

THE FUTURE OF GEOTECHNICAL ENGINEERING: DIGITALISATION, CLIMATE RESILIENCE AND NEW REGULATORY STANDARDS

The geotechnical sector is undergoing a phase of profound transformation. It is no longer solely concerned with studying the interaction between soil and structures, but with integrating complex datasets, addressing unprecedented climate challenges, and adopting next-generation regulatory standards capable of ensuring long-term safety and sustainability.

Towards “Cohesive Knowledge Systems” in Tunnelling

A shift in approach to intervention assessment underpins the latest innovations in structural geotechnics. One of the most advanced frontiers concerns data management in large-scale underground works. Modern tunnelling generates vast volumes of heterogeneous information, including operational data from Tunnel Boring Machines (TBMs), real-time geodetic monitoring, and geological mapping.

Current innovation is focused on overcoming data fragmentation through so-called **Cohesive Knowledge Systems**. The objective is to transform raw data into “collective intelligence”, using eXplainable Artificial Intelligence to support engineering decision-making and reduce uncertainty during excavation. The integration of “as-built” data with geotechnical models enables not only the monitoring of progress, but also the millimetre-accurate prediction of the impact of underground works on existing surface structures.

Infrastructure Resilience and Climate Change

Climate change is no longer an external variable, but a central design parameter. The increase in extreme weather events necessitates a reassessment of strategies for protection against natural hazards. In both mountainous and urban contexts, attention is increasingly focused on debris flow propagation and slope stability under conditions of extreme water saturation.

Modern geotechnics responds with adaptive solutions, ranging from the use of advanced geomembranes for reservoir sealing to early-warning systems for hydrogeological instability. Infrastructure safety now depends on the capacity of the ground to withstand unprecedented cycles of heat and precipitation, requiring urban planning approaches that prioritise permeability and the sustainable management of water resources.

Regulatory Developments: Eurocode 7

From a regulatory perspective, the introduction of the **second generation of Eurocode 7** represents a significant shift for designers. This new framework, which will be progressively adopted over the coming years, introduces clearer and more harmonised criteria, with particular emphasis on shallow and deep foundations.



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Key developments include the introduction of “geotechnical categories” based on project complexity and the consequences of potential failure. Greater emphasis is also placed on subsoil investigations, with more stringent standards governing both the quality and quantity of site investigations. This approach not only enhances structural safety but also enables cost optimisation by reducing conservative overdesign through improved characterisation of soil parameters.

Towards GEOFLUID 2026

All these technological and regulatory trajectories will converge at **GEOFLUID 2026**, the international exhibition of technologies and equipment for underground fluids and special foundations, scheduled to take place at **Piacenza Expo from 7th to 10th October 2026**.

The event is set to be a key milestone for the sector: it will provide an opportunity to experience first-hand the latest innovations in subsoil digitalisation, explore cutting-edge automated drilling technologies, and examine solutions addressing hydrogeological instability, as well as developments in geothermal energy and renewable sources. At a time when energy transition and infrastructure resilience are global priorities, GEOFLUID 2026 will serve as an ideal forum for dialogue between academia, design professionals, and manufacturers of advanced technologies.

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