A bridge demonstrator for monitoring aging infrastructures

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Abstract

Bridges are a critical connection in the transport infrastructure. In Germany, there about 9.100 bridges under Federal administration, another 26.700 managed by the states and 8.700 under county control. Most of the bridges were built in the 60th /70th of the last century and are now reaching their design lifetime. In addition to aging effects such as fatigue, creep, shrinkage or chloride intrusion, bridges are also subjected to much higher traffic loads compared to what they were originally designed for.

As a consequence, many bridges require a renewed general technical approval, possibly accompanied by substantial repair and maintenance measures or even a complete reconstruction. In order to evaluate the actual performance of a structure, non-destructive testing approaches are often used. These approaches allow to investigate a specific instance over time, but they do not allow to monitor the evolution and thus the prediction capabilities of the remaining lifetime are rather limited. An alternative are monitoring strategies to continuously evaluate the status of a structure.

In a current interdepartmental project, a monitoring strategy for bridges is developed and tested. For this purpose, a demonstrator bridge will be built on our test facility close to Berlin in Horstwalde.

The focus of the talk is the presentation of the general concept of the demonstrator including measurement techniques, data acquisition as well as processing algorithms. A key challenge is to combine a variety of different measurement techniques in a data fusion approach to better understand and predict the behavior of a structure in quasi real-time to allow on the one hand to support maintenance decisions and inspection planning for long term decision making as well as enable an instantaneous evaluation of the remaining load bearing capacity for planning of evacuation routes after a natural disaster or terror attacks.

The demonstrator bridge will be a two-span bridge with a total length of 24.4m. In order to simulate the loss of pre-stressing, the bridge is equipped with an external pre-tensioning system with a variable pre-stressing force.

The bridge will be equipped with a variety of sensors such as optical fibres (FBG and distributed) to measure strains and temperature in the reinforcement and in the concrete, RFID sensors for the moisture distribution, embedded sensors for acoustic emission and ultrasonic testing, dual image photogrammetry for measuring displacements as well as standard techniques such as DMS and cable actuated position sensors. It is planned to perform static measurements including the determination of influence lines simulating passing traffic under varying loads and pre-stressing conditions. In addition, dynamic measurements for extracting modal information are performed. In this case, the structure is excited by a shaker.

The structure is currently under construction with the first tests being scheduled for December 2016. Cooperation with other universities and research institutions including joint measurement campaigns are highly welcome.