Safe public infrastructure… for life

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European researchers have developed a wireless sensor system to monitor the safety of large infrastructure. The new system will not only potentially save lives when the structure is old, it is reducing costs during construction, too.

Building structures can be affected by earthquake, landslides or construction defects from a previous era. But collapses in infrastructures, sometimes tragically resulting in deaths, can be avoided in future if early-warning sensors are placed on them right from the start.

The challenge of safeguarding major infrastructures – especially those

used intensively by the public, such as bridges or historic monuments - led researchers in the EU-funded GENESI project to design a wireless sensor network (WSN) for monitoring structural health.

'You want sensors to work for the whole lifetime of the structure, which could be tens or hundreds of years,' explained coordinator Professor Chiara Petrioli, of La Sapienza University in Rome. 'This was the technical challenge before us. But we also found we could deploy the sensor networks in construction works, to make design amendments if necessary and safeguard workers on the project.'

Compared to existing technology, GENESI's sensor networks are non-intrusive and cheap to deploy and maintain. Being battery-driven, they are also suitable for remote areas with no electricity supply and can be used when the power grid is down, such after an earthquake.

Rome's metro and a Swiss road bridge

The technology was validated at two construction sites: the new B1 metro line in Rome, and the Pont de la Poya bridge in Fribourg, Switzerland.

In the metro, concrete segments of the tunnel final lining, instrumented with GENESI sensors, were deployed directly next to the tunnel-boring machine (TBM) to measure parameters such as strain, temperature and deformation in real time.

The data was fed back via proprietary low power protocols, 3G and Internet to a control and alarm panel supervised by engineers and geologists working on the project. These professionals were able to check if the drilling was being performed with safety of workers and passengers in the metro foremost in mind.

The network is simpler, quicker and cheaper to install and maintain than traditional cable-connected sensor systems and, in pursuit of long-lasting energy-efficient monitoring of the tunnel when in operation, it is partly powered by micro turbines spinning in the gusts of passing trains.

During the construction of the Swiss bridge, around 25 sensors measured parameters such as the pull on the pylons, bearing displacement, and wind, temperature and water levels.

'It proved very useful, because there always are a lot of uncertainties in design, planning and construction,' said Holger Wörsching, an engineer with Solexperts AG, a Swiss measurement company and partner in GENESI. 'When the bridge was shifted to connect to both sides, we got feedback on deformation and bending and could check the loads were right.'

Other applications

Solexperts sees many opportunities for the technology and is now also deploying it in an access tunnel for a hydro plant in Innertkirchen and an Alpine railway line vulnerable to landslides.

A GENESI spin-off company (Wsense), employing six people, is also exploring the deployment of a miniaturized version of the GENESI system to monitor Italy's many public heritage sites. Wsense is helping the country's Ministry of Cultural Heritage with another, previously-unimagined application: the precarious task of transporting artworks between museums.

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