



# Smart Maintenance, Analysis and Remediation of Transport Infrastructure

## Deliverable 5.8 SMART RAIL FINAL CONFERENCE Report



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# Project Information

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Project Coordinator:

Dr. Kenneth Gavin (kenneth.gavin@ucd.ie)

School of Civil, Structural and Environmental Engineering

University College Dublin

Newstead Building

Belfield,

Dublin 4

Ireland



## Document information

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Authors: The SMARTRAIL Consortium

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## Summary

The final conference of SMARTRAIL was held in Ljubljana on 25 and 26 August 2014 with an audience of 66 persons, representative of the railway stakeholders and researchers. It included a comprehensive presentation of the results of the project by the respective Work Package leaders, as well as three keynote presentations on; implementing the findings of the project, the impact of rail investments on the society's welfare and the perspectives of improving railway resilience through weather forecasting.

A round table discussion concluded the conference, in which the participants had the opportunity to raise questions and obtain detailed information from the panel on various subjects related to the implementation of the practical solutions developed in the project, on important issues raised by the research outcomes relating to infrastructure elements (notably the transition zones) and the importance of regulation and coordination on an international level.

## 1 Venue and audience

The conference was hosted by ZAG, and took place at the Grand Hotel Union Business in Ljubljana (Slovenia) on 25 and 26 August 2014. The organizing committee comprised Kenneth Gavin (project coordinator), Wolfgang H. Steinicke (EURNEX) and Stanislav Lenart (ZAG).

66 persons were present at the conference, representing political institutions (European Commission, Slovenian Ministry of Infrastructures and Spatial Planning, Slovak Ministry of Transports), infrastructure managers, railway undertakings, universities, research centres, professional associations and private companies from 18 countries (Slovenia, Croatia, Belgium, Ireland, Poland, Bulgaria, Sweden, Poland, Latvia, Austria, Germany, France, Switzerland, Russia, Slovakia, Netherlands, United Kingdom and Algeria).



Figure 1: Opening session of the SMARTRAIL final conference.

## 2 SMARTRAIL scientific results

SMARTRAIL Project Coordinator Dr. Ken Gavin (UCD) opened the meeting with an overview of the project, highlighting that the consortium had been successful in bringing key experience from outside railways (the scientific and commercial arenas) to the railway infrastructure managers as well as addressing the scientific problems encountered in providing better management of railway infrastructure and transferring the necessary expertise. Each Work Package outlined their process and results in respective presentations.

### 2.1 WP5 (Dissemination and support of exploitation)

Two presentations by Wolfgang Steinicke and Michael Robson (EURNEX) described the innovative involvement of users in Work Package 5 throughout the project, via a platform of infrastructure managers. The presentation outlined the process taken to create a new culture of cooperation using external railway expert Michael Robson, in the general goal to define a common language to bring regulators, politicians,

researchers, engineers, users and the general public to understand each other, and to raise interest to work in common in the so-created community. A user platform was convened and the platform was involved from the definition of the project objectives to the exploitation of project results in order to ensure the customer point of view was taken into account in the activities of the SMARTRAIL project. In addressing this goal, the WP5 process included a questionnaire and face to face interviews with infrastructure managers to find out their needs and interest in respect of scientific focus, as well as workshops and the involvement of the EURNEX advisory board. They validated the scope of the project and identified the following requirements:

- Embankment stability.
- Bridge life extension.
- Bridge scour.
- Structural Health Monitoring (SHM)
- New Rehabilitation Technologies.
- Track maintenance, e.g. Anchor Rail fastening (ARF).
- LCA/LCC Database.

This process provided valuable input to the technical work packages (1-4) in order to produce practical solutions. Each of these work packages then tackled the task to provide a User Guidelines document that set the way forward for the practical future implementation of key advances in science and technology developed during the project. The need for these guidelines, which were not part of the description of work of the project, appeared in the course of WP5, as a general demand from the users, and they were included in the project as supplementary results of interest for the users.



Figure 2: Presentation of the WP 5 activities by Dr.h.c. Wolfgang H. Steinicke.

## 2.2 WP1 (Monitoring and inspection)

For WP1, which aimed to bring about a step change in the traditional methods of visual inspection and ad-hoc monitoring with integrated monitoring systems which utilise the latest embedded sensor technology and optimised in-situ testing methods, Ken Gavin explained how an instrumented smart slope experiment was performed in Ireland with two types of sensors, suction probes and water content probes.. The cheaper sensor proved to be the most reliable during both phases of this experimental work. A model was also developed to estimate the time until failure for a given rainfall event. Geophysical techniques were investigated and found to provide consistent data on the potential for hot-spots and laboratory tests

allowed a model for the effect of moisture content on the strength and stiffness of unbound materials to be developed. Bridge scour monitoring was also an integral part of WP1, whereby a vibration-based method of assessment was evaluated for a range of conditions and scour severities. The method is based on detecting changes in the fundamental natural frequency of a structure arising due to the removal of soil by the scour process. The method shows promise at detecting and monitoring the progression of scour around critical bridge foundation elements. WP1 in conjunction with weather forecasting and warning systems will improve resilience to adverse weather.

### **2.3 WP 2 (Assessment and Models)**

Professor Eugene O'Brien of Roughan and O'Donovan Innovative Solutions (ROD-IS) outlined that WP 2 aimed to move away from the current assessment methods to extend the life and optimise rehabilitation/renewal. This included the development of a safety evaluation framework to incorporate information from Structural Health Monitoring into performance computation which can probabilistically analyse slope stability, allowing for climate change and model track settlement and stiffness. Each of the tasks were explained in detail in presentations by Dr. Stefan Lachinger of AIT (for the framework and assessment at the Nięporet Bridge in Poland), Arkadiusz Mróz of Adaptronica for the integration of Sensor, Inspection and NDT Data into a Structural Safety Model with a wireless system again at the Nięporet Bridge and Cormac Reale of UCD for the slope stability.

### **2.4 WP 3 (New rehabilitation technologies to extend service life of existing railway infrastructure)**

For WP 3, Stanislav Lenart (ZAG) presented work on open tracks, Marko Vajdic (IGH) on Transition Zones, Duo Liu of Technical University of Munich (TUM) on Modelling, Tanja Mikulic (IGH) on Tunnels, Irina Stipanovic (University of Twente) on Bridges and Aljosa Sajna (ZAG) on a novel application of Ultra High Performance Fibre Reinforced Concrete (UHPFRC).

WP 3 presented the developments of various new means to improve the rehabilitation of open track (Stanislav Lenart, ZAG), transition zones (Marko Vajdic, IGH), bridges (Irina Stipanovic, University of Twente) and tunnels (Tanja Mikulic, IGH). Aljosa Sajna(ZAG) presented a novel application of Ultra High Performance Fibre Reinforced Concrete (UHPFRC), and Duo Liu (TU Munich) discussed the validation by simulation of the numerical results on track sleepers, dynamic strain and track geometry.

### **2.5 WP 4 (Whole Life-Cycle Cost Calculation Tools)**

Stanislav Lenart (ZAG) and Simon Kovačič (Slovenske Železnice) outlined the sustainable rehabilitations of ballasted track by the use of geosynthetic reinforced soil at the Buna Bridge test site in Croatia. This has led to the conclusion of a WP4 report on the Life Cycle Cost Model and the public release on the project's web site of a Life Cycle Analysis and Life Cycle Cost tools, along with a database of the calculation parameters, which can be utilised by railway infrastructure managers and researchers alike. Karmen Fifer Bizjak (ZAG) presented this tool and the results obtained from the case study performed on Buna Bridge.

Answering a question from user members of the audience, a discussion followed regarding the need to establish the LCA/LCC tools in the European Union, and more generally the need for regulatory activities in the environmental domain, such as greenhouse gas emissions.



## 3 Keynote presentations

To punctuate the agenda with externally relevant topics to the project, three keynote speakers gave a perspective from a pan-European, private sector and academic point of view.

### 3.1 UNECE: impact of rail investments on the society's welfare

Andreas Zimmer of UNECE's Trans-European Railway (TER) Project, outlined the importance of rail infrastructure for society in his key note entitled "Rail infrastructure – An asset to Society's welfare!" He emphasised the need for better railway infrastructure to connect to the other modes (roads, airports and water) and showed the short and long-term benefits of investing in infrastructure. Using a social impact measurement and social return on investment study from the Vienna Economic School in Austria to be finalised by the end of this year, he showed that for every Euro invested, a 15 Euro return on investment will be generated over the long-term for society. Some 40% of state assets are in transport infrastructure but the maintenance costs are high and need to be reduced, which will also help to resist climate change. Weather forecast systems, for example, are needed to secure infrastructure buildings.

### 3.2 University of Zagreb: practical implementation of the SMARTRAIL solutions in Croatia

The potential practical implementation of SMARTRAIL results was highlighted by Prof. Meho Saša Kovačević of the University of Zagreb to remediate the present poor condition of critical railway infrastructure in Croatia. A vast range of necessary remediation measures is, or will be, implemented on embankments, cuttings, tunnels, etc to fulfil all of the safety and functional aspects of the railway network.

### 3.3 UBIMET: weather forecasting for railway resilience

In the afternoon, Stefan Eisenbach of private SME company UBIMET showed how suitable weather forecasting systems dedicated to railway can help to enable a resilient rail network with an example from Austria, and outlined the need for common practices and data among countries. He suggested one pilot project for a trans-national rail weather information system as a follow-up to SMARTRAIL.

## 4 Round table debate

Day one of the event concluded with a round table discussion moderated by Dr.h.c. Wolfgang H. Steinicke, which provided an opportunity for the participants to raise questions on the results of the project, which solicited responses from the panel on the following subjects:

- To help with the implementation of the various outputs, the panel confirmed that the User Guidelines produced as the key output of the project would be available shortly on the website of the project.
- Transition zones will continue to be a problem, as for some railways simply back filling with ballast will be the cheapest solution, however the full report on the measurements carried out by TU Munich provides information which will help infrastructure managers in assessing the best option for their particular problem.



- The LCA database produced in WP4 provides a tool which can be used to speed up the production of Environmental Assessments for future work, and work needs to take place to have this tool recognised as a standard across the EU.
- There is a need for the various agencies such as the UNECE, Danube Strategy and the European Commission to come together in terms of pooling resources and data to improve the efficiency of projects.
- UNECE's plan on major corridors and lines, also taking into consideration the achievements of SMARTRAIL with cost/benefits/risk assessment and resilience to adverse weather.
- The practical deliverables of SMARTRAIL can be summarised as geosynthetic mats, transition zones, tunnel refurbishment, Weigh in Motion, Paint corrosion, LCA/LCC and Environmental assessments, embankment stability and bridge scour modelling. Each provides practical solutions which have the potential to be implemented and to improve cost effective maintenance of the rail network.



Figure 3: Roundtable Session at SMARTRAIL Final Conference (from left to right: Michael Robson, Irina Stipanovic, Eduardo Fortunato, Eugene O'Brien, Andreas Zimmer, Stefan Eisenbach).



Figure 4: Roundtable discussion SMARTRAIL Final Conference (from left to right: Eduardo Fortunato, Eugene O'Brien, Andreas Zimmer, Stefan Eisenbach).

## 5 Conclusion

A summary of the meeting, including all the Powerpoint presentations of the final conference are publicly available on the SMARTRAIL website: [http://smartrail.fehrl.org/index.php?m=3&id\\_directory=7631](http://smartrail.fehrl.org/index.php?m=3&id_directory=7631). An article on the conference, including the link to these documents as well as to the website and LinkedIn group of the project, will be published in FIRM, FEHRL's infrastructure research magazine.

## Annex 1: Conference schedule

### SmartRail Final Conference

25<sup>th</sup> & 26<sup>th</sup> August, 2014

Ljubljana, Slovenia

#### ORGANIZING COMMITTEE

Kenneth Gavin, UCD (SmartRail Project Coordinator)

Wolfgang H. Steinicke, EURNEX

Stanislav Lenart, ZAG

#### VENUE

##### Monday 25<sup>th</sup> August, 2014

**Conference:** Grand Hotel Union Business (GHUB), [Miklošičeva 3](#), Ljubljana, Slovenia

**Conference dinner:** Gostilna na gradu, [Grajska planota 1](#), Ljubljana

Departure for dinner at 18:40 in front of hotel Grand Hotel Union, [Miklošičeva 1](#), Ljubljana. Participants will have possibility to walk to the restaurant in the castle (appr. 15 min) or take a [funicular railway](#).

##### Tuesday 26<sup>th</sup> August 2014

**Site visit:** Building site for railway rehabilitation in Eastern Slovenia (Grobelno) and Railway Museum in [Šentjur](#), [Gajstova pot 4](#), 3230 Šentjur

Bus transfer of conference participants for the site visit will be organized. Bus departure at 8:50 in front of hotel Grand Hotel Union, [Miklošičeva 1](#), Ljubljana. Lunch at tourist farm [Domačija Debeljak](#), Lovnik 11, 2319 Poljčane. Return to Ljubljana at 16:00.



## CONFERENCE SCHEDULE

Monday 25 <sup>th</sup> August, 2014		Speaker	Affiliation	LOCATION
09.00	Registration & Welcome Coffee			GHUB, 1 <sup>st</sup> floor lobby
–				
09.30				
09.30	Welcome	K. Gavin	UCD	GHUB,
–	Opening “User Involvement”	W. H. Steinicke	EURNEX	Orchid room
10.00				
10.00	Key Note “Rail Infrastructure – Asset for Society’s welfare	A.Zimmer	UNECE TER	GHUB, Orchid room
–				
10.30				
10.45	Coffee Break			1 <sup>st</sup> floor lobby
–				
11.00				
11.00	“Project Results”			GHUB,
–	WP1 Finding from WP1 – Monitoring & Inspection	K. Gavin	UCD	Orchid room
12.30	WP1 Corrosion Sensors	M.B.Leban	ZAG	
	WP2 Assessment and Models	Eugene O’Brien	RODIS	
	WP3 Rehabilitation technologies	I. Stipanovic, S. Lenart, M. Vajdic, D. Liu, T. Mikulic, A. Sajna	UT, Various	
12.30	Lunch			GHUB, Restaurant
–				
13.30				
13.30	Key Note “Remediation of ageing rail infrastructure in Croatia: Past present and future status of the railway network“	S.Kovačević	University of Zagreb	GHUB, Orchid room
–				
14.00				
14.00	“Project Results”			GHUB, Orchid room
–				
15.00	WP3&WP4 Sustainable rehabilitations of ballasted track by the use of geosynthetic reinforced soil	S.Lenart, S.Kovačić	ZAG SŽ	
	WP4 LCA/WLC SMARTRAIL Tool	K.B. Fifer	ZAG	
	WP5 Project Results	M. Robson	EURNEX	

15.00 – 15.30	Coffee Break			GHUB, 1 <sup>st</sup> floor lobby
15.30 – 16.00	“Enabling resilient rail network - Weather forecasting”	S.Eisenbach	UbiMET	GHUB, Orchid room
16.00 – 17.30	“Roundtable Discussions“ Summary of First Day  Roundtable participants: I. Stipanovic, E. O’Brien, E. Fortunato, M. Robson, A. Zimmer, S. Eisenbach, S. Kovacevic	W. H. Steinicke, K. Gavin (moderators)		GHUB, Orchid room
19.00	Conference Dinner			Restaurant “Gostilna na gradu”

Tuesday 26 <sup>th</sup> August 2014		Speaker Affiliation	LOCATION
09.00 – 12.00	Site Visit		Building site for railway rehabilitation in Eastern Slovenia
12.30	LUNCH		
13.30- 14.00	Summary & Closing	K. Gavin	UCD
16.00	Return to the Grand Hotel Union, <a href="#">Miklošičeva 1</a> , Ljubljana		



## KEY NOTE SPEAKER INFORMATION

**Meho Sasa Kovacevic** is full professor at the Faculty of Civil Engineering in Zagreb. He received his BA in 1991, MSc in 1994 and PhD in 1999. Additionally, he holds diplomas in Geotechnical soil investigation (Geodelft, Netherlands, 2004), Geotechnical instrumentation for field measurement (Geodelft, Netherlands, 2001), Design-build-contracting (American Society of Civil Engineers, USA, 1999) and Geotechnical instrumentation for field measurement (American Society of Civil Engineers, USA, 1997). Currently, he is Head of the Department for Geotechnics and Head of Chair for Rock Mechanics and Investigation Works. His most significant contribution to the science and practice is reflected in the wider implementation of a number of methods of geotechnical measurements and observations in construction practices, as well as developing of field and laboratory testing methods of soil and rock. Under his supervision, more than 80 students have graduated, 7 received MSc and 5 received PhD. Professor Kovacevic participated and participates as a manager or associate in five national research projects, and in four international scientific research project. He has authored or co-authored 17 papers in journals and 95 papers at conferences. He is also editor of three books in the field of geotechnics. In period 2004 – 2008 prof. Kovačević was secretary of Croatian Geotechnical Society and in period 2006 -2010 he was a Vice Dean for Business on Faculty of CE in Zagreb. He is currently president of the Croatian Association for Underground Construction and member of the scientific committee of the International Geothermal Center in Bochum. He is also member of Croatian Society for Rock Mechanics, International Society for Rock Mechanics, International Society for Soil Mechanics and Geotechnical Engineering and American Society of Civil Engineers. Prof. Kovacevic is chartered Civil engineer (20 years of experience) with more than 90 projects as main designer. He is also chartered design auditor.



**Andreas C Zimmer** is Deputy Project Manager, UNECE Trans European Railway since 2014. Previously his role was as Competitive Manager at Railcargo Austria. He has extensive experience working with rail infrastructure management. In his current role he has responsibility for ensuring that the TER Project is implemented according to the work programme approved by the TER Steering Committee. This includes preparing the draft programmes of work for TER Project. <http://www.unece.org/trans/main/ter/ter.html>



**Stefan Eisenbach** studied meteorology and geography at the University of Vienna (Austria) and attended special courses at the Institute of Mountain Risk Engineering about snow physics, avalanches and avalanche protection. During his studies Mr. Eisenbach organized large scale field campaigns about cold air pools in valleys and got an invitation by the Pacific Northwest Laboratory (PNNL) of the US Department of Energy (DOE) for further research activities in this topic. In 2004 Mr. Eisenbach joined the meteorological institute UBMIET he is responsible for meteorological networks (e.g. testing of new sensors) and for all research and development activities in the railway sector. He is as well responsible for the implementation of meteorological information and the development of meteorological alert systems for the Austrian Federal Railways





## Annex 1: List of participants

<b>Surname</b>	<b>First name</b>	<b>Job title</b>	<b>Company</b>	<b>Country</b>
Adesiyun	Adewole	Deputy Secretary General	FEHRL	Belgium
Bačić	Mario		Faculty of Civil Engineering, University of Zagreb	Croatia
Bajt Leban	Mirjam		ZAG	Slovenia
Baša	Igor		slovenske železnice-Infrastruktura d.o.o.	Slovenia
Bell	Brian	Consultant	UIC - MAINLINE project	UK
Birkner	Catherine		FEHRL	Belgium
Bruyelle	Jean-Luc		EURNEX	Germany
Černe	Fedor		Ministry for Infrastructure and Spatial Planning	Slovenia
Convery	Sheila	Administrative manager	UCD	Ireland
Dąbrowski	Adam		The Railway Institute	Poland
Dimitrova	Joanna	CFO	NRIC	Bulgaria
Dremelj	Alenka	head of Railway line maintenance	slovenske železnice-Infrastruktura d.o.o.	Slovenia
Erlingsson	Sigurdur	Prof.	VTI	Sweden
Fifer Bisjak	Karmen	Assis. Prof	ZAG	Slovenia
Flerin	Gregor	Senior Technical Associate	sž-Infrastruktura d.o.o.	Slovenia
Fortunato	Eduardo	Senior Research Officer	LNEC	Portugal
Gavin	Kenneth	Senior lecturer	University College Dublin	Ireland
Goger	Thierry	Secretary General	FEHRL	Belgium
Gorobecs	Mihails	Leading researcher	Riga Technical University	Latvia
Grebenc	Andrej	Adviser	European Commission	Belgium
Janja	Gros	Civil engineer	HZ-infrastruktura d.o.o.	Croatia
Jamnik	Juljana		CESTEL d.o.o.	Slovenia
Kemperle	Ema	PR	ZAG	Slovenia
Klofutar	Jakob		slovenske železnice	Slovenia
Kovačević	Meho Saša	Head of Dpt. for Geotechnics	Faculty of Civil Engineering, University of Zagreb	Croatia
Kovačič	Simon		sž-Infrastruktura d.o.o.	Slovenia
Krajnc	Damijan		sž-Infrastruktura d.o.o.	Slovenia



Kropf	Urška		ZAG	Slovenia
Kukovica	Jernej		sž-Infrastruktura d.o.o.	Slovenia
Lachinger	Stefan		AIT Austrian Institute of Technology	Austria
Legat	Andraž	Director	ZAG	Slovenia
Lenart	Stanislav		ZAG	Slovenia
Levcenkova	Anatolijs		Riga Technical University	Latvia
Libric	Lovorka		Faculty of Civil Engineering, University of Zagreb	Croatia
Likar	Barbara		ZAG	Slovenia
Liu	Duo		Technische Universität München	Germany
Mhanna	Mohannad	Project Coordinator	IRT Railenium	France
Miklavžin	Vlasta		Prometni Institut Ljubljana, d.o.o.	Slovenia
Mikulic	Tanja		Institut IGH	Croatia
Mróz	Arkadiusz		Adaptronica Sp. z o.o.	Poland
Nikolic	Milica	Geodesy engineer	HZ Infrastruktura d.o.o.	Croatia
O'Brien	Eugene	Director	RODIS	Ireland
Ogrizek	Dušan		LINEAL d.o.o.	Slovenia
Olpinski	witold		The Railway Institute	Poland
Pires	José	PhD student	EPFL	Switzerland
Pivk	Matjaž		sž-Infrastruktura d.o.o.	Slovenia
Prpic	Tomislav	President	HDŽI	Croatia
Reale	Cormac	PhD Researcher	University College Dublin	Ireland
Robson	Michael	Technical expert	EURNEX	Germany
Šajna	Aljoša		Slovenian National Building and Civil Engineering Institute	Slovenia
Šarčević	Ljubo		Ginex international	Slovenia
sedlak	mikulas	adviser	ministry of transport	Slovakia
Šemrov	Darja		University of Ljubljana, Faculty of Civil and Geodetic Engineering	Slovenia
Sever	Drago	izr.prof.	University of Maribor	Slovenia
Šolinc	Neža	Controlling and Commercial Department	ZAG	Slovenia
Soloviev	Vladimir		MIIT	Russia
Sporcic	Velimir	Civil engineer	HZ Infrastruktura d.o.o.	Croatia

SREBOT	PRIMOZ	professional worker	Slovenian Railways - Infrastructure	Slovenia
Steinicke	Wolfgang H.	Secretary General	EURNEX	Germany
Stipanovic	Irina		University of Twente	Netherlands
Šturm	Janez		Prometni institut Ljubljana d.o.o.	Slovenia
Sušac	Maroje	B.Sc.Civ.Eng. Authorized Designer	DARH 2 L.l.c.	Croatia
Vajdic	Marko		Institut IGH	Croatia
zahir	djidjeli	professor	national high school of publics works	Algeria
Zepic	Franc	Secretary, PAC	Ministry of Infrastructure and Spatial planning	Slovenia
Žnidarič	Aleš	Head of Section for Bridges and Other Engineering	Zavod za gradbeništvo Slovenije	Slovenia