EpsiMon
INFRASTRUCTURE MONITORING

Edge London Bridge

London, United Kingdom

Fibre optic monitoring of a piled raft foundation for a high-rise building

Edge London Bridge is a 27-storey reinforced concrete frame building over a 4-storey basement. The foundation system is a piled raft, fully integrated with the response of the superstructure to control differential settlement. Some of the piles were required to support a significant part of the structure unassisted, during a top-down basement sequence, before the raft was cast.

Epsimon was commissioned by AKT II to design, install and operate a distributed fibre optic (FO) monitoring system for two of the foundation piles, their plunge columns, and the surrounding section of the raft. The monitoring was in operation throughout the construction and initial fit-out of the building, providing real-time strain, displacement and temperature profiles with unprecedented spatial density.

These data were used by the designers to calibrate their numerical models and optimise piled raft designs in similar schemes, based on actual performance rather than overly conservative factors of safety.

Challenges and solutions

One of the main challenges was that the piles needed to be **monitored continuously throughout the top-down basement excavation**. Every element of the system, from the fibre optic cables, to the data acquisition hardware, to the processing and visualisation software, needed to be robust enough to enable monitoring for the project duration with minimal down time.

A key factor was the **careful design and attention to detail** in the planning and installation of the fibre optic cables. Epsimon worked closely with the contractor to ensure that the logistical requirements of the various construction stages were accounted for.

In order to minimise site presence and interference with construction activities, the FO monitoring system was set up to **operate autonomously**. The data were automatically uploaded for real-time processing and visualisation in Epsimon's cloud-based software.

Project highlights

- **Instrumented:**
  - **two 35m-deep piles of 1.8m & 2.0m diameter**
  - **two plunge columns at basement level**
  - **90m² of 1.5m-thick raft**
- **21,500+ measurement points at 0.08m-intervals**
- **Automated monitoring for 30 months**
- **Real-time data processing and visualisation**

Technology used

- **Distributed temperature & strain sensing (DTSS)**
- **Brillouin optical frequency domain analysis (BOFDA) spectrum analyser**

Monitoring objectives and solution

The purpose of the monitoring was to provide **high quality field measurements for calibrating numerical design models**. This required capturing detailed information about the load-bearing behaviour of the piles and raft, namely to:

- record the evolution and distribution of strain within the piles over time, during the top-down excavation and the construction of the superstructure;
- enable the load sharing between the piles and raft to be quantified at every stage of the construction;
- identify localised stress concentrations within the piles, both in tension (due to heave) and compression (due to the super-imposed load).

Distributed Fibre Optic Sensing (DFOS) technology was the optimal solution to achieve these objectives. The ability to **record strain profiles** with **measurement points at closely spaced intervals** meant that the piles, columns and raft could be monitored with a **very high spatial density**. This enabled the project team to observe in detail the changes in strain and load distribution within the foundations, which would have been impossible to achieve with conventional instrumentation.

Armoured fibre optic sensing cables were used to withstand the harsh construction environment, particularly during the excavation of the basement, while still providing reliable measurements. The data were recorded using a BOFDA spectrum analyser, with a measured **precision of up to ±2 microstrain**. The raw data were processed with Epsimon's ***Real-Time Monitoring System*** (***RTMS***) cloud-based software which displayed strain, temperature and displacement profiles and time-histories on an online dashboard within seconds of the measurement having been taken on site.

Project details

- ► **Clients: AKT II, Mace**
- ► **Timeline: June 2023 to February 2026**

Scope of services

- ► **Design of the DFOS monitoring scheme**
- ► **Procurement and integration of system hardware**
- ► **Installation of the fibre optic instrumentation**
- ► **Operation of the monitoring system, including real-time data processing and visualisation**

Key outcomes and benefits

The DFOS monitoring provided **new insights on the piles-ground and piles-raft interactions**. For example, the data showed to what depth the ground heave affected the piles, depending on the level of excavation, and the extent to which the resulting tensile force counteracted some of the dead load of the building. The data were used by the geotechnical engineers to calibrate their design models, allowing them to optimise similar foundation schemes. This has resulted in a **significant reduction in pile sizes** on other projects, with associated **savings in materials, time, cost and embedded carbon**.

The DFOS instrumentation installed at Edge London Bridge enables future ad-hoc measurements to be recorded in order to better understand the **effects of long-term heave on deep basements** and the **relative load share in pile raft foundations**.

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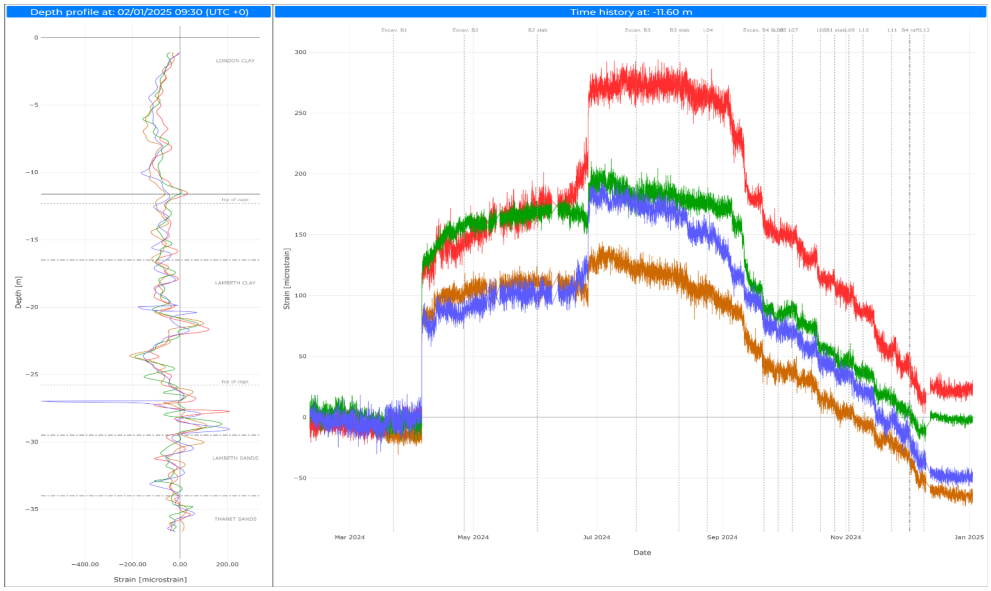

Strain profile (left) and time history (right) from one of the piles, displayed on Epsimon's *RTMS* dashboard.

"Epsimon delivered a state-of-the-art monitoring system that allowed us to visualise the data in real-time, providing unique insights into the behaviour of pile raft foundations. The success of this work would not have been possible without Epsimon's commitment, expertise and hands on approach."

Dr Dimitrios Selemetas
Technical Director, AKT II