Vibrations Reveal State of Bridge Ropes

New Method to Rapidly Check Concrete Bridges with External Tendons – KIT Researchers Facilitate Predictive Maintenance of Infrastructure Facilities in Germany

Externally prestressed concrete bridges can be found all over Germany. (Photo: S. Siegel/KIT)

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The new ResoBridge method has been developed to check bridges during running traffic within one day. It measures the vibrations of the tensioning ropes of externally prestressed concrete bridges. The test method developed by Karlsruhe Institute of Technology helps control the state of infrastructure facilities and optimizes early planning of necessary repairs. In the future, it may also be used to check cable-stayed bridges and constructions as well as hybrid towers of wind power plants.

Nearly 40,000 bridges exist in Germany. They have to withstand enormous loads. In particular, they have to cope with the growing heavy goods vehicle traffic. To guarantee safety of bridges, regular inspections are required. However, visual methods allow the damage to be detected in a rather advanced state only. Other methods, such as ultrasound, radiography or magnet-inductive testing, are time-consuming and expensive. Moreover, the bridges partly have to be closed for the traffic.

The ResoBridge method developed by Lothar Stempniewski and Steffen Siegel of the KIT Institute of Concrete Structures and Building Materials (IMB) represents an inexpensive and reliable alternative. The patented method is suited for concrete bridges with external tendons that are not cast into the concrete. These bridges are equipped with a hollow concrete box underneath the road. Six steel ropes inside the box ensure stability. Such externally prestressed concrete bridges can be found all over Germany.

The tensioning ropes to be checked are located in the hollow concrete box of the bridge. (Photo: S. Siegel/KIT)

The ResoBridge method is based on an acceleration sensor measuring natural vibrations of the tensioning ropes. The values measured are compared to results of earlier measurements. “A decreasing frequency indicates decreasing tension of the rope. Significant changes of the values suggest damage of the wires or braids,” explains Steffen Siegel, IMB. The method measures the frequency spectra with an accuracy of up to 0.01 Hertz. To detect changes, an initial value has to be determined as a reference. The KIT researchers were involved in the development of an instrument that stores all values measured and indicates frequency changes.

The instrument is easy to operate. Measurement of the values, inclusive of the assembly and disassembly of the sensor at the measurement point, takes a few minutes only. The check of a bridge will take one day without the bridge having to be closed for the traffic. Hence, ResoBridge saves time and costs. All bridge data are recorded centrally. The method can also be used to compare various tensioning units and bridges. Presently, the method is being further developed for use on other constructions. Future application to cable-stayed bridges and constructions as well as to hybrid towers of wind power plants is envisaged.

Karlsruhe Institute of Technology (KIT) is a public corporation according to the legislation of the state of Baden-Württemberg. It fulfills the mission of a university and the mission of a national research center of the Helmholtz Association. Research activities focus on energy, the natural and built environment as well as on society and technology and cover the whole range extending from fundamental aspects to application. With about 9000 employees, including nearly 6000 staff members in the science and education sector, and 24000 students, KIT is one of the biggest research and education institutions in Europe. Work of KIT is based on the knowledge triangle of research, teaching, and innovation.

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