Translation of an excerpt of the investigation report

“Train derailment Garmisch-Partenkirchen station – Farchant station on 03/06/2022”

Status as of 27/05/2025, version 1.0.

Note:

In accordance with Article 3 of Implementing Regulation (EU) 2020/572, points 1, 5 and 6 of Annex I of an investigation report shall be written in a second official European language. This translation should be available no later than three months after the delivery of the report.

The following English translation is a corresponding excerpt of the investigation report. The German language version is authoritative.

Excerpt translation:

1 Summary

The first section contains a brief description of the event, as well as information on the consequences, primary causes and safety recommendations provided in the individual case.

1.1 Brief description of the event

On 03/06/2022 at around 12:16 pm, the passenger train RB-D 59458 derailed on the journey from Garmisch-Partenkirchen to Munich main station between Garmisch-Partenkirchen and Farchant stations at km 97.676.

1.2 Consequences

During the train derailment, five people were fatally injured, 16 people suffered serious injuries and 62 sustained minor injuries. Material damage with an estimated value of EUR 4,750,000 was caused to the vehicles and to the infrastructure due to the train derailment. The affected track section was blocked for several months after the event.

1.3 Causes

During the investigation of the event, the following actions, failures, incidents or circumstances were identified as safety-critical factors. These are differentiated into causal or contributing and systemic factors according to Implementing Regulation (EU) 2020/572. Identified shortcomings in the emergency management are also addressed.

A system with designations in square brackets is used to provide better clarity about the factors and aspects of emergency management.

A detailed assessment of the event with classification as safety-critical factors is provided in the sections below.

What happened: Date/time, and action/failure/circumstance/incident	Causal factor	Contributing factor	Systemic factor
03/06/2022, 12:16 PM When travelling on the prestressed concrete railway sleepers used on the bend, the structure failed and the entire sleeper support on the outside of the bend shifted towards the outside. This resulted in an expansion of the track and, consequently, in the derailment of the train.	Failure of the structure of the prestressed concrete railway sleepers [F1]		
Part of the initial situation In 2006, Leonhard Moll Betonwerke GmbH & Co KG, Laußig plant, produced prestressed concrete railway sleepers, the formula for which has resulted in damaging internal chemical reactions during the service life.	Combined process of alkali-silica reaction (ASR) and secondary ettringite formation (SEF) [F2]		State of the art technology for controlling the risk of ASR and SEF at the time of producing the sleepers [S2]
2006 to 2022 In accordance with the guidelines, the installed prestressed concrete railway sleepers were only inspected visually by the responsible maintenance personnel during track inspections. Internal monitoring did not identify any deficiencies relating to the inspection procedures used that required immediate action.	Inspection procedures used to identify damage due to ASR and SEF [F3]		Controlling the risk of ASR and SEF in the life cycle of the prestressed concrete railway sleeper [S3]

Table 1: Summary of influencing factors

1.4 Safety recommendations

The following safety recommendations were issued in an interim report in accordance with Section 6 of the Eisenbahn-Unfalluntersuchungsverordnung (EUV, German railway accident investigation regulation) and Article 26(2) of Directive (EU) 2016/798. The following recommendations were made:

- develop a technical procedure for comprehensive inspection of the condition of prestressed concrete railway sleepers from all manufacturers when installed.
- ensure central traceability of installed prestressed concrete railway sleepers.

The safety recommendations above are maintained.

In addition, the following safety recommendations are issued in accordance with Section 6 EUV and Article 26(2) of Directive (EU) 2016/798. It is recommended that:

- the differentiation of individual risks in all phases of the infrastructure manager's safety management system must be established based on the relevance of all operational, organisational and technical risks in accordance with the requirements of Delegated Regulation (EU) 2018/762, Annex II, section 3.1.1.1 a).
- between the infrastructure manager and railway undertaking, in accordance with the requirements of Delegated Regulation (EU) 2018/762, Annex I and II, section 4.4, the notification of reports of infrastructure deficiencies must be traceable in terms of release and handling, be made transparent for everyone involved and established based on uniform operating terminology.

5 Conclusions

The following section contains a summary of the identified causal, contributing and systemic factors. In addition, two further subsections are provided containing information about measures already taken, and additional comments

5.1 Summary and conclusion

The actions, failures, incidents or circumstances identified in this investigation report resulted in the train derailment between Garmisch-Partenkirchen station and Farchant station.

Three causal and two systemic factors that influenced the event have been identified.

In relation to the causal factor "Failure of the structure of the prestressed concrete railway sleepers" [F1]

While travelling on the prestressed concrete railway sleepers used in the bend, due to the forces applied by the train combined with the already damaged prestressed concrete railway sleepers, there was a one-sided shifting of the entire outer sleeper support towards the outside of the bend. This incident resulted in an expansion of the track and caused the derailment of the train. In all probability, avoiding the structural failure of the prestressed concrete railway sleeper would have prevented the event. The Federal Authority for Railway Accident Investigation has already issued corresponding safety recommendations numbered 02/2024 and 03/2024 concerning improving traceability and inspecting the condition of prestressed concrete railway sleepers in an interim report about this event.

In relation to the causal factor "Combined process of ASR and SEF" [F2] and systemic factor "State of the art technology for controlling the risk of ASR and SEF at the time of producing the sleepers" [S2]

In 2006, Leonhard Moll Betonwerke GmbH & Co KG, Laußig plant, produced prestressed concrete railway sleepers, the formula for which, combined with external climatic influences, has resulted in a combined process of ASR and SEF during the service life. This circumstance resulted in severe damage to the prestressed concrete railway sleepers and, in combination with causal factor [F1], in the failure of the structure. In all probability, avoiding the combined process of ASR and SEF would have prevented the event.

The generally accepted technical knowledge at the time of producing the prestressed concrete railway sleepers was not sufficient to fully control the risk of ASR and SEF. The prestressed concrete railway sleepers investigated here were produced in 2006 according to the standards/knowledge at the time. Since then, DBS [Deutsche Bahn standard] 918 143 has been amended several times, among other things due to experiences relating to ASR/SEF. The guidelines were then strengthened with the binding introduction of Annex G "Assessment of the ASR potential of prestressed concretes – ASR performance testing and formula assessment" in 2018. In accordance with Annex G, among other things, regular monitoring/formula assessments now needed to be performed. When irregularities were identified, regulations on prompt traceability and measures for further sleeper production were still missing. Prestressed concrete railway sleepers from before 2018 are still used in the

rail network of DB Netz AG. A number of measures have been introduced and adjusted by the infrastructure operator since the event. However, DB Netz AG was not able to make a conclusive statement about how to deal with the prestressed concrete railway sleepers produced before the introduction of Annex G before the preparation of the report.

It is the responsibility of various corporate areas to further develop state of the art technology relating to ASR and SEF in construction products and their life cycle, including in relation to the product prestressed concrete railway sleeper.

In relation to the causal factor "Inspection procedures used to identify damage due to ASR and SEF" [F3] and systemic factor "Controlling the risk of ASR and SEF in the life cycle of the prestressed concrete railway sleeper" [S3]:

In accordance with the valid regulations, the installed prestressed concrete railway sleepers were only inspected visually by the responsible maintenance personnel during track inspections. According to the diagnostic examination on prestressed concrete railway sleepers by Bauhaus University Weimar, this visual inspection procedure was not suitable for fully detecting ASR and SEF. The expert justified this opinion by stating that the internal damage in the examined prestressed concrete railway sleepers was considerably higher than could be suspected from the externally visible damage. In addition, when installed, a large part of the prestressed concrete railway sleepers were covered by ballast as well as rails and track fittings. In all probability, a different procedure to detect internal damage caused by ASR and SEF would have prevented the event.

It has been noted that knowledge gained in the meantime relating to the combined process of ASR and SEF has resulted in changes to the production and delivery conditions for prestressed concrete railway sleepers. However, it was not possible to identify any updates to the maintenance procedures for prestressed concrete railway sleepers already in the operation life cycle phase that fully controlled altered or new risks relating to the knowledge about the combined process of ASR and SEF. This meant that the systemic risk of ASR and SEF was not controlled during the life cycle of the prestressed concrete railway sleepers.

In actual fact, the infrastructure manager increasingly assigned the fundamental risk control to the specialist independent decisions and discretion of maintenance managers by adjusting the maintenance requirements.

It was also noted that no concept could be identified in the two maintenance monitoring and manager supervision processes that had been set up that would monitor these personnel in relation to their decisions and discretion concerning structural failures due to ASR and SEF, which had been explicitly provided to inspect the risk from ASR and SEF and was also sufficiently specific in terms of content, frequency and methods in order to be effective. The infrastructure manager stressed repeatedly that the entire process of maintenance monitoring is based on random samples. In relation to the manager supervision, it was also not possible to identify any structured approach to monitoring of subordinate personnel in terms of risk control for the life cycle management of prestressed concrete railway sleepers at risk of ASR and SEF.

From this it must be determined that the training and the independent application of the skills gained by the maintenance personnel were key elements that the infrastructure manager established for controlling the risk.

Against the background of this overall picture, the Federal Authority for Railway Accident Investigation is issuing safety recommendation 10/2025 to establish the differentiation of individual risks in all phases of the infrastructure manager's safety management system. This must originate from the relevance of all operational, organisational and technical risks according to the requirements of the Delegated Regulation (EU) 2018/762, Annex II, section 3.1.1.1 a).

This could allow for effective management of fixed assets throughout the entire life cycle with appropriate risk management, linked information sharing and with targeted monitoring.

5.2 Measures taken since the event

After the event, the infrastructure manager formed a "Concrete sleeper expert panel" with external and internal expertise. As part of the work of this expert panel, new rules have been issued on the personnel responsible for the regulations for guideline 821.2018. The expertise was also combined in the "Concrete sleeper project". The project was divided into four working groups to develop short-term, medium-term and long-term measures. At the time of writing the report, working group 1 "Risk mitigation" had finished its work. This developed emergency measures and informal instructions on controlling the risk resulting from the damaged prestressed concrete railway sleepers in the network. The figure below shows the

time line of short-term measures taken by the infrastructure manager from the event until the conclusion of working group 1.

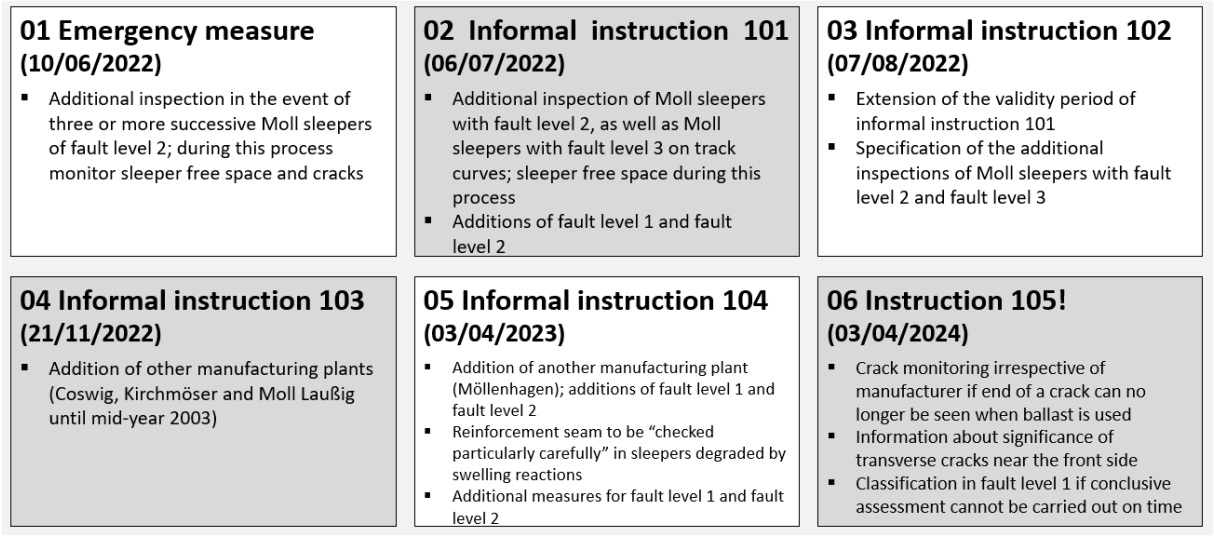

Figure 1: History of emergency measures and instructions[1]

Particular mention must be made of the emergency measure introduced on 10/06/2022, a week after the event. This stipulated an additional inspection where there were three or more successive prestressed concrete railway sleepers of fault level 2 from the manufacturer Leonhard Moll Betonwerke GmbH & Co KG, Laußig plant, with an additional free space for the prestressed concrete railway sleepers. After assessing the results of the emergency measure, the informal instruction FuW-101 was issued around a month after the event. This tightened the regulations of the emergency measure and now applied for all prestressed concrete railway sleepers from the manufacturer Leonhard Moll Betonwerke GmbH & Co KG, Laußig plant, of fault level 2 and for prestressed concrete railway sleepers of fault level 3 that were on a bend. Furthermore, additions were made for fault level 1 and fault level 2 for prestressed concrete railway sleepers from the named manufacturer. This was justified with the "*possibility that faults of fault levels 2 and 3 in prestressed concrete railway sleepers from the Moll Laußig plant ("MS") develop differently than previously assumed".*[2] In the subsequent instructions, following extensive assessments of inspection results, further manufacturers were identified as problematic, meaning that in the most recently valid instruction W-105!, valid from 03/04/2024, extensive measures were stipulated for tracking cracks in prestressed concrete railway sleepers from all manufacturers. In relation to the requirement to uncover

[1] DB Netz AG
[2] DB Netz AG, 821.2018-informal instruction-101, valid from 06/07/2022

cracks in areas where there is ballast in particular, the measures are similar to the measures already stipulated in 2007 for prestressed concrete railway sleepers from the manufacturer Rethwisch.

It is planned that these instructions will be transferred into guideline 821.2018 in June 2025 as part of the medium-term measures of working group 2 “Systematic knowledge gained”. The main focal points of the update to the guideline are removing the subjective criterion of load-bearing capacity. This will be replaced by an objective definition of fault level 1 and fault level 2. It is also intended that a *“stricter, uniform benchmark for all sleepers”*[3] will be introduced. As a further medium-term and long-term measure, working group 3 “Systematisation of dealing with concrete sleepers” will look in more depth at the life cycle of prestressed concrete railway sleepers in terms of DBS 918 143. Finally, working group 4 “Mapping” will deal with the long-term measure of developing automated sleeper and damage detection for the prestressed concrete railway sleepers that are already in use. The remedial measure currently largely consists of expanding the inspection guideline, which will result in delegation of responsibility to the on-site maintenance personnel. This will involve an increase in workload for the employees conducting the work.

After the event, the infrastructure manager conducted extensive investigations of the earthwork. This did not result in any findings about this structure that influenced the event.

In addition to the infrastructure measures described, the operational regulations were updated in relation to communication between the signaller and driver. Modules 408.0203 “Verifying processes, orders and messages” and 408.0641 “Other irregularities in technical equipment” of guideline 408 “Operating Regulation” have been supplemented/amended with update 4.1, valid from 21/08/2023. Section 5 “Messages from drivers and third parties” was newly introduced in module 408.0203. All messages about infrastructure defects must be documented in the log book and forwarded to the authority responsible for arranging fault clearance. This rule applies not only for drivers, but also for groups of people designated as “third parties”, such as private individuals or police authorities. In module 408.0641, section 2 was supplemented and substantiated to the effect that once there is a suspicion of a superstructure defect, all trains must be instructed to drive on sight and at a maximum of 25 km/h. If the message indicates that the track is no longer passable, or no longer passable

[3] DB InfraGO AG

at 25 km/h, it must be blocked. The measures implemented must not be cancelled by the signaller, rather this may only be done after instructions have been issued by a specialist. The signaller is only allowed to tighten the measure.

5.3 Additional observations

In the investigation report on the train derailment on 30/06/2020 in Niederlahnstein station, the Federal Authority for Railway Accident Investigation has already identified that the message from a driver about a superstructure defect three days before the relevant event had not been forwarded to the relevant authorities by the signaller. In this context, the Federal Authority for Railway Accident Investigation concluded that the qualification of a signaller does not include the skill of assessing track defects and he did not feel compelled to take further measures. This circumstance must be seen in the same context as the communication described in this case between the driver of train RB-D 59462 and Garmisch-Partenkirchen 1 signaller on the eve of the event. In this case, forwarding of the message to a specialist may also have resulted in a different course of events, even though the Federal Authority for Railway Accident Investigation does not classify this circumstance as directly relevant for the chain of events due to other influences. The restrictive requirements as per guideline 408.0641 section 2 can only take effect if the people involved use uniform terminology and come to the same conclusions. This was not the case either for the train derailment in Niederlahnstein station on 30/06/2020 or for the train derailment between Garmisch-Partenkirchen and Farchant stations on 03/06/2022.

Against the background of repeated incidents, the Federal Authority for Railway Accident Investigation is issuing safety recommendation 11/2025, between the infrastructure manager and railway undertaking, in accordance with the requirements of Delegated Regulation (EU) 2018/762, Annex I and II, section 4.4, the notification of reports of infrastructure deficiencies must be traceable in terms of release and handling, be made transparent for everyone involved and established based on uniform operating terminology.

6 Safety recommendations

The following safety recommendations were issued in an interim report on 03/06/2024 in accordance with Section 6 EUV and Article 26(2) of Directive (EU) 2016/798:

No	Addressee and safety recommendation	Relates to company
02/2024	National safety authority: It is recommended that a technical procedure must be developed for comprehensive inspection of the condition of prestressed concrete railway sleepers from all manufacturers when installed.	Infrastructure manager
03/2024	National safety authority: It is recommended that central traceability of installed prestressed concrete railway sleepers must be ensured.	Infrastructure manager

These are maintained.

In addition, the following safety recommendations are issued in accordance with Section 6 EUV and Article 26(2) of Directive (EU) 2016/798:

No	Addressee and safety recommendation	Relates to company
10/2025	National safety authority: It is recommended that the differentiation of individual risks in all phases of the infrastructure manager's safety management system must be established based on the relevance of all operational, organisational and technical risks in accordance with the requirements of Delegated Regulation (EU) 2018/762, Annex II, section 3.1.1.1 a).	Infrastructure manager
11/2025	National safety authority: It is recommended that, between the infrastructure manager and railway undertaking, in accordance with the requirements of Delegated Regulation (EU) 2018/762, Annex I and II, section 4.4, the notification of reports of infrastructure deficiencies must be traceable in terms of release and handling, be made transparent for everyone involved and established based on uniform operating terminology.	Infrastructure manager Railway undertaking