TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 65, Issue Special III, November, 2022

A STUDY ON TRAINS SERVICE FOR MODERN RAILWAY MAINTENANCE IN EUROPE

Vladimir VOICU, George CARUTASU

***Abstract**: The system currently used for track maintenance works in Germany is inconvenient and risky for the involved employees. This article analyzes the disadvantages of the current approach and presents a new system (a modern service train), highlighting the results of a test conducted in 2021. In addition, the article offers an overview of the positive effects on workforce security, also showing what its further development might look like.*
***Key words:** Railway safety, railway maintenance, work safety, modular vehicle system, railway efficiency increase*

1. INTRODUCTION

With currently rising fuel prices, the interest of various companies in shifting freight and passenger transport on the rail is growing fast. Rail transport is now more than ever competitive because many goods can be transported at moderate costs - provided the necessary infrastructure is in good condition.

This is however not an easy task – as railway maintenance is costly, complicated and workforce-intensive. On average, the maintenance of one railway kilometer costs 70000 EUR per year in Europe [1]. To top it all, the manual process of railway maintenance poses high risks for the safety and health of the employees, as train traffic must be upheld during these works.

Modern service trains which can greatly reduce manual labor have been in use in Germany since 1965 - however these are only suitable for major track renewal projects, since with these vehicles' new rails, new sleepers and new or processed ballast are being laid at the same time.[2] Such major projects are rare - much more often only a rail or a certain number of sleepers are replaced. In these common cases, the current process heavily relies on manual labor performed by a group of employees, who are exposed to various risks.

Service trains already used in some countries in Europe could be the universal solution in achieving a higher workforce security not only during major track renewal projects, but also during day-to-day repair works.

2. A BRIEF OVERVIEW OF THE CURRENT RAILWAY MAINTENANCE SYSTEM IN GERMANY

While some minor repairs can also take place without stopping train traffic in the relevant track (which means that the employees only work when there are no planned train journeys and interrupt their work for every train passing on this track), this is not a valid option in most cases (like a rail- or sleeper renewal) since the track will of course become impassable when these critical components are changed. This means a planning process – regulated by the guideline 406 or DB manual 40600 [3] must take place.

This process is necessary to be able to find a time interval where the repair works can take place. The key principle is that the specified time frame for the repairs in the inspection report

must be respected (so that operational limitations do not have to come into effect), while minimizing the negative effect on the train traffic. Simply put: if a rail must be changed within the next 6 weeks, the planning process aims to find a time interval for the repair works, which affects train traffic the least.

After the time frame has been found, it is necessary to secure the resources for the maintenance project. These are employees with the necessary qualifications, but also equipment, materials and vehicles. Some of these resources can be secured internally by the DB Netz AG and some must be contracted with external firms. For a rail change, we would need some workers, one technical supervisor, two welders, safety personnel, logistics personnel and a maintenance train that brings out the new rail and will take the old one back to headquarters.

The currently used maintenance system has some serious disadvantages. One of the greatest challenges: to ensure the safety of the workers it does not suffice to close the working track for train traffic, as trains keep passing in the neighboring track, sometimes with speeds up to 250 km/h. It is easy to see that workers must be protected from this danger – for instance by installing an Automatic Track Warning Systems (ATWS) or a magnetic safety barrier system towards the neighboring track.

The current system is also very demanding for the employees because they are exposed to all kinds of weather conditions (heat, rain, wind, snow, etc.), which negatively impact their comfort during their working hours and sometimes can lead to various diseases.

Other main disadvantages include the noise- and light pollution produced during the repair works – especially since most time intervals identified are at night or on weekends. No less important is the fact that in most cases the distance from headquarters to the construction site is covered by one rail vehicle (carrying for instance the new rails and necessary machines and devices, but not offering enough space for the workers) and several road vehicles (carrying the employees), which is very unfavorable from an ecological point of view.

3. ROMIS/FIZ – A MODERN SERVICE TRAIN

To eliminate the disadvantages of the current railway maintenance system, the German company Robel created a modern service train called ROMIS. This vehicle is today in use in several European countries like Austria, Great Britain, Norway and Belgium. For the German market, the company is currently developing a localized version named FIZ (short for Fahrbahninstandhaltungszug, literal translation Railway maintenance train). This service train (Figure 1) consists of three components: a Mobile Maintenance Unit (MMU), an intermediate vehicle (IV), and a Traction and Supply Unit (TSU).

The TSU has a lounge for up to eight employees in addition to the main driver's cab with two seats. One kitchen with a sink, a refrigerator, and a toilet are among the amenities accessible. The TSU's technical section follows, supplemented by the on-board-workshop and a battery cabinet. The area extends in IV, and here is the material and tool storage room. At the transition to the TSU, two opposed tail lifts are mounted.

The ceiling has two cranes, each capable of lifting to 2.5 tons, and longitudinal and transverse movability allows access to the IV's storage room and the MMU's workroom. Along the IV, there are lattice boxes with suitable restraining mechanisms built on the right and left. The middle aisle's floor is made up of flaps and an underfloor compartment for rails. The crane that scoops up the rails in the MMU's operating area is loaded into this compartment. The MMU is the core of the train – simplified this could be described as a covered workspace with no floor. In addition to LED strips for glare-free illumination, roller shades are installed, which close the bottom open area down to the gravel while in use.

Fig. 1. FIZ service train – overview of train components [4].

Fig. 2. View into the MMU of the FIZ service train [5].

Another open platform with stairs and the second driver's cab of the FIZ are in the final section of the MIE. The maintenance train can travel as fast as 100 km/h and is powered by a 2x600 kW Diesel engine, while the maximum working area in the MMU is 17 x 4.2 m. It can be used for various maintenance tasks, such as rail replacement up to 15 m in length including tensioning and welding, correction of track geometry with vertical tampers, single sleeper replacement, ballast renewal or change of track switch components. [4].

To check the usability and advantages of the train, a test construction site was simulated in May 2021 on the manufacturer's premises. The aim of the action was to compare the current system used for maintenance works and the implementation of the same construction site using ROMIS/FIZ.

The use of the FIZ in the daily railway maintenance in Germany brings several advantages over the current system. First and foremost, it protects the employees from trains passing in the neighboring tracks right and left of the working track – thus rendering other safety options such as the ATWS or the magnetic barrier unnecessary. This means an improved work safety for the personnel, as well as lower costs for the infrastructure company.

Furthermore, while the working track is closed for train traffic while repair works take place, there is no guarantee with the current system that a human error of the train dispatcher could not lead to a train being sent in the closed working track. By entering the track with the FIZ, this is no longer a risk, as further trains are prevented by the interlocking system to enter this track (which is shown as occupied in the signal box).

Another impact of the confined room is the potential for the overhead wire to be left on, while protective operational speed limitations in the neighboring track sections are no longer necessary. In addition, another main advantage for the workforce is the improvement of working conditions. This advantage ranges from the protection against environmental influences such as rain and wind to the better lighting and ventilation inside the MMU. Another important aspect for employee satisfaction is the opportunity to spend breaks safely and the possibility of using amenities like a kitchen or a toilet, which is not possible when working according to the current system.

The environmental effect is also not to be ignored: through use of the FIZ, the multiple street vehicles are no longer necessary and all employees can travel by the service train to the location of the repair works. Noise- and light-pollution are also reduced through the closed workspace, thus impacting residential areas close to the railway less than it is the case nowadays. The FIZ has been since delivered to the German infrastructure company DB Netz AG in September 2021, is stationed in Cologne and is currently in the approval process by the ERA (European Union Agency for Railways). The FIZ should be ready for service on German tracks in 2023.

Network Rail, the British infrastructure provider that already runs eight ROMIS trains, boosts available working time by 50% using this modern system. This is achieved only through the fact that all necessary materials and machines are already on board and the personnel can be transported jointly. The company also saw 30 percent cost savings when analyzing rail replacement works alone – this amounts to approximately 4000 pounds per repaired rail defect less than in the conventional system [6].

The disadvantages of the ROMIS/FIZ are manageable: the efficient use of this modern train requires a careful planning resulting in scheduled shifts with multiple rail changes or the bundling of a rail change with other outstanding repair works. The system is thus rather unsuitable for ad hoc measures, which must still be completed using the current system.

Fig. 3. Working conditions inside FIZ (authors own photo)

The potential for further development of the system is immense: solutions such as sewer flushing units on container wagons and local subsoil rehabilitation are already available. [6]. Another challenge for the future will be the automation of several steps (e.g., the loosening of sleeper screws) during the track maintenance process.

4. CONCLUSIONS

The test in May 2021 has clearly shown that modular track maintenance systems like the FIZ/ROMIS provide a solution for current requirements such as enhanced track availability and decreased pollution while also ensuring higher worker safety and comfort.

The system is currently in use in other European nations, and the FIZ, which will enter into force in 2023, should enable improved efficiency and lower costs in Germany as well.

5. REFERENCES

[1] EIM-EFRTC-CER Working Group, *Track Maintenance & Renewal*, Session 2012.

[2] Marx L., Moßmann D., *Arbeitsverfahren für die Instandhaltung des Oberbaus*, 7. Edition., Volume DB Fachbuch. 2011.

[3] Schill T., Scharf K., Kimpel F., *Handbuch 40600 - Baubetriebsplanung, Betra und La*. Germany, 2022.

[4] ROBEL Bahnbaumaschinen GmbH, *Robel Gleisbaumaschinen*, https://www.robel.com/.

[5] Paul A., *Innovation in der Instandhaltung: Der Fahrbahninstandhaltungszug*, Der Eisenbahningenieur, 2021.

[6] Schmid G., Hechenberger P., Mühlbacher C., *Mobile Instandhaltung löst neue Aufgabenstellung im Bahnbau*, Der Eisenbahningenieur, 2019.

Un studiu privind trenurile de serviciu pentru întreținerea de căi ferate în Europa

În prezent, sistemul utilizat pentru lucrările de întreținere a căilor ferate în Germania este complex, dificil de exploatat și riscant pentru angajații implicați. Acest articol analizează dezavantajele abordării actuale și prezintă un nou sistem (un tren de serviciu modern), evidențiind rezultatele unei testări realizate în anul 2021. În plus, articolul oferă o privire de ansamblu asupra efectelor pozitive asupra securității muncii operatorilor umani, arătând cum ar putea arăta dezvoltarea ulterioara a sistemului trenurilor de serviciu.

Vladimir VOICU, PhD Student, Politehnica University Timisoara, Faculty of Management in Production and Transportation, vladimir-virgil.voicu@student.upt.ro, +40 256404284, 14 Remus str., 300191 Timisoara, Romania.

George CARUTASU, Prof. PhD. Habil., Romanian-American University, Informatics, Statistics, Mathematics, george.carutasu@rau.ro, Expozitiei 1B, Sector 1, 012101, Bucharest, Romania, PhD Supervisor, University Politehnica Timisoara, Doctoral School, Timisoara, Romania, george.carutasu@upt.ro, +40 372120324