	Postdoctoral position in geotechnics and underground works	
	Impact of pore pressure variations induced by pressurised TBM on neighbouring constructions: field data analysis and numerical modelling with artificial intelligence tools	

In urban areas, mechanised tunnelling requires an accurate prediction of the impact of tunnel boring machines (TBM) on neighbouring structures, particularly those founded on piles. Such an assessment is crucial for optimising the design of future underground infrastructure and improving risk management strategies during construction. The problem of TBM/soil/foundation interaction is relatively complex due to its three-dimensional nature, the multiple sources of displacement around the machine, the complexities inherent in soil behaviour (including nonlinear mechanical response, hydro-mechanical coupling and time-dependent effects), and the soil–foundation interaction mechanisms driven by relative stiffness and interface laws.

The LTDS/ENTPE (UMR CNRS 5513) and the French Centre for Tunnel Studies (CETU) work on this topic for several years. They have notably acquired experimental data from an original full-scale experiment ("TULIP" project) carried out on the Grand Paris Express construction site (Mohamad[1] et al, 2022; Michalski[2] et al, 2024). This experimental data base has been used to develop a 3D numerical model with a Lagrangian approach, taking into account the different fields of pressure exerted by the TBM. This model is now able to reproduce the experimental measurements on TULIP site, both surface and subsurface settlements, as well as TBM-soil-pile interactions, under steady-state and transient conditions (Abdallah[3] et al, 2025).

However, this model assumes drained soil behaviour (a classical hypothesis in tunnelling engineering), despite pore pressure variations being observed at some experimental sites. Furthermore, the potential of this numerical model has not yet been fully exploited. In particular, a broader range of geometric and geotechnical conditions should be investigated to more accurately assess the influence of key parameters, and ultimately develop a simplified physics-based tool suitable for the preliminary design of urban underground infrastructure.

The objectives of this postdoctoral research are twofold:

1) **To improve understanding of pore pressure variations induced by pressurised TBMs and their impact on design methods,** through analysis of experimental data from various construction sites (Grand Paris Express, Toulouse metro, *etc.*), and coupled hydromechanical numerical simulations to evaluate the limits of 'classical' drained calculations.
2) **To develop a physics-informed machine learning surrogate model to predict pile displacements during TBM excavation.** The model will be trained using data from numerical simulations based on the previously described 3D model. It is intended to support decision-making in the preliminary design stage by offering fast computations suitable for sensitivity analyses.

To postulate, please send your cover letter and CV to the supervisors indicated below.

Supervisors	**Denis BRANQUE** – Senior Researcher - University of Lyon, ENTPE, LTDS - UMR CNRS 5513, Vaulx-en-Velin, France – denis.branque@entpe.fr **Nicolas BERTHOZ** – Head of the geotechnical division – French Centre for Tunnel Studies, Bron, France – Nicolas.berthoz@developpement-durable.gouv.fr **Antoine RALLU** – Researcher- ENTPE, LTDS - UMR CNRS 5513, antoine.rallu@entpe.fr
Location	ENTPE-LTDS, 3 rue Maurice Audin, 69518 Vaulx-en-Velin, France
Duration	12 months - Starts as soon as possible
Required skills	- PhD graduation in the areas of civil engineering or geomechanics /geotechnics - Good knowledge of constitutive modelling and hydromechanical coupling in soils - Good practice of numerical modelling tools using finite differences method (or finite elements method) - Experience of ITASCA software (FLAC3D, 3DEC) and knowledge of Artificial Intelligence methods (physics-informed machine learning surrogate models) are a strong asset for the candidate. - Understanding of French, and ability to communicate orally and write in English

[1] Mohamad W. et al. (2022). *Full scale study of pile response to EPBS tunnelling on a Grand Paris Express site*, Tunn. And Underg. Space Techn., 124, 104492.
[2] Michalski A. et al. (2024). *Greenfield response to EPBM tunneling in paris and relations with TBM operation variables*. Journal of Geotech. and Geoenv. Eng., 150, 05024011.
[3] Abdallah A. et al. (2025), *Numerical and Experimental Analysis of the Impact of Steady-State and Transient Pressure Conditions Around an EPB-TBM on Soil and Piles*, Tunn. and Under. Space Techn. (under review).