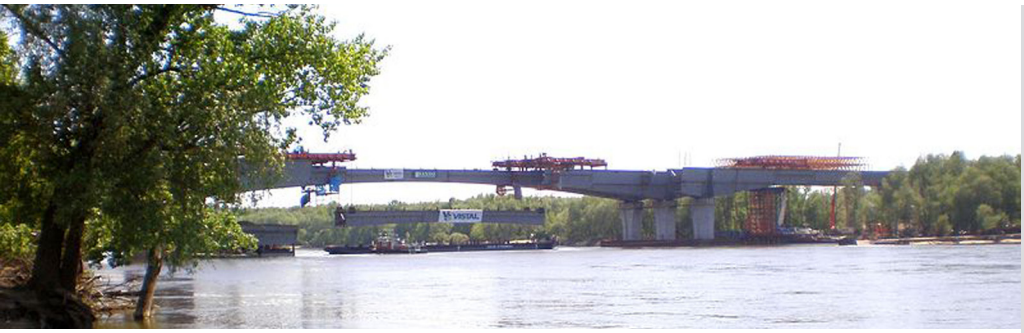
Leica Geosystems TruStory
Monitoring Bridge Structures Under Static Loads



The Maria Skłodowska-Curie Bridge (Polish: Most Marii Skłodowskiej-Curie, formerly North Bridge) is a road bridge over the Vistula River in Warsaw, Poland. The road bridge in the capital of Poland links the northern suburbs of Białołęka and Bielany and opened on 24 March 2012. The total length of the bridge is 795 m (the main river span is 160 m). The applied precise Nivel220 inclinometers network makes it possible to measure the deflections of a bridge construction under static loads without the necessity of using external reference points. The project has been implemented in cooperation of the Road and Bridges Research Institute in Warsaw, Leica SU Poland and O.N.T Krakow.

The most typical application of the new system is deflection monitoring of various bridge constructions, where installing mechanical sensors would be very difficult or even impossible (road traffic or intensive exploitation of railway tracks).

Why a New Approach?
Before implementing the bridge load monitoring system, the customer had been doing classical surveying (leveling supported by precise measurements TDA5005 high-accurate industrial total station). Such approaches were successful until the construction boom in Poland, resulting in a necessity of applying high-speed online systems, which are ready to be used in many, usually very distant, places in a short time. Moreover, the research body of the Road and Bridge Research Institute came across the idea of developing new technology, which could bring new possibilities and make the whole process of static load testing more comfortable and useful.

The new architecture of the North bridge load monitoring system comprises an integrated work between 20 precise Leica Nivel220 inclinometers and a Leica TM30 Monitoring Sensor.

Monitoring Setup on the Bridge
The Leica Nivel220 inclinometers have been placed in specially designed adapters, to detect deflections of the bridge construction. The adapters have to be attached to the bridge construction or set up along the construction's edge. Each Leica Nivel220 device is powered and linked to the next one by cables, so that a network (maximum 32 pieces) is built up. The first Leica Nivel220 is attached to a "master station" consisting of a military toughbook, power supply with backup battery and an integrated radio modem. From this "master station" the monitoring data is sent to the monitoring office.

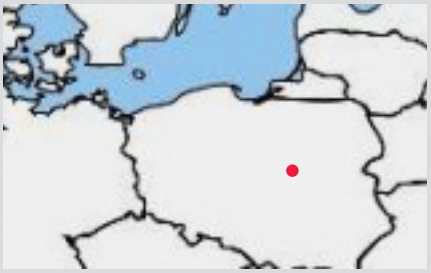
The Leica TM30 total station is operated via Bluetooth® technology, making the whole application more flexible.

- **Scope/Objective**
  An innovative integrated surveying system applied in the monitoring of bridge structures under static loads

- **Customer/Institution**
  Road and Bridge Research institute

- **Date**
  April 2011

- **Location**
  Warsaw, Poland

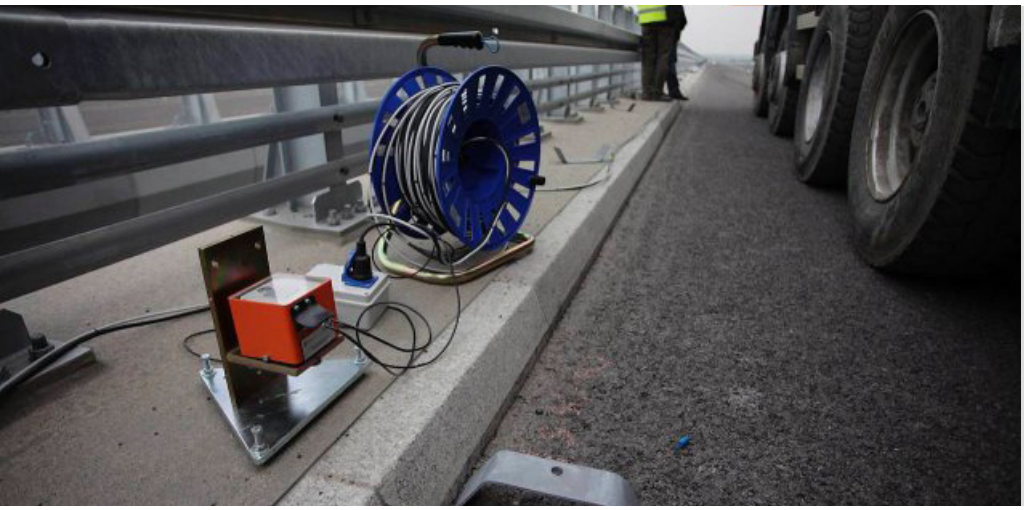


- **Project Summary**
  Instruments
  Leica TM30 Monitoring Sensors
  Leica Nivel220 Precision Inclination Sensors
  Leica GMP104 Monitoring Prisms
  Leica GMP112 Prisms
  Software
  Leica GeoMos Monitor + Analyzer

- **Additional Field Equipment**
  Specially-designed adapters
  Power wires of different lengths (25 m, 50 m and 100 m)
  Power supply system with backup batteries
  Military toughbook

- **Communication**
  Satelline radiomodems
  Bluetooth® Wireless Technology

Mobile on-site Office
- Panasonic Toughbook
  3rd party analytical software based on Matlab® engine for reading data from the SQL database, calculating the bridge deflection curve and visualizing & saving the data (in on-line mode)



Benefits

- Flexible installation
- Reliable and precise sensor network
- Real-time data transmission
- High accuracy and reliability of collected data

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Data Analysis and Results

The Leica GeoMoS monitoring software run in the monitoring office, schedules the Nivel220 readings and stores the data to the SQL database. Afterwards, a third party application powered by Matlab® core presents the results, by modeling the data with special "spline-curves" algorithm. This application accesses the measured raw data from the SQL database and processes the data to the particular demands of the project.

In addition, the Nivel220 inclinometer network is supported by total station surveying data (high accurate results given by the Leica TM30 0,5'' precise total station) exemplifying the deflection progress of the tested bridge structure. Based on the surveying results (inclination angles) the system constantly determines the height displacement line by modeling the data with a specially-developed algorithm using "spline-curves". Moreover, the system delivers very high accurate data as well as high frequency of sampling.

Conclusion

The system was tested on several newly built as well as on already existing bridge structures, examined under static loads, across Poland. Bridge monitoring was performed during construction works, final tests and further exploitation of a structure. The proposed and successfully implemented bridge load monitoring system brings many benefits for both its user and other customers. First of all, it can compete against the classical methods mainly based on leveling. In many cases, a bridge construction is unique, long and extraordinary, making it difficult to perform time-consuming and in many cases erroneous leveling methods. Moreover, a system user can analyze constructions in real time, considering static loads while examining bridge construction, which is simply crucial.

Customer Benefits

The customer appreciates the highest accuracy and reliability of collected monitoring data. That's the reason why the institute has been using Leica Geosystems equipment, as well as the constant and still thriving cooperation between specialists from both sides. Leica Geosystems, responsible for the delivery of instruments and accessories and also for the whole process of the project implementation. For example, Leica Geosystems provides a full CCP service and maintenance in aftersales. Very often, the specialists are invited to participate in practical projects run on-site. The customer saves time in addition to getting more reliable and accurate data. Based on the new amount of data, they are able to implement new modeling algorithms running on highly efficient computers, making examined constructions safer and expressing real behavior during the exploitation.

The designed bridge load monitoring system is one of the most precise and at the same time flexible bridge monitoring installations in Europe.

The Road and Bridge Research Institute in Warsaw has been a key customer of Leica Geosystems Poland since 2006. The area of common co-operation comprises integrated monitoring systems, precise leveling and high-accurate total station surveying combined with innovative software and database solutions. The project was carried out by specialists from Road and Bridge Research Institute under the supervision of Dr Ing. Piotr Olaszek in cooperation with: Dr Ing. Krzysztof Karsznia from Leica Geosystems Poland. Dr Ing. Mariusz Pauluk, Msc Ing. Miłosz Augustyński & Msc Ing. Paweł Bytnar from Oprogramowanie Naukowo Techniczne, MathWorks distributor in Poland

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