

Masonry Arch Bridge Monitoring - Formia Rail Line

CLIENT: ETS / MICROGEO S.R.L.

Wireless remote condition monitoring to support Italian bridge strengthening works

Challenge

Concern had arisen regarding the condition of a multi-span masonry arch bridge located on the Roma - Formia railway line in Italy. As part of the process of designing a strengthening solution there was a need to understand the behaviour of the structure, particularly with regards to movement or settlement of the arches.

A strengthening scheme was designed based on stitching cracks and reinforcing the arch barrels with a concrete shell secured to the masonry with steel bars. In order to validate the retrofit design, a precise and reliable monitoring system was required. Rail engineering experts ETS Srl and Microgeo Srl considered options and selected a wireless monitoring solution using Senceive technology.

Over all other instrumental solutions, a wireless one was selected to assess two of the arches on a trial basis (Fig.1). This offered a high cost savings, allowed control of thresholds safe values of monitored parameters and provided automated alerts in case of excessive movement.

Solution

Senceive proposed deployment of four triaxial tilt sensors on each barrel, positioned at the top of the piers and on the arch haunches in order to measure rotation. An optical displacement sensor (ODS) was mounted at the crown to detect vertical movement based on change in measured distance to the ground. The ODS nodes were fitted to one-metre beams using swivel mounts, with the beams simply installed using self-tapping screws.

The wireless mesh network formed by these sensors transmitted data to a solar powered 3G gateway. The mobile cellular network relayed this data to a secure cloud server, which could be viewed and analysed by registered users of Senceive's WebMonitor software.

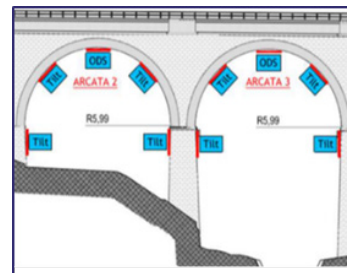


Fig. 1 Layout of monitoring system



Outcome

The sensors are extremely precise and the accuracy of ODS distance measurements showed a repeatability of ± 0.15 mm - enough to detect the natural "breathing" of the bridge to sub-millimetre precision (See Fig.2).

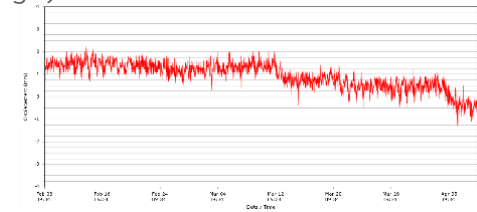


Fig. 2 Showing sub-mm precision of ODS

The scalability of the FlatMesh™ system allows it to be expanded easily and allows the user to control reporting rates, text alert trigger levels and gives the option of real-time monitoring. With a battery life of up to 15 years, the nodes are completely autonomous and monitoring duration can be increased if required. Eliminating any kind of intervention or maintenance also reduces the risk to site workers.