BRIDGEMON

Bridgemon Newsletter

About the BridgeMon Project

BridgeMon is a research project funded under the *Research for the Benefit of SMEs* scheme of the 7th Framework Programme of the European Commission (http://ec.europa.eu/research).

Many of the world's bridges are old and need to be periodically repaired or replaced. But premature replacement wastes money and non-renewable carbon-intensive resources such as concrete and steel. BridgeMon is led by three SMEs from Slovenia, the Netherlands and Poland who, with the help of research providers from Ireland and Slovenia, are working to extend the lives of existing bridges. They are developing bridge monitoring technologies to prove that many bridges are safe and can be kept in service for longer, thus ensuring more sustainable road asset management.

A bridge is safe when the stresses due to traffic load are less than its resistance to that load. The BridgeMon project is developing techniques to is gather information about both sides of this inequality, traffic load and bridge resistance.

The BridgeMon SMEs have expertise in both traffic load and bridge resistance. The consortium is led by Cestel, a world leader in Bridge Weigh-in-Motion (WIM), a system whereby an existing bridge is used to weigh passing trucks. Cestel have partnered with two SMEs that specialise in monitoring the resistance of bridges to load, one for the road sector and one for the railway sector.

In the area or bridge weigh-in-motion measurements, the ambition of BridgeMon is to achieve a step increase in the accuracy of these systems. Several strategies are being pursued in parallel, such as automated calculation of influence lines, auto-calibrations, Moving Force Identification (MFI) and Tikhonov regularization. These improvements will increase the accuracy of the truck weight data by at least one accuracy class according to the COST 323 specification for weigh-in-motion.

In the area of structural health monitoring, BridgeMon is developing and implementing tools for improved bridges assessment, including modules to evaluate fatigue life of steel bridges and the structural health of railway bridges, both combined with Bridge WIM (traffic loading).

The new technologies will give the SMEs Unique Selling Points in the bridge monitoring markets. The results will give potential for massive growth in these SMEs in the coming 5 years, in both turnover and employment.

(Peter Favai, Cestel – Bridgemon coordinator)

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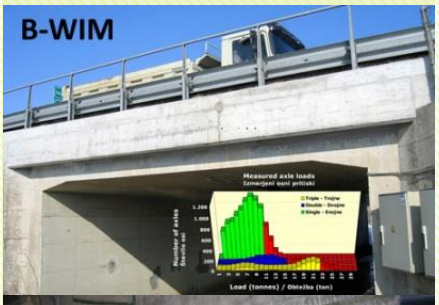
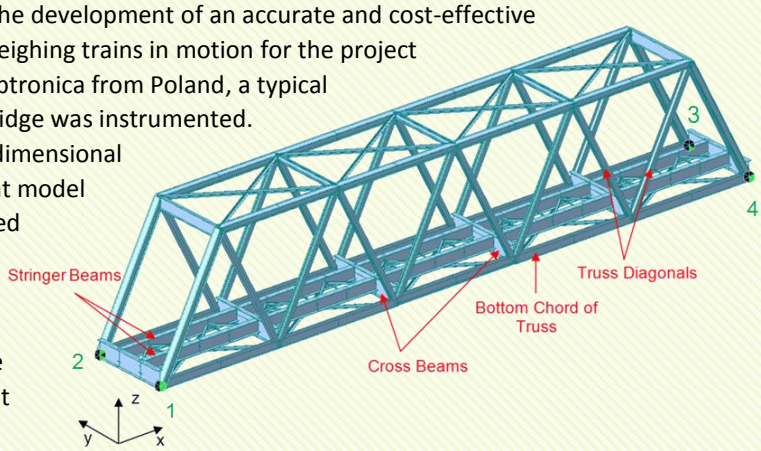


Railway Bridge WIM Experiment in Poland

As a part of the development of an accurate and cost-effective method of weighing trains in motion for the project partner, Adaptronica from Poland, a typical steel truss bridge was instrumented. Initially, a 3-dimensional finite element model was developed that served as a resource for designing the measurement setup.



Field testing with the SiWIM hardware and software was performed on the Nieporęt railway bridge between 20th and 25th of May, 2013. Forty five trains were captured, of which four were the calibration trains that were also weighed using a low-speed weigh station near Warsaw. The reference weights of all four trains were provided by Adaptronica after the field testing was complete.

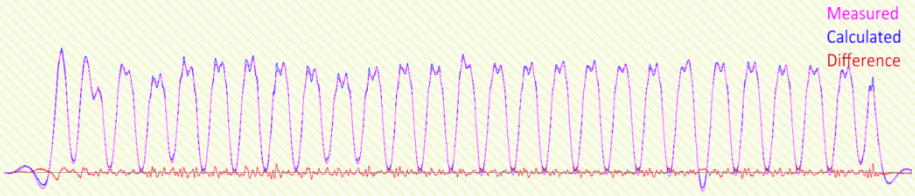
In summary, the objectives of BridgeMon project are to develop:

- *a method of using an existing bridge to weigh vehicles in motion with Class A accuracy,*
- *a novel method of monitoring steel road bridges, susceptible to fatigue damage,*
- *an accurate and cost-effective method of weighing trains in motion,*
- *an improved method of structural health monitoring (SHM) of railway bridges.*

Bridge WIM Systems

Bridge Weigh-in-Motion is the strategy of using an existing bridge as a scale to weigh vehicles as they cross overhead at full speed. They use a number of sensors placed underneath, across the width of the structure, typically around the mid-span section where responses are the highest.

The basic methodology, proposed by Fred Moses in the late 1970's, has since been considerably improved, with respect to hardware and even more so, with software. Results from two European research projects on WIM in the 1990's (COST 323 and WAVE) have been successfully implemented and are today marketed as the SiWIM® system by the Cestel company, one of the Bridgemon partners.



First results are very promising. The figure above shows an excellent match between the measured and the calculated signals, which for the case of constant train velocity, resulted in errors of gross weights of individual carriages of less than 2.6%. In the second year of the project, work will focus on improvements and new algorithms to increase accuracy of results even further.

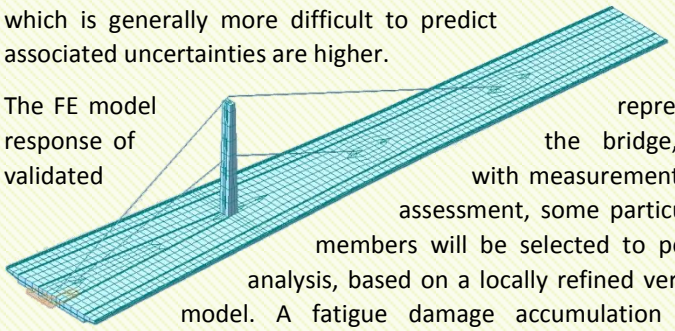
(Robert Corbaly – ROD-IS, Aleš Žnidarič, ZAG)

Case Study in Extending the Life of a Bridge - Fatigue Experiment in the Netherlands

As part of BridgeMon, a method is developed to monitor the safety of steel road bridges susceptible to fatigue damage. More accurate calculation of the remaining fatigue life of steel bridges will then be possible, allowing for optimisation of repair strategies.

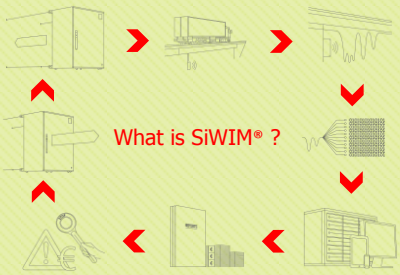
In order to effectively monitor fatigue damage at any point on a bridge, the concept of *virtual monitoring* is being developed. This will allow calculation of the stresses at all points on a bridge, including points where there are no sensors installed. This is achieved by installing a Bridge WIM system to obtain traffic load data. Some of the Bridge WIM sensors will double up as sensors to directly monitor stresses in the bridge. The real added value comes by using the calculated vehicle weights and locations to find the stresses at all other points. A Finite Element (FE) model is calibrated on site and, together with static vehicle weight information, it allows the calculation of all stresses, even at locations without any instrumentation.

In the last week of October, 2013, a cable-stayed steel box girder bridge near Rotterdam in the Netherlands was instrumented with two coupled monitoring systems: a bridge WIM system over the road (left) and a more traditional one based on strain gauges over the canal and inside the pylon (right). Its assessment is expected to be difficult due to its complexity. For this reason, the assessment will be divided into two. First there will be a global assessment of the structure, considering the main structural members (pylon and girder). Secondly a fatigue analysis will be done of the orthotropic deck which is generally more difficult to predict and where the associated uncertainties are higher.



The FE model represents the global response of the bridge, which will be validated with measurements. For the fatigue assessment, some particular locations and members will be selected to perform a detailed analysis, based on a locally refined version of the global model. A fatigue damage accumulation analysis will be performed to estimate and predict damage at all points on the bridge – direct measurement points and virtually monitored points.

(Daniel Cantero, ROD-IS, Aleš Žnidarič, ZAG)



Using B-WIM Results

B-WIM systems are not intended only for bridges, as they provide the same traffic information as the pavement WIM systems. The project coordinator **Cestel** and its partners around the world use them on the daily basis for:

- Traffic analysis for planning sector
- Traffic analysis for infrastructure maintenance
- Road damage remediation calculation
- Pre-selection for overweight enforcement
- WIM data distribution
- Dangerous goods analysis
- Bridge safety assessment
- Checking routes for special heavy transports with respect to bridges

Data from SiWIM® system can be used for pre-selection to assist enforcement units to extract potentially overloaded vehicles for the traffic flow or to distinguish between loaded and empty vehicles for the purpose of border/customs control.

(Matija Mavrič – Cestel)

BridgeMon at IABSE Conference in Rotterdam

Rotterdam in the Netherlands was the location for the 2013 Conference of the *International Association for Bridge and Structural Engineers* (IABSE). The title of the conference, "Assessment, Upgrading and Refurbishment of Infrastructures", was the essence of what the BridgeMon project is all about. Presentations focused on the latest technologies being developed for monitoring the capacity of existing bridges and monitoring the loading experienced by these bridges. The conference attracted experts from over 50 countries around the world, with over 265 presentations given over three days.

Bridgemon partners ROD-IS and Cestel prepared a paper on results obtained from simulations carried out as part of the task on 'Advanced Static Bridge WIM Algorithms'. The 'Multiple-Equation' Bridge WIM algorithm is one of the algorithms which has been proposed to improve accuracy over conventional Bridge WIM approaches. Results from the simulations carried out showed an improvement in the accuracy of calculated axle weights.

The presentation attracted a good turnout despite the fact that there were four parallel sessions in progress at the conference. The topic appeared to be received well by all in attendance, evoking interest from several delegates. Overall the conference served as a very useful outlet for spreading the message of the BridgeMon project and was a great success.

(Robert Corbally, ROD-IS)

Next Activities

These are the running and coming activities with **BridgeMon** attendance:

- November 2013: mid-term assessment meeting in Delft, the Netherlands
- 2013: Continuation of measurements on Harmsen bridge, the Netherlands.
- March 2013: Intertraffic fair, Amsterdam, the Netherlands
- April 2014: Transport Research Arena TRA2014, Paris, France
- July 2014: North American Travel Monitoring Exposition and Conference (NATMEC), Chicago, USA
- Autumn 2014: demonstrations of results in Slovenia, Poland and the Netherlands
- October 2014: 12th Slovenian Road and Transportation Congress, Portorož, Slovenia
- November 2014: Civil Engineering Research in Ireland conference, Belfast, UK

For the latest information visit **bridgemon.fehrl.org**

BridgeMon is a research project from the **Research for the Benefit of SMEs** (Small and Medium size Enterprises) scheme of the 7th Framework Programme of the European Commission.

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