions and type of gasket, and prescribes the torque for bolt tightening.** Instructions for filling and unloading tanks must obligate operators to verify the condition of bolts and gaskets at each lid closure. In case of defects (damaged gasket, damaged or missing bolt, etc.), the defective or missing components must be replaced with compliant elements of the prescribed material quality. Bolts must be tightened with a torque wrench according to the prescribed torque during closure.

If the tank owner or holder does not possess the original documentation, it is necessary to engage a qualified pressure vessel specialist to perform the calculations and prescribe the fastening elements and tightening torque for each type of tank.

Due to improperly closed hatches, 24.94 t of sulfuric acid was released into the environment in this case.

4.2.12. Review of the wagons maintenance documentation

For the purpose of the investigation, the maintenance documentation of wagon No. 33 87 7866 801-6 was reviewed as relevant. This wagon was the first to derail and the only one that continued to move with two derailed wheelsets until the train came to a stop after leaving the entry switch area of Vrčin station. Furthermore, it was only from this wagon that sulfuric acid leaked into the environment following its overturning.

The wagon-tank was declared with the code L10DH and marked for the transport of a hazardous material with UN No. 1830 (sulfuric acid with a concentration over 51%). According to the RID regulations for sulfuric acid with UN number 1830, the minimum required tank code is L4BN, so the declared code is hierarchically higher and meets the conditions for the transport of sulfuric acid.

According to Report No. 01671-24 dated 7.10.2024 regarding the inspection of the tank (provided by the wagon owner "ATIR-RAIL SA"), the most recent periodic inspection of the tank was carried out on 27.09.2024. The inspection was conducted on schedule and in accordance with the requirements of the RID regulations. During the inspection, the leak-tightness test was successfully performed.

The owner, "ATIR-RAIL SA," provided documentation on the regular maintenance of wagon number 33 87 7866 801-6 at the Želvoz workshop in Smederevo, which was completed in October 2024. Checks and repairs were carried out on the wagon according to revision type G4.8, in accordance with VPI-EMG. The revision was completed on schedule.

"ATIR-RAIL SA" also provided an excerpt from its "Wagon Maintenance Specifications," item 7.2.7. This item prescribes the mandatory replacement of the composite center bowl insert during revisions of types 4.0, 4.2, and 4.8, with parts having the same technical characteristics as the original and in accordance with the recommendations in UIC 510-1. It is not known whether the person responsible for maintenance was aware of which insert is the original center bowl insert.

The other wagons in train No. 51202 were within the scheduled dates indicated on the wagons for the next overhaul. There were no indications relevant to the cause of the accident that would require a review of the maintenance documentation for these wagons.

4.2.13. Examination during the cutting of wagon No. 33 87 7866 801-6 at Vrčin station

Considering the damage assessment and the established extent of damage (invoice No. 03 63G dated 3.3.2025), the owner of wagon No. 33 87 7866 801-6, "ATIR-RAIL SA," authorized "Srbija Kargo" a.d. to scrap the wagon. To verify the condition of the center bowls and side bearers and their potential influence on the accident, the wagon was cut on 24.9.2025 at Vrčin station, with representatives of CINS in attendance.

In Figure 4.2.13.1, the condition of the lower and upper center bowl of the rear bogie, viewed in the direction of train No. 51202 movement during the accident, is shown. No burrs or scratches were observed that could indicate increased resistance to rotation in the center bowl. On the upper edge of the composite insert, a small area with initial edge slippage is visible (indicated by an arrow). This is unusual, considering only four months had passed since the last scheduled overhaul and insert replacement.

Figure 4.2.13.1: Upper and lower center bowl of the rear bogie

Wagon No. 33 87 7866 801-6 is designed for S traffic (V_{max}=100 km/h), and accordingly, it has fixed upper and lower side bearers with a clearance between them. In Figure 4.2.13.2, the lower and upper bearers of the second bogie are shown. No signs of abnormal wear were observed on the sliding surfaces that could affect the rotational moment of the bogie relative to the car body.

Figure 4.2.13.2: Upper and lower slide bearers of the rear bogie

During the inspection of the lower center bowl of the front bogie, (Figure 4.2.13.3.a)), freshly torn metal fragments (indicated by black arrows and Nos. 1 and 2) are visible. These are the result of gas cutting in the immediate vicinity of the center bowl and are not relevant to this investigation.

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Figure 4.2.13.3: Uper center bowl of the front bogie

On the upper edge of the composite insert, torn edges with marks from the upper center bowl are visible (indicated by a red arrow and number 3). Considering that the insert was replaced during maintenance only four months earlier, this occurrence is unexpected.

During maintenance, it is necessary to check the frequency of unacceptable damage to the inserts in order to assess whether the quality of the insert compromises the functionality of the center bowl until the next scheduled overhaul, and whether the prescribed interval between overhauls is appropriate with the existing inserts.

No signs of metal-to-metal contact were observed on the rims of the upper and lower center bowls.

In the lower part of the center bowl, flaking of the composite insert is visible (indicated by arrow 4). On the opposite side of the center bowl, there is a deposit of flakes (indicated by arrow 5). Figure 4.2.13.3.b) shows a single flake which, based on all visual and tactile characteristics, appears to be material from the insert.

The observed condition of the upper bowl is shown in Figure 4.2.13.4. It can be seen that the lower part of the bowl has an uneven polished area covering approximately one-quarter of the circumference. This damage could not have occurred as a result of movement after derailment, since the upper bowl was in contact with the composite insert, which has significantly lower mechanical properties, and had no contact with the metal parts of the lower bowl that could have caused damage. No traces of detached fragments from the upper bowl are present. This irregularity of the upper bowl originates from prior damage. The damage should have been identified during routine maintenance, and the bowl should have been replaced. Flaking of the insert, being the weaker of the two materials in contact, as shown in Figure 4.2.13.3, is clearly caused by this prior damage to the upper bowl.

Figure 4.2.13.4: Upper center bowl of the respective bogie

It can be assessed that this situation contributed to a certain increase in friction within the center bowl. Considering that this involved friction between the metal upper center bowl and the non-metallic insert, and that no signs of direct contact or friction between the metal parts of the upper and lower center bowls were observed, it can be estimated that there was an effect on a minor increase in the rotational moment of the bogie in the curve. In combination with other critical elements in this specific case, this could have increased the lateral force Y on the leading wheel and, by increasing the Y/Q force ratio, contributed to wheel climb on the rail and derailment.

During the inspection of the overturned wagon-tank carried out on 14.2.2025 at Vrčin station by CINS representatives, it was observed on the front bogie, viewed in the direction of travel at the time of derailment, that the right pair of side bearers was in place (Figure 4.2.13.5.a)). At the location of the left pair of side bearers (Figure 4.2.13.5.b)), the upper side bearer was present, but the lower one was missing (circled in the figure). During the cutting of the structure on 24.9.2025, after the bogie was removed, the detached side bearer was found inside the bogie structure, immediately next to the left upper side bearer (Figure 4.2.13.6.). Deformation from the impact is visible on it. Based on this, it can be stated with certainty that this side bearer detached at the end of the tank wagon’s overturning process.

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Figure 4.2.13.5: Slide bearers of the front bogie

Figure 4.2.13.6: Position of the torn lower slide bearers

4.2.14. Analysis of speedometer records

"Srbija Kargo"a.d. provided graphical and tabular representations, as well as an analysis of the data from the train movement recording device on locomotive 193-910. Figure 4.2.14.1. shows the train speed, main air pipe pressure, and activation indicators of individual brake components.

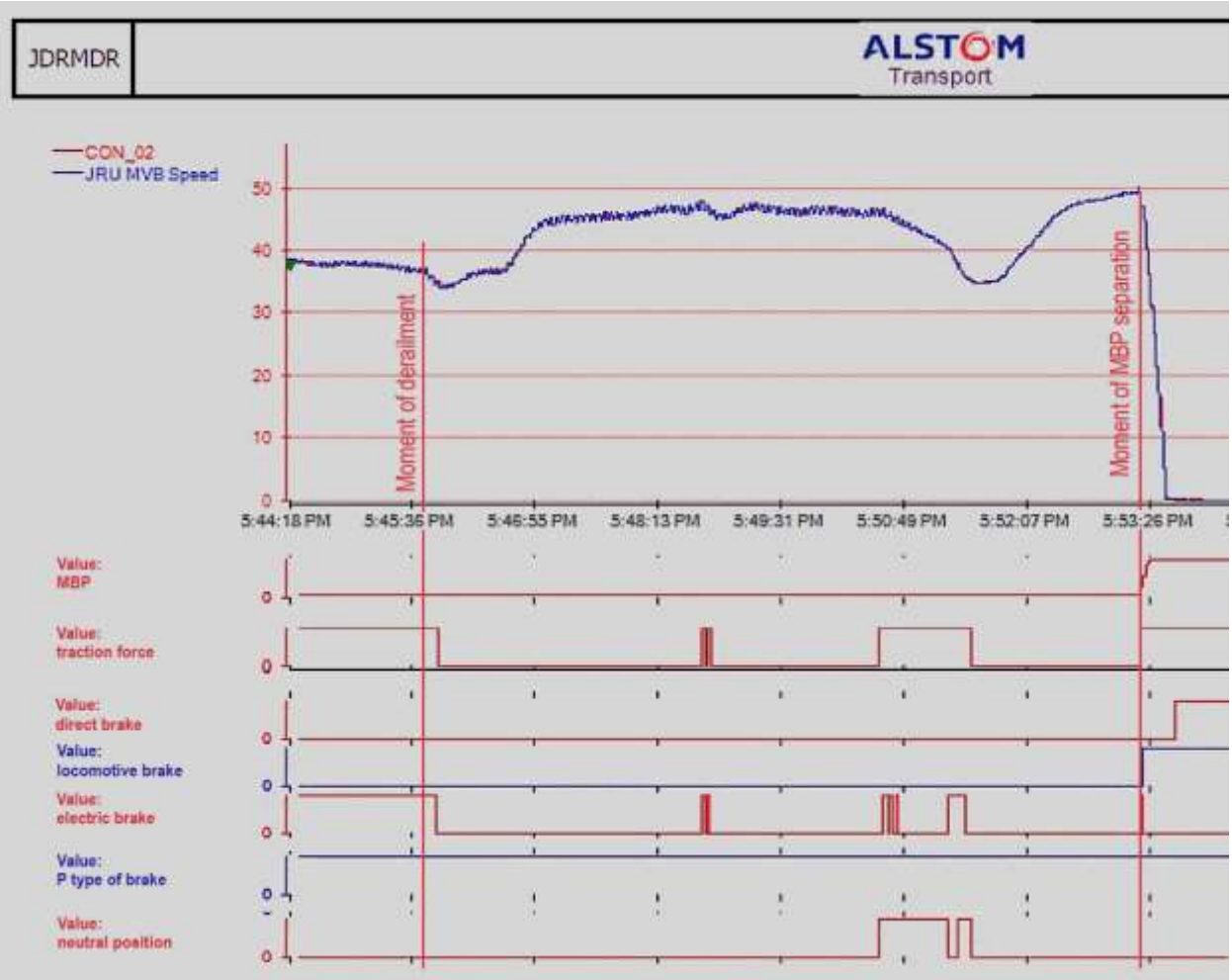

Figure 4.2.14.1: Extract from the graphical record of the train movement recording device, locomotive 193-910

CINS representatives determined on site that the head of the locomotive stopped at km 24+753 (88 sleepers from the km 27+700 hectometer mark and 246 sleepers from the km 27+900 hectometer mark). From the graphical record and the provided tables, the locomotive stopped at 17:53:59 according to the locomotive time.

Based on the data on the length of the locomotive and wagons printed on the vehicles, the front wheelset of the 11th wagon in the direction of travel, which was the first to derail, was located 158 m behind the locomotive head. Using the provided tabular data from the locomotive recording device, starting from the distance travelled, the locomotive stop mileage, and the derailment point mileage, it can be determined that the locomotive time at the moment when the first wheelset of 11th wagon derailed at km 30+522 was 17:45:45 (Table 4.2.14.1.).

Table 4.2.14.1: Data on derailment point from TRU device, Alstom, on locomotive 193-910

Distance travelled by locomotive (*m*)	Locomotive time (*hh:mm:ss*)	Locomotive speed (*km/h*)	Mileage (*km*)		Note
			Of locomotive	Of first wheelset of 11th wagon (loc.+158 *m*)	
15989	17:53:59	0	**24+753**	(24+911)*	Locomotive stopping point
10454	17:45:52	35,0	30+288	30+446	Electric brake switched off
10378	17:45:45	36,8 (10,2 *m/s*)	30+364	**30+522**	Derailment location of 11th wagon

**Since the train decoupled and the eleventh wagon overturned, their actual positions at the stopping site do not correspond to this theoretical value.*

In the period before and at the time of the derailment, the locomotive's electric brake was operating in order to regulate the speed on the descent, which in the derailment zone, according to the gradient indicator, is 7.4‰. Seven seconds after the derailment, corresponding to a travelled distance of 76 m, the electric brake was disengaged. In Figure 4.2.14.1, a vertical red line marks the moment of derailment.

From the speed diagram, it is observed that motion up to the moment of derailment was at a constant speed. The derailment caused increased resistance and a slight drop in speed, visible on the diagram, which likely prompted the driver to disengage the electric brake.

The speed in the derailment zone was below the 50 km/h limit (restricted-speed running), which, according to data provided by "IŽS" a.d. and the line markings existed in the zone from km 30+100 to km 30+600 (cause for introduction: "poor track geometry").

The vertical red line on the figure also marks the moment of the main air pipe rupture and the automatic braking activation at Vrčin station.

The image also shows the moment of the rupture of the main air pipe and forced braking at the Vrčin station, drawn with a vertical red line.

4.2.15. Train Braking and Loading

According to the train composition and braking report (Form S-4 No. 3 of Požarevac station dated 11.02.2025), train No. 51202 had a total mass of 1245 t, of which the wagons was 1156 t and the locomotive 89 t. The actual braking mass of 790 t is greater than the required braking mass (673 t). The form states that the wagons are braked in mode P, and the locomotive in mode G, which is consistent with IRS 40421 UIC for a composition of 1156 t.

Inspection of the composition after the derailment at Vrčin station revealed that on the thirteenth wagon (No. 33 72 7867989-5), the brake was disengaged, which was accounted for in Form S-4. On all other wagons, brakes were engaged and set to position P. Inspection of data from the locomotive 193-910 recording device (Figure 4.2.5.1.) shows that the locomotive was actually in braking position P, which aligns with the incorrect stance of the Railway Directorate from 04.12.2022 regarding the Brakes and Train Braking Regulation ("Official Gazette RS", No. 68/21, Annex 3, Item 4.5), but does not comply with IRS 40421 UIC (current edition 2, 2025). A similar situation was already observed in a previous serious accident investigation conducted by CINS and recorded in the Final Report.

It should be noted that on locomotive 193-910 there is no external indicator on the basis of which the wagon examiner could determine the activated type of brake, so setting the brake in the correct position is the responsibility of the train driver.

Inspection of couplings at Vrčin station showed that at five wagon joints the couplings were not properly tightened, and a gap of 10 to 15 mm existed between buffers.

Records from the locomotive registration device indicate that between Lipe and Vrčin stations, the driver did not use the pneumatic brake, and movement before the accident was at approximately constant speed without jerks, under the influence of the locomotive's electrodynamic brake. In such circumstances, the aforementioned irregularities had no impact on the occurrence of the accident under investigation.

According to the provided consignment note, all wagons were loaded slightly below the axle load of 20 t. Post-accident control weighing of the derailed wagons showed no irregularities in loading.

4.2.16. Wagon Usage Permits

The Law on Interoperability of the Railway System ("Official Gazette RS", No. 62/2023) of 27.06.2023 allows that vehicles that were in operation prior to 05.05.2005 may obtain a usage permit under relaxed conditions (see section 3.3.4.). A usage permit is required for registering the vehicle in the national vehicle register.

Based on the provided wagon documentation for train No. 51202, it was determined that at the time of documentation delivery, two years after the legislative amendments, nine out of fifteen wagons in the train composition were not registered in the national vehicle register (see Table 4.2.16.1.). Of these nine wagons, three have a usage permit and are expected to be registered in the national register shortly.

Table 4.2.16.1: Overview of NVR/VVR registration and usage permits for wagons of train No. 51202

Wagon No.	Order in composition	Vehicle keeper marking	National Vehicle Register	Permit for placing in service
33 72 7867 856-6	1	*SRB*	No	Yes
33 72 7867 855-8	2	*SRB*	No	Yes
33 72 7865 000-5	3	*SRB-ELIXG*	Yes	-
33 72 7867 832-7	4	*SRB-BOR*	No	No
33 72 7867 892-1	5	*SRB*	No	No
33 87 7864 171-6	6	*F-ATRR*	Yes	-
33 87 7847 014-0	7	*F-ATRR*	Yes	-
33 87 7839 023-1	8	*F-ATRR*	Yes	-
33 87 7847 017-3	9	*F-ATRR*	Yes	-
33 72 7867 822-8	10	*SRB*	No	No
33 87 7866 801-6	11	*F-ATRR*	Yes	-
33 72 7867 837-6	12	*SRB-BOR*	No	No
33 72 7867 989-5	13	*SRB-BOR*	No	No
33 72 7867 845-9	14	*SRB*	No	Yes
33 72 7867 865-7	15	*SRB*	No	No

It is necessary to carry out additional measures to completely end the practice of having unregistered vehicles operating in the railway system.

4.2.17. Rescue service performance analysis

Considering that the train contained a substance (sulfuric acid) which could endanger human health and is potentially hazardous to the environment, and that there was uncontrolled release of this dangerous substance from the tank wagon, directly threatening human health, personnel from the MUP RS, the Police Department of the City of Belgrade, and the MUP RS Sector for Emergency Situations were dispatched to the scene upon notification. Furthermore, after becoming aware of the accident, special measures were undertaken by the Ministry of Environmental Protection, Sector for Environmental Supervision and Preventive Action, and the City Institute for Public Health.

The response and performance of the rescue services corresponded to the situation and contributed to controlling harmful effects and preventing possible broader consequences for people and the environment.

4.3. Conclusions on the accident causes

4.3.1. Direct cause of the accident

The direct and immediate cause of the accident was wheel climb on the rail in a sharp curve with a radius of 295 m, due to track twist over the relevant distance between the bogie centers axis, significantly exceeding the permissible limit of GHI, in combination with cant exceeding the GHI. The condition of the center bowl assembly of the leading bogie of the derailed wagon, most likely contributed, to a lesser extent, to an increase in the yawing/turning moment and, consequently, to an increase in the lateral (Y) force acting on the leading wheel and the Y/Q force ratio, which is decisive for this type of derailment.

4.3.2. Basic causes that derive from skills, procedures and maintenance

Track maintenance in the derailment area was not carried out in accordance with the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure (“Official Gazette of the Republic of Serbia”, No. 39/2023). The disturbed track geometry exceeding the GHI, which was the reason for the introduction of a restricted speed running in the derailment area, was not urgently remedied; instead, this condition persisted for more than five months. The causes for the introduction of the restricted speed running should have been eliminated, and the restriction, in accordance with the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure (“Official Gazette of the Republic of Serbia”, No. 39/2023), should have been lifted no later than 30 days from its introduction (see section 3.3.5.).

During the routine overhaul of the derailed wagon, which was carried out only four months prior to the accident, no defects were identified on the upper center pivot that would have required its replacement (see sections 4.2.12. and 4.2.13.).

4.3.3. The main causes arising from the conditions established by the legal framework and the application of the safety management system

The Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023) stipulates that, in cases where values of relative track geometry parameters exceed the emergency intervention limit, the possible measures include closure of the railway line, remediation of track geometry, or reduction of speed (see section 3.3.5.).

On the section of main railway line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana) between Vrčin station and the Lipe junction, a restricted speed running of 50 km/h was introduced due to poor track geometry. Based on the above, it can be concluded that, on this section, the measure of "speed reduction" was applied as a result of the poor condition of the track.

We note that the "speed reduction" measure, in cases where certain track parameters (twist and track gauge) exceed operational limits, is not adequate. This measure cannot reduce the risk of wheel climb (track twist) or the risk of wheel drop into the track (track gauge deviation), i.e., derailment the train. An urgent remediation of the track geometry is required (see section 4.2.4.).

4.3.4. Additional remarks on deficiencies and defects found during the investigation, but not relevant to the conclusions about the causes

The release of 24.94 t of sulfuric acid into the environment as a result of this accident occurred due to the improper closure of the tank lids (see section 4.2.11.).

IŽS a.d. does not hold an permit for the use of the line where the accident occurred, nor has it submitted documentation to the Railway Directorate regarding the reconstruction of the section of the main line No. 103 (Belgrade Center - Rakovica - Jajinci - Mala Krsna - Velika Plana), based on which the Directorate decides on the need to issue a permit for use (see section 4.2.6.). This behavior is not in accordance with the provisions of the Law on Interoperability of the Railway System (Official Gazette of RS, No. 41/2018 and 16/2022 – Authentic Interpretation), which was in force at the time of the reconstruction of the relevant track section (see section 3.3.3.), nor with the provisions of the current Law on Interoperability of the Railway System (Official Gazette of RS, No. 62/2023) (see section 3.3.4.).

In train No. 51202, out of 15 wagons, 9 wagons were not registered in the National Vehicle Register, and 6 of these did not have a permit for use (see section 4.2.16.). The Law on Interoperability of the Railway System ("Official Gazette of RS", No. 62/2023) simplified the conditions for granting permit for use for older wagons that previously could not obtain one (see section 3.3.4.). Although two years have passed since the implementation of the Law on Interoperability of the Railway System ("Official Gazette of RS", No. 62/2023), there are still railway vehicles (wagons) in operation that do not have a permit for use and/or are not registered in the register of railway vehicles.

The measurement criteria for EM 80L track recording vehicle, due to their characteristics, deviate from standard requirements and compromise the uniformity of the criteria (e.g., for twist measurements). Furthermore, instead of using AL, IL, and IAL categories, they are applied as equivalents of Type A, B, and C errors, leading to ambiguity. If the same track section is measured using both sets of criteria, the interpretation of the results is inconsistent.

Information was received from “IŽS”a.d. that, due to a malfunction, the EM-80L track recording vehiclehave not been used for a long time. In the event that the EM-80L track recording vehicle is no longer used by "IŽS" a.d., only the criteria from the SRPS EN standard should be maintained.

Given that the Rulebook on Maintenance of the Superstructure and Substructure of Railway Tracks (“Official Gazette of RS”, No. 39/23) is in force, in the event that the EM-80L track recording vehicle is no longer used on the network of the public railway infrastructure manager “IŽS”a.d, the question arises of the need for an Instruction on Unified Criteria for Track Condition Monitoring on the JŽ Network (“Official Gazette ZJŽ”, No. 6/01 and 4/04, and “Official Gazette ŽS”, No. 14/22).

5. Measures taken

N/A.

6. Safety recommendations

Aiming to potentially improve railway safety and preventing the occurrence of future accidents, CINS has issued the following safety recommendations:

To the Directorate for Railways the following recommendations are issued: SR_01/26, SR_02/26, SR_03/26, SR_04/26, SR_05/26, SR_06/26, SR_07/26, SR_08/26, SR_09/26, SR_10/26, SR _11/26 and SR_12/26:

SR_01/26 The Directorate for Railways should carry out supervision over the safety certificate for the management of the railway infrastructure of "IŽS"a.d. and the implementation of the safety management system due to the lack of application of the criteria prescribed by the Instruction on Uniform Criteria for Track Condition Control on the JŽ Network ("Official Gazette ZJŽ" Nos. 2/2001 and 4/2004, "Official Gazette ŽS" No. 14/22) during the acceptance of works after the renovation of the section of main railway line No. 103 (Beograd Centar – Rakovica – Jajinci – Mala Krsna – Velika Plana), and to take measures within its competence in accordance with Article 15 of the Law on Railway Traffic Safety ("Official Gazette RS" No. 41/2018) (see sections 3.3.7. and 4.2.1.).

SR_02/26 The Directorate for Railways should carry out supervision over the safety certificate for the management of the railway infrastructure of "IŽS"a.d. and application of the safety management system due to the failure to apply the criteria prescribed in the Instruction on Amendments and Supplements to the Instruction on Uniform Track Condition Control on the JŽ Network ("Official Gazette ZJŽ", Nos. 6/01 and 4/04), No. 4/2022-3496-718 of 25.03.2022, during the acceptance of works after machine maintenance of the section of main railway line No. 103 (Beograd Centar – Rakovica – Jajinci – Mala Krsna – Velika Plana), and to take measures within its competence in accordance with Article 15 of the Law on Railway Traffic Safety ("Official Gazette RS" No. 41/2018) (see sections 3.3.6. and 4.2.3.1.).

SR_03/26 The Directorate for Railways should, through amendments and supplements of the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023) align the values for type C errors for track gauge twist given in the Annex of the Rulebook with the urgent intervention limit values from SRPS EN 13848-5, for which modern rail vehicles are designed (see section 4.2.4.).

SR_04/26 The Directorate for Railways should consider the possibility, through amendments and supplements to the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023), of providing for the presentation of twist measurement results not only on a 3 m base, but also on a longer base, for example 8 or 10 m (see section 4.2.4.).

SR_05/26 The Directorate for Railways should amend and supplement the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure ("Official Gazette of the Republic of Serbia", No. 39/2023), by abolishing, in Article 5, paragraph 2, item 1), the reduction of speed as a measure to mitigate the risk of train derailment in cases where the values of the parameters twist and track gauge exceed the limit for urgent (immediate) intervention (see sections 4.2.4. and 4.3.3.).

SR_06/26 The Directorate for Railways should amend and supplement Article 4, sub-item 5) of Annex 3 to the Rulebook on Brakes and Braking of Trains and Railway Vehicles ("Official Gazette of the Republic of Serbia", No. 68/2021), in accordance with the relevant requirements of IRS 40421, Issue 2 of 2025 (see sections 3.3.9. and 4.2.15.).

БП_07/26 "IŽS" a.d. should carry out a review of the causes leading to the recurrence of track geometry defects at the same location (see section 4.2.3.2.). Upon determining the causes and assessing the safety risks that have arisen as a result, it should take effective measures to eliminate the identified safety deficiencies, in accordance with the requirements of Article 5 of the Law on Railway Traffic Safety ("Official Gazette of the Republic of Serbia", No. 41/2018).

SR_08/26 "IŽS" a.d. should, through amendments and supplements, align the Instruction on Uniform Criteria for Monitoring the Condition of Railway Lines on the ŽS Network with the requirements of the Rulebook on the Maintenance of the Railway Tracks Super and Sub Structure with regard to the application of standard SRPS EN 13848-1 for the acceptance of works (see section 4.2.1.) and standard SRPS EN 13848-5 with respect to the GHI for twist (see section 4.2.4.).

SR_09/26 "IŽS" a.d. should adopt a decision on the use of the EM-80L track recording vehicle. In the event that "IŽS" a.d. decides to discontinue the use of this track recording vehicle, it is necessary, through amendments and supplements, to remove from the Instruction on Uniform Criteria for Monitoring the Condition of Railway Lines on the ŽS Network ("Official Gazette of ZJŽ", Nos. 6/01 and 4/04, and "Official Gazette of ŽS", No. 14/22) the sections relating to the EM-80L track recording vehicle (see section 4.3.4.).

SR_10/26 "IŽS" a.d. in the Rulebook on Organization and Job Classification of the Joint-Stock Company for the Management of Public Railway Infrastructure "Infrastruktura železnice Srbije, review the adequacy of the existing workforce and consider the possibility of providing an appropriate number of staff in the construction sector both on the section of the railway where the accident occurred and across the entire network, in order to ensure the safe operation of railway traffic. In accordance with the appropriate number of staff, it should plan the procurement of the necessary machinery and tools, all with the aim of ensuring the safe operation of railway traffic (see section 4.2.5.).

SR_11/26 *Elixir Group d.o.o. Šabac* should supplement its Instruction for the Proper Securing of Wagon-tanks after Loading and before Leaving the Factory Premises, in order to ensure the tightness of the tanks (checking the cleanliness and evenness of the seating surfaces, using undamaged prescribed gaskets, closing the openings with the designed number of bolts using a torque wrench with the torque specified by the manufacturer), provide the necessary conditions for its implementation, and additionally train the staff for correct handling (see section 4.2.11.).

SR_12/26 *Serbia Zijin Copper d.o.o. Bor* should supplement its Instruction "Loading of Sulfuric Acid into Wagon-tanks" in order to ensure the tightness of the tanks (checking the cleanliness and evenness of the seating surfaces, using undamaged prescribed gaskets, closing openings with the designed number of bolts using a torque wrench with the torque specified by the manufacturer), provide the necessary conditions for its implementation, and additionally train the staff in correct handling (see section 4.2.11.).

To the Ministry of Construction, Transport and Infrastructure the recommendations are issued: SR_13/26 and SR_14/26:

SR_13/26 The Ministry of Construction, Transport and Infrastructure, Inspectorate Sector, Railway Traffic Inspection Department, shall carry out supervision at "IŽS" a.d regarding the failure to take measures to obtain a permit for the infrastructure structural subsystem in accordance with the provisions of Articles 21 and 30 of the Law on the Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", Nos. 41/2018 and 16/2022 – Authentic Interpretation), or in accordance with the provisions of Article 24 of the Law on the Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", No. 62/2023), and shall take measures within its competence (see sections 3.3.3, 3.3.4, and 4.2.6.).

SR_14/26 The Ministry of Construction, Transport and Infrastructure, Inspectorate Sector, Railway Traffic Inspection Department, shall carry out an extraordinary inspection at the owners of wagons, Elixir Group d.o.o. Šabac and Serbia Zijin Copper d.o.o. Bor, as well as at the carrier "Srbija Kargo"a.d., regarding the use of railway vehicles that are not registered in the national vehicle register and/or do not have a Permit for use in accordance with the provisions of the Law on the Interoperability of the Railway System ("Official Gazette of the Republic of Serbia", No. 62/2023), and shall take measures within its competence (see sections 3.3.4. and 4.2.16.).

To *Autorité française de sécurité ferroviaire* the safety recommendation SR _15/26 is issued:

SR_15/26 *Atir-Rail SA*, should analyze the frequency of unacceptable damage to the center bowl inserts during regular maintenance, in order to assess whether the quality of the insert compromises the functionality of the center bowl until the next scheduled overhaul, and in its maintenance instructions, provide appropriate measures for quality control during regular overhauls, including verification that an original center bowl insert is used during replacement (see sections 4.2.12. and 4.2.13.).