Structural Monitoring – Trancão Bridge – Lisbon

CLIENT: MATEREO

How MATEREO are using Senceive technology to monitor the structural behaviour of one of the busiest bridges in Portugal

Challenge

The Trancão Bridge in Portugal, a viaduct over the Trancão river, is one of the busiest bridges in the country with an average daily use of 85,000 vehicles per day. This arch bridge, made of reinforced concrete in 1959, is 329 m long by 30.29 m wide and has 5 spans separated by expansion joints.

Trancão Bridge – Lisbon

Due to the lack of regulatory design obligations regarding seismic design at the time the structure was built, the bridge needed to be heavily retrofitted to enhance its performance during seismic events.

Restoration work to reinforce the bridge's structure was necessary to increase structural performance and safety. A base isolation and a seismic damping system were installed at the base of the arches to reduce the amplitude of vibrations during seismic events.

Additionally, continuity of the deck was established at the expansion joints to ensure joint behaviour of the structure, so it can function as a single dynamic unit. The main work consisted of cutting the base of the arches and placing high-distortion and damping rubber bearing devices, as well as placing viscous dampers, which involved a complex load transfer processes and displacement control.

The base isolation and damping system are designed to absorb and dissipate the energy generated during seismic events, protecting the structure from excess stress and deformation.

However, it's essential to monitor the structure's behaviour, as it's not a "set it and forget it" solution. Over time, the system may wear out or undergo changes that affect its efficiency, such as the rubber bearings degrading or the fluid in the dampers becoming less viscous.

The base isolation and damping system

Solution

Because the movements of the bridge are completely different after the restoration works, monitoring experts MATEREO recommended that a monitoring system be installed to collect regular/continuous data on structural integrity to analyse how the bridge's new systems are performing.

The need of the monitoring system is to check if the bridge is behaving according to the structural model developed by structural engineers, not only during seismic events but also the general behaviour of the bridge regarding operational and environmental effects.

Seasonal changes in weather conditions, such as temperature and humidity fluctuations, can also affect the behaviour of the base isolation and damping system. For example, changes in temperature can cause the rubber bearings in the base isolation system to become stiffer or softer, which can affect the system's efficiency in absorbing and dissipating energy.

MATEREO selected Senceive's wireless condition monitoring technology due to the benefits of continuous and precise data.

Wireless tilt sensor installed

"The implemented system demonstrates high levels of robustness and reliability and the analysis of the collected data proved to be effective in extracting useful information in the early detection of changes to the structural behaviour of this important bridge.

We are convinced that this is the right path and that in the future this type of implementation will be a "standard" in any infrastructure, namely bridges and buildings."

-MATEREO

Outcome

MATEREO installed a variety of Senceive wireless sensors in strategic locations including Triaxial Tilt Sensors, Optical Displacement Sensors, and Crack Sensors to monitor movement of the structure. These movements vary during the day due to thermal changes, so 24/7 monitoring is important to help monitor daily and seasonal movements to analyse trends in the data and identify and abnormal movements.

They have implemented a probabilistic approach to continuously monitor displacement and tilt data and detect abnormal movements of the bridge which leads to early detection of potential damage and prediction of future behaviour of the bridge.

“With this approach, we can continuously monitor the global and local behaviour of the bridge and receive alerts regarding abnormal movements of each sensor, which allows to detect and localize potential damage in an early stage and take actions before the increase of severity of damage.”

MATEREO says these sensors are the key to improve decision-making towards predictive maintenance of critical infrastructures. “The implemented system demonstrates high levels of robustness and reliability and the analysis of the collected data proved to be effective in extracting useful information in the early detection of changes to the structural behaviour of this important bridge.

They have already determined from data analysis that temperature is the main influence of the bridge movements.

The solution has proved to be effective in extracting useful information allowing structural engineers to easily assess the safety of the bridge and to predict maintenance needs.

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Senceive wireless tilt sensor and crack sensor

MATEREO dashboard with information about current state of Trancão bridge