

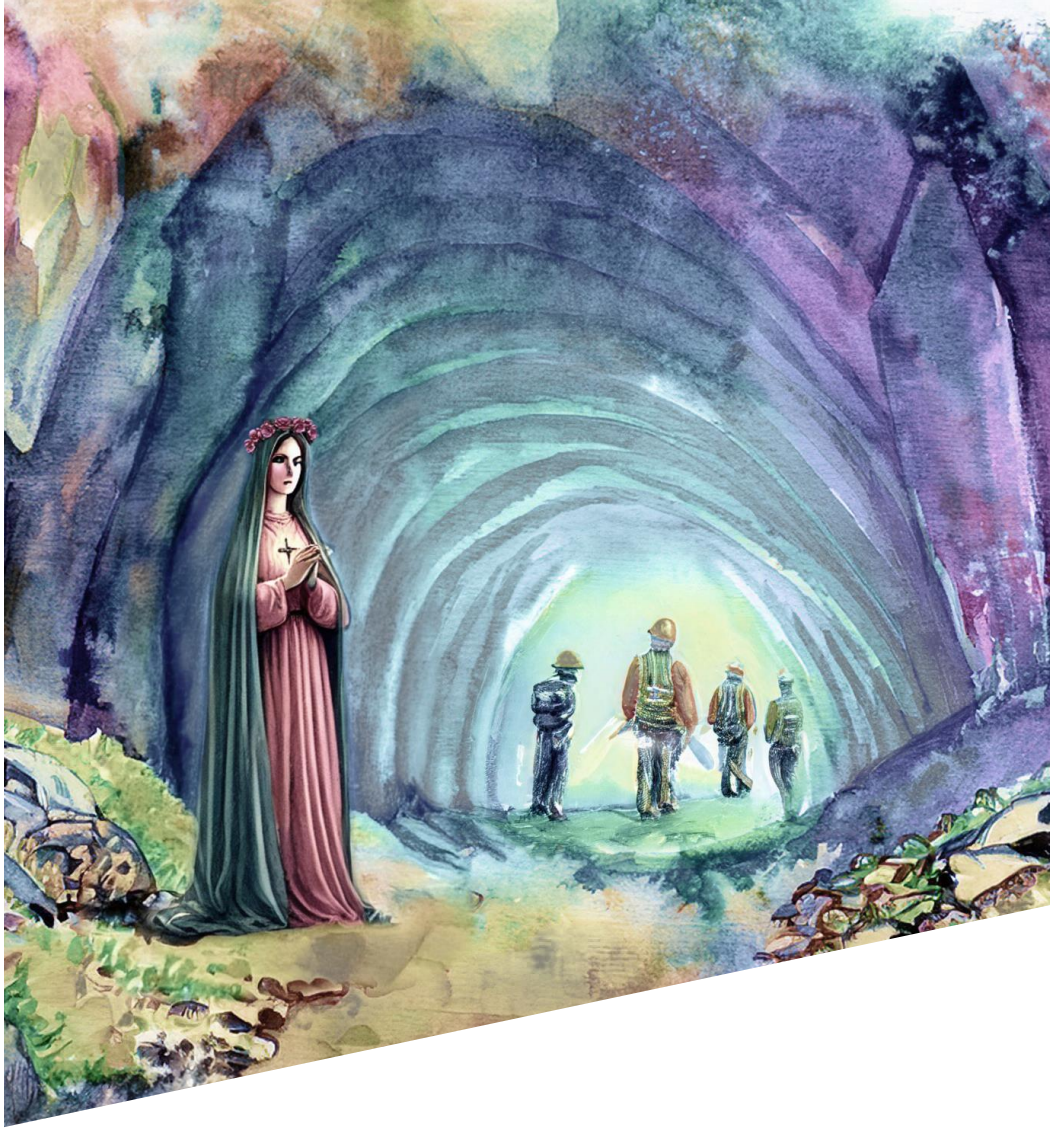
ROCK REPORT

Mechanics & Tunnelling

Quarterly Newsletter of the Institute of Rock Mechanics and Tunnelling

04 Volume 5
December 2024

IRMT



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Marcher's Column

We are still in a phase where not enough tunnel construction engineers are being trained to meet the demands of the tunnelling sector. However, it is becoming evident that many major tunnelling projects in Austria are nearing completion, while the pipeline for new projects is not yet clearly visible. In my view, this poses a risk not only for the continuity of the existing skilled labour market, but also for the transfer of know-how in the coming decades and for the future career prospects of tunnel engineers in training.

Looking across the border to Germany, the situation doesn't appear much better. However, looking westward to Switzerland provides a positive example: Switzerland manages to generate a nearly seamless succession of new tunnelling projects. This serves as a call to action for the country's policymakers, together with public clients, to promptly initiate new infrastructure projects. Every investment in road and rail infrastructure is an investment in the country's future. One shining example is the Koralm project, which is set to transform the economic landscape between Graz and Klagenfurt. And a critical remark, if I may: major infrastructure projects should not be decided through referendums but must be championed by bold politicians!

In this edition of the Rock Report, we highlight a range of exciting developments, including the launch of a new international research project on sustainability: [REgENERaTE](#). We also cover various collaborative seminars and teaching milestones. This year, our [ATC²](#) Tunnel Symposium was held in Innsbruck - a tremendous success. Congratulations to our colleagues in Innsbruck for their outstanding work!

Dear friends of the Institute, we thank you for the trustful cooperation and wish you a peaceful and enjoyable Christmas. The very best Christmas greetings. Good health, happiness and success for 2025! We look forward to many new tasks and a good time together.

Glück Auf!

Thomas Marcher

Title Picture:

Artwork of Saint Barbara and tunnel miners.
Created with the image generating AI Adobe Firefly
Picture: Adobe Firefly
Prompt Engineering: Manuel Winkler, Ines Metzler

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December, 2024 – published
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Research Focus



REgENERaTE

The **REgENERaTE** project (**RE**use for **EN**ergy Exploitation and storage of existing urban **T**unnels in **E**urope) started on December 1st and aims to harness tunnel structures as innovative energy sources, exploring their potential for the production and storage of thermal energy. The research project runs for three years and is supported by Austria's FFG (Austrian Research Promotion Agency). Its goal is to integrate existing tunnels into local energy networks. This would allow underground spaces to serve not only their original purposes, such as transportation, but also as thermal storage systems and energy sources.

The project consortium includes partners from Romania, Germany, Italy, and Austria, combining diverse expertise to enable a multidisciplinary approach. The key scientific contributors include Politecnico di Torino (project coordination), Technical University of Darmstadt, Graz University of Technology (RMT), as well as public and private institutions such as energy providers, infrastructure companies, and local authorities. On the Austrian side, the City of Bregenz, IKB (Innsbrucker Kommunalbetriebe AG), and Wiener Linien GmbH & Co KG are involved as cooperation partners.

The Institute for Rock Mechanics and Tunnelling plays a leading role in two work packages, headed by Prof. Thomas Marcher and Georg Kaml. A particular focus is placed on a pilot site which will be equipped with sensors and monitoring instruments. The goal is to comprehensively investigate the thermal properties of tunnel structures, including the thermal conductivity of the surrounding rock and atmospheric conditions. Another key work package focuses on retrofitting existing tunnels for energy use.

Overall, REgENERaTE will make a significant contribution to Europe's energy transition and support the vision of climate-neutral cities

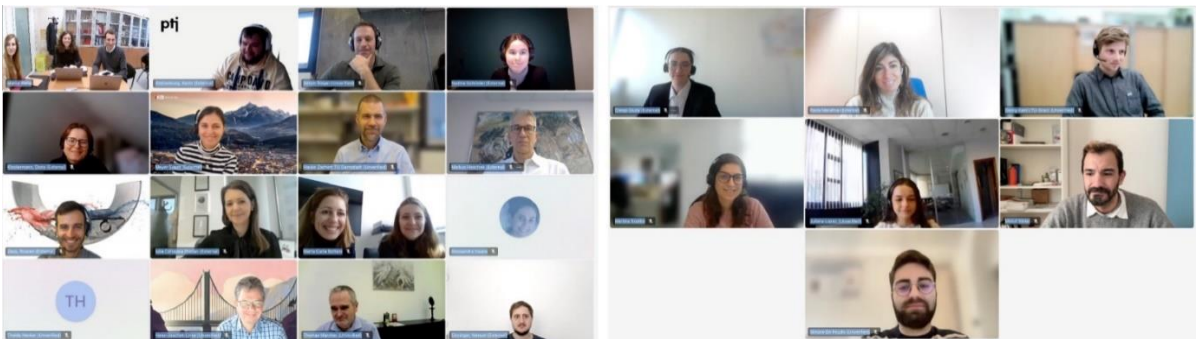


Figure: The project consortium during the kick-off meeting.

Highlights I



1st International Rock Mass Classification Conference (RMCC)

The 1st international Rock Mass Classification Conference (RMCC) took place in Oslo / Norway at the end of October 2024. The conference was organized by the Norwegian Geotechnical Institute (NGI) and RMT alumni Dr. Georg Erharter was the main organizer and conference chairman. RMT sent a delegation of four people to the RMCC where all of them had different roles: Prof. Thomas Marcher contributed to several papers and was chairing a session on digitalization in rock mass classification and characterization, Paul Unterlass and Alla Saponova contributed posters to the conference and Ines Metzler contributed and presented a journal paper about soft rocks to it.

Many internationally leading figures from the world of rock engineering attended the RMCC and the conference was a great success in general. The program contained a pre-conference workshop hosted by RockMass Technologies, many high-quality presentations, three exciting keynote lectures, a podium discussion and a scientific farewell to Dr. Evert Hoek (find it on [YouTube here](#)). The RMCC started a timely discussion about the role of rock mass classification in the 21st century and in the light of new regulations such as the latest update of the Eurocode 7. The conference ended with a discussion about the second RMCC and it is now planned to happen in 2027 in Greece.



Figure: The main organizer of the 1st Rock Mass Classification Conference Dr. Georg Erharter in the front row in the middle surrounded by the conference participants. (Picture: Helena Støvne).

Highlights II

ATC² Conference Innsbruck

On the 14th of November, the ATC² Symposium was held in Innsbruck, attracting over 170 participants. Thomas Marcher from RMT and Robert Galler from Montanuniversität Leoben expanded this event beyond its traditional venues in Graz and Leoben, bringing it to new locations. The symposium at Villa Blanka in Innsbruck offered an in-depth exploration of challenges in alpine tunnel engineering, with a special focus on complex projects in geologically demanding alpine terrain.

Throughout the day, experts showcased innovations in tunnel boring machine (TBM) design, automation in shotcrete application and Building Information Modelling (BIM). Discussions further addressed evolving contractual and operational challenges in large-scale tunnelling.

The event concluded with a forward-looking panel discussion.

I would like to extend my gratitude to our colleagues from the University of Innsbruck for hosting an excellent event.



Figure: RMT delegation at the ATC² conference in Innsbruck.

PhD Seminar BOKU/UIBK/TUG

On the 13th of November, one day before the ATC² conference, it was our colleagues from iBT (Arbeitsbereich Baumanagement, Baubetrieb und Tunnelbau, Universität Innsbruck) turn to host the biannual PhD Seminar. For the fourth time the inter-institutional event took place, continuing the tradition of collaboration among the BOKU – Institute of Constructive Engineering – IKI (Prof. Bergmeister), the University of Innsbruck – iBT (Prof. Flora) and the Graz University of Technology – RMT (Prof. Marcher). The seminar again featured diverse range of topics, with RMT leading discussions on machine learning applications in geotechnical engineering, represented by talks from Mario Wölflingseder and Paul Unterlaß. The event concluded with “iBT-Treff”, a lecture series organized by iBT with the topic “Kraftwerksbau im alpinen Raum” and some well earned refreshments afterwards.

The next PhD Seminar will be hosted by RMT in Graz mid April, we are looking forward to welcome our colleagues to Graz and to an insightful seminar.



Figure: Participants of the 4th PhD Seminar hosted by iBT in Innsbruck. (Picture: Felix Ehmke).

Highlights III

2. Steinschlag Symposium Schladming

On November 28, 2024, the 2nd Rockfall Symposium took place in Schladming. The event brought together more than 120 participants from academia, federal state geologists, municipal decision-makers, tourism/alpine associations, planners, insurance providers and experts in the field to exchange ideas on the challenges and solutions in managing rockfall risks.

The symposium offered a diverse program that highlighted both scientific insights and practical perspectives. Key topics included emerging technologies such as probabilistic methods, multi-method monitoring, and innovative sensor systems, which have enabled significant advances in the prediction and mitigation of rockfalls. Another central focus was the growing influence of climate change on gravitational processes.

Experts demonstrated how shifts in climatic parameters impact the stability of rock slopes and emphasized the critical role of protective forests in reducing rockfall risks. Practical case studies, including reports from federal state geologists and an analysis of the "Zacharias"

storm event in Styria, underscored the importance of interdisciplinary approaches. Legal issues, particularly liability and responsibility, were also thoroughly addressed.

A highlight of the symposium was the panel discussion, where representatives from federal state geology, tourism and alpine associations, insurance providers, municipal decision-makers, law, and academia debated the challenges of rockfall management. The discussion emphasized the necessity of close collaboration among various stakeholders to develop sustainable and effective solutions.

The 2nd Rockfall Symposium impressively demonstrated that managing rockfall risks requires a combination of technological innovation, expert knowledge, and interdisciplinary cooperation. The impacts of climate change, the adoption of new technologies and artificial intelligence, and the further development of risk management strategies were identified as key areas for future focus.



Figure: The audience listening to one of the talks.



Figure: Panel discussion.

Highlights IV

Saint Barbara Celebration

On November 29th, 2024, we celebrated our annual Saint Barbara event in an exciting new format, designed to engage and inspire students with an interest in the field of rock mechanics and tunnelling. The evening began with a warm welcome and comprehensive overview of RMT's milestones and achievements from the past year, presented by Thomas Marcher.

Our cooperation partner and event sponsor, Implenia, took the stage next. Represented by RMT alumni Stefan Brunnegger and Christopher Mittasch, they shared insights from their own Master's theses, conducted in collaboration with Implenia, and reflected on their career journeys since graduating from TU Graz. Their stories offered a glimpse into the transition from education in academia to industry and the valuable opportunities provided by such partnerships.

Following this, Matthias Hahn introduced Ingenieur:innen ohne Grenzen Austria

(Engineers Without Borders Austria), a non-profit organization committed to supporting engineering projects worldwide. His presentation highlighted past and ongoing initiatives, showcasing the impactful work of the organization.

The evening concluded with a lively networking session, where attendees connected over drinks and snacks, fostering meaningful exchanges between students, faculty, and industry representatives.

We extend our heartfelt gratitude to everyone who participated, especially our presenters, sponsors, and all attendees, for making this event a resounding success. We are excited to continue building on this new format in the coming years!

Please find some impressions from the event in the pictures below.



Figure: Mr. Mittasch presenting his work at this year's sponsor Implenia.



Figure: The audience intently listening to the interesting presentations.

Guests & Visits I

Field Excursion Rock Mechanics – U2 Vienna

As part of the lecture *Field Excursion Rock Mechanics*, we had the privilege of exploring two construction sites of the Vienna Metro U2 extension project, providing invaluable insights into shallow innercity underground engineering and tunneling.

Our day began at the Matzleinsdorferplatz construction lot, where we received a comprehensive overview presentation. The session detailed the project's scope, design, and technical challenges. Following this, we descended into the tunnels and the future metro station, witnessing firsthand the complexity of shallow tunneling operations.

In the afternoon, we visited the construction

lot at the future station Reinprechtsdorferstraße. Here, the focus was also on the intricacies of shallow tunneling in dense urban environments. The challenges of managing geological variability, minimizing surface settlements, and coordinating with surrounding infrastructure were impressively addressed by the project team.

We extend our gratitude to Wiener Linien for hosting us and offering such a fascinating behind-the-scenes look at their engineering efforts. The visit was a unique opportunity to connect theoretical rock mechanics concepts with real-world applications, deepening our understanding in the field.



Figure: RMTs Georg Kaml and Paul Unterlaß with the attendees of the *Lecture Field Excursion Rock Mechanics* and our guide from Wiener Linien in one of the future U2 metro tunnels near Reinprechtsdorferstraße.

Guests & Visits III

Thursday lecture series – Dipl.-Ing. Gerhard Gobiet

On Thursday, October 24th, 2024, RMT had the privilege of hosting Dipl.-Ing. Gerhard Gobiet project manager of the Semmering Base Tunnel (SBT) construction project, as one of our guests at Graz University of Technology. Mr. Gobiet delivered an interesting presentation about the Semmering Base Tunnel project from start to finish. Beginning with the challenges encountered during the feasibility study, through the challenges during the environmental impact assessment, to the numerous (geotechnical) challenges encountered during construction and everything in between was covered by the intense talk. The lecture was followed by an intense discussion with the audience in the lecture room which was filled to capacity.

Thank you very much, Mr. Gobiet, for providing us with your insights into the fascinating Semmering Base Tunnel Project.



Figure: Dipl.-Ing. Gobiet on the left discussing with the audience, Prof. Marcher on the right moderating the discussion.

Erasmus+ research stay at the NGI

Mario Wölflingseder, the newest member of our institute, had the privilege of visiting the Norwegian Geotechnical Institute (NGI) for an enriching research stay. During his time there, he engaged with numerous experts, fostering valuable exchanges of knowledge and ideas. Moreover, he gained first-hand insight into the distinctive tunnelling practices in Norway compared to those in Central Europe. From seeing varying rock types and construction processes to experiencing Norway's advanced approach to digitalization, which provided Mario with an exceptional foundation as he embarks on his PhD journey.



Figure: Unsupported full face excavation in Norwegian hard rock conditions.

Publications and Presentations I

73rd Geomechanics Colloquium 2024

At this year's Geomechanics Colloquium in Salzburg, Georg Kaml presented strategies for optimizing hydrothermal tunnel water systems, specifically open geothermal installations in tunnel construction. The focus was on enhancing the thermal performance of such systems through approaches like the integration of absorbers. Simulations showed that the temperature of drainage water can be significantly increased by using this method. Particularly promising are absorbers integrated into the tunnel lining, as they deliver stable output over the long term. This research highlights the importance of geothermal energy sources for a sustainable future and provides starting points for further investigations.

The corresponding paper can be found here: <https://doi.org/10.1002/geot.202400046>.



Figure: Mr. Georg Kaml at the 73rd GMK.

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VÖBU – “Forschung in der Geotechnik”

On November 21st, the second edition of "Forschung in der Geotechnik" took place, hosted by the Institute of Soil Mechanics, Foundation Engineering, and Computational Geotechnics, in collaboration with the VÖBU.

In a welcoming and engaging atmosphere, practitioners had the opportunity to explore cutting-edge research insights shared by experts from TU Graz, BOKU Vienna, Montanuniversität Leoben, and the University of Innsbruck. Representing our institute, Georg Kaml presented innovative approaches to optimizing open hydrothermal systems, while Paul Unterlass and Mario Wölflingseder demonstrated practical applications of generative unsupervised machine learning methods.

The event highlighted the strong collaboration between academia and industry, driving advancements in geotechnical engineering.



Figure: Mr. Georg Kaml (left) and Prof. Dietmar Adam (right) discussing after the talk.

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Publications and Presentations II

1st International Rock Mass Classification Conference

On October 30th and 31st, 2024, a RMT delegation attended the [1st International Rock Mass Classification Conference \(RMCC\)](#) in Oslo, Norway, organized by the Norwegian Geotechnical Institute (NGI). The conference, led by Georg Erharter, focused on the latest advancements in rock mass classification, with a special emphasis on digital methods and modern technology.

Thomas Marcher chaired the session on digital methods and modern technology for rock mass classification and characterization, which featured a range of insightful presentations. Within the session of comparing and correlating rock mass classification systems, Ines Metzler presented her research on RMT's in-situ test program in the argillaceous soft rock lithology of the Angath adit tunnel within the ChaMod-HSSR research project.

Another significant session at the conference was the scientific farewell for a pioneer in the field of rock mechanics, Dr. Evert Hoek, which was supported by representatives of IAEG and ISRM. During the event, Paul Unterlaß presented a poster on transfer learning based TBM advance classification, while Ines Metzler presented a poster on the challenge of classifying argillaceous soft rock (HSSR).

The conference provided an excellent platform for knowledge exchange, and we happily contributed to the advancement of rock mass classification and characterization research. Publications are still in production and will be presented in the next RockReport once published.

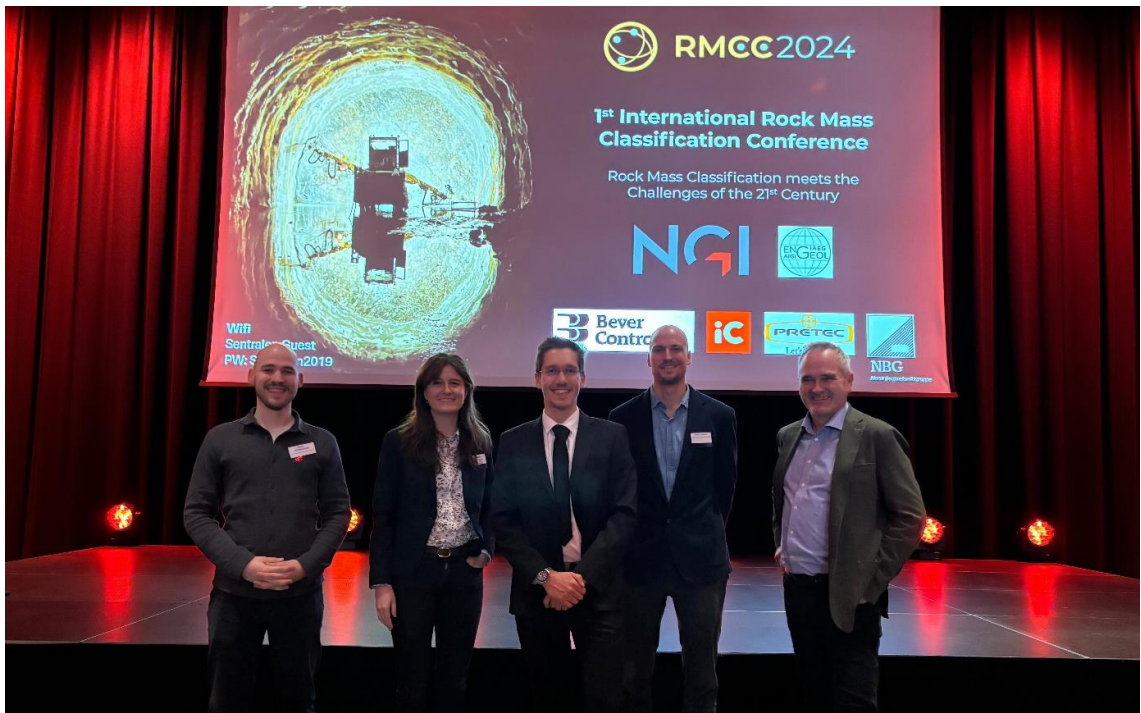


Figure: RMT delegation at the RMCC in Oslo. F.l.t.r.: Mario Wöflingseder, Ines Metzler, Georg Erharter, Paul Unterlaß and Thomas Marcher.

Publications and Presentations III

International Distribution and Development of Rock Mass Classification: A Review

Erharter, G.H., Bar, N., Hansen, T. F., Jain, S. & Marcher, T. (2024). In *Rock Mechanics and Rock Engineering* (in press). OPEN ACCESS: <https://doi.org/10.1007/s00603-024-04215-8>

This paper was prepared as part of a special issue in the journal *Rock Mechanics and Rock Engineering* that was organized as part of the [1st international Rock Mass Classification Conference](#). This review offers an up-to-date examination of the global utilization of rock mass classification systems (RMCS) across applications such as tunnels, caverns, mining slope stability, and more. A “family tree of rock mass classification systems” is presented that traces their evolution over the decades. The family tree illustrates a prolific period of system development between 1970 and 2000, followed by a decline in progress and

increasing specialization of systems. Based on surveys within the rock engineering community carried out between 2022 and 2024, the dominant systems for underground engineering and slope-related tasks were found to be GSI, RMR, and the Q-system, which have demonstrated their practical efficacy over 5 decades. Based on the surveys, two “world maps of rock mass classification” have been produced that visualize the international RMCS distribution. However, the survey shows that only some new or derived systems developed in the last 25 years have gained global acceptance.

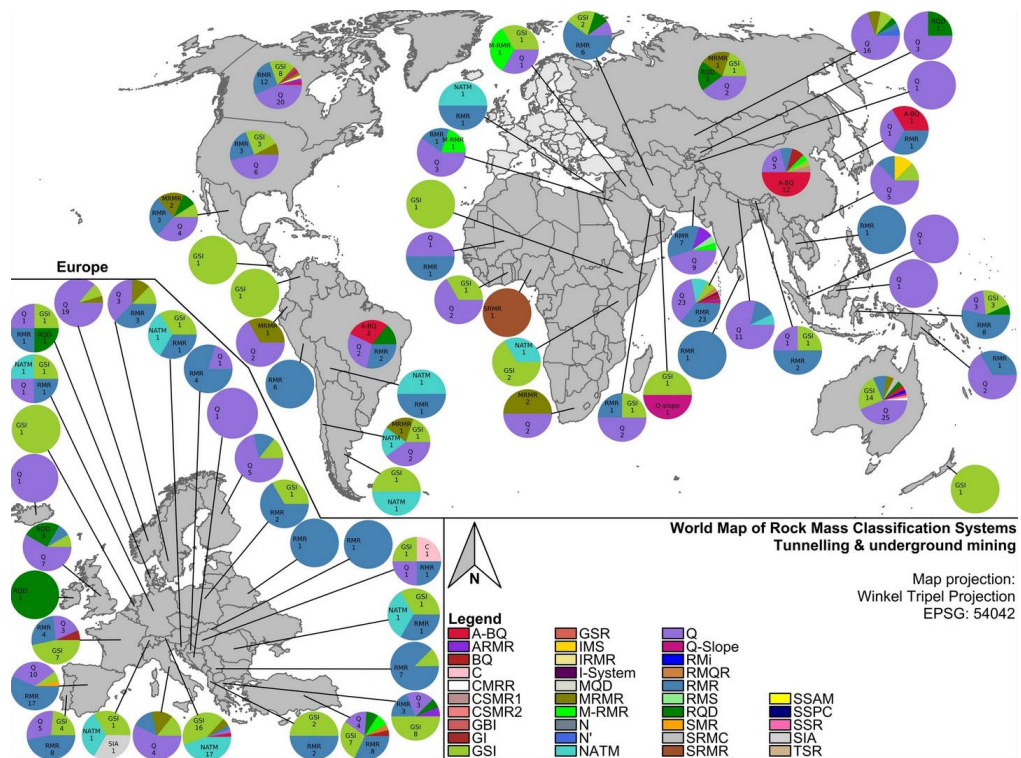


Figure: World map of rock mass classification systems for underground application. See the online version of the article for a high-res version and full names of systems. Taken from Erharter et al. (2024)).

Publications and Presentations IV

Sustainable energy from the depths: Optimization strategies for hydrothermal tunnel water systems

Geisler, T., Kaml, G. & Marcher, T. (2024). In: *Geomechanics and Tunnelling*. 17, 5, S.426-436 11S.
<https://doi.org/10.1002/geot.202400046>

In principle, a distinction can be made in tunnel geothermal energy in closed and open hydrothermal systems. Closed systems use absorbers operating in a closed circuit for heat exchange, while open systems use the energy inherent in the drainage water directly. Closed systems are constantly evolving, whereas the performance of open hydro-thermal systems is dictated by the amount of discharge and the temperature. In this context methods have been investigated to optimize power output. On the one hand by separating cold tunnel water inflows, and on the other hand by installing absorbers in combination with open systems. Using sample data, it was shown that such measures can increase the thermal output by up to 0.5 MW. Although the system effectiveness decreases slightly over time, a significant increase in output was observed in the long term compared to systems without absorbers. The results show that the thermal performance of open hydrothermal tunnel systems can be increased at a later stage. This allows existing tunnels to be used for sustainable applications, thus contributing to a more environmentally friendly energy industry.

Rockfall as a gravitational natural hazard – influencing factors and approaches to action at municipal level

Kienreich, R., Kammerer, L., Frühwirt, T. & Marcher, T. (2024). In: 53. *Geomechanik-Kolloquium, Tagungsbeiträge, Heft 2024-3*, S.253-272. ISSN 1611-1605, Freiberg (D).

The article deals with the quantification of the rockfall risk on natural rock slopes. In a first step, the rock mechanical risk is determined and, in a second step, climate-related trigger factors are added. The process steps are the search for rock types (GA), the determination of slope behaviour types (BVT) and, in combination with climatic trigger factors, the system behaviour (SVT) of a slope. The random set method was used in the calculations and the risk was specified in bandwidths. A special focus is placed on the change in the strength behaviour of the rock types because of freeze-thaw cycles.

Upcoming Special Sessions / Issues

EURO:TUN

Vienna, Austria (2025/09/22-24)



The ECCOMAS Thematic Conference on Computational Methods and Information Models in Tunnelling (EURO:TUN 2025) will take place on September 22-24, 2025 in Vienna, Austria on the premises of the TU Wien. RMT will organise and chair the mini symposium “Numerical modelling in NATM tunnelling”.

This mini-symposium aims to advance numerical modelling techniques for enhancing the effective application of NATM. Key topics include finite element, finite difference, and discrete element methods for simulating excavation and reinforcement sequences, as well as their limitations. Special emphasis is placed on constitutive models, including those accounting for anisotropy, swelling rock conditions, and transitional material behaviour (e.g., hard soil/soft rock). The selection of appropriate constitutive models, parameter identification, and adherence to geomechanical design guidelines are critical focus areas.

The symposium will also explore advanced 3D analyses, incorporating tunnel support ahead of the tunnel face, complex excavation sequences, radial support, pre-support elements, and concrete models for shotcrete. By integrating these aspects with cutting-edge research and case studies, the event fosters a deeper understanding of simulation approaches, promoting innovation in NATM tunnelling methods and addressing the challenges of deep-seated rock tunnels and shallow tunnelling in soil or transitional materials. [LINK](#)

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Civil Engineering Design - CEND

civil
engineering
design

CALL FOR PAPERS

Prof. Thomas Marcher and Prof. Wang Xiangyu (Curtin University) currently serve as guest editors for a special issue (SI) of CEND. Civil Engineering Design journal with a focus on “Advancing Infrastructure through Digital Innovation”. [LINK](#)

The December 2024 issue will be a special issue regarding Data Analytics, Machine Learning (ML) and Artificial Intelligence (AI).

Contribute your latest research and insights to the expanding landscape of Data Analytics, Machine Learning (ML), and Artificial Intelligence (AI). We welcome scholarly submissions showcasing innovative applications, advancements, and practical implementations of these technologies in the infrastructure field. Share your valuable contributions to enrich the discourse and advance the collective understanding of the transformative role played by intelligent data analytics and Machine Learning in diverse domains. Deadlines will follow soon.

Teaching I

Joint Privatissimum – RMT & Institute of Soil Mechanics, Foundation Engineering and Computational Geotechnics

The joint Privatissimum 2024 took place at Klugbauer conference hotel where the PhD students from the institutes of Rock Mechanics and Tunnelling and Soil Mechanics, Foundation Engineering and Computational Geotechnics presented their achieved progress and the proposed plans for their research endeavours.

Within the two days, every PhD student delivered a presentation about the current research project followed by open questions for discussion. Where the professors and PhD students discussed with the presenter the possible solutions and/or adjustments to come over the introduced scientific problems. The PhD candidates delivered outstanding

presentations creating ideal scientific environment. Which triggered the critical thinking of the attendees to involve in discussing the demonstrated challenges.

Furthermore, the annual Privatissimum also created a good opportunity for future collaboration between students from both institutes.

RMT team is looking forward to contributing in the next privatissimum with new scientific discoveries, ideas and challenges. Aiming to contribute to developing the geotechnical engineering field.



Figure: Participants of the joint Privatissimum at Klugbauer.

Teaching II

Recent master graduates at RMT

Andreas Zani

Supervision: Marcher T., Metzler I.

On November 25th, 2024, DI Andreas Zani successfully defended his master's thesis titled Photogrammetric Documentation in Tunnelling – Case study of the Angath Test Gallery. His presentation was both insightful and well-received, leading to a thorough discussion with the examination committee and ultimately earning him his well-deserved degree.

Andreas's research focused on leveraging photogrammetry as a precise and efficient tool for documenting the excavation process and shotcrete installation in a test gallery at the Angath adit tunnel. He developed a time-efficient workflow for data acquisition, ensuring it did not interfere with the construction process. By back-calculating the effective shotcrete thickness in a three-dimensional model, Andreas demonstrated how classical photogrammetry could be effectively applied to address specific research questions in a tunnelling context.

Congratulations, Andreas, on this remarkable achievement! Best wishes for your future career!



Figure: F.I.t.r.: Prof. Marcher, Andreas Zani, Dr. Richter, Prof. Fuchs-Hanusch

Master Thesis topics presentations

RMT team is gladly announcing the master theses / projects presentations session that will be held on 20th of January 2025 at 12:30 PM in seminar room Rock Mechanics (ATEG032) at campus "Alte Technik". The session is directed to civil engineering and geosciences students who have interest in the field of rock mechanics and tunnelling and would like to engage in a related master thesis and/or project. The presentations will be given by the RMT team explaining the context of the master theses/projects topics and requirements.

You can find here an extract of open [master theses](#) and projects offered by the RMT institute.

Hope to see you there!

MAR	Mission to the Mars	RMC	Rock mass characterisation or classification
EGI	Engineering geological investigation	ANA	Numerical analysis
BIM	Building information modeling	NUM	Analytical analysis
CST	Case study	MAP	Geological field mapping
RIA	Risk assessment	LIT	Literature study
SR	Hard Soil - Soft Rock	LAB	Laboratory Works
ANI	Anisotropie	SOE	Software evaluation
ML	Machine Learning	TCC	Time and cost calculation
RM	Rock Mechanics	HTH	Hydrothermal Energy
MWD	Measurement While Drilling		

Figure: RMTs key research fields.

Teaching III

Winter school

TU Graz and the Eastern Switzerland University of Applied Sciences (OST) are pleased to invite students to the Winter School 2025, taking place on February 10th and 11th, 2025, at the OST campus in Rapperswil and with a hybrid transmission to Graz.

This two-day event is designed to provide students with an overview of cutting-edge topics in sustainable geotechnical engineering. The program will cover innovative materials for construction, alternative energy applications such as geothermal storage, techniques for analyzing drilling data, and challenges associated with hard soils and soft rocks.

Participants will have the opportunity to learn more about the application of emerging technologies such as generative AI in

geotechnics, including how tools like GPT can be used to assist with data-driven tasks in geoengineering. This includes automating the analytical tasks and creating customized solutions through Assistants and API integrations for decision-making support.

The Winter School 2025 is designed to help students explore sustainable innovations in geotechnical engineering through focused sessions and hands-on examples. Join us to discuss real-world challenges, exchange ideas, and discover practical tools and methods shaping the future of the field.

We look forward to welcoming you in Rapperswil or online!

Winter School 2025 “Sustainable Innovations in Geotechnical Engineering”



Program:

February 10th, 2025

Morning Session

- **Innovative Materials for Construction**
Learn about advanced sustainable materials designed for efficiency in geotechnical projects. *(Presented by OST)*

Afternoon Session

- **Geothermal Energy and Storage Solutions**
Explore alternative energy systems and their applications in sustainable construction. *(Presented by OST)*

February 11th, 2025

Morning Session

- **Hard Soils and Soft Rocks**
Discuss the complexities of geotechnical behavior in challenging ground conditions. *(Presented by RMT)*
- **Measured While Drilling (MWD) Data Analysis**
Learn how MWD data analysis supports decision-making in geotechnical processes. *(Presented by RMT)*

Afternoon Session

- **Generative AI in Geotechnics**
Discover the potential of new generation of AI for innovative problem-solving approach in geoengineering. *(Presented by RMT)*

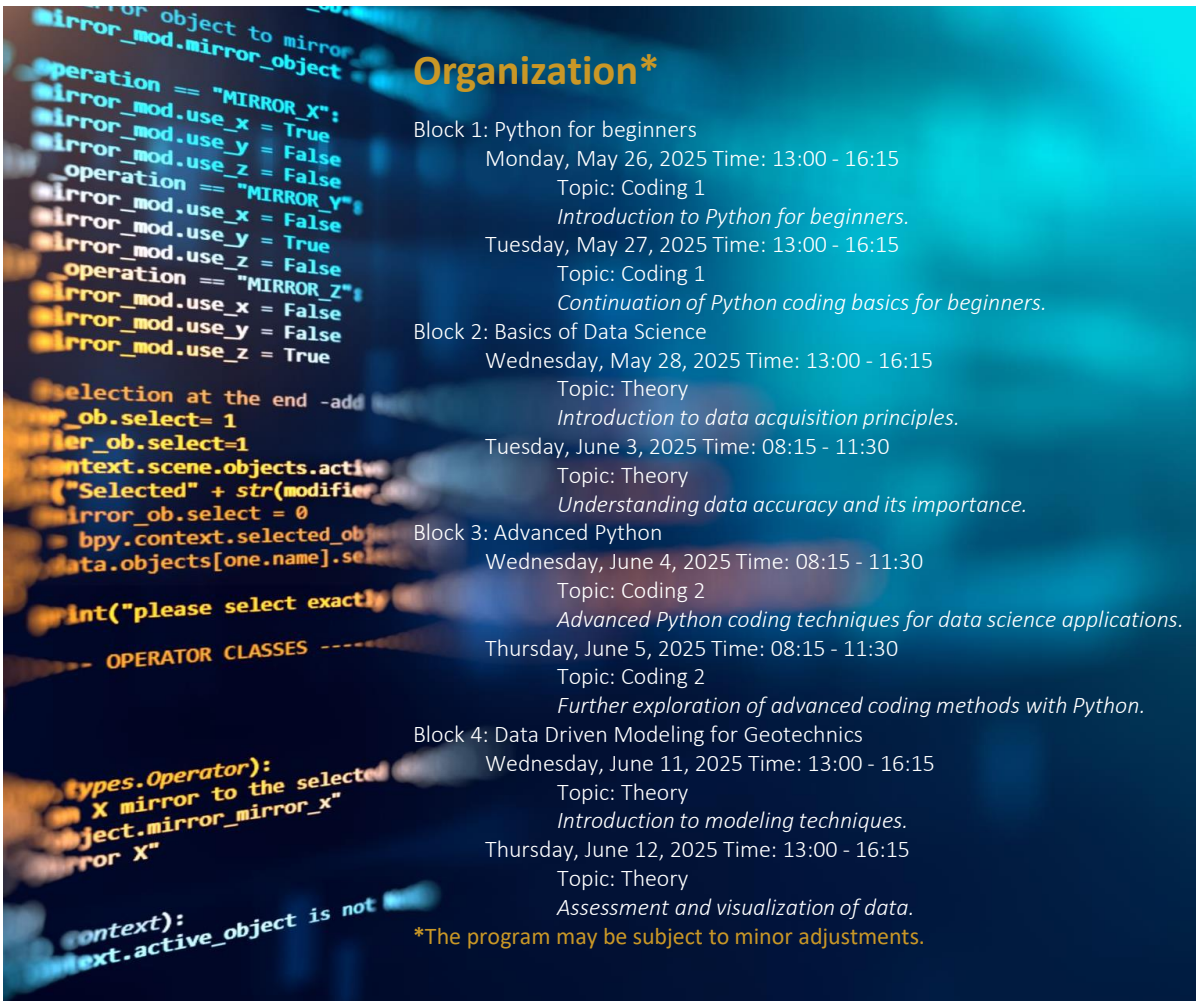
Teaching III

Applied Data Science for Geotechnics – 220.422 SS25

Concept: This course aims at teaching data analysis by means of programming with Python for students of civil engineering and geosciences. No previous knowledge in programming or data science is required. Those who are new to Python, shall start the course from Block 1: “Coding for beginners” module to learn the basics of Python programming language. Students with programming experience can join the course from Block 2 “Theory, data acquisition”. The Theory lectures will introduce data science concepts, especially focusing on data pre-processing, data accuracy assessment, data driven model building (including machine learning), and visualization, all tailored to geotechnics and geosciences.

Objective: By the end of the course, you’ll have the tools you need to handle complex datasets and apply modern data science techniques to real-world geotechnical challenges.

Registration: Via TUGraz online or email to alla.sapronova@tugraz.at. The course will be conducted in English and includes interactive sessions with case studies.



Organization*

- Block 1: Python for beginners
 - Monday, May 26, 2025 Time: 13:00 - 16:15
Topic: Coding 1
Introduction to Python for beginners.
 - Tuesday, May 27, 2025 Time: 13:00 - 16:15
Topic: Coding 1
Continuation of Python coding basics for beginners.
- Block 2: Basics of Data Science
 - Wednesday, May 28, 2025 Time: 13:00 - 16:15
Topic: Theory
Introduction to data acquisition principles.
 - Tuesday, June 3, 2025 Time: 08:15 - 11:30
Topic: Theory
Understanding data accuracy and its importance.
- Block 3: Advanced Python
 - Wednesday, June 4, 2025 Time: 08:15 - 11:30
Topic: Coding 2
Advanced Python coding techniques for data science applications.
 - Thursday, June 5, 2025 Time: 08:15 - 11:30
Topic: Coding 2
Further exploration of advanced coding methods with Python.
- Block 4: Data Driven Modeling for Geotechnics
 - Wednesday, June 11, 2025 Time: 13:00 - 16:15
Topic: Theory
Introduction to modeling techniques.
 - Thursday, June 12, 2025 Time: 13:00 - 16:15
Topic: Theory
Assessment and visualization of data.

*The program may be subject to minor adjustments.

Figure: Applied Data Science for Geotechnics lecture program.

Teaching IV

New Edition: "Joint NATM Master of Science: Construction, Rehabilitation, and Operation of NATM and TBM Tunnels"

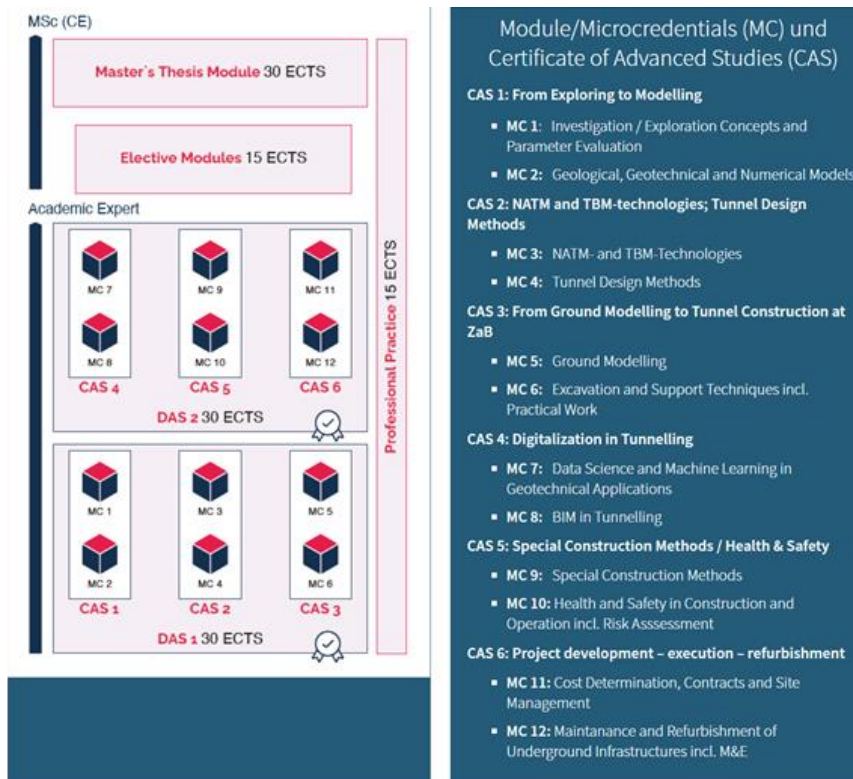
The university programme in NATM Engineering is a collaboration between the Institute of Rock Mechanics and Tunnelling at TU Graz and the Institute for Subsurface Engineering at Montanuniversität Leoben. The 7th edition introduces a new modular structure to enhance flexibility and customization.

This programme is designed for engineers with a background in civil engineering or mining technology, as well as geotechnical engineers and engineering geologists seeking to specialise in tunnelling, particularly using the New Austrian Tunnelling Method (NATM).

In this unique Master's programme, offered globally, participants will deepen their

expertise in tunnelling with a focus on NATM and tunnel boring machines (TBM). The modular structure allows participants to progress in stages or choose individual modules relevant to their interests.

The Master's programme offers flexible learning pathways, including completing the entire programme for a Master's degree, or selecting individual modules for microcredentials. Additional degree options include 'Certificate of Advanced Studies (CAS)', 'Diploma of Advanced Studies (DAS)', and 'Academic Expert (AE)' based on defined module combinations.



All details: www.natm.at

thomas.marcher@tugraz.at

Faces

...today's with our new head of laboratory and one of our student assistants.

Wolfgang Hohl

As a graduated mining engineer, and having spent all my professional career in mining related organizations, I was quite surprised as I was offered the position as head of the rock mechanics laboratory at RMT. Of course, it was a pleasant surprise, since one of my previous posts was in the same role at the University of Leoben, a time I enjoyed very much.

Here in Graz, building on the excellent infrastructure of a well-run lab, my focus for the foreseeable future will be to continually modernize and expand the infrastructure of the laboratory, to be able to continue to provide excellent services for research, teaching and the industry.

My personal research interests are connected to the usage of laboratory data sourcing not only from the actual tests, but from all processes within the rock mechanics lab. There is no question in my mind, that the combination and usage of these data sets will allow for a better understanding of the behaviour of each single rock specimen.



Alexej Weilharter

Dear readers,

My name is Alexej Weilharter, and since the beginning of this semester, I have been working at the Rock Mechanics and Tunnelling (RMT) Institute. My interest in rock mechanics began during the "Fundamentals of Rock Mechanics" course in my undergraduate studies. This made joining the RMT Institute a great opportunity to further explore this field.

What I particularly enjoy about working at the institute is the combination of foundational rock mechanics concepts with programming tasks. This mix provides variety and makes the work both practical and educational.

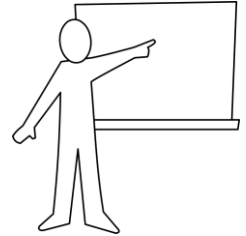
Working at the RMT Institute has allowed me to deepen my knowledge and gain valuable experience in applying theoretical principles to real-world problems. It is a chance to develop skills in both traditional and modern approaches to rock mechanics, which I find both interesting and challenging. I look forward to continuing my work here and gaining further insights into this exciting field.

Diary of Events

> Thursday Lecture Series by Dr. Georg Erharter

Graz, Austria (2025/06/12, 17:15 CET)

Lecture entitled “Moderne Vortriebsklassifizierung im maschinellen Tunnelbau: Beispiel Eisenbahnverbindung Rishikesh-Karnaprayag / Indien”. by Dr. Georg Erharter. The lecture will take place in the lecture room HS L (Lessingstraße 25/1, 8010 Graz).



> EUROCK 2025

Trondheim, Norway (2025/06/16-20)

The Norwegian Group of Rock Mechanics organises the 2025 international Symposium of ISRM - EUROCK 2025. RMT will be represented with Thomas Marcher chairing a session and giving a keynote lecture entitled: “The challenges of hard soil and soft rock: an inside into this material’s brittle to ductile behaviour.” [LINK](#)



> EURO:TUN 2025

Vienna, Austria (2025/09/22-24)

The ECCOMAS Thematic Conference on Computational Methods and Information Models in Tunnelling (EURO:TUN 2025) will take place on September 22-24, 2025 in Vienna, Austria on the premises of the TU Wien. RMT will organise and chair the mini symposium “Numerical modelling in NATM tunnelling”. [LINK](#)



> ATC²-Symposium 2025

Leoben, Austria (2025/11/13)

Symposium by the Austrian platform ATC² (Austrian Tunnel Competence Center), a collaboration of Graz University of Technology and Montanuniversität Leoben. The aim of the symposium is to transfer innovative ideas and know-how in tunnelling. In English. In 2025, ATC² will be hosted by Montanuniversität Leoben.



> 21st ICSMGE 2026

Vienna, Austria (2026/06/14-19)

The **Austrian Geotechnical Society** and the **Austrian Society for Geomechanics** are proud to jointly organise the 21st International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE) to be held in Vienna in June 2026. [LINK](#)



> 6th International Conference on Information Technology in Geo Engineering (ICITG)

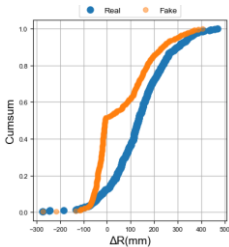
Graz, Austria (2026/10/13-16)

The 6th ICITG will be an arena to discuss all topics related to the ongoing digital transformation in Geo-Engineering. Case studies of IT in Geo-Engineering, integration of digital systems, benchmark datasets, information modelling, monitoring technology and artificial intelligence are some of the key topics. It is organized under the auspices of the Joint Technical Committee 2 (JTC2) on “Representation of Geo-Engineering Data” of the Federation of International Geo-Engineering Societies (FedIGS) by the Norwegian Geotechnical Institute (NGI) and Graz University of Technology. Contact: georg.erharter@ngi.no



Have a look at our Master's Theses I

The institute has different research areas and offers numerous topics for a master thesis.



- **Improving the quality of synthetic measurement while drilling (MWD) data generated from SMOTE technique. (supervisor: [A. Soliman](#))**

The project aims to use feature engineering and data pre-processing techniques to improve the quality of synthetic (fake) MWD data that generated from SMOTE algorithm and it's extensions. E.g., borderline SMOTE. So that, the synthetic data will be more following the real data e.g., in terms of the cumulative distribution.

- **Aspects of steel – rock contacts in TBM tunneling (supervisor: [G. Erharter](#) (Norwegian Geotechnical Institute) and [T. Marcher](#))**

New contractual developments set a focus on the effect of shield friction in hardrock TBM tunneling. Low speed and low stress contacts between steel and rock have not been explored a lot so far and the goal of this study is to focus on geometrical and mineralogical aspects of contact points between tunnel boring machine (TBM) shields and the tunnel wall. Research questions that need to be answered are for example: What are the contact points between a TBM shield and the tunnel wall in slanting and curved driving conditions? Which mode of TBM driving is most unfavorable in terms of expected frictional resistance? Are there correlations to standard abrasivity tests such as the Cerchar abrasivity? Methodologically the thesis should contain theoretical work, analog models, and geotechnical laboratory work (abrasivity tests). The master thesis is part of a currently ongoing bigger research endeavor on this matter.



- **Data Science in Geotechnics (supervisor: [A. Sapronova](#))**

Advances in engineering equipment that is now capable to delivers massive in-situ data at runtime, open the possibility of employing data analysis and data-driven modeling to ensure proactive risk management and optimize the work. Although a large number of features characterize the geotechnical data, its extreme volumes and sparsity place special constraints on the applications of the data science methods in geoen지니어ing and the special focus shall be placed on the data quality assessment, pre-processing routines, and integration of the data from various sources.



Have a look at our Master's Theses II



- **Characterization and Modeling of Hard Soil/Soft Rock considering Anisotropy and Swelling Capacity (supervisor: [I. Metzler](#))**

The ChaMod-HSSR project (cf. Rock Report 03/23) aims at an extensive characterization of transitional material excavated with the construction of the Angath adit in Tyrol, Austria. The local Unterangerberg formation comprises hard soil/soft rock (HSSR) with strong anisotropic tendencies as well as a certain swelling capacity due to the clay minerals present within the rock mass. To achieve a comprehensive rock mass characterization, the project objectives are the creation of a reliable and precise database of geological and geotechnical parameters to be achieved via in-situ and laboratory tests, and are to be implemented in numerical models in the third step. The latter aim at predicting relevant, possibly extraordinary material behavior on both, small- and large-scale models. Master's theses may be assigned for selected parts of the project depending on the student's interests as well as the current project and construction progress.

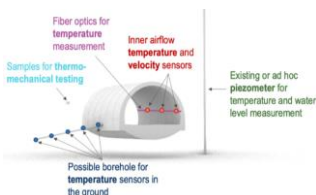
- **Definition of discontinuities in case of foliated rock (foliation) (supervisor: [T. Marcher](#))**



Determination of the mechanical properties of the discontinuities using selected examples of Phyllites in the Central Alps (Switzerland and Austria). Backcalculation on the influence of the schistosity on the tunnel stability. Determining the influence of tunnelling on the activation of potential discontinuities.

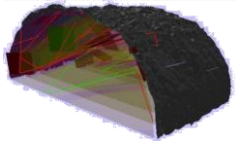
- **REuse for ENergy Exploitation and Storage of Existing Urban Tunnels in Europe (supervisor: [G. Kaml](#))**

The project REGENERATE focuses on the thermal use of existing tunnel structures. The goal is to harness thermal energy for heating and cooling in urban areas. Existing tunnels will be converted, for example, as heat exchangers and energy storage systems. The project is being carried out in cooperation with the Polytechnic University of Turin (Italy), the Technical University of Cluj-Napoca (Romania), and the Technical University of Darmstadt (Germany), among others. These partnerships enable the consideration of different climate zones, urban areas, and energy demands. The main objective of the project is to contribute to the decarbonization of urban areas. To this end, various types of tunnels are being examined to identify suitable structures for energy adaptation. Their potential is being evaluated through pilot monitoring and numerical modeling. For interested students, master's theses on selected topics will be offered, depending on the progress of the project.



Have a look at our Master's Theses III

- **Digital Face (supervisor: [A. Sapronova](#))**



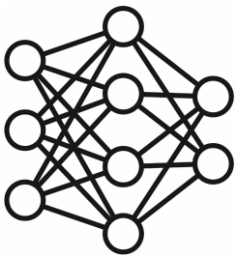
Various data near and at the tunnel face is available during the underground construction: from hand-made technical sketches made by geologists to the 3D point-cloud datasets from seismic surveys. Integration of such information into a harmonized database that will help to forecast the geological conditions and ensure safe tunnelling. Ongoing research aims to find methods for the information extraction and integration to move further from the survey data to the dynamically updated visual and digital representation of a tunnel face.

- **Experiences gained with regard to explorations of long, deep-seated tunnels (supervisor: [T. Marcher](#))**



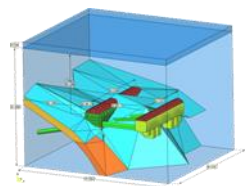
How many exploratory boreholes are necessary in the course of long, deep seated (base-)tunnels? Which insitu and laboratory tests are carried out as standard? How are the explorations distributed between the different project phases? The work focuses on the collection of data based on the experience gained in the construction of deep-seated tunnels in the Alpine region. The data will be systematically analyzed and the results of the different tunnel constructions will be compared.

- **Machine Learning (supervisor: [P. Unterlass](#))**



An exciting area of research is being led by the Machine Learning in Geotechnics (MLGT) Group. The research of this group focuses on machine learning, but the research topics are quite diverse, as one thesis deals with the application of Artificial Neural Networks (ANN) for anomaly detection in multivariate tunnel boring machine operational data and another with automatized information extraction from archived civil-engineering reports.

- **A case study: Cavern Stability Analysis (supervisor: [T. Marcher](#))**



In the course of excavating a cavern, difficult tunnelling conditions were encountered in an executed project. The aim of the thesis is to numerically backcalculate the observed behaviour. The involved company offers a position as a trainee and practice-oriented supervision.

Cooperation

iKB Eins für alle.

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