HESSEN

Application Report

Landesamt für Straßen- und Verkehrswesen

(Federal Office for Street Construction)

Monitoring Measurement on the Döllbach Valley Bridge

Introduction

The Döllbach Valley Bridge is located in the vicinity of Fulda and is a part of the A7 Federal Freeway, one of Germany's most important north-south connections. At the time the bridge was built in 1968 the rapid increase in traffic, particularly heavy load traffic, was not foreseeable. Due to its age and high stress resulting from use of thawing salt containing chloride, the structure shows considerable signs of corrosion. For this reason, it was decided to build a new bridge. For this purpose the eastern half of the road was reinforced to allow it to take over the entire traffic in both directions during the first construction phase. Then the western half of the bridge was dismantled and rebuilt followed by new construction of the eastern half of the highway. A decision was made to monitor the structure with measuring instruments for a period of 5 years to ensure that any structural problems are recognized within due time. The Engineering Office MBK Messtechnik Beratung in Darmstadt was requested to measure the values at the site.

Structure

The prestressed concrete bridge consists of 2 separate roadways each with a width of 11.5 m and length of 576 m. It is subdivided in to 12 sections of 11 x 46 m and 1 x 70 m.

The maximum height is 52 m.

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Measuring Assignment

The primary values to be measured were defined as the changes in the fissure widths on the 2 x 12 coupling joints as well as 2 x 2 cracks in the roadway and one single crack in the bottom of the bridge. Moreover 6 measuring points were selected for the temperature, 2 measuring points for the concrete moisture, one for measuring the pressure below the asphalt and 2 measuring points on the north and south abutments for measuring the bridge expansion. The 40 values are to be measured continuously and buffered locally, because only one GMS connection is available for transferring data. An alarm is to be triggered when certain, variably set limits are exceeded. The equipment was supplemented to include a video camera, which stores its image data on a local hard disk, to allow certain events such as traffic jams or heavy transports to be associated with the values measured.

Marginal Conditions

Since the two roadways are not connected to one another, the distance between the two measuring points farthest apart from one another is over 1.3 km. The entire equipment is exposed to the exterior temperature and it was necessary to arrange the measuring points in such a manner that the instrumentation was not affected by the extensive work to reinforce the eastern half of the road. A scanning rate of 100 measurements per second is required to dynamically capture opening and closing of the fissures.

Type of Measuring Equipment

The distance between the individual measuring points made it necessary to select a decentralized measuring system which is stringently synchronized to meet the dynamic requirements. The low sensor signal levels and the great distances between the measuring points made it necessary to exclude a centralized measuring system from the very beginning.

A carrier frequency amplifier type e.bloxx A6 from Gantner Instruments GmbH was connected to the measuring center using a bus cable. This bus cable serves as the power supply to the measuring point as well as for communication with the measuring center. This bus structure makes it relatively simple to add new measuring points to the system. The displacement of the fissures at the abutment joints is measured by WTH

series inductive displacement transducers from the Messotron Company. The e.bloxx A6-CF measuring amplifier offers, on the one hand, the input ranges required for inductive displacement transducers and, on the other, an RS 485 interface for establishing a bus structure. Moreover these modules are capable of capturing deformation changes at high scanning rates allowing calculation of the minimum and maximum values right in the module itself. It is then only necessary to transfer the extreme values to the center, drastically reducing the data rate. Pt100's connected to e.bloxx A5-1

type measuring modules serve to measure the temperatures on the inside at the top and bottom of the bridge, the inner and outer temperatures as well as the sun radiation on the top of the bridge. The temperature inside the switch cabinet is also monitored for diagnostic purposes. A Hydromette M4050 from the GANN Company for measurement of the moisture in the concrete is also installed in series with a relay multiplexer for expansion of the measuring points.

The cabinet with the equipment for central storage of the measured data is located on the eastern half of the bridge, because this section of the bridge will be dismantled last. This location was selected to ensure that the construction work for reinforcing the bridge is not impeded. An industrial PC serves as the control computer. The power for the computer and measuring modules is supplied by a 24 Volt uninterruptible power supply. The Internet connection for remote maintenance is completed by a VPN Ethernet router via GPRS. A switching contact on the router also allows interruption of the power supply to the entire system for restart in the event of an error.

Software

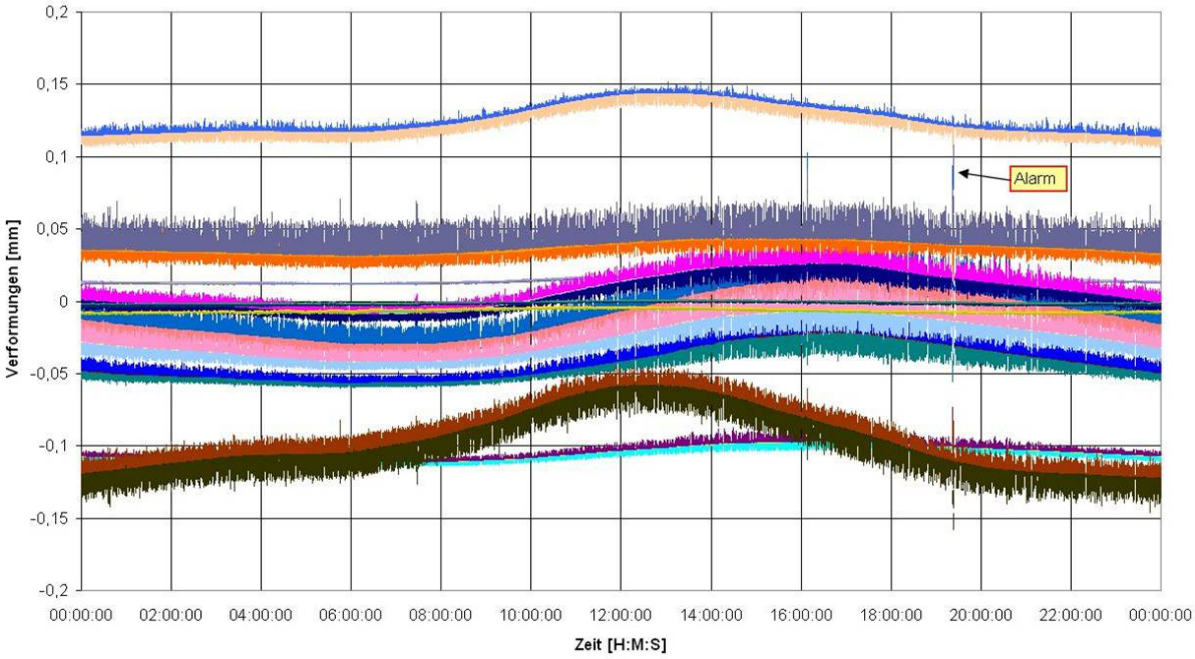
The software for controlling the system runs fully automatically and consists of a number of independent programs. The actual measured values are captured using the standard MW software package from MBK Messtechnik Beratung. This software communicates with the e.bloxx measuring modules over a USB RS485 converter using the ASCII protocol. Every 5 seconds the maximum, minimum and momentary values for all 24 coupling joints as well as the other measuring points are fetched and stored directly on hard disk. With a total of 96 measured values, the quantity of data amounts to approx. 3.2 Mbytes per day. A new file is generated every day for security reasons and for a better overview of the data. The file name allows unique identification of this file.

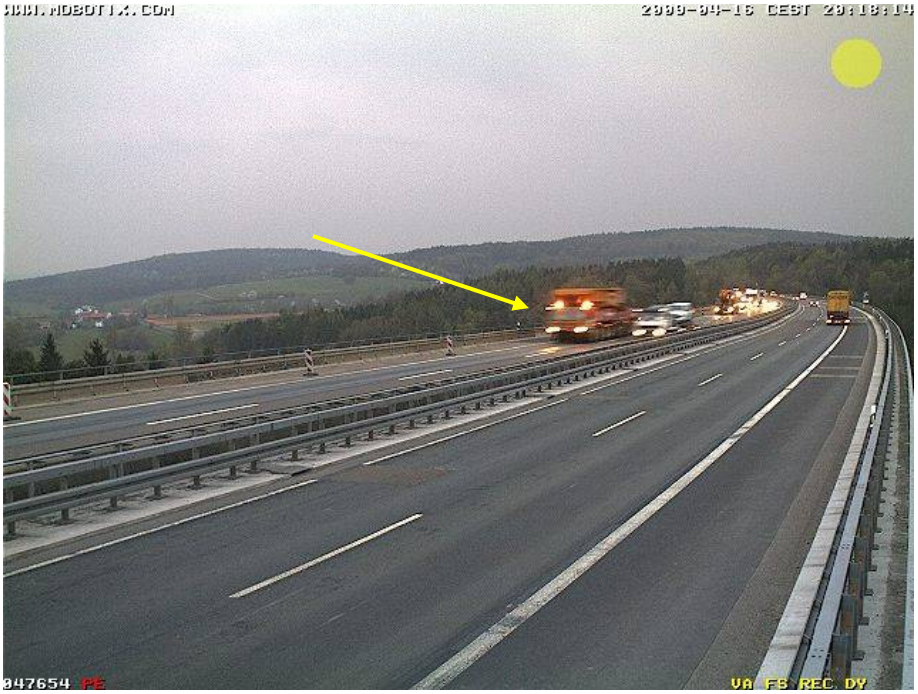
An evaluation program starts every day shortly after midnight to classify the maximum values for the vibration ranges into certain classes, evaluate them and save them in an Excel table. This table is then transferred via email to a previously defined group of people together with the status message. An alarm is generated instead of a status message if a limit is exceeded.

Measured Data with Alarm Message

The diagram shows the measured data for which an alarm was sent via SMS (marked with alarm in diagram). More precise evaluation showed that an increase was recorded at all measuring points. The chronological intervals of the increases and their chronological propagation allowed it to be concluded

that a heavy transport or overloaded vehicle crossed the bridge in the north-south direction. This was distinctly confirmed by evaluation of the camera images and corresponding chronological association.





Thank you to Mr. Koster, MBK to provide us this article.