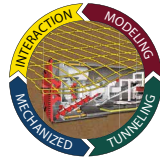


STATIK &
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SFB 837
Interaction Modeling in
Mechanized Tunneling

RUHR
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COMPUTATIONAL MODELING AND DESIGN OF ARTIFICIAL SOIL FREEZING IN TUNNELING

Doctoral defense by **RODOLFO JAVIER WILLIAMS MOISES**

Thursday, 06.11.2025 – 14:00 - 18:00 – IC 03/414

This thesis presents a computational framework for modeling and designing frozen soil structures formed using the artificial ground freezing (AGF) method in tunneling. AGF is a ground improvement technique that uses freeze pipes installed in the soil to form a frozen body over days to months. In tunneling, it provides temporary ground support and watertightness. The framework integrates computational geomechanics modeling with AGF design principles, enabling the optimal design of frozen soil structures in tunneling projects. It includes tools for geomechanical analysis of AGF, simulation of conventional and mechanized tunneling in frozen ground, and optimization of freeze pipe layouts. The backbone

of the framework is a thermo-hydro-mechanical (THM) finite element model for soil freezing and thawing, enhanced with constitutive models for pore pressure coefficients, strength, and creep of frozen soils, and is computationally robust for high seepage flow simulations. In a case study under high seepage flow and a fixed number of pipes, the framework uses machine learning to design an optimized pipe layout that outperforms a conventional layout with uniform spacing in reducing freezing time. Overall, the thesis advances computational modeling and data-driven optimization methods for AGF in tunneling, demonstrating potential for integration into the design phases of ground-freezing engineering.

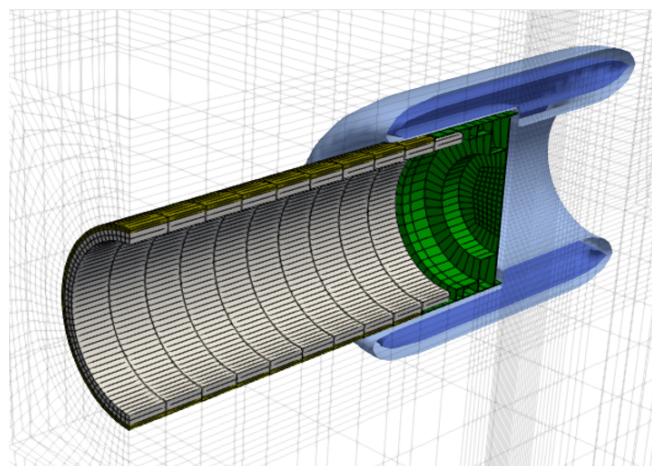
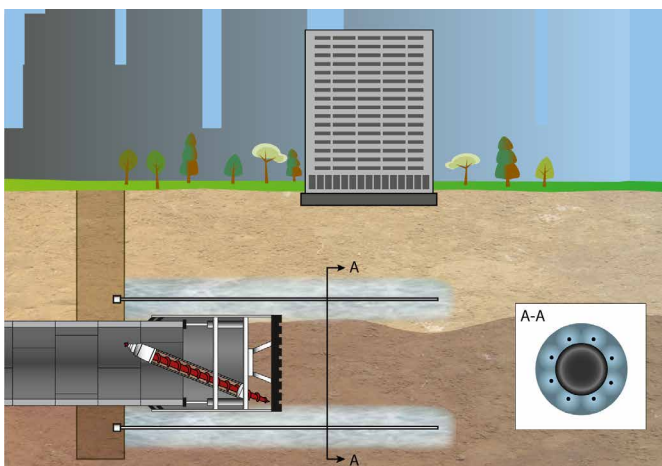


Figure: Mechanized tunneling through frozen ground. Left: Urban tunneling schematic. Right: Finite element model.