



MAINLINE

MAINtenance, renewal and Improvement of rail transport iNfrastructure to reduce Economic and environmental impacts

Collaborative project (Small or medium-scale focused research project)

Theme SST.2011.5.2-6.: Cost-effective improvement of rail transport infrastructure

Deliverable 5.1: Assessment of asset management tools

Grant Agreement number: 285121

SST.2011.5.2-6.

Start date of project: 1 October 2011

Duration: 36 months

Lead beneficiary of this deliverable: Network Rail

Participant short name: NR

Due date of deliverable: 01/02/2012

Actual submission date: 27/05/2013

Release:

Final

Project co-funded by the European Commission within the 7th Framework Programme

Dissemination Level

PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Abstract of the MAINLINE Project

Growth in demand for rail transportation across Europe is predicted to continue. Much of this growth will have to be accommodated on existing lines that contain old infrastructure. This demand will increase both the rate of deterioration of these elderly assets and the need for shorter line closures for maintenance or renewal interventions. The impact of these interventions must be minimized and will also need to take into account the need for lower economic and environmental impacts. New interventions will need to be developed along with additional tools to inform decision makers about the economic and environmental consequences of different intervention options being considered.

The project 'MAINtenance, renewAL and Improvement of rail transport iNfrastructure to reduce Economic and environmental impacts' (in short MAINLINE) is a project within the EU's 7th Framework Programme. It has been part funded on the basis of the contract SST.2011.5.2-6 between the European Union represented by the European Commission and International Union of Railways (UIC) acting as coordinator for the project.

MAINLINE proposes to address all these issues through a series of linked work packages that will target at least €300m per year savings across Europe with a reduced environmental footprint in terms of embodied carbon and other environmental benefits. It will:

- Apply new technologies to extend the life of elderly infrastructure
- Improve degradation and structural models to develop more realistic life cycle cost and safety models
- Investigate new construction methods for the replacement of obsolete infrastructure
- Investigate monitoring techniques to complement or replace existing examination techniques
- Develop management tools to assess whole life environmental and economic impact.

The consortium includes leading railways, contractors, consultants and researchers from across Europe, including from both Eastern Europe and the emerging economies. Partners also bring experience on approaches used in other industry sectors which have relevance to the rail sector. Project benefits will come from keeping existing infrastructure in service through the application of technologies and interventions based on life cycle considerations. Although MAINLINE will focus on certain asset types, the management tools developed will be applicable across a broader asset base.

Partners in the MAINLINE Project

UIC, FR; Network Rail Infrastructure Limited, UK; COWI, DK; SKM, UK; University of Surrey, UK; TWI, UK; University of Minho, PT; Luleå tekniska universitet, SE; DB Netz AG, DE; MÁV Magyar Államvasutak Zrt, HU; Universitat Politècnica de Catalunya, ES; Graz University of Technology, AT; TCDD, TR; Damill AB, SE; COMSA EMTE, ES; Trafikverket, SE; SETRA, FR; ARTTIC, FR; Skanska a.s., CZ.

Work Package 5 in the MAINLINE Project

D5.1 is the first deliverable of Work Package 5.

The main objective of WP5 is to create a tool (Life Cycle Assessment Tool - LCAT) that can compare different maintenance/replacement strategies for track and infrastructure based on a life cycle evaluation. The evaluation shall quantify:

- Direct economic costs
- Availability (Delay costs/user cost/benefit from upgrade etc.)
- Environmental impact costs

The comparison cannot be based only on the optimization of the economic and environmental aspects. The tool's optimisation process must also take into account minimum target safety levels.

Table of Contents

Glossary	4
1. Executive Summary	5
2. Acknowledgements.....	6
3. Introduction	7
4. IM Questionnaire preparation, distribution return and analysis	8
5. Conclusion	9
Appendix 1 Bridge questionnaire	10
Appendix 2 Tunnel questionnaire	13
Appendix 3 Cuttings questionnaire	16
Appendix 4 Track questionnaire	19

Glossary

Abbreviation / acronym	Description
DoW	Description of Work
EB	Executive Board
IM	Infrastructure Manager
LCAT	Life cycle assessment tool
POSE	UIC Panel of Structures Experts
TEG	UIC Track Experts Group
UIC	International Union of Railways

1. Executive Summary

D5.1 reports on the activities of Task 5.1 of Work Package 5. Following discussions at Executive Board (EB) level it was decided that Task 5.1 would undertake a survey of railway Infrastructure Managers (IMs) on behalf of all the WPs within MAINLINE, rather than just concentrating on asset management tools, as had been envisaged when the DoW was prepared.

Hence a series of questionnaires, covering the main areas of interest to the MAINLINE project (bridges, tunnels, cuttings and track) were prepared for circulation by UIC (International Union of Railways), the Coordinator.

Responses from six Infrastructure Managers confirmed that the majority used Life Cycle Costing for both maintenance and renewal projects, although only two used a specific tool for this calculation. The use of environmental information within a Life Cycle Assessment was only considered for large projects. This highlights that planning and forecasting can be improved, potentially bringing financial, environmental and risk benefits to Infrastructure Managers through the application of the Life Cycle Assessment Tool (LCAT) methodology defined by MAINLINE.

The responses received have enabled work in Task 5.3 and Task 5.4 to progress to a satisfactory conclusion; WP1.1 (Benchmark of new technologies to extend the life of elderly rail infrastructure) has also used the questionnaire responses.

The questionnaire responses and the associated detailed analysis can be found in D5.3 "Recommendations for Format of a Life Cycle Assessment Tool (LCAT)" and D5.4 "Proposed methodology for a Life Cycle Assessment Tool (LCAT)".

2. Acknowledgements

This report has been prepared within Work Package WP5 of the MAINLINE project by the following team with Network Rail as the WP leader:

- Network Rail (NR), United Kingdom
- COWI A/S (COWI), Denmark
- Lulea Tekniska Universitet (LTU), Sweden
- Sinclair Knight Merz (SKM), United Kingdom
- Turkiye Cumhuriyeti Devlet Demir Yollari Isletmesi Genel Mudurlugu (TCDD), Turkey
- TWI Limited (TWI), United Kingdom
- Service d'études sur les transports, les routes et leurs aménagements (SETRA), France
- International Union of Railways (UIC)
- Universitat Politecnica de Catalunya (UPC), Spain

Contributions from Infrastructure Managers for the questionnaire concerning LCC & LCA tools are acknowledged.

3. Introduction

Deliverable D5.1 is a report on the activities of Task 5.1, which is described in the MAINLINE DoW as *“Survey a selection of infrastructure owners (rail, road and utility, both within and outside Europe) to determine the range of asset management tools available, their ease of use and applicability to both environmental and economic accounting and railway infrastructure owners (particularly in Eastern Europe and developing economies) to determine the range and size of track and infrastructure maintenance and renewal projects planned over the next ten years and how these tools are used to develop work banks to estimate both future funding requirements and performance & sustainability outputs.”* It was, along with deliverable D5.2 from Task 5.2, intended to inform the work of Task 5.3 and Task 5.4 in producing recommendations for the main work item in WP5, Task 5.5, which is to produce the MAINLINE Life Cycle Assessment Tool (LCAT).

Very early in the life of the project it became apparent that a number of other WPs were wishing to survey the rail infrastructure members of UIC to assist in their work and, following discussion at EB level, it was decided that only one MAINLINE questionnaire should be created for each principal asset type being addressed by the project (bridges, tunnels, cuttings and track). This questionnaire was to be distributed by UIC to members of its relevant specialist groups (POSE and TEG) and also circulated within other relevant UIC research projects by individuals working in both projects.

4. IM Questionnaire preparation, distribution return and analysis

Discussions were held with the leaders of WPs 1, 3 and 4 to ascertain their requirements, which in many cases proved to be too detailed for Infrastructure Managers to answer. Hence a simplified questionnaire, consisting of questions that could essentially be answered with a yes or a no, but also requested additional details, where they were available, or contact details for specialists who could be approached directly for one to one discussions, was devised and shared with the project coordinator and scientific leader. After obtaining their approval, final versions were prepared and passed to UIC for distribution to members of the Track Experts Group and the Panel of Structures Experts. Copies of the questionnaires form the appendices to this report. In essence, they contained sections for:

- Maintenance
- Renewals
- Examinations and Monitoring
- Life Cycle Analysis

The questionnaires were distributed by UIC as described above, with a request that the responses be directed back to UIC. When received, these responses were forwarded to the Task 5.1 leader. Each return, as it was received, was sent to the relevant task leader so that they had immediate access to the results.

Detailed analysis of those returns received can be found in D5.3 “Recommendations for Format of a Life Cycle Assessment Tool (LCAT)” and D5.4 “Proposed methodology for a Life Cycle Assessment Tool (LCAT)”.

However, an outline summary is below for reference:

- 25% of respondents use a life cycle costing tool for maintenance projects
- 50% of respondents use a life cycle costing tool for large scale renewals projects
- 25% of respondents carry out environmental assessments for maintenance projects
- 63% of respondents carry out environmental assessments for large scale renewals projects.

5. Conclusion

In accordance with the project DoW, a survey has been undertaken in an attempt to quantify the current use of asset management tools by railway Infrastructure Managers.

Responses from six Infrastructure Managers confirmed that the majority used Life Cycle Costing for both maintenance and renewal projects, although only two used a specific tool for this calculation. The use of environmental information within a Life Cycle Assessment was only considered for large projects. The responses received have enabled work in Task 5.3 and Task 5.4 to progress to a satisfactory conclusion.

The questionnaire responses highlight that planning and forecasting can be improved; potentially bringing financial, environmental and risk benefits to Infrastructure Managers through the application of the Life Cycle Assessment Tool (LCAT) methodology defined by MAINLINE.

Appendix 1 Bridge questionnaire

Bridges

a) Maintenance & strengthening

Have you introduced any new techniques or products in the following maintenance areas in the last 10 years?	
Waterproofing	
Painting/corrosion protection	
Bearings or joints	
Please give details on a supplementary sheet	
How many bridges do you expect to strengthen in the next 10 years?	
Do you use advanced composites (FRP) for strengthening concrete or metallic bridges?	
Do you use commercial strengthening systems on masonry arch bridges?	

b) Replacement

How many bridge decks do you expect to replace in the next 10 years?	
How many bridges do you expect to totally replace in the next 10 years?	
Roughly what percentage of bridge replacement is due to:	
Strength or condition?	
Changed operational requirements (higher speeds/more tracks etc)?	
Have you introduced any new techniques or products in the last 10 years for:	
Fabrication?	
Installation?	
Please give details on a supplementary sheet	

c) Examination & monitoring

Are reports from routine visual examinations supplemented by photographs?	
Do you normally use monitoring / instrumentation as part of routine examination?	
Do you normally use non destructive testing as part of routine examination?	
Do you use monitoring / instrumentation to answer specific questions and, if so, is this?	
Very short term (less than 1 week)	
Medium term (less than 1 year)	
Continuous	
Is monitoring done remotely	
If so, is the data automatically processed before transmission	
Please give details of methods used on a supplementary sheet	
Do you use non destructive testing to answer specific questions?	
Please give details of methods used on a supplementary sheet	

d) Life cycle analysis

Do you carry out life cycle, whole life or net present value costing for maintenance projects?

Do you carry out life cycle, whole life or net present value costing for renewal projects?

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Do you carry out environmental assessments for maintenance projects?

Do you carry out environmental assessments for renewal projects?

If so, does this include the calculation of equivalent CO₂ production

During construction only

“Cradle to grave”

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Please attach any documents that you think will assist the project in understanding your answers above

Please give a name(s) to contact for further information:

Topic	Name	Telephone No	Email
Maintenance & strengthening			
Replacement			
Examination & monitoring			
Life cycle analysis			

Appendix 2 Tunnel questionnaire

Tunnels

a) Maintenance & strengthening

How many tunnels are there on your railway network?	
What is the total length of tunnels on your railway network?	
Roughly what percentage of your tunnels:	
are masonry (brick or stone) lined?	
are concrete (insitu or precast segments) lined?	
are lined with metal (steel or cast iron) segments?	
are unlined?	
What length of tunnel do you expect to refurbish in the next 10 years?	
Have you introduced any new techniques or products for tunnel maintenance in the last 10 years?	
Please give details on a supplementary sheet	
What length of tunnel do you expect to strengthen in the next 10 years?	
Please give reasons for strengthening on a supplementary sheet	
Have you introduced any new techniques or products for tunnel strengthening in the last 10 years?	
Please give details on a supplementary sheet	

b) Replacement

Do you expect to have to replace any tunnels in the next 10 years?	
Do you expect to build any new tunnels in the next 10 years?	

c) Examination & monitoring

Are reports from routine visual examinations supplemented by photographs?	
Do you normally use monitoring / instrumentation as part of routine examination?	
Do you normally use non destructive testing as part of routine examination?	
Do you use monitoring / instrumentation to answer specific questions and, if so, is this?	
Very short term (less than 1 week)	
Medium term (less than 1 year)	
Continuous	
Is monitoring done remotely	
If so, is the data automatically processed before transmission	
Please give details of methods used on a supplementary sheet	
Do you use non destructive testing to answer specific questions?	
Please give details of methods used on a supplementary sheet	

d) Life cycle analysis

Do you carry out life cycle, whole life or net present value costing for maintenance projects?

Do you carry out life cycle, whole life or net present value costing for renewal projects?

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Do you carry out environmental assessments for maintenance projects?

Do you carry out environmental assessments for renewal projects?

If so, does this include the calculation of equivalent CO₂ production

During construction only

“Cradle to grave”

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Please attach any documents that you think will assist the project in understanding your answers above

Please give a name(s) to contact for further information:

Topic	Name	Telephone No	Email
Maintenance & strengthening			
Replacement			
Examination & monitoring			
Life cycle analysis			

Appendix 3 Cuttings questionnaire

Cuttings

a) Maintenance & strengthening

What length of cuttings do you have on your railway network?

What percentage of your cuttings are:

rock cuttings?

soil cuttings?

What length of cutting do you expect to refurbish in the next 10 years?

Have you introduced any new techniques or products for cutting maintenance/ refurbishment in the last 10 years?

Please give details on a supplementary sheet

What length of cutting do you expect to strengthen in the next 10 years?

Please give reasons for strengthening on a supplementary sheet

Have you introduced any new techniques or products for cutting strengthening in the last 10 years?

Please give details on a supplementary sheet

b) Replacement

Do you expect to have to replace any cuttings in the next 10 years?

Do you expect to build any new cuttings in the next 10 years?

c) Examination & monitoring

Are reports from routine visual examinations supplemented by photographs?

Do you normally use monitoring / instrumentation as part of routine examination?

Do you normally use non destructive testing as part of routine examination?

Do you use monitoring / instrumentation to answer specific questions and, if so, is this?

Very short term (less than 1 week)

Medium term (less than 1 year)

Continuous

Is monitoring done remotely

If so, is the data automatically processed before transmission

Please give details of methods used on a supplementary sheet

Do you use non destructive testing to answer specific questions?

Please give details of methods used on a supplementary sheet

d) Life cycle analysis

Do you carry out life cycle, whole life or net present value costing for maintenance projects?

Do you carry out life cycle, whole life or net present value costing for renewal projects?

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Do you carry out environmental assessments for maintenance projects?

Do you carry out environmental assessments for renewal projects?

If so, does this include the calculation of equivalent CO₂ production

During construction only

“Cradle to grave”

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Please attach any documents that you think will assist the project in understanding your answers above

Please give a name(s) to contact for further information:

Topic	Name	Telephone No	Email
Maintenance & strengthening			
Replacement			
Examination & monitoring			
Life cycle analysis			

Appendix 4 Track questionnaire

Track

a) Maintenance & strengthening

Have you introduced any new techniques or products for plain line maintenance in the last 10 years?

Please give details on a supplementary sheet

Have you introduced any new techniques or products for switch & crossing maintenance in the last 10 years?

Please give details on a supplementary sheet

Do you expect to have to improve/strengthen plain line/s&c to carry additional tonnage or higher speeds in the next ten years?

Have you introduced any new techniques or products for track improvement in the last 10 years?

Please give details on a supplementary sheet

b) Replacement

What length of plain line do you expect to renew within the next 10 years?

How many sets of switches and crossings (s&c) do you expect to renew in the next 10 years?

Roughly what percentage of plain line/s&c renewal is due to:

Existing track reaching the end of its life?

Changed operational requirements (higher speeds/tonnages etc)?

Do you cascade track removed from main lines to secondary routes?

Have you introduced any new techniques or products for track/s&c renewal in the last 10 years?

Please give details on a supplementary sheet

c) Examination & monitoring

Are reports from routine patrolling supplemented by photographs?

Do you use any routine monitoring / instrumentation for plain line/s&c?

Do you use any routine non destructive testing for plain line/s&c?

Please give details on a supplementary sheet

Do you use monitoring / instrumentation to answer specific questions and, if so, is this?

Very short term (less than 1 week)

Medium term (less than 1 year)

Continuous

Is monitoring done remotely

If so, is the data automatically processed before transmission

Please give details of methods used on a supplementary sheet

Do you use non destructive testing to answer specific questions?

Please give details of methods used on a supplementary sheet

d) Life cycle analysis

What is your life expectancy for: (please give a range if different lives are expected for different categories of line)

Rail?

Fishplates?

Wooden sleepers?

Concrete sleepers?

Steel sleepers?

Switches?

Crossings?

Track fastenings (Pandrol clips etc)?

What is your frequency for: (please give a range if different frequencies are used on different categories of line)

Plain line tamping?

S&C tamping?

Rail grinding?

Ballast cleaning?

Weedkilling?

Please list any other regular activities on a separate sheet.

Do you carry out life cycle, whole life or net present value costing for maintenance projects?

Do you carry out life cycle, whole life or net present value costing for renewal projects?

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Do you carry out environmental assessments for maintenance projects?

Do you carry out environmental assessments for renewal projects?

If so, does this include the calculation of equivalent CO₂ production

During construction only

“Cradle to grave”

If so, is the tool used

Commercially produced (please give program name and supplier details below)

Developed specifically for our own use

Please attach any documents that you think will assist the project in understanding your answers above

Please give a name(s) to contact for further information:

Topic	Name	Telephone No	Email
Maintenance & strengthening			
Replacement			
Examination & monitoring			
Life cycle analysis			