Westend Bridge - Germany

Project Description:

The Westend bridge is part of the Berlin city highway that connects downtown Berlin with the airport in the north. The 38 years old structures is a pre-stressed concrete bridge. In the past the bridge had to be strengthened multiple times due to cracks and open connecting joints within the floor slab. After the reunification of Berlin the commercial traffic into the city increased considerably and, hence, doubts arose whether the bridge would sustain this new loading.

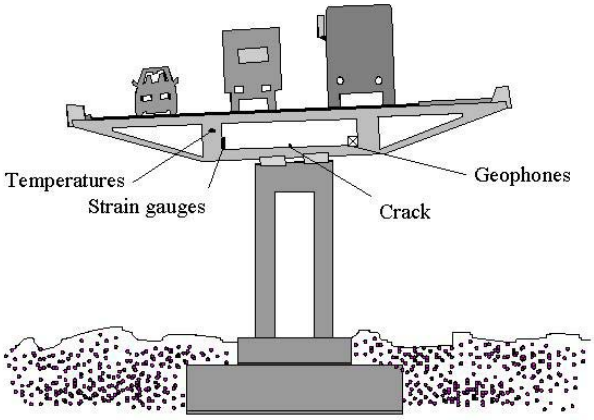
Westend bridge Berlin, Germany

Quick Facts:

- **Name and Location:** Westend Bridge, Berlin, Germany
- **Owner:** City of Berlin, Germany
- **Structure category:** medium span bridge
- **Spans:** 8 spans: 25.0/ 36.3/ 37.5/ 31.1/ 38.1/ 38.0/ 31.6/ 5.0 m
- **Structural system:** Pre-stressed concrete box girder and reinforced concrete columns
- **Start of SHM:** January, 1994
- **Number of sensors installed:** 36
- **Instrumentation design by:** BAM, Division Buildings and Structures, Germany

Description of Structure:

The 243 m long superstructure is continuous and consists of a three-cell box girder with a maximum width of 14 m. It is supported by 7 reinforced concrete columns with a hollow cylindrical cross section. The column in the middle of the bridge which is fixed at both ends takes the horizontal loads. All the remaining columns are pin-ended. The whole bridge is built on foundation slabs. The two bridge abutments are formed by RC-walls.



Cross section and sensor distribution within the superstructure

Purpose of Inspection:

The purpose of the inspection of the Westend bridge was to assess their condition with respect to the presence of multiple cracks within the girder. The inspection was performed by using a monitoring system that records permanently the current traffic loads, stresses and the structure's health. Since 1994 this systems is working till now and has, with an increasing number of measurement channels, supplied continuously bridge data.

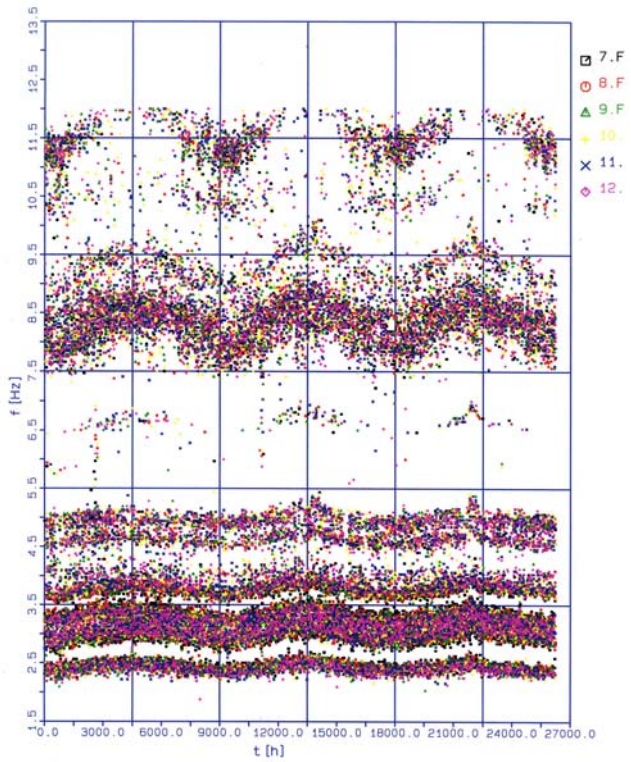
Sensor Details*:

Type	Number	Location
Strain gauges	4	all sensors are fixed within the box girder of span 2 and 3 except the temperature sensors which are attached at the web of one the girders
Velocity transducers	20	
Accelerometers	3	
Crack sensors	1	
Inclinometers	2	
Position Sensitive Detectors	1	
PT100	5	

Examples of outcomes:

It could be found out, that in general the dynamic loads acting on a bridge are dependent on the weight of their vehicles. In case of the Westendbridge it could be shown, that the increasing dynamic loads are correlated to the quality of the road surface.
Analyzing the traffic data obtained by load monitoring, changes in the load spectra

could be observed and the increasing number of heavy load vehicles and their weight could be quantified.
Performing global condition monitoring it could be found out, that the natural frequencies of the bridge are varying with respect to changes of the structural temperature (see figure), what means that changes of the bearing capacity can be assumed.
Local condition monitoring proves a strong temperature dependent but reversible behavior of the cracks in the slab of the girder.



Observed natural frequencies, duration 3 years

Benefits of using SHM technologies in the project:

The Westend bridge is those structure where BAM has performed all over the time a lot of investigations to develop dynamic approaches for the inspection of bridges (see references) including SHM. Many of the questions bridge owners have, like actual acting static traffic loads, dynamic amplification factors or combined loadings due to traffic and temperature or condition monitoring and the automatic detection of damage cannot be answered without SMH.

References:

Rücker, W. F., Said, S.; Rohrmann, R. G.; Schmid, W., “Load and Condition Monitoring of a Highway Bridge in a Continuous Manner”, Proc. IABSE Symposium. Extending the Lifespan of Structures, San Francisco, 1995

Rohrmann, R. G., Said, S., Schmid, W., Rücker, W. F., “Results of the automatic monitoring of the Westend bridge in Berlin”, Research report A, B and C, BAM Berlin 1996 till 1998 (in German).

Link, M.; Rohrmann, R. G.; Pietrzko, S., “Experience with the automated procedure for adjusting the finite element model of a complex highway bridge to experimental model data”, Proc. of the 14th IMAC, Dearborn, 1996

Rohrmann, R.G., Baessler,M., Said,S., Wolfgang Schmid,W., Ruecker, W.F., “Structural causes of temperature affected modal data of civil structures obtained by long time monitoring”, Proc. of the 18th IMAC, San Antonio, 2000

Submitted by:

Federal Institute for Materials Research and Testing (BAM)
Division Buildings and Structures
D-12200 Berlin, Germany
87 Unter den Eichen
Phone: +49(30) 8104-3293
Fax: +49(30) 8104-1727
Email: rolf.rohrmann@bam.de