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Bridge Instrumentation

Gheorghita Boaca[1], Constantin Ionescu[1]
[1]*Department of Structural Mechanics, "Gh. Asachi" Technical University of Iasi, Iasi, 700050, Romania*

Summary

This article shows how to mounting sensors on bridges and structures that are designed by using such sensors.

Currently the bridges are located on important communication routes, which if broken cause considerable losses, both economically and socially speaking.

The article is part of the prosecution behaviour research bridges in service. Knowing the behaviour of bridges in use, the degradation that can be used to develop a success both in managing the funds needed and to design new bridges

KEYWORDS: road, transport pavements, life-cycle assessment, environmental impact.

1. INTRODUCTION

Analyzing the evolution of transport infrastructure over time, it appears that they are constantly subjected to the action of degradation. Communications channels to achieve the first stone blocks were used and natural aggregates in the rough with good characteristics for long-term operation. Thanks to the development of transport infrastructure to keep pace commensurate with the actions they must take.

The combined effects of degradation, deterioration and defects of a bridge is constantly developing and leading to decreased ability of taking load. Bridges must be maintained through maintenance. Maintenance is determined by the permanent structures and their implementation phase since they have a low cost, and development also may expose degradation.

2. IDENTIFICATION REACTION

Identification of the structure behaviour under both the actions and the actions useful loads from the environment can lead to prevent and stop the deterioration of the structure thus maintenance costs. However, analysis is needed, information,

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experiments, for accurate knowledge of the structure. All this may create a technical data package which constitutes support for a more realistic analysis of the bridge. Data from experimental tests form the basis for analytical model. The analytical model can be studied more easily, can change values, dimensions and load characteristics, one can imagine different charging schemes, some more common or less common.

Result of an analysis on a model to highlight the condition in which the structure according to field data: bearing capacity of the structure as a whole, to be imposed limits on operating time that can be exploited, the works are necessary, cost their operating time after repair.

Field data, the behaviour of the structure are obtained by methods and techniques known use loads. Basic methods used mainly static or moving loads. These methods are based on various theories that highlight various properties of the structure. Some methods can produce, but not sufficiently accurate or relevant. Choosing a type of test should be done only if the results expressed as precisely the behaviour of the bridge, to take into account and to be useful in maintenance and rehabilitation project.

In some countries were conducted major research projects aimed at identifying behaviour of bridges in service. The research sought to determine the accurate behaviour of the bridge structure. Research results are found in test methods, methods for tracking the status, data acquisition systems, measuring instruments and sensors. Thus, when analyzing the results, you can choose the best option. Tracking behaviour of bridges in use by governments for roads and bridges in the United States and other countries where this system was developed (Austria, Canada, etc.), has improved overhead control, database related to the level of maintenance, reduced costs, created models that could be analyzed by computer programs, could determine the remaining service period etc..

3. MONTING DEVICES

Various types of devices to track the behaviour of bridges during static or dynamic tests, or in service are used for measuring pressure, position, movements, deformations, etc.

Depending on the type of sensors, their density and precision, one can determine where degradation will occur and how they manifest.

3.1. Local tension sensors

These sensors are designed to catch the item or placed, since the execution stage within the concrete element to measure the tension caused by actions. If you know how the elasticity of the material, then the size distortion (other than that induced by loading) can be evaluated. If reinforced concrete, the effect of temperature, sliding, must be known.

Sensor location should be chosen so as to provide the best results. For example, a simple beam bridge leaning against the sensor is mounted on the beam applied to the middle opening, both large fibber and the fibber tablets.

Reinforced concrete bridges on national roads in operation, built many years ago (about 40-60 years), were very often the carriageway below the permissible STAS site in force, and have wide sidewalks as a 1,00m. Modernization solutions, which provide assurance of a minimum of 7.80 m carriageways and two walks with minimum width of 1.00 m, indicating the achievement of a console "sidewalk" up to 3.00 m. In order to track the status of efforts in recess to mount sensors to measure local stress.

3.2. Deformation sensors, extensors

These sensors can capture the deformations it undergoes a bridge, or an element in its composition, the execution stage and throughout the service. Deformations they undergo a bridge can give valuable information on structure behaviour in different applications.

Deformation of an element occurs when it is subjected to. A bridge is often subjected to loads from self weight of traffic and temperature. Loads of its own weight and temperature of the bridge deforms when the construction phase, so that action can be considered static. The maximum weight deflection occurs after completion of the construction phase, the structure of resistance was loaded with all the constructive elements of the bridge.

Influenced by temperature deformations still be considered during the design and operation should be pursued in order not to exceed limits considered in design. Deformations of the charges is useful in many cases, a significant disadvantage because it can interfere with a carrying capacity exceeding considered, or frequency of deformations can cause degradation of components due to the effect of fatigue.

Deformation measurement points should be characteristic of an item. Data from measurements can be crucial information for understanding the behaviour of the bridge.

Most common deformations in a bridge structure are arrow and elongation.

3.3. Sensors for detecting cracks and distribution applications

Are used to determine the distribution of strains. Can also be used to detect cracks of elements in the area most in demand.

A size crack in concrete elements is important because these may be affected by the reinforcement provided to take efforts to spread.

Sensors are available in areas where cracking can occur elements, or where cracks have appeared and their intended behaviour.

3.4. Position sensors

These sensors provide information about the behaviour of existing joints and cracks.
Sensor can indicate movement of an element in space. It is used in most cases the tracking infrastructure, primary and abutment to track stability.

Important information is obtained if the infrastructure affected by land, threatening the stability of the bridge.

3.5. Sensors to detect subsidence

With this you can highlight and subsidence can be followed from the bridge foundation.

It is known that the settlement infrastructure is considered a major degradation can have serious consequences in the operation of a bridge. Tracking subsidence bridge infrastructure is important to announce an unstable bridge infrastructure.

The disadvantage is that the existing bridges are also difficult to install a sensor, as would be placed in the best possible position. However, a performance monitoring bridges in terms of poaching can be achieved by precision levelling.

3.6. Tilt detection

As subsidence, are spins infrastructure as dangerous for the safe operation of bridges.

For bridges in operation, with direct foundation is very important to know what changes occur after floods or earthquakes, which could paralyze the operation of the bridge.

A very important measurement is to track rotations infrastructure stability of bridges, especially where they may be influenced by the phenomenon of land.

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A measure, now usually earthquake is mounting devices that prevent a possible collapse of a bridge superstructure.

3.7. Dimensional movement

Represent devices that can detect movement both horizontally and vertically. Is an integrated device are more sensors. Mounting such a tool can be usually at the top of the infrastructure or superstructure characteristic points.

3.8. Vibration measurement

He began to be of great interest to researchers because it was found that can detect deterioration of bridge structure in a fast and efficient. There is still a significant spreading of a degradation detection method using vibration. However their modes of vibration measurement on bridges are possible and perform increasingly more often.

Measurements can be performed with a mobile device, located on the bridge when the test or can be mounted sensors for continuous measurement.

3.9. Temperature measurement

Knowing the temperature is important to make a bridge behaviour analysis for both the temperature difference between day and night, and the annual temperature variations.

Location of sensors for measuring temperature is the soffit and about, or the atmospheric temperature near the bridge for the bridge area.

3.10. General condition

To get a clearer picture of the bridge operation can install cameras for monitoring traffic and weather conditions.

4. EXEMPLES AND RECENT INFORMATION

4.1. Great Belt Bridge (Laursen et al. 2006)

This bridge was opened in 1998 at a cost of € 2.85 billion. This bridge has a length of 19 km and four lanes. Before opening the bridge traffic was 8100 vehicles per day. Immediately after opening, circulation rose to 18,000 vehicles per day, and

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now traffic is 24,500 vehicles per day. Denmark recently invested 60 million Danish kroner (approximately € 8 million) for inspection equipment to inspect every part of the structure.

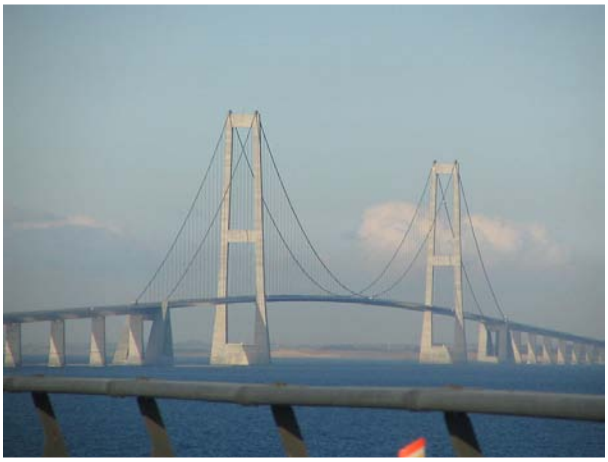

Fig. 1 - Great Belt Bridge, Danemarca, Autor: Tone V. V. Rosbach Jensen

4.2. Croatia (Radic, et al. 2006)

Croatia has a large number of old bridges in service. Krk Bridge in the spring, with an opening of 390 m, was built of prefabricated elements has been assembled by a crane. This bridge is a very bad and must be modernized. Carriageway slab is only 13 cm thick, tall columns of up 70 m, only 30 cm thick walls. This bridge is a difficult case for rehabilitation.

Fig. 2 - Krk-Bridge, Croatia, www.wikimedia.org

4.3. Serbia (Jensen et al. 2006)

Novisad bridges of which were damaged during the Balkan war of 1999 were reconstructed. An interesting fact is that in the last 100 years there have been nine bridges over the Danube in Novisad, of which only one survived and eight were destroyed during the war. Bridge cables to Novisad had a slow collapse: for it took about an hour until everything fell. Of the 12 missiles fired at the bridge, only six were successful.

Fig. 3 – Slobode Bridge, Novi Sad, Serbia, www.panoramio.com

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