Monitoring System for a Cable-Stayed Bridge in Plock

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Summary

Not so long ago, a pretty bridge was completed in Poland, over the Vistula River, near the city of Plock. The bridge is made of steel. It is a cable-stayed bridge with a main span of 375 m. The bridge is subjected to permanent structural control by what we will call a 'monitoring system'. This system monitors the following factors: force in the stays, inclination of the pylons, strains in the structure, wind load. The following gauges were employed: load cells, inclinometers, strain gauges, anemometers. The conclusions were divided into four groups: remarks concerning the operation of the system, remarks on the safety of the bridge, knowledge-building observations on the behavior of cable-stayed structures and data on real environmental effects on bridges. The conclusions drawn after the first two years of data acquisition are reassuring. The behavior of the bridge is not unexpected and the parameters measured are within the foreseen limits.

Keywords: monitoring system, measurements, cable-stayed bridge

On a worldwide scale, modern structures are becoming more and more complicated, sophisticated, daring and sometimes amazing. There are a lot of bridges among them. Very often their spans are long, slender and supported by cables. For this reason, it was proposed to observe selected bridges using a modern approach, by employing a procedure of permanent data acquisition concerning the structural state and behavior of a structure. Such a procedure is often called 'monitoring system', [1]

Fig. 1: Plock Bridge. General view

The bridge over the Vistula River, near the city of Plock, see Figure 1, is made entirely of steel, except the piers under the deck. It is a cable-stayed bridge with a main span of 375 m. The main section of the total length of 615 m is made up of a five-span three-cell box girder supported by 28 pairs of stays. It is interesting to note that there is only one plane of stays and both pylons are connected rigidly to the superstructure [2].

The monitoring system of the bridge was expected to gain information on the behavior of the bridge regarding: force in the stays, inclination of the pylons, strains of the structure, wind load. The following gauges were employed, see Figure 2: load cells (8 sensors in selected stays), inclinometers (2 sensors in pylons), strain gauges (10 sensors in main span girder and one pylon), anemometers (2 sensors: one in the midspan, 20 m above water-level, and one on the top of a pylon, 80 m above water-level). Furthermore, there is a data acquisition unit involving: a computer, amplifiers, a power unit designed to ensure uninterrupted supply and other devices/accessories.

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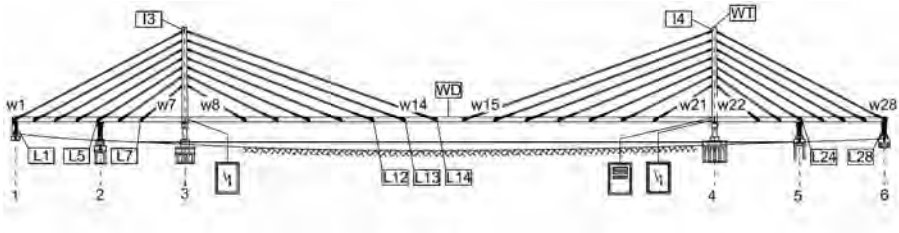

Fig. 2: The diagram of the bridge. The gauges: L1÷L28 – load cells, I3÷I4 – inclinometers, WD, WT – anemometers. The strain gauges are spread in the bottom of pylon (no.4) and superstructure.

The bridge was completed by the end of 2005, but for the following two years it was not open to traffic due to a delay in the realization of adjacent sections of the new route. This was an opportunity to obtain data on the behavior of a cable-stayed bridge subjected to environmental loads, without the ordinary live load caused by vehicle traffic, except for several trucks, which were servicing an adjacent bridge under construction. The conclusion drawn after the first two years of data acquisition is reassuring. The observed behavior of the bridge is not unexpected and the parameters measured are within the foreseen limits.

The system which was installed inside the bridge in Plock is a very useful tool in gathering important information on the loads generated by environmental effects and the loads induced by car traffic on a cable stayed bridge. Moreover it is a very good opportunity to assess the real range of forces in stays due to different types of loads over long periods. The data gathered in the system can be very useful to verify the standards and design criteria for cable-stayed bridges. Moreover, it can be used to asses the probability of simultaneity of occurrence of different types of loads.

The system was installed by the company Freyssinet Polska in cooperation with the French firm Advitam. The operator of the system is Wroclaw University of Technology.

References

[1] WIT de M., "Risk Based Structural Health Monitoring", *Proceedings of Seminar on Cable-Stayed and Suspension Bridges*, Wroclaw University of Technology, Wroclaw, 2005, pp. 306-312.

[2] HAJDIN N., STIPANIC B., KRAWCZYK J., WACHALSKI K., "The Roadway Bridge over Vistula River in Plock (Poland)", *Proceedings of the 5th International Conference on Bridges across the Danube, Bridges in Danube Basin*, Euro Gardi Group, Novi Sad, 2004. pp. 359-370.