CETRA 2014

3rd International Conference on Road and Rail Infrastructure
28–30 April 2014, Split, Croatia

Road and Rail Infrastructure III

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CETRA 2014
3rd International Conference on Road and Rail Infrastructure
28–30 April 2014, Split, Croatia

TITLE
Road and Rail Infrastructure III, Proceedings of the Conference CETRA 2014

EDITED BY
Stjepan Lakušić

ISSN
1848-9850

PUBLISHED BY
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Kačićeva 26, 10000 Zagreb, Croatia

DESIGN, LAYOUT & COVER PAGE
minimum d.o.o.
Marko Uremović · Matej Korlaet

PRINTED IN ZAGREB, CROATIA BY
"Tiskara Zelina", April 2014

COPIES
400

Zagreb, April 2014.

Proceedings of the
3rd International Conference on Road and Rail Infrastructures – CETRA 2014
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EUROPEAN EXISTING RAILWAY TRACKS: OVERVIEW OF TYPICAL PROBLEMS AND CHALLENGES

Irina Stipanovic Oslakovic[1], Xincai Tan[2], Kenneth Gavin[3]
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Abstract

Railways are one of the key modes of transport. The existing aging ballasted tracks play a critical role in rail transport infrastructure. In order to identify the challenges and problems faced by railway infrastructure managers in European countries, a survey was conducted as part of the EU FP7 SMART RAIL project.. The survey consisted of two parts: questionnaires were sent to relevant specialists in various European countries; and a literature survey was undertaken. Key findings include that: (a) rail transport are increasingly globally; (b) with technological advances, rail trends are for faster, heavier and longer trains, as well as increased energy effectiveness and greater reliability, whilst trying to reduce costs; (c) most of the railway tracks in Europe have reached or exceeded their design service life; (d) ballasted tracks are the most popular and economical track bed structure. One of the main challenges is how to enhance these existing ballasted tracks in the context of the trends for increased use. Most countries have their own standards in railway engineering and maintenance. Technical data were obtained from seven countries, which should be useful for engineering design or evaluation. The survey can be used as guidance or/and reference on railway track management and research in particularly in European countries.

Keywords: existing railways, survey, aging, design service life

1 Introduction

Railways are one of the key modes of transport. Aged ballasted tracks play a critical role in European rail transport infrastructure. To identify the challenges and problems faced by railway infrastructure managers in Europe, a survey was conducted as part of the EU FP7 SMART RAIL project [1]. The survey used two means of data collection: questionnaires were sent to relevant specialists in various European countries; and a literature survey was undertaken. The questionnaire was sent to all partners of this EU project SMARTRAIL and some network experts outside the project through email. More than 50 experts were asked to answer the questionnaire. These experts were from 14 countries in Europe: Austria, Croatia, Czech, Germany, Greece, Ireland, Latvia, Poland, Russia, Sweden, Slovenia, Switzerland, The Netherlands, and the United Kingdom. Eight responses to the questionnaire from seven different countries were received, although in most cases the answer to at least one question was omitted. The seven countries were: Croatia, Greece, Ireland, Russia, Slovenia, Switzerland and the United Kingdom (UK).. These are referred to as the respondent countries (RCs). The questionnaire survey mainly focused on track issues, including general issues, vehicles, rails, fastening systems, sleepers, ballasts and sub-ballasts, placed soil and geosynthetics, subgrade, dra-

inage systems, maintenance and the like. The literature survey included the railway market, climate, train speeds and lengths, standards and technologies.
This paper presents the results of the questionnaire and literature survey, followed by a discussion of factors contributing to the European existing railway tracks and future demands.

2 Factors affecting tracks performance

A railway network is a complex system. system is quite a complicated system. First, operations and infrastructure influence each other in various ways. The quality of the rolling stock influences the wear of the infrastructure and thus the amount of maintenance and renewal needed. Secondly, infrastructure failures, but also planned interventions for maintenance, influence the reliability of the operations. An important aspect of rail infrastructure is that the assets or railways system components have long life spans and once installed it is very costly and complicated to modify the initial design. Decisions in design and maintenance will thus have a long-lasting impact. [2]
There are a number of factors affecting the performance of existing railway tracks. Their effects are complex and often inter-connected. Figure 1 shows an Ishikawa diagram (fishbone diagram) to present the key factors that contribute to the behaviour of existing European railway tracks.

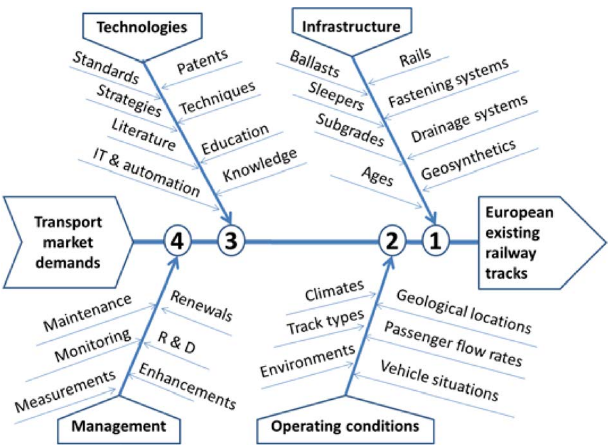

Figure 1 Ishikawa diagram (or fishbone diagram) showing the key factors contributing to European existing railway tracks.

3 Results of the survey process

3.1 Methodology of the survey

Figure 2 shows the methodology for the survey process. Two methods were applied to collect data: a questionnaire and a literature survey, [2].

3.2 Results of the questionnaire survey

The age of the railway tracks currently operated in the RC's is presented in Figure 3. It is possible that this question may have been interpreted differently by some respondents. Irish and Swiss responses, who indicate their tracks are relatively new were related purely to railway tracks rather than railway lines. In the case of others, they might have understood that railway lines or track systems were the focus of the question. The answer to the question "what is the oldest railway track system still in service" was much more consistent. Figure 4 shows that many track systems built in the first half of 19th century, are still in operation.

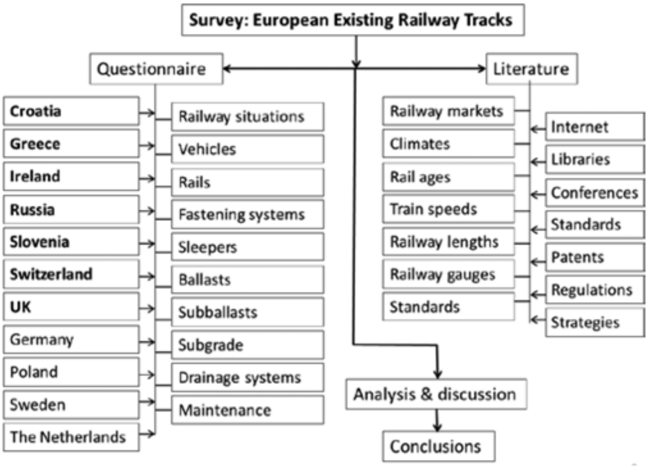

Figure 2 Map of the survey process

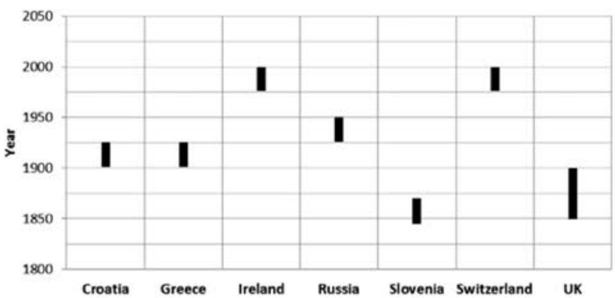

Figure 3 The age of the majority of railway infrastructure in use.

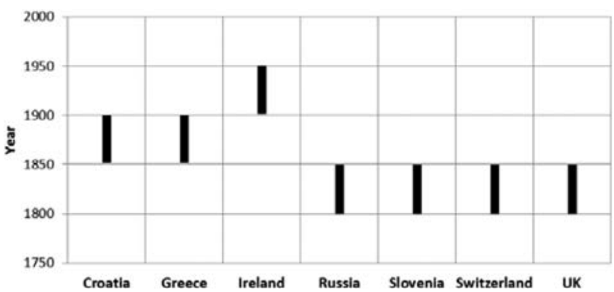

Figure 4 The oldest railway track system still in service.

When asked "what is the most frequent cause of failures on the railway track system", switches and crossings had the highest frequency of failure, followed by landslides and problems with transition zones. One railway operator specifically noted the correlation between aged or infrastructure in poor condition and failure frequency. The weakest component was generally seen to be related to the rail tracks.

The frequency of performing preventive inspection and maintenance for the railway track was very different across the RCs, from daily to weekly and half-year frequency. In Greece, surveys are conducted twice a year by a track recording car and monthly and weekly by the track agents; whilst in Slovenia, the respective rates are annualmaintenance and weekly – preventive inspection. In Switzerland, visual inspection is carried out every fifteen days and vehicle measurements are made twice a year.
The track stiffness adopted across Europe varied widley from 40 kN/mm to 200 kN/mm, See Table 1, which includes data also on the maximum axle loads by Country. In Figure 5 an overview of the current highest speed and expected future highest speed demand based on the existing railway system is presented. The data shows that in the majority of countries the current speed is between 120 km/h and 160 km/h. Most countries are planning for speeds in the range 160 km/h to 200 km/h in the future.

Table 1 Future evolutions in relation to vehicle load carrying capacity and high speed rail

	Stiffness of the existing railway tracks [kN/mm]	Max. axle load [t/axle]
Croatia	150 – 200	22,5
Greece	50-75	22,5
Ireland	-	18
Russia	100 – 150	30
Slovenia	60 – 100	30
Switzerland	100 – 200	22,5
UK	40 – 100	25

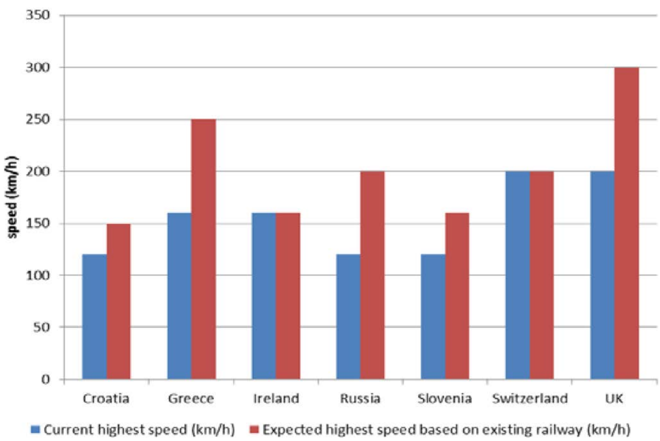

Figure 5 Highest speed of the current and expected future rail transport

The most cost-efficient solution to the railway track is generally considered to be ballasted track. The largest proportion of the RC's maintenance budget is generally expended in relation to ballast, renewal/replacement followed by rail tracks, and subgrade materials.
The average unit cost for the maintenance of railway track was quite consistent in the surveyed countries, and varied between 40 and 67 €/m. For example in Switzerland unit cost for mechanized maintenance, which include ballast distribution, tamping, compaction and stabilization is 67 €/m. Renewal of ballast, rails, sleepers without cleaning up of infrastructure is 1400 €/m, while renewal of ballast, rails, sleepers with cleaning up of infrastructure is 2500 €/m.

3.3 Results of literature survey

The literature survey was focused on the issue what the future rail transport trends are. Figure 6 shows the population per km track in these countries in a number of European countries. [4] It can be seen that surveyed countries (Croatia, Greece Ireland, Russia, Slovenia, Switzerland, UK) are covering from average to very high population densities per km track.

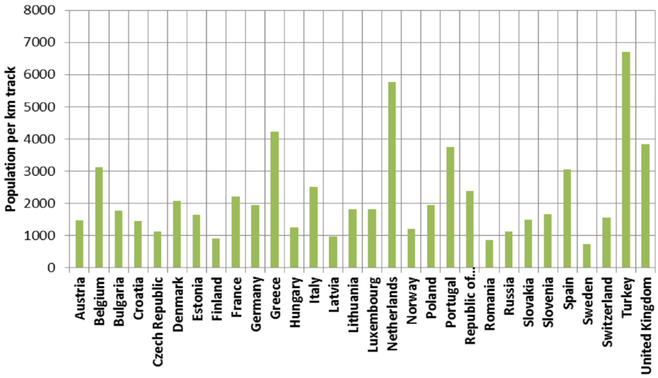

Figure 6 Population per length of railway track in selected European countries (data source: [4])

Figure 8 shows statistical data from 1980 to 2009 for railway passenger journeys in four different countries, USA, China, Japan and the UK. It can be seen that for all the four countries, railway passengers journeys and/or in length have been increasing annually. This implies that rail transport markets are increasing rapidly both in established and emerging economies. Since 1992, traffic on the Chinese railway network has increased by more than 110 percert [5]. In 1990s, the network had a 2% average annual growth rate; while in 2000s, the growth rate increased to 8% annually for both passenger and freight. This growth actually depends upon a number of factors, for example, national economic and trade growth, market evolution and demands, railway management competence and actions, national transport strategy and funding, and the like [6].

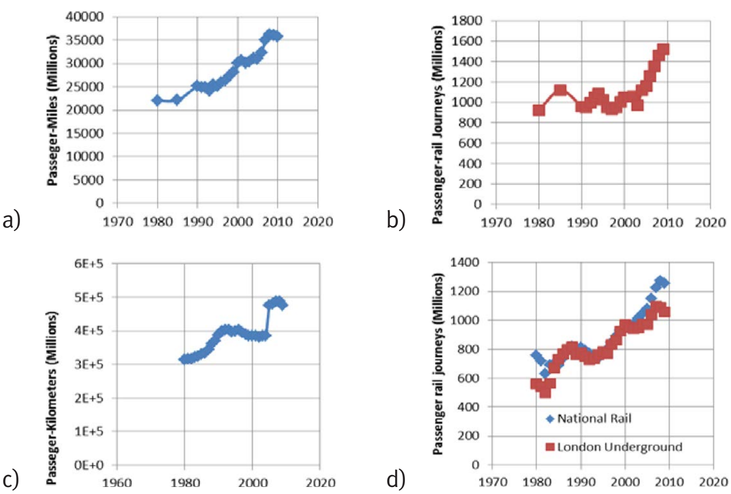

Figure 7 Statistical data from 1980 to 2009 for railway passenger journeys for four different countries: a) United States of America, b) China, c) Japan and d) the UK, [7-10]

From [4] historical data on train speeds has been collected and analysed. Before 1990, the data adopted a linear proportional increase. After 1990, however, train speeds have increased remarkably. With increasing rail market and advanced technologies, it is predicted that the train speed will continue to increase.
After analysing the related data from selected countries, it could optimistically be concluded that future railway demands will be increasing globally.

4 Conclusion

A survey on European existing railway tracks was carried out to identify challenges related to current infrastructure. There is a strong demand for rail transport and continuous research and development is being carried on to make railways faster, heavier, longer and greener. Most of the existing railway tracks in Europe have reached their design service life; the main challenge is how to enhance these existing ballasted tracks. Most countries have their own standards in railway engineering and maintenance. Some typically technical data have been obtained from seven countries which may be useful for engineering design or evaluation. The effects of climate on track services are critically significant. There are a number of projects on R&D of railways worldwide. There is a great deal of information on railways in various sources, e.g., journals and magazines, societies conferences, internet, etc. it would be helpful to obtain sufficient literature search and review before starting a new research and development project. It is found that: (a) the markets for rail transport are increasingly global; (b) with technological advances, rail transport trends are for faster, heavier and longer trains, as well as increased cost and energy effectiveness and greater reliability; (c) most of the railway tracks have reached or exceeded their design service life; (d) ballasted tracks are the most popular and economical track bed structure but there are some challenges related to how to enhance these infrastructure systems.

Acknowledgement

We gratefully acknowledge the support from the EU 7th Framework Programme. for SMART RAIL project, funded under SST.2011.5.2-6 Cost-effective improvement of rail transport infrastructure, grant agreement no: 285683SMARTRAIL project.

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