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.

Invitation to the BridgeMon Demonstrations

As the BridgeMon project draws to a close a number of workshops have been organized in order to showcase the latest developments in bridge weigh-in-motion and bridge monitoring technologies which have arisen from BridgeMon. These workshops should be of particular interest to road and rail infrastructure managers, and all stakeholders and interested parties are invited to attend.

The first workshop will take place in Poland at the headquarters of Polish Railways in Warsaw on the 6th of November. This workshop will be conducted in Polish and will focus on railway applications. Results from the newly developed Railway Bridge-WIM system, which was used to calculate the weights of trains crossing a steel truss bridge near Warsaw, will be presented, along with techniques which were developed to identify damage in railway bridges.

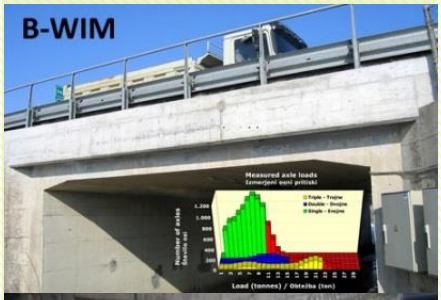
The second workshop will take place at the Rijkswaterstaat offices in Rotterdam on the 18th of November. This workshop will be conducted in English and will provide an overview of all aspects of the BridgeMon project, including Bridge-WIM developments, railway applications and the newly developed 'virtual monitoring' concept for fatigue analysis of steel bridges.

The final workshop will take place at ZAG's offices in Ljubljana, Slovenia, on the 25th of November. This workshop will be conducted in Slovenian and will cover all aspects of BridgeMon, with site visits and live demonstrations of the upgraded Bridge-WIM software planned for two nearby bridges in the afternoon.

(Peter Favai, Cestel – BridgeMon coordinator)

In this issue

About the BridgeMon Project 1
Invitation to the BridgeMon Demonstrations 1
Temperature and Velocity Auto-calibration 2
New Partner 2
Testing of Axle-Detection Methods near Belfast 2
Case Study in Extending the Life of a Bridge - Fatigue Experiment in the Netherlands 3
Virtual Monitoring 3
BridgeMon at TRA2014 Conference in Paris 4
Next Activities 4
Project partners 4



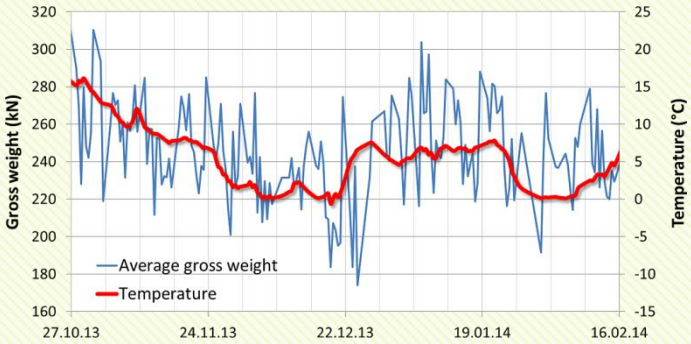
New Partner

Corner Stone International Sagl. from Switzerland has officially joined the BridgeMon consortium. Corner Stone is an independent consultant on Weigh-In-Motion technologies and applications of Weigh-In-Motion, working both for users and vendors of WIM systems. Participation in the BridgeMon project will provide Corner Stone with in depth knowledge of the latest developments in Bridge-WIM technology. The application of Bridge-WIM in virtual monitoring of steel bridges and the prediction of fatigue is of particular interest.

The Bridge WIM sensors installed on a bridge will be used to calculate the weight of every truck that crosses. This will be used in turn to calculate the stresses at every point on the bridge, including points where there are no sensors. This will provide Bridge Engineers with stress histories for every point and will give them everything they need to calculate the remaining fatigue life for every element on the bridge, not just the elements where sensors have been installed.

Temperature and Velocity Auto-calibration

Environmental temperatures heavily affect behaviour of some types of bridges, thus making results of weighing very unstable. This can be clearly seen from the diagram below which displays the average 12-hour temperatures as a function of average gross weight of heavy vehicles. Furthermore, the uneven pavement, with bumps before the bridges induce dynamic oscillations of the bridge, which again has negative impact on accuracy of the weighing results. Shifts of the calibration factor are particularly apparent during long-term measurements.



Complexity of bridges reduces the efficiency of lab-based calibration procedures. Thus, the statistical methods have been applied to identify the variation of bridge stiffness as a function of temperature and of dynamic interaction of various types of freight vehicles. The first results are extremely promising, demonstrating considerable improvements of long-term stability of results. This is essential for achieving BridgeMon objectives.

(Aleš Žnidarič, ZAG)

Testing of Axle-Detection Methods near Belfast

The ability to identify exact spacings between the axles of a vehicle is a key to ensure accurate Bridge-WIM calculations. Modern systems use strategically positioned sensors underneath the bridge to eliminate the requirement for any installation on the roadway, allowing the system to be installed without having to close the road.

Detecting axles from strain signals can be challenging in certain structures where it is not easy to identify peaks of the crossing axles. In BridgeMon, wavelets are used to accentuate peaks in the measured strain signals and hence improve the accuracy of axle-detection within Bridge-WIM, and consequently, the overall accuracy of the axle loads of the vehicles.

Testing of alternative axle-detection algorithms will be carried out using data from the beam-and-slab Loughbrickland Bridge, in Belfast, Ireland. This type of bridge has proven to be challenging with regard to the accurate detection of axles from the strain signals. A piezo-based WIM system, installed in the road surface, is also located directly adjacent to the bridge. It is providing more reliable axle spacings, which are compared to those calculated by the Bridge-WIM system, to validate the accuracy of the alternative axle-detection algorithms which are being explored.

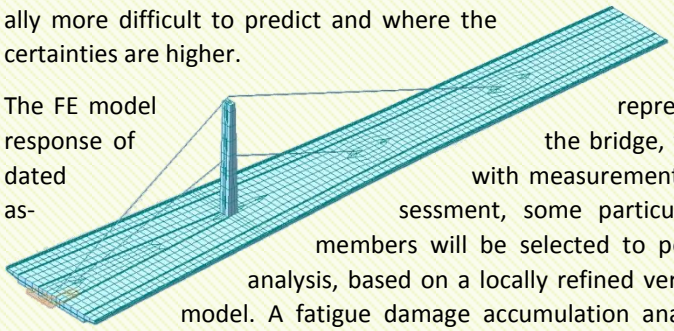
(Robert Corbally – ROD-IS)

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.

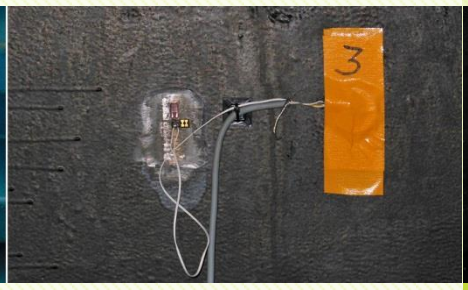
In order to effectively monitor fatigue damage at any point on a bridge, the concept of *virtual monitoring* is being developed. This will allow calculation of the stresses at all points on a bridge, including points where there are no sensors installed. This is achieved by installing a Bridge WIM system 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.

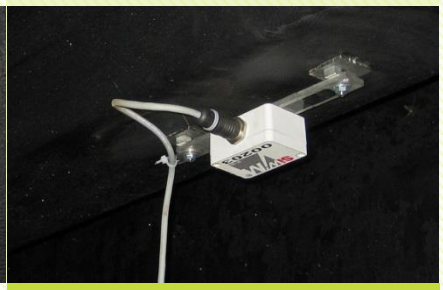
In the last week of October, 2013, a cable-stayed steel box girder bridge near Rotterdam in the Netherlands was instrumented with two coupled monitoring systems: a bridge WIM system over the road (left) and a more traditional one based on strain gauges over the canal and inside the pylon (right). Its 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.

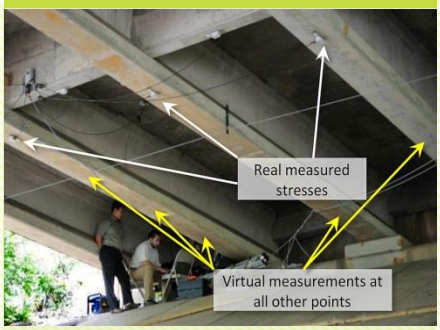


The FE model represents the global response of the bridge, which will be validated with measurements. For the fatigue assessment, some particular locations and members will be selected to perform a detailed analysis, based on a locally refined version of the global model. A fatigue damage accumulation 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)







Virtual Monitoring

The virtual monitoring system being developed will allow both traffic loading and fatigue damage of bridges to be monitored. A Bridge-WIM system will be used to gather information on the weights of vehicles crossing a bridge, and this information will then be combined with a calibrated finite element model of the bridge to carry out fatigue damage calculations for any critical locations. This virtual monitoring system will be particularly advantageous for carrying out structural health monitoring of steel bridges, which are very often subject to fatigue damage, particularly at connection details. The ability to virtually monitor any location on a bridge, without the requirement for vast numbers of sensors will provide a cost-effective method of estimating the remaining fatigue-life of the bridge. The virtual monitoring system will provide an overview of the remaining fatigue-resistance of any critical locations on a bridge, allowing informed decisions to be made towards optimised repair or maintenance strategies.

(Robert Corbally. ROD-IS)

BRIDGEMON

Next Activities

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

- July 2014: North American Travel Monitoring Exposition and Conference (NATMEC), Chicago, USA
- Autumn 2014: demonstrations of results in Slovenia, Poland and the Netherlands
- August 2014: Civil Engineering Research in Ireland conference, Belfast, UK
- April 2015: 12th Slovenian Road and Transportation Congress, Portorož, Slovenia

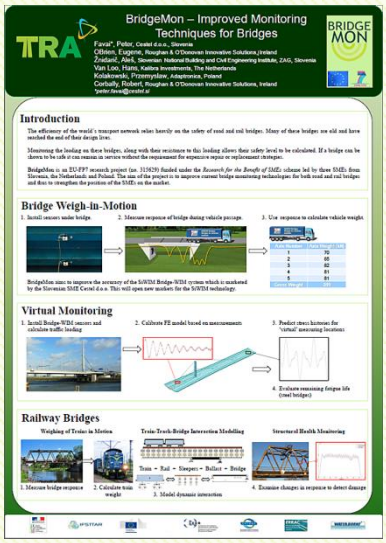
Visit us on our LinkedIn site!
http://www.linkedin.com/groups/BridgeMon-5033238

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.

CAPACITIES

BridgeMon at TRA2014 Conference in Paris

Paris was the location for the 2014 Transport Research Arena (TRA) conference, which took place on the 14-17th of April. The conference covered a broad range of topics related to many different aspects of transport. As part of the conference an 'Outreach Marketplace' poster session was held, which allowed examples of industry-related research to be showcased. This was viewed as an ideal opportunity to present the innovative bridge monitoring technologies being developed within BridgeMon.



The poster illustrated the Bridge-WIM concept for monitoring traffic loading on bridges, while also presenting the idea of 'virtual monitoring' as a method of using traffic loading information along with a finite element model of a bridge, to predict the remaining fatigue life of the structure. A section of the poster also outlined the developments in monitoring techniques for railway bridges. It outlined the application of the newly developed railway Bridge-WIM system for calculating train loading, along with the structural health monitoring techniques that are being developed for identifying damage in railway bridges.

The BridgeMon poster was on display for one full day and provided interested parties with an overview of what the BridgeMon project is about.

(Robert Corbally, ROD-IS)

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

Project partners

Cestel d.o.o.
Špruha 32
1236 Trzin
Slovenia
Peter Favai, peter.favai@cestel.si
Project Coordinator
www.cestel.si

Kalibra Investments BV
PO Box 158
2600 AD Delft
Netherlands
Gerben Visser,
visser@kalibra-invest.com
www.kalibra-invest.com

Adaptronica ZOO SP
Ul. Szpitalna 32
05 092 Lomianki
Poland
Dr. Przemyslaw Kolakowski,
pkolak@adaptronica.pl
www.adaptronica.pl

Roughan & O'Donovan Limited – ROD-IS
Arena House, Arena Road
Sandyford, Dublin 18
Ireland
Prof. Eugene OBrien,
eugene.obrien@rod.ie
www.rodis.ie

Zavod za gradbeništvo Slovenije
Dimičeva 12
1000 Ljubljana
Slovenia
Aleš Žnidarič, ales.znidaric@zag.si
www.zag.si

CornerStone
Via Ai Crott 5
CH-6702 Claro
Switzerland
Hans van Loo,
hans.vanloo.int@gmail.com