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Long-term ageing tunnel structural behaviour at CERN and probabilistic risk assessment

Rapid development of transportation demands growing use of tunnel networks in many cities all over the world. After construction, underground tunnel structures inevitably deteriorate with time. Regardless of tunnel geometry and ground condition, tunnel ageing evidence generally includes visible cracks and water infiltration, whereas the ground-tunnel interaction mechanism is not yet well understood.

This study aims to advance fundamental understanding of ageing tunnel behaviour by a case study of a critical tunnel TT10 section at the European Organization for Nuclear Research (CERN), where the world-famous Large Hadron Collider (LHC) is housed. Even decades after tunnel construction, Tunnel TT10 continues to deform with the development of substantial cracks and water seepage.

In tunnel TT10, a network of Distributed Fibre Optic Sensing (DFOS) cables has been deployed to measure the continuous strain development in the tunnel structure. Furthermore, a series of computational models will be conducted to simulate long-term tunnel behaviour. The computed results will be compared against the field measurements by DFOS to give more insight into the mechanism of long-term tunnel behaviour. Furthermore, probabilistic risk assessment (PRA) will be performed to identify the most critical tunnel deterioration modes. In this CROLINE project, the investigation will be led by the researchers at University College Cork and CERN with external advice from colleagues in the University of Cambridge.

The expected research outcome aims to provide a risk-based framework for tunnel maintenance. The knowledge and skills to be gained at CERN in this project will be widely applicable to ageing underground infrastructures all over the world. In addition, this study will assess CERN tunnel structure condition in compliance with regulations so as to ensure the serviceability of the LHC inside CERN tunnels as a high-quality physical lab for quality education and research.