



Research work

ANTICIPATING DEVELOPMENTS AND IMPROVING PRACTICES

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**MINISTÈRE
CHARGÉ
DES TRANSPORTS**

*Liberté
Égalité
Fraternité*

What are **the goals** of our research work?

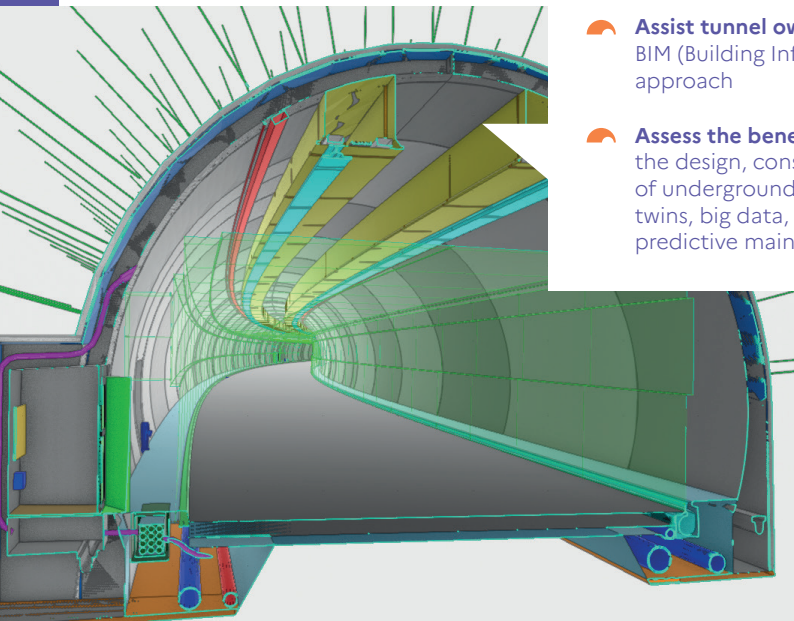
PROMOTE the ecological transition

- 🌱 **Enable the environmental impacts of tunnelling projects to be assessed** by developing tool kits and life cycle analysis models, developing assessment tools to support eco-design initiatives and fostering innovative and improved practices, whilst ensuring compliance with commitments
- 🌱 **Experiment with solutions that are more respectful of the environment,** during the design, construction and operating phases of tunnels (for example by developing a territorial approach to managing and reusing excavated materials, optimising ventilation by aerualic modelling, optimising equipment maintenance scenarios and testing innovations...)



SUPPORT the digital transition and technological developments

- 🌱 **Assist tunnel owners** in adopting a BIM (Building Information Modelling) approach
- 🌱 **Assess the benefits of other tools** for the design, construction and operation of underground infrastructures (digital twins, big data, artificial intelligence, predictive maintenance...)





ANTICIPATE changes in the use of underground infrastructures

- 📌 **Analyse the possible impacts** of the growth in green transport modes and new mobilities at tunnel design, construction, operation and refurbishment phases, from a civil engineering, equipment and safety point of view
- 📌 **Ensure compatibility between tunnel design** (geometry, signalling) and **intended usage** and that users have a good understanding of this design
- 📌 **Take into account the increasing use of ITS** (intelligent transportation systems)
- 📌 **Encourage an increasingly systematic use of underground space** in city planning

OPTIMISE design and construction methods in order to control risks

- 📌 **Develop an iterative approach** to progressively reduce geological, hydrogeological and geotechnical uncertainties throughout the various stages of a project (by developing methodologies for conducting surveys and tunnel studies or for the design of supporting structures and wall coatings)
- 📌 **Set up approaches to select the appropriate methods for the design and construction of underground infrastructures:** improve tools to better control costs and deadlines; experiment with and track innovations, including waterproofing and the use of concrete; assess the risks to neighbouring structures and minimise disruptions, especially in shallow urban environments; assess the stability and sustainability of deep structures



ENSURE efficient asset management




- 🔦 **Implement optimised methods** for assessing the condition and performance of tunnels and their equipment through monitoring, inspecting, probing and expert appraisals
- 🔦 **Develop asset management policies** to schedule the actions necessary to keep tunnels and their operating systems in “good condition” whilst optimising costs and favouring more sustainable and energy-efficient facilities
- 🔦 **Develop inspection, maintenance or repair methods** that limit the impact on operations (e.g. reduce the number and duration of closures)

MITIGATE the risks associated with tunnel operations

- 🔦 **Improve dependability** by implementing RAMS approaches (Reliability, Availability, Maintainability and Safety) and identifying cybersecurity issues...
- 🔦 **Take into account the risks** relating to the emergence of new energy carriers: the fire risk, which remains a major concern in tunnels, and above all the risk of explosion




- 🔦 **Foster a safety culture** among project owners and operating bodies, in particular by promoting the deployment of and new developments in Safety Management Systems (SMS)
- 🔦 **Develop operational risk analysis, assessment and management methods** that incorporate events of an accidental or intentional origin; develop rail tunnel mass evacuation strategies



Research work constitutes a significant part of the CETU's activities. The work conducted is mainly applied research which seeks to improve the knowledge, techniques and methods used for civil engineering, equipment, operations and safety aspects of tunnelling. It addresses the key concerns of the State and the professional community, providing the material required to develop standards of practice for underground infrastructure.

Research activities are either jointly conducted by several CETU technical departments, with the aim of achieving a "breakthrough" on key issues, or conducted by a specific department, with the aim of developing or maintaining high-level skills and addressing the multiple expectations of stakeholders.

Actions are often carried out in partnership, for example with the ministry's scientific and technical network, universities and academia, research institutes and organizations, French and foreign industry associations, tunnel owners, national projects....



A photograph of a tunnel interior, showing a concrete floor with yellow lights and a white wall. The image is partially obscured by a blue triangular graphic element in the bottom right corner.



by *Magazine* © Pictures: Métropole de Lyon (cover), Cetu and iStock



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