SUSTAINABLE BRIDGES

Assessment for future traffic demands and longer lives

**Funding:** European (6th RTD Framework Programme)

**Duration:** Dec 2003 - Nov 2007

**Status:** Complete with results

**Total project cost:** €10,251,360

**EU contribution:** €6,887,965

**Call for proposal:** FP6-2002-TRANSPORT-1

**CORDIS RCN:** 85578

**Background & policy context:**

Railway bridges in Europe are exposed to increasing loads and higher speeds. There is a need to improve their capacity for the passenger and freight transport. In most cases the latter can be achieved through proper structural assessment, determination of the true behaviour of the structure, strengthening of certain sections or by monitoring critical properties. At the same time, new approaches can be applied in order to improve the performance: e.g. a probabilistic approach for loads and resistance.

Codes for bridge design are developed to consider all the uncertainties that are present in the construction phase of a structure. These codes are also often used for the evaluation of existing bridges. However, far better information on material and structural properties is available for an existing structure than for one not yet built. Nevertheless the same factors of safety are often applied to existing structures as to the ones being constructed. Many bridges can be allowed to carry greater loads and faster trains if better codes and methods for assessment are used.

Researches have been carried out in the field, but there is still a need for further integration, innovative development and testing in order to establish procedures for the safe and effective management and upgrading of railway bridges.

This project indicated it was possible to save about 2% of the capital value of the bridges by allowing increased loads and extending residual service life.

**Objectives:**

The overall goal is to enable improved capacity without compromising the safety and economy of the working railway.

The specific objectives are to:

- Increase the transport capacity of existing bridges by allowing axle loads up to 33 tones for freight traffic at moderate speeds;
- Increase the capacity for passenger traffic with low axle loads by increasing the maximum speeds up to 350km/hour;
- Increase the residual lifetime of existing bridges with up to 25%;
- Enhance management, strengthening and repair systems.

**Methodology:**

The work was organised within 9 WP:

1. Map existing knowledge and bridge types (WP 1)
2. Investigate demands for interoperability between countries (WP2)
3. Develop new methods for condition assessment and inspection (WP 3)
4. Develop new methods to determine capacity and resistance. Investigate loads and load distributions (WP 4)
5. Develop monitoring methods based on new technologies (WP 5)
6. Develop new repair and strengthening methods using e.g. carbon fibres (WP 6)
7. Demonstrate new methods by field testing of existing and new bridges (WP 7-8)
8. Train bridge consultants and contractors in the use of the new methods (WP 9)

The science and technology approach consists of:

- Use of the established principles from Structural Mechanics and Materials Science and their integration with new achievements in monitoring, measurement and modelling techniques.
- Analyses of bridge types and bridge details which are critical regarding load carrying capacity, allowable speed and/or residual life.
- New innovative modelling in order to achieve a more true picture of the actual behaviour of the bridge structure.

The project was carried out by a consortium of bridge owners, consultants, contractors and research institutes from all over Europe.

Parent Programmes:
FP6-SUSTDEV-2 - Sustainable Surface Transport

Institute type: Public institution
Institute name: European Commission
Funding type: Public (EU)

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### Technologies:
- Road structures
- Repair and strengthening methods for bridges

**Development phase:** Research/Invention

### Key Results:

Four documents can be considered as the main results of the project. They provide guidelines for bridge engineers, bridge owners and operators on the state-of-the-art and available tools; aim to improve operation, maintenance and management; ensure the most efficient use of existing railway infrastructure.
R.1: Guideline for Inspection and Condition Assessment of Railway SB-ICA, (2007): Provides inspection and condition assessment tools to get comparable description of the railway infrastructure condition in different countries of the European Community. It summarizes tools available to update insufficient, inaccurate or incomplete bridge documentation.

R. 2: Guideline for Load and Resistance Assessment of Existing European Railway Bridges SB-LRA, (2007): Provides guidance and recommendations for applying the most advanced and efficient methods, models and tools for the assessment of the load carrying capacity of the existing railway bridges.

R.3: Monitoring Guidelines for Railway Bridges SB-MON, (2007): Describes the procedure to follow in order to establish, design, implement and operate the monitoring systems in a systematic and coherent way. It introduces the model monitoring system as the fundamental planning tool.

R.4: Repair and Strengthening of Railway Bridges Guideline (SB-STR, (2007): Provides the railway owners with decision making support on the strengthening measures for concrete, steel or masonry railway bridges. The main focus of the guideline is on the safety requirements regarding the ultimate limit state.

The project has also produced the Overall Project Guide which provides support to the railway engineer, operator or manager in using the technical guidelines and reports developed within the project. It gives guidance on the approaches and methods presented in the guidelines and reports that might be helpful in upgrading existing railway bridges for higher speeds and loads or that might help to extend their service life.

This project shows that it is possible to save about 2% of the capital value of the bridges by allowing increased loads and extending residual service life.

**Technical Implications**

T1: The developed guidelines will help European railways to meet the ever increasing demand in rail transport capacity (stressing on bridge structural performances), extend the residual service lives of existing bridges, enhance management, strengthening and repair systems.

T2: Only a few existing bridges are likely to be able to accommodate trains travelling at 350 km/hr or freight trains with 33 tonne axles. Nevertheless, the use of the guidelines developed by this project will enable some bridges to meet these requirements and increases well above the current typical capability of around 160 to 200 km/hr speeds and 22.5 tonne axles should be obtainable.

T3: The project has identified a need for further collaborative work in relation to masonry arch bridges, where knowledge of structural behaviour and monitoring are less advanced than for other typical construction materials.

T4: Although the work has focussed on railway bridges, the results should be also of interest to those responsible for highway bridges.

**Policy implications**

P1: The project contributes to the overall EU goal on the promotion of intermodal transport and environmentally friendly transport modes.

P2: The detailed project guideline SB-ICA (2007) on inspection and condition assessment of railway provides bridge owners who do not currently have their own bridge management system or standardised defect classification system with state of the art guidance on how to establish such systems. It is hoped that the recommendations in SB-ICA (2007) may form the basis for further work to establish agreed pan European systems, although it is accepted that railways with well established systems may take some time to adopt the recommendations as currently proposed.

Documents:
- ERRAC_Project_Evaluation_SustainableBridges (Other relevant documents)

**STRIA Roadmaps:** Infrastructure

**Transport mode:** Rail transport

**Transport sectors:** Passenger transport, Freight transport

**Transport policies:** Safety/Security, Societal/Economic issues

**Geo-spatial type:** Infrastructure Node