Science 4 Technology – Poster Exhibition 2024

Department Mineral Resources Engineering

Chair of Subsurface Engineering

MONTAN UNIVERSITÄT LEOBEN

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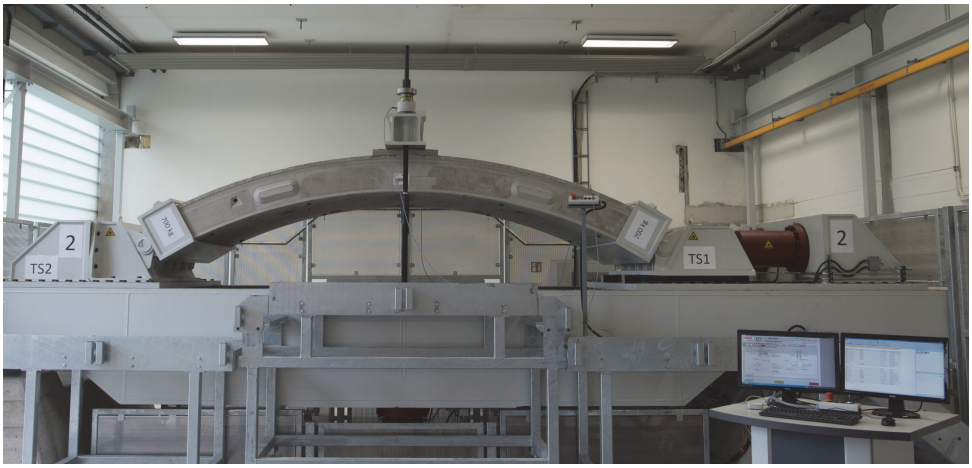
Fibre-Reinforced Concrete Tunnel Linings

Steel and synthetic fibres as a sustainable reinforcement

In the testing facility of the Chair of Subsurface Engineering at the University of Leoben, tunnel segments are examined at a 1:1 scale to ensure they meet tunnel construction standards. In the ongoing "Fibre-reinforced concrete segments" research project, different reinforcement methods are being explored in collaboration with both academic and industry partners. These tests aim to validate material hypotheses and, down the line, contribute to shaping regulations in Austrian tunnel building, paving the way for the adoption of fibre-reinforced concrete.

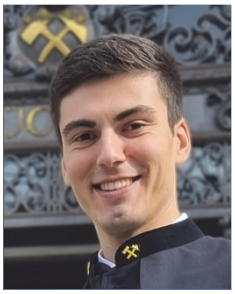


In addition to investigations aimed at determining the maximum loads that can be absorbed, special aspects such as the transfer of forces at the longitudinal segment joint are also considered.

CO_2 emissions
processing effort
costs

ductility
resistance to cracking
corrosion resistance

The primary emphasis was placed on examining the most commonly used types of fiber concrete, specifically steel and synthetic fibers, in precast tunnel linings. Alternative reinforcement methods are gaining traction for potential project integration, as they offer notable reductions in CO_2 emissions during production compared to traditional steel bars.



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Research Partners:

FFG Forschung wirkt.
ÖBV österreichische bautechnik vereinigung
TU Graz Graz University of Technology
ASFINAG
ÖBB INFRA
BEKAERT better together
CONTEC FIBER
MASTER® BUILDERS SOLUTIONS
KIRCHDORFER CONCRETE SOLUTIONS
PORR
LAFARGE

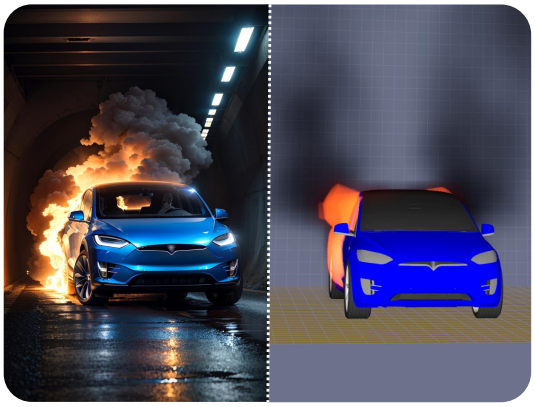
Enhancing Tunnel Safety: CFD Models in Action

Unveiling Insights and Solutions Through Computational Fluid Dynamics

Tunnels: Vital Lifelines, Potential Hazards

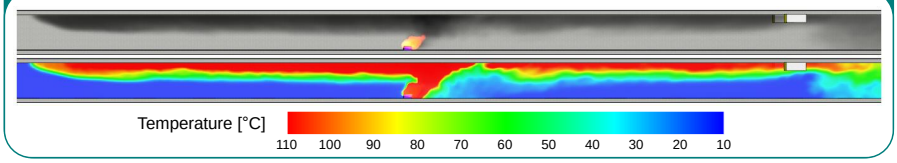
Tunnels are essential for transportation and infrastructure, but they also harbour potential dangers. From fire emergencies to hazardous chemical releases, understanding these risks is crucial for ensuring public safety and uninterrupted operations.

Simulating Fires and Gas Dispersions in Underground Environments



Enhancing Tunnel Safety Through Fire Simulation

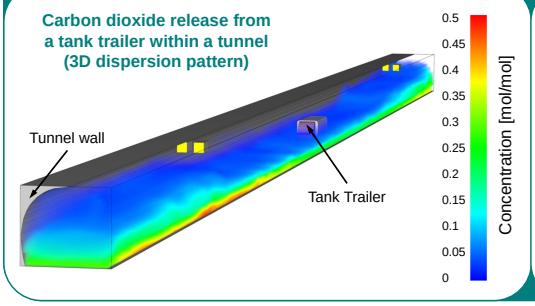
The assurance of public safety and uninterrupted functionality within tunnel environments necessitates a profound comprehension of fire dynamics. The precise simulation of fire scenarios is pivotal for prognosticating critical phenomena such as backlayering and formulating efficacious ventilation strategies.



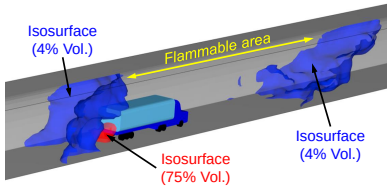
Advanced Analysis of Hazardous Gas Dispersion in Tunnels

Understanding the dispersion of hazardous gases within tunnel environments is pivotal for ensuring safety and operational resilience. Employing CFD simulations to model gas dispersion scenarios allows for the prediction of critical phenomena and the development of robust mitigation strategies. Through rigorous analysis of dispersion patterns, opportunities arise for the optimisation of ventilation concepts and refinement of emergency response protocols.

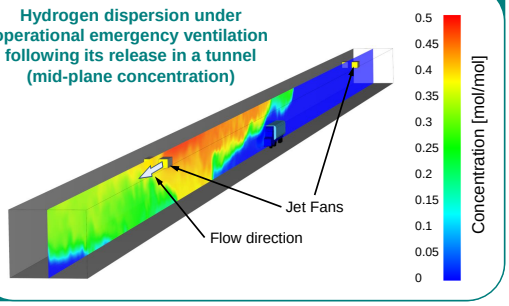
Carbon dioxide release from a tank trailer within a tunnel (3D dispersion pattern)



Hydrogen release from a tank trailer within a tunnel (Flammable area: 4-75% volume)



Hydrogen dispersion under operational emergency ventilation following its release in a tunnel (mid-plane concentration)



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The Chair of Subsurface Engineering and the Research Center "Zentrum am Berg" collaborate closely, synergizing CFD modelling with experimental research to pioneer underground security initiatives and propel advancements in tunnel safety strategies.

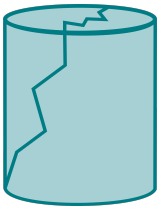
ZaB ZENTRUM am BERG

Mechanics of Volcanic Rocks

How texture and composition can affect behaviour of volcanic systems

Volcanoes provide
- rich soils for agriculture
- geothermal energy production
- opportunities for tourism

But… volcanic systems are dynamic, variable and hazardous



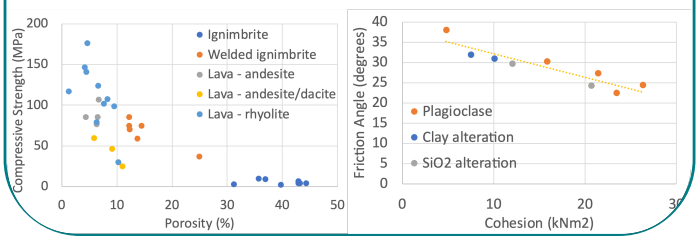
How do properties of volcanic rocks affect
- eruption potential?
- slope stability?
- Geothermal energy production potential?

Sample Collection

The basis for any rock engineering investigation is obtaining representative samples. Working with volcanic rocks requires sample collection on volcanoes in often hazardous and difficult-to-access locations, or drilling to great depths. The number and quality of samples for individual volcanoes is usually limited.

Physico-Mechanical Relationships

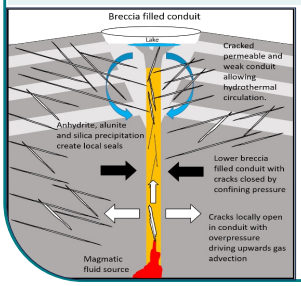
Linking mechanical properties to physical properties that are observable in the field is key to characterizing complex volcanic environments. Developing these physico-mechanical relationships requires multidisciplinary techniques from rock mechanics, petrophysics, petrology, hydrogeology, geochemistry.

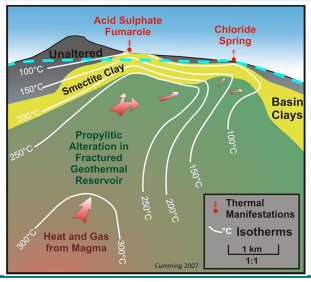


Analysis: Models, models, models

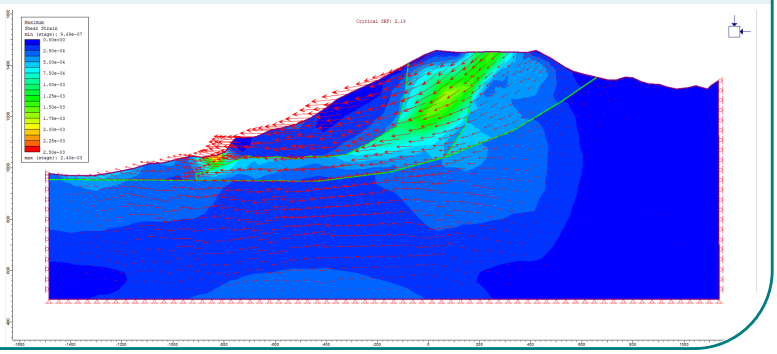
With the physico-mechanical relationships and tools like numerical models we can investigate volcano questions such as:

What do phreatic eruption potential and geothermal energy have in common? Hydrothermal alteration can seal pores so water cannot flow through. Pressure can build up, leading to eruptions in volcanoes[1], or trapping a reservoir of hot water that we can drill into for energy[2].





Can hydrothermal alteration weaken volcanoes so they will collapse? Yes, hydrothermal alteration can increase porosity and decreases strength[3] so volcano slopes become less stable.



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[1]Kennedy, B. M. et al. Pressure Controlled Permeability in a Conduit Filled with Fractured Hydrothermal Breccia Reconstructed from Ballistics from Whakaari (White Island), New Zealand. Geosciences 10, 138 (2020).
[2]Cumming, W. Resource conceptual models of volcano-hosted geothermal reservoirs for exploration well targeting and resource capacity assessment: Construction, Pitfalls and Challenges. Geothermal Research Council Transactions 40, 623–638 (2016).
[3]Langer, K. Changes in geotechnical soil parameters due to influence of hydrothermal alteration at the volcano La Soufrière de Guadeloupe. MSc Thesis, Montanuniversiät Leoben. (2023)