

Distributed temperature and strain sensing of foundations CSIC with industry partner Arup

The technology

CSIC is working with Arup on several high-profile, London-based construction projects to instrument piles. CSIC is embedding networks of fibre optic temperature and strain sensors into piles and diaphragm walls during construction to monitor the performance of these subsurface concrete structures. The sensors enable engineers to measure the strain and temperature fields in multi-dimensional space and effectively visualise the condition of the underground structure in a manner that until now has not been possible.

The approach

Verifying structural integrity is vital for design and quality assurance. Construction of foundation elements relies heavily on the workmanship and ground conditions encountered, making them vulnerable to structural defects and variables in construction quality.

Embedding distributed fibre optic sensing (DFOS) cables in these structures allows the capture of strain and temperature data along a given length of fibre enabling engineers to 'see from within' a concrete structure. As light travels through the cable, a small fraction is reflected back. The amount of reflection is sensitive to changes in strain and temperature and these changes can be located and quantified to monitor the behaviour of the structure.

During pile load tests, monitoring the development of strain provides critical information on the structural performance of a particular foundation design. Where it is impractical or uneconomical to test full-scale piles, load tests may be carried out on smaller piles.

The benefits

CSIC's distributed temperature and strain profiling technique makes visible the invisible - no other technology can see strain and temperature fields in the same way.

Distributed temperature and strain sensing

- enables strain and temperature data to be measured over a wide area and enables the visualisation of a mesh layer of sensor data. One system may be used to measure structural integrity and load capability
- involves a low level of intrusion to the structure
- offers valuable insights into how a structure has engaged with the surrounding ground and whether, during the construction of the structure, any defects have formed which might impact performance
- delivers the capability to use either strain, temperature, or both, to measure and monitor the integrity (geometry and quality of construction) of a pile
- has the potential to provide a complete picture of a pile's behaviour from construction to advanced stages of its life and operation
- enables a multidimensional picture of the measurand to be visualised