Extended Life of Railway Bridges. Results from EC-FP7-project MAINLINE

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Summary

There is a need to extend the life of many existing railway bridges. To facilitate this is one of the objects of the EC-FP7-Project MAINLINE, covering a period from 2011 to 2014. Three case studies are presented in which existing bridges are being studied in order to extend their life length: First a concrete trough bridge strengthened with post stressed bars in drilled holes through the slab is considered; followed by another concrete trough bridge strengthened with sawn in Near Surface Mounted Reinforcement (NSMR) of Carbon Fibre Reinforce Polymers (CFRP); and finally a steel truss bridge which will be loaded to failure to calibrate the assessment methods.

Keywords: railway bridges, extended life, assessment methods, concrete trough bridge, steel truss bridge, strengthening, calibrate model, loading to failure, fatigue.

1. Introduction

The project MAINLINE addresses the question of life length through a series of linked work packages which will target a reduced environmental footprint in terms of embodied carbon and other environmental benefits. The project will:

- Apply new technologies to extend the life of elderly infrastructure (WP 1)
- Improve degradation and structural models to develop more realistic life cycle cost and safety models (WP 2)
- Investigate new construction methods for the replacement of obsolete infrastructure (WP 3)
- Investigate monitoring techniques to complement or replace existing examination techniques (WP4)
- Develop management tools to assess whole life environmental and economic impact (WP 5).

This paper will concentrate on the work in WP1. So far a "Benchmark on new technologies to extend the life of elderly rail infrastructure" has been published [1]. Here three examples will be given on how to apply new or improved procedures for bridges [2], [3].

2. Bridges being considered

In order to upgrade a concrete bridge in Haparanda, built in 1959, design calculations following the Eurocodes have been performed. They indicate that the shear capacity in the transversal direction of the trough bridge slab is insufficient. One way of increasing the shear capacity is to introduce a prestressing force in the slab, shown in Fig. 1. In 2012 the bridge was strengthened with eight post-stressed bars installed in holes drilled through the slab. In this way it was possible to increase the bending and shear capacity of the slab to enable an upgrading of the line from an axle load of 25 to 30 ton.

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Fig 1. Haparanda bridge. The left insert shows one of eight post-stressed bars installed in holes drilled through the slab. The right insert shows traffic on the two tracks on the top of bridge.

Another trough bridge was strengthened with Near Surface Mounted Reinforcement (NSMR) of Carbon Fibre Reinforced Polymer (CFRP) bars. A third 50 year old steel truss bridge will be tested to failure to calibrate the assessment methods.

3. Discussion and Conclusions

A Questionnaire on bridges has been prepared and eleven Infrastructure Managers have responded. If the results from this bridge sample are extrapolated from the about 125 000 km of network and the about 150 000 railway bridges overseen by these Infrastructure Managers to the full European network, which is about 230 000 km, a rough estimate may be obtained of the needs for the next years. Such an extrapolation suggests that in the next ten years we may expect to strengthen some 1 500 bridges, to replace some 4 500 bridges and to replace the deck of some 3 000 bridges. Some of the bridges that are planned to be replaced may instead be strengthened, if the new technologies presented here would be used.

4. References

[1] ML-D1.1.," Benchmark of new technologies to extend the life of elderly rail infrastructure". *Mainline Deliverable D2.1*, 2012, 72 pp. Available at http://mainline-project.eu/Result,7.html

[2] "Sustainable Bridges – Assessment for Future Traffic Demands and Longer Lives". A European FP 6 Integrated Research Project during 2003-2007. Four guidelines and 35 background documents are available at www.sustainablebridges.net: *Inspection and Condition Assessment*, 259 pp; *Load and Resistance Assessment of Railway Bridge, 428 pp; Guideline for Monitoring of Railway Bridges*, 83 pp; *Guide for use of Repair and Strengthening Methods for Railway Bridges, 139 pp*

[3] PUURULA, A (2012): "Load-carrying capacity of a strengthened reinforced concrete bridge. Non-linear finite element modeling of a test to failure. Assessment of train load capacity of a two span railway trough bridge in Örnsköldsvik strengthened with bars of Carbon Fibre Reinforced Polymers (CFRP)". *Doctoral Thesis*, Luleå University of Technology, 2012, 328 pp, ISBN 978-91-7439-433-7. Available at: http://pure.ltu.se/portal/files/36697444/Arto_Puurula.pdf