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DEVELOPMENT OF THE FUTURE RAIL FREIGHT SYSTEM TO REDUCE THE OCCURRENCES AND IMPACT OF DERAILMENT

Gordana VASIĆ [1]
Stephen INGLETON [2]
Andreas SCHÖBEL [3]
Björn PAULSSON [4]
Mark ROBINSON [5]

Abstract *– This paper provides an overview of D-RAIL, an EU FP7 project that focuses on freight train derailments. The project will identify root causes of derailment of particular significance to freight vehicles, which have a wider range of operating parameters (as a result of the huge range in loads, speeds and maintenance quality) than passenger vehicles. D-RAIL will extend this study to include the expected demands on the rail freight system forecast for 2050, such as heavier axle loads, faster freight vehicle speeds, radically new vehicle designs, or longer train consists. A set of alarm limits will be specified which can be selected as appropriate by infrastructure managers, depending on local conditions. Current monitoring systems and developing technologies will be assessed with respect to their ability to identify developing faults and potential dangers. Where current systems are shown to be deficient, the requirements for future monitoring systems will be specified. D-RAIL will also examine vehicle identification technologies. Integration of alarm limits, monitoring systems and vehicles across national borders and network boundaries will be examined and a deployment plan set out based on RAMS and LCC analyses. D-RAIL results will input to standards, regulations and international contracts.*

Keywords – derailment, freight trains, monitoring, vehicle and track inspection.

1. INTRODUCTION

Rail freight, as part of an intelligent and integrated logistic system, is of strategic and economic importance to Europe. To achieve this, railway infrastructure and vehicles should be well-maintained, and system upgrades and innovations coordinated with the aims of reducing accidents and operating costs, as well as congestion, pollution and noise.

Derailments cause major network disruption, and can have significant societal impact. In Europe, there are still a large number of low-cost derailments (typically in shunting yards) and a small number of high-cost ones. In the EU during the past 10 years, 691 freight train derailments have been reported – the true number is likely to be much higher. The European Railway Agency (ERA) estimates that open line freight train derailments cost EU 27 countries more than 200 million Euros per year [1]. Although the number of fatal train accidents is declining in general (by 6.3% a year [2]), derailments are still a major problem, especially when trains with dangerous goods are involved.

Regulations covering reporting of accidents are now in place in the European Union, but there is still significant variation in the quality of reporting across the Member States. Detailed information on derailments, their causes and costs, in each country is generally not publicly available. Costs, in particular, are very difficult to estimate since different financial procedures are implemented in different countries, and the aftermath of derailments (including accident investigations and public inquiries) can often last

[1] Gordana VASIĆ, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK, gordana.vasic@ncl.ac.uk.
[2] Stephen INGLETON, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK, stephen.ingleton@ncl.ac.uk
[3] Andreas SCHÖBEL, Vienna University of Technology, Institute of Transportation', Karlsplatz 13 / 230-2, A-1040 Vienna, Austria, andreas.schoebel@tuwien.ac.at
[4] Björn PAULSSON, UIC/Trafikverket, bjorn.paulsson@trafikverket.se
[5] Mark ROBINSON, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK, newrail@ncl.ac.uk

several years.

There is a need for new research into freight train derailments. Given the projected freight market growth in Europe, it is important to ensure the number of freight train derailments is reduced – this is a key driver for the present research. The EU FP7 project D-RAIL provides the approach, structure, and technical content to improve prevention of freight train derailments, and mitigation of derailment impact. The project started in October 2011 and its duration is 3 years.

Figure 1 shows a derailment, of a freight train, consisting of a Class 66 locomotive and a set of stone wagons, at Brentingby, UK, in 2006.

Fig.1. Brentingby derailment, UK, 9.2.2006. [3]

2. PROJECT AIMS AND OBJECTIVES

The aim of D-RAIL project is to significantly reduce the number and impact of freight train derailments. The project seeks to provide cost-effective solutions to support this key objective. This will have a dramatic impact on the disruption and associated cost of derailment to the freight industry and improve the competitiveness of rail freight operation against other transport modes within Europe.

3. CONSORTIUM

The D-RAIL consortium consists of twenty partners from ten European countries. This is a global project and includes the International Union of Railways (UIC), Russia (RZD) and the USA (Harsco). Many of our partners have significant international rail experience outside the EU.

The project is led and managed jointly by UIC and NewRail. The team consists of experts in railway engineering, vehicle and track dynamics, and risk assessment and risk management, teamed with railway users and experts with practical knowledge of the derailment problems and implementation issues. Experts in measuring and condition monitoring form part of the team. A good balance has been achieved between the railways, industry partners and academia.

Wider involvement of European railways is ensured through the involvement of UIC which represents an additional number of railway partners such as Network Rail, ProRail, RFI and ADIF. In addition, broad industry involvement is obtained thorough the inclusion of UNIFE as a member of the Steering Committee.

List of D-RAIL partners:

R&D organisations & Universities

- NewRail, Newcastle University
- RSSB
- Vienna University of Technology
- NEA Transport
- Chalmers University
- Politecnico di Milano
- Huddersfield University
- VUZ Railway Research Institute

Railways

- Deutsche Bahn
- SNCF
- SBB
- ÖBB
- Trafikverket
- UIC

Industry Partners

- Lucchini
- MerMec
- Faiveley Transport
- TelSys
- Oltis Group
- Harsco Rail

4. RESEARCH PROGRAMME

The research programme targets an improved understanding of the fundamental issues associated with freight derailments, the economic impact and the means with which to address and mitigate future occurrences. Here is a short description of the project's work packages (WP).

WP1 'Derailment Impact' has provided a comprehensive review of recent freight derailments to identify the principal root causes. The severity and impact on railway operations was also assessed to understand the economic implications for damage to vehicle and infrastructure, and disruption to network operation.

WP2 'Freight Demand And Operation' has evaluated trends for rail freight towards the target freight system of 2050. This embraced European rail policy and strategy for future freight including movement, logistics, sector economics and the likely impact on forward operation of technologies.

WP3 'Derailment Analysis And Prevention' is identifying and evaluating, through modelling and simulation, the key contributory factors associated with derailment including combined causal effects (e.g., a slight track twist and a failing bearing) for the freight vehicle and track system. The study is evaluating these factors to provide cost-effective solutions and to demonstrate a step change in

prevention.

WP4 'Inspection And Monitoring Techniques' is reviewing and assessing current technologies related to derailment prevention and mitigation. One example is shown in Fig. 2. Inspection and monitoring are being considered for both the freight vehicle and the track, since it is the interaction of these that is important. Cost-effective methods to improve the existing monitoring systems will be developed.

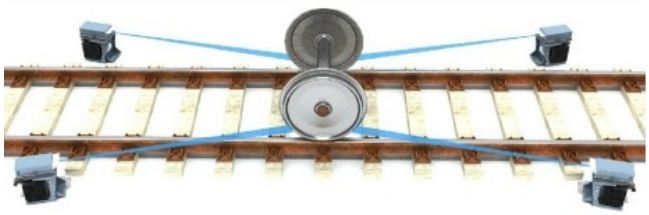

Fig.2. Measuring system for wheel surface defects [4]

WP5 'Integration Of Monitoring Techniques' will develop and integrate different wayside and on-board monitoring concepts (including vehicle identification) related to derailment prevention and mitigation. Suitable concepts are to be developed and selected on the basis of RAMS and LCC analysis to support wider industrial implementation.

WP6 'Field Testing And Evaluation' will validate improvements to track and freight vehicle(s) through field testing and to measure the combined interactions. Both existing and new technologies, including telemetry and monitoring outputs, will be evaluated to determine the step changes in safety performance required for derailment prevention.

For field testing and validation, D-RAIL will have access to VUZ's test track in the Czech Republic, which will be used for testing of wayside and vehicle-mounted monitoring technologies, and also to Barrow Hill (a heritage site and freight locomotive maintenance yard in the UK) for initial implementation and testing of new wayside monitoring technologies. The goal of the wayside monitoring is to study each passing vehicle's response to a variety of stimuli and therefore identify vehicle faults with greater certainty.

WP7 'Operational Assessment And Recommendation' will use RAMS analysis to identify the impact of vehicle monitoring on the reliability, availability and safety of the railway system. Economic assessment of monitoring concepts including migration with regard to LCC and social economic effects and risk assessment for relevant vehicle states and monitoring scenarios will be undertaken.

WP8 'Dissemination And Exploitation' will ensure that the findings of the research are widely disseminated, and that new products and technologies are fully exploited by the industry. This will be undertaken by the consortium members who already form a wide geographical, demographic and industrial spread across Europe. UIC are also part of the consortium and will be able to provide assistance in promoting and disseminating the findings of the research on a pan-European and international basis. Outreach and marketing of the research findings will occur throughout the project to a wide variety of stakeholders and engineers to ensure industry awareness.

5. EXPECTED FINAL RESULTS AND OUTCOMES

A key output from the activities will be:

- The ability to define the causes of derailment (combined or otherwise).
- A quantifiable step change in the number of freight derailments.
- Recommendations for monitoring systems based on technical and economic grounds.
- Reliable implementation scenarios and guidelines for national and international use.
- New technological developments and innovations for industrial applications.

The expected benefit is to reach a reduction of derailment impact which would at least balance the mechanical effect of the expected railway traffic increase on accident numbers. Other project outcomes will be to:

- Define and describe the foreseeable (macro-) features of the railway freight system towards a target freight system in 2050, taking into account the European Transport Policy, available studies and research on freight logistics and relevant trends of sector economics as well as railway technology developments.
- Define cost-effective scenarios, integrating system changes and new safety measures, in order to reach the proposed target system(s) and the expected reduction of derailment occurrences and impacts.
- Demonstrate (through field tests) the feasibility of the most innovative system changes and safety measures within the proposed time scale.

6. IMPACT FOR STAKEHOLDERS

Any reduction in the number or severity of the derailments represents a significant benefit to all railway parties (train operators, infrastructure owners, vehicle owners, terminal operators, shippers, etc.).

For train operators

- The more advanced monitoring systems developed or implemented through D-RAIL will result in lower levels of derailment which will in turn reduce service disruptions, train delays, loss

of equipment and goods, incidents involving dangerous goods (RID), fatalities and maintenance costs. The resulting improved levels of reliability will reduce the number of incidents which have serious implications for the whole railway system.
- D-RAIL will also integrate existing and new monitoring technologies with existing railway control and operating systems to facilitate implementation and use throughout Europe.
- D-RAIL will provide added insight into vehicle conditions that affect *operating* costs, using criteria developed through state-of-the-art simulation and field tests.
- Vehicle identification will allow for tracking and removal of unsafe vehicles.

For infrastructure owners
- The ability of D-RAIL to allow vehicles to run at higher speeds with reduced risk of derailment will result in a reduction in the complexity of operation of a mixed-traffic railway. Better use of existing infrastructure will result in increased capacity and increased traffic flow.
- Identification of vehicles that generate excessive or unbalanced loading that might cause derailments (and consequently damage to the track structure) will reduce maintenance requirements.
- Reduced risk of hazardous environmental incidents.
- At border crossings and other network access points the wayside monitoring systems will identify and stop unsafe vehicles before entering the connected network.

For vehicle owners
- D-RAIL will provide added insight into vehicle conditions that affect *maintenance* costs, using criteria developed through state-of-the-art simulation and field tests.
- Identification of recurring vehicle problems associated with certain classes of vehicles.
- The reduction in derailments should reduce vehicle repair costs.
- Identification of vehicles that generate excessive loadings will allow for better long-term management of vehicle maintenance.

For terminal operators
- The more advanced monitoring systems developed or implemented through D-RAIL will result in lower levels of derailment which will in turn reduce service disruptions in the terminals.
- D-RAIL will help improve loading practices that can result in the safe even loading of freight vehicles to limit imbalance and loss of products.
- D-RAIL will create a more competitive environment for freight logistics solutions on rail.

For shippers
- Improved safety will increase the attractiveness of rail transport by reducing loss and damage due to derailments.
- Improved safety will result in more efficient and reliable movement of goods and reduce costs.

7. CONCLUSIONS

The project is aimed towards providing significant improvements in derailment prevention, detection and mitigation of the subsequent effects.

Recommendations for improvements to existing European standards for freight operation will be assessed and provided.

The research will be reported in relation to the target freight system for 2050 and how findings will benefit economic and technological developments in future rail freight operation.

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