

## Impact of fibre optic measurements in segmental tunnel linings for National Grid and Crossrail

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Tunnel lining segments awaiting installation in the National Grid Power Tunnel

### The projects

CSIC has worked on two projects this year to embed fibre optic cables in tunnel segments, to provide improved understanding of the performance of the segments during installation and operation.

The first project, on National Grid's new 32km power tunnel below London, is a collaboration with Industry Partner Costain. This project involves tunnelling in soft ground with a tunnel-boring machine, with rapid installation of the concrete ring segments inside the machine. As the lining comes out from the machine, the annulus between the ring and the soil is filled with pressurised grout. Simultaneously the machine pushes against the end of the installed ring to move forward.

The second project is a collaboration with Hochtief on the Crossrail tunnel contract 310, from Plumstead to North Woolwich, where the tunnels are mainly constructed in chalk (most tunnels in central London are built in London Clay/Lambeth Group) with a large water head above it at the deepest point, where the tunnels run under the River Thames.

### Applications

At the National Grid site, CSIC's fibre optics are providing insights into the complex loads applied to the linings during construction. By building a detailed picture at all stages, CSIC will elucidate the nature and magnitude of the loading applied to the segments 'from cradle to grave'. This will provide unique and invaluable information of tunnel lining performance to industry and help optimise future designs.

At the Hochtief/Crossrail project, CSIC's combined instrumentation has accurately measured and monitored the behaviour of tunnel segments in chalk, the effect of loading caused by tidal changes, and the behaviour at cross passages connecting the two running tunnels. This has provided new data at a level of detail that has, until now, not been available to industry.

### Impact and benefits

By introducing instrumentation at the start of construction, CSIC was able to collect data regarding complex construction loading:

- at the curing stage in the factory
- during transportation
- throughout the entire tunnel construction process
- during cross passage construction

This data:

- provides insights into the behaviour of tunnel segments
- informs optimised future designs

*“National Grid, through the London Power Tunnels project, is delighted to facilitate the pioneering work being carried out by CSIC on both the Fibre Optic Strain Sensing and the Computer Vision research and development projects. Developing new technology and methods for monitoring the structural health of tunnels is expected to be of great benefit to National Grid in the future, using techniques that can potentially be further adapted to a broad range of infrastructure asset monitoring. CSIC has demonstrated a high level of ingenuity and endeavour and we look forward to working with them to the successful completion of the projects.”*

Mark Farmer, Project Engineer, London Power Tunnels, National Grid