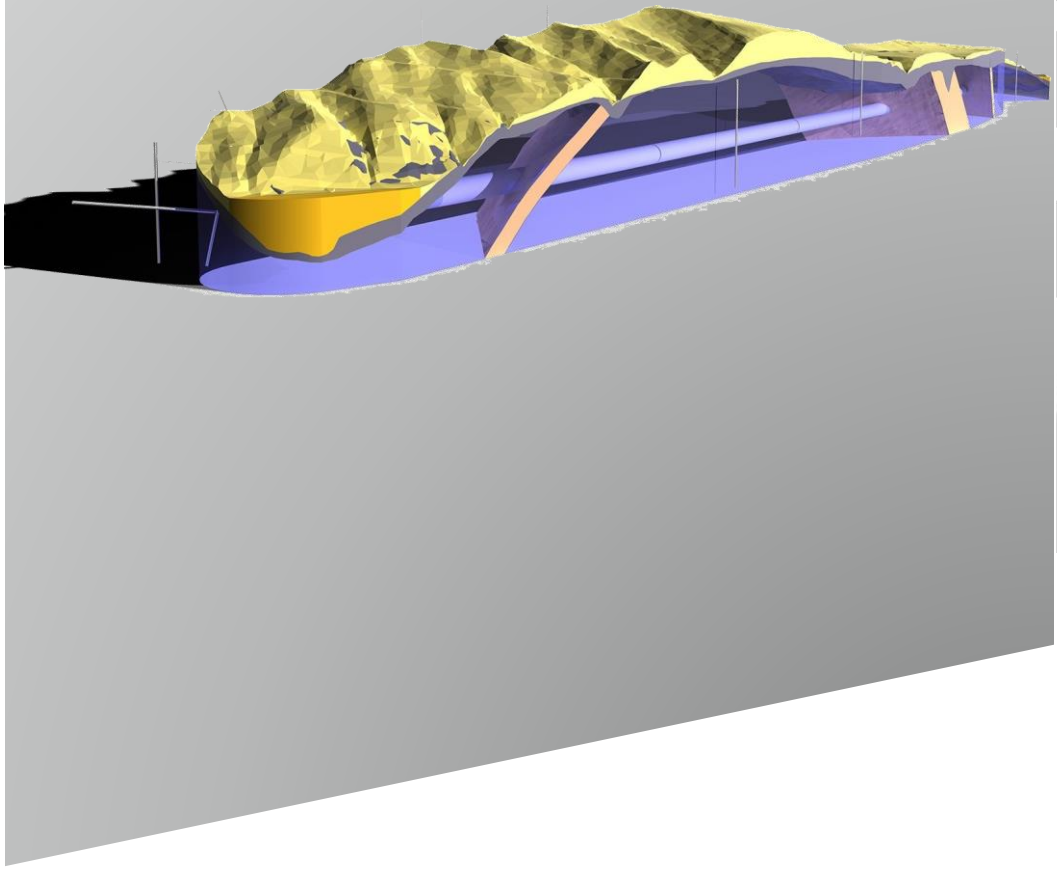
ROCK REPORT

Mechanics & Tunnelling

Quarterly Newsletter of the Institute of Rock Mechanics and Tunnelling

02 Volume 5
July 2024

RMT



NAWI Graz GEOZENTRUM

TU Graz Graz University of Technology

MLGT Machine Learning in Geotechnics

Content

Marcher's Column

As head of the institute, one of the most rewarding experiences is to observe the significant development of the doctoral students during their four to five years at the institute. At the beginning they are often uncertain and waiting for guidance, but through determined scientific work their final achievements are remarkable. In addition to supervising their research, my role is to make my network available to them and to involve them in various tasks such as project work, administration and teaching support.

This was also the case with Tom Geisler: "geothermal energy in tunnels" is an important research area for our institute, and with Tom's efforts we have made significant progress, starting with the Brenner Base Tunnel and extending to numerous other applications. I would like to take this opportunity to thank Tom for the commitment he has shown for four years as a PhD student and university assistant. Your dedication and enthusiasm have extended not only to research but also to teaching and other organizational tasks, including your outstanding work as "programme manager" for the international NATM course. We wish you all the best for your future, Tom!

In this issue of the Rock Report, we report i.e. on a publication that received a special award. We report as well on various cooperation seminars and teaching highlights. This year, the RMT successfully organized and carried out the one-week excursion for the Master's degree course "GHE, Geotechnical and Hydraulic Engineering". During the excursion through Carinthia, South Tyrol, North Tyrol and Salzburg, we were able to convey a broad spectrum of geotechnics, rock mechanics & tunnelling and hydraulic engineering. A big thank you to our hosts.

Dear friends of the Institute, enjoy reading the current issue.

Glück Auf! Thomas Marcher

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Title Picture:
Rendering of the BIM ground model of the "Tunnel Angath". (Erharter et.al., 2023 - https://doi.org/10.1016/j.tust.2023.105039)

Picture: Georg Erharter

July, 2024 – published
Paul Unterlaß – editor in chief
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Highlights I

Rigorosum Thomas Geisler

On April 29th, 2024, our appreciated colleague Dr. Thomas Geisler successfully defended his dissertation on the topic of “Assessment of Geothermal Power in Tunnels Using Open Hydrothermal Systems and Engineering Optimization Options” with distinction. This significant achievement reflects years of dedicated work and research aimed at advancing the accessibility and acceptance of sustainable energy solutions for the greater good of society.

Throughout his time at RMT, Tom significantly contributed to the growth of our institute. With his extensive network of contacts, he built up during the past years at RMT and his ability for designing relevant research questions that were precisely aligned with current demands, Tom aided us in acquiring a variety of national and international research projects. In managing these, he developed excellent leadership and communication skills, which had always been an inspiration for his colleagues. His invaluable attribute of remaining composed in challenging environments, and quickly adapting to unexpected events, made him a pillar for our team in situations where things went of the plan. Tom, also a passionate lecturer, was actively involved in teaching of various courses at Bachelor’s and Master’s level. Our students highly appreciated the competence with which he conveyed various topics on rock mechanics and tunnelling. Further, Tom was a main responsible for the organization of our previous NATM Master’s program, that, due to him, had been a great success despite challenging boundary conditions with participants from all over the world and living in different time zones.

In addition to his professional contributions, Tom was a great friend and motivator, always ready to support his teammates, even in their personal lives. His recently discovered passion for road cycling, which on frequent occasions he shared with his colleagues on evening rides, has already taken him on many round trips.

The one-way journey back to your home county of Tirol you are about to start now, will definitely mean a farewell to RMT. Nonetheless, thank you Tom for the inspiration you have provided to us colleagues. We are very grateful for the contributions you have made to our institute and are sure, that the personal connection with us will remain intact. We wish you immense success in your upcoming endeavours and are sure that you will be an enrichment for your future environment.

Figure: Dr. Geisler with his fellow PhD colleagues.

Figure: F.l.t.r. Prof. Zangerl, Prof. Marcher and Dr. Geisler.

Highlights II

Tunnelling and Underground Space Technology – Best Paper Award 2023

We are pleased to announce that our esteemed colleague Dr. Georg Erharter has received a "Best Paper Award 2023" from the journal "Tunnelling and Underground Space Technologies". The awarded paper, titled "Building information modelling based ground modelling for tunnel projects - Tunnel Angath/Austria," shows an advanced application of ground modelling for geotechnics and tunnelling.

The paper addresses the challenges of implementing Building Information Modelling (BIM) in ground modelling due to the inherent heterogeneity and uncertainty of underground conditions. It introduces a new concept and framework that splits the BIM ground model into several sub-models: the "factual data model," the "geotechnical model," and the "geotechnical synthesis model." These concepts align with international developments and aim to standardize and enhance BIM ground modelling practices. The theoretical framework is illustrated through a case study of the Tunnel Angath in Austria.

Find the open access paper here: https://doi.org/10.1016/j.tust.2023.105039

... and note that there is supplementary data available for the paper containing an exemplary BIM ground model (.IFC file)


ELSEVIER

Tunnelling and Underground Space Technology incorporating Trenchless Technology Research

Best Paper Award 2023

Awarded to:

Erharter G.H, Weil J, Bacher L, Heil F, Kompolschek P.

For the paper:

Building information modelling based ground modelling for tunnel projects – Tunnel Angath/Austria

Volume 135, May 2023

Figure: Certificate Best Paper Award 2023, Tunnelling and Underground Space Technology.

Meeting "Arbeitskreis 3.3 – Versuchstechnik Fels"

On 3rd April RMT hosted the biannual meeting of "Arbeitskreis 3.3 - Versuchstechnik Fels" of the Deutsche Gesellschaft für Geotechnik e.V.. Our institute was represented by Manfred Blümel and Thomas Fruehwirt. Before the start of the technical discussions Prof. Thomas Marcher welcomed the German experts on rock mechanical testing in our institute's seminar room.

Throughout the day, there were numerous insightful presentations and engaging technical discussions, fostering a productive exchange of ideas and advancements in the field. The successful day was concluded by an intensive exchange of experience in the informal setting of a traditional Austrian restaurant, where attendees had the opportunity to further discuss their work and forge stronger professional relationships.

We look forward to hosting similar events in the future and were happy to provide the technical infrastructure for the committee's meeting and its work on future recommendations for laboratory testing.

Figure: Representatives of "Arbeitskreis 3.3 – Versuchstechnik Fels" @ Graz University of Technology.

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Highlights III

PhD Seminar BOKU/UIBK/ TUG

On April 9, 2024, the inter-institutional dissertation seminar took place, continuing the biannual tradition of collaboration among the BOKU - Institute of Constructive Engineering – IKI (Prof. Bergmeister), the University of Innsbruck - Construction management, construction operations and tunnel construction – IBT (Prof. Flora), and the Graz University of Technology Graz – Institute of Rock Mechanics and Tunnelling (Prof. Marcher). This year's session featured a diverse range of topics, with the RMT leading discussions on innovative applications in tunnel geothermal energy and machine learning. Additional presentations by participants from the other institutes addressed the latest advancements in basalt fibre reinforcement and the utilization of Building Information Modelling (BIM) applications in tunnel construction. The event concluded at a traditional wine tavern in Vienna, fostering an environment of camaraderie and scholarly exchange. Attendees left with renewed enthusiasm and anticipation for the next seminar, which is scheduled to take place in Innsbruck.

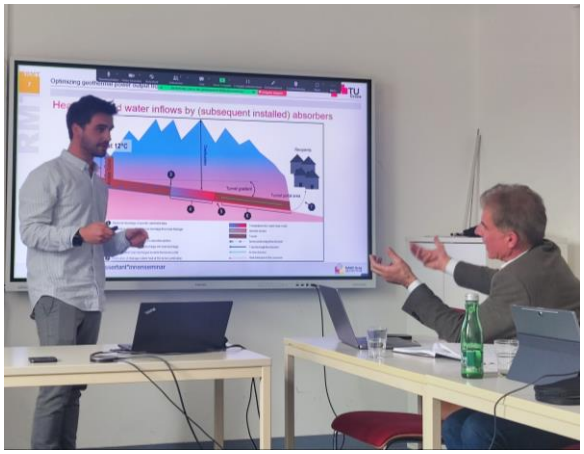

Figure: Thomas presenting the topic of geothermal energy while discussing with Prof. Bergmeister.

3rd Joint Young Members Meeting Innsbruck

On May 23rd, the 3rd Joint Young Members Austria Symposium took place in Innsbruck, bringing together young engineers from Austria, Germany, Italy, and the United Kingdom. In addition to Austrian participants, members of the British Geotechnical Association Early Career Group and the Young DGGT from Germany were also present. International exchange is crucial for the professional development of young engineers. Such events promote knowledge transfer and networking, opening up new perspectives and solutions in geotechnics. The symposium offered a variety of interesting lectures on topics such as soil and rock mechanics, numerical methods, tunnelling and foundation engineering. The presentations showcased current research and concrete projects where young engineers played a key role. Sustainability topics were also highlighted. Overall, the symposium was a great success, enabling participants to make valuable contacts and gain new insights. Events like these are essential for strengthening innovation and international collaboration in geotechnics.

Figure: RMT and friends at the 3rd Joint Young Members Symposium. (Picture: Haris Felic).

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Site Visit

Field Excursion Geotechnics and Hydraulic Engineering

In the week of June 3rd – 7th, 2024, our master's students in Geotechnical and Hydraulic Engineering went on the biennial Geotechnics and Hydraulic Engineering excursion. This year, organized by RMT and supported by IBG and IWB colleagues, we took 30 students to various sites out west. Starting in Klagenfurt, Franz Ruprecht introduced us to the geotechnical challenges of constructing in the Klagenfurt basin. Continuing to Alta Badia, Volkmar Mair guided us through the monitoring of mass movements and landslides. In Meran, we visited the cavern for a future parking garage, shown around by Paolo Zanandrea and Manuel Bode, and finished our time in South Tyrol at the Laas marble quarry. At the Angath adit tunnel, Gerhard Praschberger, Philipp Gschwentner, Thomas Mayer, Daniel Wegscheider and Magdalena Hofstätter showcased a tunnelling project as part of a larger infrastructure expansion next to an archeological site. In the Lower Inn Valley, Peter Hanisch and Paul Koller presented the flood protection measures to us. The scope of the excursion ended with visits to the hydropower plants Tauernmoos and Stegenwald, where Walter Kühner and Herwig Berkenhoff led the tours, respectively.

The excursion provided the students with invaluable insights into applied engineering challenges and contributed to their academic education with practical applications.

Figure: Upper left: parking garage cavern Meran; upper right: HPP Stegenwald; lower left: HPP Tauernmoos; lower right: mass movement Alta Badia.

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Publications & Presentations I

Assessment of factors controlling the slaking behaviour of rocks from the Rhenodanubian Flysch Zone, Austria, using mineralogical-geomechanical laboratory tests

Kaspar, M., Latal, C., Frühwirt, T., & Blümel, M. (2024). In New challenges in rock mechanics and rock engineering: Proceedings of the ISRM European Rock Mechanics Symposium (EUROCK).

The Rhenodanubian Flysch Zone of Austria comprises claystones, siltstones, sandstones and marly limestones. Such rock types are often referred to as weak or soft rocks due to their behaviour when exposed to water or subject to mechanical load. In this study, the flysch rocks were investigated with respect to their slaking durability, uniaxial compressive strength, abrasivity and mineralogical composition. The correlations of engineering rock properties of these soft rocks are weaker compared to those of grain bound crystalline rocks making their characterization and classification challenging.

Assessment of Direct Tensile Strength Tests in Rock Through a Multi-laboratory Benchmark Experiment

Pérez-Rey, I., Muñiz-Menéndez, M., Frühwirt, T., Konietzky, H., Jacobsson, L., Perras, M. A., Atefi-Monfared, K., Mas Ivars, D., Sánchez Juncal, A., & Alejano, L. R. (2024). *Rock Mechanics and Rock Engineering*, *57*(5), 3617-3634. https://doi.org/10.1007/s00603-023-03751-z

This study aims to experimentally assess repeatability and reproducibility of direct tensile strength (DTS) tests with deformability measurements on two types of rocks. The tests were conducted in four rock mechanics laboratories located in different countries. A total of 51 tests were performed on cylindrical specimens of the two rocks, using different test equipment and measuring devices. The findings indicate that the DTS test with deformability measurements on cylindrical rock specimens is operationally feasible. However, certain shortcomings have been identified during the course of the experiments with the existing methodologies, such as the one suggested by the ISRM for DTS tests.

Investigation on shear strength parameters of soil and soft rock material in the low stress range

Siahkouhi, M., Pletzer, C., Marcher, T., & Schneider-Muntau, B. (2024. *International Journal of Geotechnical Engineering*. Advance online publication. https://doi.org/10.1080/19386362.2024.2314893

The use of the Mohr-Coulomb shear parameters, friction angle (ϕ') and cohesion (c'), to define the expected shear strength of soil is a widespread approach in the verification of the stability of a wide variety of structures. Due to technical limitations, these parameters are generally determined in the lab at excessively higher stress levels compared to field stress levels. The aim of this work is to investigate material behaviour in the lower stress range in the laboratory and to illustrate the development of the failure surface in these areas. For this purpose, special tests were carried out in which, by increasing the pore water pressure, a reduction in the effective stresses in the specimen could be achieved.

Publications & Presentations II

EAGE Ditigtal 2024 – Paris | conference talk

In April 2024, Ass. Prof. Alla Sapronova participated at the 4th EAGE Digitalisation Conference and Exhibition with her presentation entitled “Correlational Analysis of MWD Data for Rock Mass Characterization and Risk Assessment” , co-authored by A. Soliman, F. Klein, and T. Marcher. The presentation showed how MWD data can be used for decision support in tunnel construction optimization.

The work demonstrated an application of data-driven (DD) modelling, including Machine Learning (ML) to predict over/under excavation in conventional tunnelling. The study stressed the necessity of proper measurement while drilling (MWD) data pre-processing, including data quality assessment and feature engineering: the training dataset for ML was constructed of averaged MWD data and calculated correlational coefficients between MWD variables.

By applying a combination of clustering and oversampling techniques, the authors were able to construct an accurate ML model even when the MWD dataset was of limited volume and showed an imbalance between over excavation and under excavation cases. For oversampling, the Synthetic Minority Oversampling Technique (SMOTE) method was used.

By adding correlation coefficients to ML inputs authors were able effectively distil the analytically valuable insights from MWD data and improve the identification of similarities between data points by SMOTE.

The conference provided a valuable platform for discussing advanced techniques in digitalization and their applications in geosciences, highlighting the continuous evolution and integration of data-driven methods in the field.

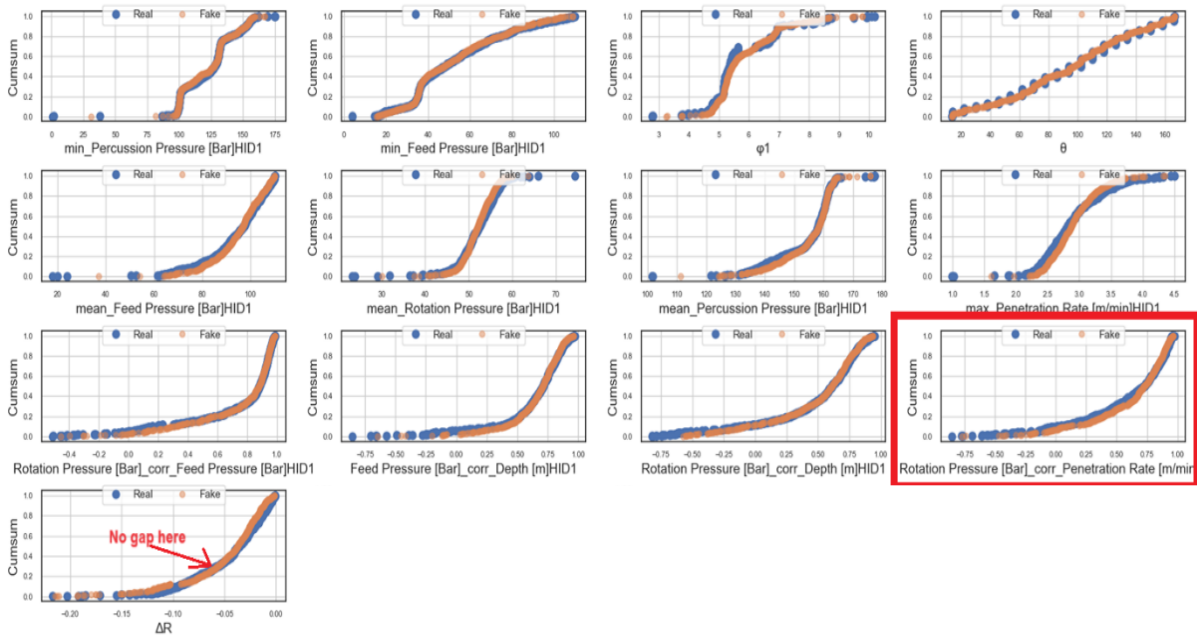

Figure: Difference between observed data (blue) and data oversampled with SMOTE (orange). After adding the correlation coefficient between rotation pressure and penetration rate (red rectangle) as an extra input to SMOTE, the oversampled data matches the real for target variable ΔR accurately.

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Upcoming special session / issues I

1st international Rock Mass Classification Conference (RMCC)

Oslo, Norway (2024/10/30&31)

The RMCC will provide an arena for international rock mechanics experts from academia and practice. The conference stands under the paradigm "Rock Mass Classification meets the Challenges of the 21st Century" and will be organized by the Norwegian Geotechnical Institute. RMT's Georg Erharter will be chairman at the conference and Prof. T. Marcher has joined the scientific committee. LINK

Save the date!

Contact: georg.erharter@ngi.no, thomas.marcher@tugraz.at

Civil Engineering Design - CEND

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.

Upcoming special session / issues II

2. Steinschlagsymposium 2024

Schladming, Austria (2024/11/28)

In Fortsetzung zu dem sehr erfolgreichen 1. Steinschlagsymposium 2021, soll das 2. Steinschlagsymposium 2024 eine Verbindung von Wissenschaft und Praxis für kommunale Verantwortliche, Verwaltung, Planer und Sachverständigen ermöglichen. Der Bogen wird von rechtlichen Themen über das Risikomanagement, Messtechnik, Geologie und Geotechnik bis hin zu Erfahrungsberichten gespannt werden. Im Rahmen einer Podiumsdiskussion werden Erwartungen aus der Verwaltung, Wegehalter, Tourismusverbänden und Versicherungen diskutiert. LINK zum Anmeldeformular.

Save the date!

Contact: rainer.kienreich@tugraz.at, thomas.marcher@tugraz.at

Steinschlag – Risikoeinschätzung und Maßnahmen aus der Sicht kommunaler Entscheidungsträger

TU Graz

Programm

Begrüßung

09:00 **Begrüßung durch den Bürgermeister der Stadtgemeinde Schladming**
Bürgermeister Dipl.-Ing. Hermann Trinker
(Stadtgemeinde Schladming)

09:10 **Eröffnung**
Univ.-Prof. Dipl.-Ing. Dr.-Ing. Thomas Marcher
(Vorstand des Instituts für Felsmechanik und Tunnelbau, Technische Universität Graz)

09:20 **Umgang mit Steinschlagrisiko an natürlichen Felsböschungen**
Mag. Rainer Kienreich
(Institut für Felsmechanik und Tunnelbau, Technische Universität Graz)

Block I – Moderation Univ.-Prof. Dr.-Ing. T. Marcher

09:40 **Probabilistische Methoden zur Bewertung von Risiken**
Kevin Lundberg
Univ.-Prof. Dipl.-Ing. Dr. techn. Philip Sander
(RiskConsult GmbH, Innsbruck; Institut für Projektmanagement und Bauwirtschaft, Universität der Bundeswehr, München)

10:10 **AlpSenseRely – Multi-Methoden-Monitoring zur Vorhersage klima-induzierter Naturgefahren**
Leinauer Johannes, Msc.
Univ.-Prof. Dr. Michael Krautblatter
(Lehrstuhl für Hangbewegungen, Technische Universität München)

10:40 **Erfassung von Hangbewegungen und Steinschlägen mit geodätischen und faseroptischen Sensoren**
Univ.-Prof. Dr. Werner Lienhart
(Institut für Ingenieurgeodäsie und Messsysteme, Technische Universität Graz)

Block II – Moderation Mag. J. Leitner

11:10 **Alpine Infrastrukturen, Herausforderungen und Zukunftsperspektiven**
Dipl.-Ing. Clemens Matt, Msc.
(Generalsekretär des Österreichischen Alpenvereines)

11:40 **Auswirkungen des Klimawandels auf gravitative Prozesse: Welche Veränderungen der Klimaparameter erkennen wir?**
Mag. Dr. Michael Avian (Department für Klima-Folgen-Forschung, GeoSphere Austria, Wien)

12:10 **Die Schutzfunktion des Waldes vor geogenen Naturgefahren in der Schutzwald-Hinweiskarte im Waldatlas**
Dipl.-Ing. Frank Perzl
(Bundesforschungszentrum für Wald, Institut für Naturgefahren, Innsbruck)

12:40 – 13:40 Mittagspause

Block III – Moderation Mag. G. Valentin

13:40 **Steinschlaggefahr auf Infrastruktur und Siedlungsräume: Erfahrung aus der öffentlichen Verwaltung**
Dr. Volkmar Mair (Amt für Geologie und Baustoffprüfung, Bozen, I)

14:10 **Steinschlaggefahrenmanagement in Kärnten – Erfahrungen mit der Gefahrenhinweiskarte und bei Steinschlagereignissen**
Mag. Franz Goldschmidt
(Amt der Kärntner Landesregierung, Abteilung 8 - Geologie und Gewässermonitoring, Klagenfurt)

14:40 **Und dann kam Zacharias! Katastrophenereignis in der Steiermark Resümee und Ausblick**
Mag. Karin Schmölzer, Mag. Martin Schröttner
(Amt der Steiermärkischen Landesregierung, Abteilung 15, Graz)

15:00 **„Trockene" Felsstürze versus Bergsturz: Auswirkungen der Rheologie der Sturzmasse auf die Abschätzung von Wirkungsbereichen mit Simulations-Modellen**
Mag. Michael Mölk
(Fachbereich Geologie, Wildbach- und Lawinenverbauung, Innsbruck)

Block IV – Moderation Univ.-Prof. Dr. T. Marcher

15:30 **Steinschlag und Haftung**
Univ.-Prof. Dr. Walter Doralt
Ass.-Prof. Dr. Peter Schwarzenegger
(Institut für Zivilrecht, Ausländisches und Internationales Privatrecht, Universität Graz)

16:00 **Podiumsdiskussion**
Moderation: Univ.-Prof. Dr. Walter Doralt & Univ.-Prof. Dr. Thomas Marcher

Bezirkshauptmann Mag. Nico Groger
(Land Steiermark, Bezirkshauptmannschaft Liezen)

Dr. Volkmar Mair (Amt für Baustoffprüfung und Geologie, Bozen, I.)

Stadtamtsdirektor Mag. Johannes Leitner
(Stadtgemeinde Schladming)

Geschäftsführer Mag. (FH) Mathias Schattleitner
(Tourismusverband Schladming-Dachstein)

Mag. Helmut Sitter
(UNIQA Versicherung AG)

HR Mag. Gerald Valentin
(Land Salzburg, Geologischer Dienst)

17:00 Abschluss und Verabschiedung

Es kann, in Abhängigkeit des Umfangs der Diskussionsrunden, zu zeitlichen Verschiebungen kommen.

Änderungen vorbehalten

28. November 2024

Teaching I

Recent master graduates at RMT

Mario Wölflingseder

Supervision: Marcher T., Unterlaß P.

On June 17th, 2024, DI Mario Wölflingseder successfully defended his master's thesis titled "Anomaly detection with a Variational Autoencoder in tunnel boring machine data" with distinction. This study introduces an unsupervised machine learning model utilising a Variational Autoencoder in combination with bidirectional Long Short-Term Memory cells for anomaly detection. Prominent sections were considered for testing the model, while the rest of the dataset was used to train the ML algorithm. The proposed algorithm learns to reconstruct the training data from a dimensionality reduced representation of the data as accurately as possible. When the model is exposed to data containing anomalies, it displays higher reconstruction errors. By setting a threshold for the reconstruction error a differentiation between non-anomalous and anomalous data is achieved. The trained model is capable of reliably recognizing fault zones in the test datasets.

Sascha Westpfahl

Supervision: Marcher T., Winkler M.

Three days earlier on June 14th, 2024, DI Sascha Westpfahl defended his master's thesis on the topic of "Application of a hyperelastic cross-anisotropic model to simulate the behaviour of soft anisotropic rocks" with distinction. In his thesis, he put a main focus on the behaviour of soft rocks, which is known to be highly stress-dependent and non-linear. A hyperelastic cross-anisotropic model, originally proposed for overconsolidated soils, was applied to back-simulate various experimental stress-strain curves to investigate the suitability of the model for the intended materials. The influence of various model parameters had been studies and a calibration procedure for the constitutive model parameters based on standard laboratory tests on rocks had been developed.

Congratulations Sascha, for your great contribution!

Figure: F.l.t.r. Prof. Liu, Mario Wölflingseder, Dr. Georg Erharter (online) and Prof. Marcher.

Figure: Mr. Sascha Westpfahl

Teaching II

Recent master graduates at RMT

Georg Kaml & Michael Kienzl

Supervision: Marcher T., Geisler T.

On April 8th this year, we celebrated a significant academic achievement of two Students. Mr. Georg Kaml and Mr. Michael Kienzl, who had previously completed their Bachelor's theses with us, successfully defended their Master's theses, marking a continuation of their scholarly journey. Their research focused on a substantial mass movement in the rear Salzburg Reitalmtal. Through detailed engineering geological mapping and the integration of various data sets, they were able to provide a comprehensive analysis that characterized both the historical context and the recent dynamics of slope movements in the area.

The defense took place in front of an esteemed examination committee, consisting of Prof. Marcher, Prof. Marte, and Prof. Winkler, who rigorously evaluated their work and were impressed by the depth of their research and their ability to synthesize complex data into clear findings.

We congratulate Michael and Georg on their well-deserved success and commend them for their work and dedication to their field of study. We also wish them the very best for their future careers and endeavours. Additionally, we are thrilled to announce that one of these talented graduates has accepted a position at our institute, joining our team as a new member of staff. This appointment not only highlights the strength of our academic programs but also ensures that our institute will continue to benefit from the skills and insights of our alumni.

RMT wishes the graduates all the best for their future endeavours!

Figure: The examination board and the graduates. F.l.t.r.: Prof. Marcher, Michael Kienzl, Georg Kaml, Prof. Winkler & Prof. Marte.

Teaching III

Lecture Alert: NTNU Joint Course

In May 2024 Graz University of Technology approved an application for a joint online course that will be jointly hosted by RMT and the Department of Geoscience and Petroleum, Norwegian University of Science and Technology (NTNU), Norway.

The course “Application of AI in Geotechnical Engineering: Data Science & Geotechnical Engineering” will start in Fall 2024 and will be taught by Prof. Thomas Marcher and Ass. Prof. Alla Sapronova, both RMT and from NTNU Prof. Kristin Hilde Holmøy and Prof. Hakan Basarir. The course aims to teach master students majoring in engineering the power of data, focusing on data pre-processing and data-driven modelling. Practical examples provided by NTNU and RMT will demonstrate the applications and limitations of data-driven methods.

Course Description

With the boom in digital transformation and automation, data's power in civil engineering is rising. Data-driven modelling is now used for proactive management, process optimization, decision support, and risk analysis in engineering projects. Despite large amounts of available data, quality constraints often limit its direct use in analysis. Data-driven modelling processes must include data quality check, model evaluation and shall comply with engineering principles to ensure robustness and reliability of model’s outputs.

This course will guides students through the data-driven project life-cycle: from data acquisition and pre-processing to analysis and result presentation. The course also covers an introduction to generative AI and co-pilot-enabling solutions.

A key component of this course is a hands-on data-driven project, based on a real dataset. Students will apply learned data science principles to tackle real-life geoengineering challenges.

The course is comprised of seven lectures and five hands-on exercises (two workshops, a hackathon, and two guided group projects).

There are still places available, you’d better be quick!

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Faces

...today‘s with our new project assistant and two of our student assistants working in the lab

Georg Kaml

Good day, my name is Georg Kaml, and I started as a project assistant at the institute in May 2024.

My passion for mountaineering and nature inspired me to pursue a degree in geology. During my bachelor's studies, I developed a keen interest in engineering geology and hydrogeology. Subsequently, I wrote both my bachelor's and master's theses at the Institute of Rock Mechanics and Tunnellng, focusing on mass movements. Upon completing my master's thesis, I was delighted to be offered the opportunity to begin a PhD (project assisted).

I am looking forward to a future in which I can contribute my skills and interests in geothermal energy, particularly in tunnel construction and underground heat storage.

Bruno Correa Kleuters

Hello, everyone! I'm Bruno, and last October, I commenced my master's program in Geotechnical and Hydraulic Engineering at the Graz University of Technology.

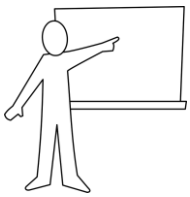
My longstanding fascination with nature and mountains gradually steered my interests toward making a more meaningful impact on the natural environment. Throughout my various experiences on construction sites, my focus progressively shifted towards geotechnical engineering. As a passionate hiker, my interest in the field of geotechnics has led me to pursue this master's degree, allowing me to delve deeply into the complexities of rock mechanics.

Thus, I am more than happy for the opportunity to work at the laboratory of Rock Mechanics and Tunnelling (RMT).

I am eager to learn from my colleagues and to gain profound insights into the field of rock mechanics. Let’s rock it!

Diary of Events

> Thursday Lecture Series by Dipl.-Ing. Gerhard Gobiet
Graz, Austria (2024/10/24, 17:15 CET)



Lecture entitled “Semmering-Basistunnel: Herausforderungen eines Großprojekts von Start bis Ende”. by Gerhard Gobiet, Project Manager of the Semmering-Basetunnel project, ÖBB-Infrastruktur AG. The lecture will take place in the lecture room HS L (Lessingstraße 25/1, 8010 Graz).

> VÖBU Seminar “Forschung in der Geotechnik”
Graz, Austria (2024/11/21, 09:00 CET)

Die Komplexität der Herausforderungen bei geotechnischen Fragestellungen hat in den letzten Jahren ständig zugenommen. Da Universitäten eine Schlüsselrolle in Forschung und Entwicklung im Bereich der Geotechnik einnehmen, ist es das Ziel dieses Seminars den Wissensaustausch mit PraktikerInnen und Interessierten zu forcieren. Das Seminar wird im Hörsaal VI an der TU Graz (Rechbauerstraße 12, 8010 Graz) stattfinden.

LINK zum Programm.
LINK zur Anmeldung.

> ATC²-Symposium 2024
Innsbruck, Austria (2024/11/14)

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 2024, ATC² will be hosted at the guest location in the City of Innsbruck. Information on the topics of this event will follow. https://atc2-symposium.eu/

> 2nd Mini-Symposium “Rockfall”
Schladming, Austria (2024/11/28)

The second edition of the Rockfall Symposium in Schladming will again shed light on experiences and approaches to this topic from various disciplines. Save the date and stay tuned for further updates.

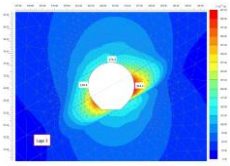
- LINK to the program.
- LINK to the registration.

>“Barbarafeier” 2024 – reloaded
Graz, Austria (2024/11/29)

RMT’s “Barbarafeier” will be reloaded in a sense that our students will be in the focus. Students achievements and a guest lecture by a “non-profit” organization will kick off the event, followed by drinks and snacks in a relaxed atmosphere. All our friends are welcome to join.
More Information will follow in the next issue of the RockReport. Stay tuned and safe the date.

Have a look at our Master‘s Theses I

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



- **A case study: back-calculation of shallow tunnel highly sensitive to surface settlements in urban environment (supervisor: T. Marcher)**

Numerical study. The tunnel has been excavated with side drifts (Ulmenstollen). The focus of the work is on the prediction of the tunnel stability and surface settlements. Numerical analysis shall be performed of which settlements can be expected if a different excavation concept is chosen. The surrounding ground consists of sand. The influence of improving the ground prior to excavation shall be considered as well..

- **Aspects of steel – rock contacts in TBM tunneling (supervisor: G. Erharter)**

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 bigge rresearch 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 geoengineering 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

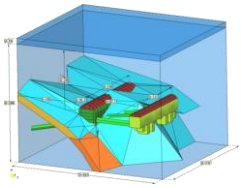
- **Characterization and Modeling of Hard Soil/Soft Rock considering Anisotropy and Swelling Capacity (supervisor: I. Metzler)**

The ChaMod-HSSR project (cf. Rock Report 03/3) 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)**

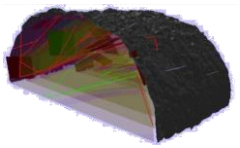
Determination of the mechanical properties of the discontinuities using selected examples of Phyllites in the Central Alps (Switzerland and Austria). Backcalculation on the influence of the schistosity on the tunnel stability. Determining the influence of tunnelling on the activation of potential discontinuities.

- **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.

Have a look at our Master‘s Theses III

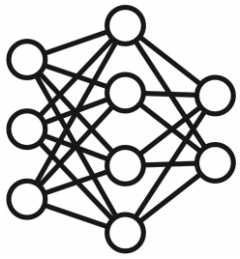


- **Digital Face (supervisor: A. Sapronova)**

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.

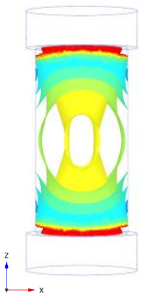
- **Experiences gained with regard to explorations of long, deep-seated tunnels (supervisor: T. Marcher)**

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.



- **Numerical and experimental investigation of rock anisotropy**

(supervisors: M. Winkler)

Rock is a complicated material, for example it is very often anisotropic making its’ deformational and strength characteristics dependent on the loading direction. To learn more about this phenomenon, numerical and experimental studies need to be carried out.

Cooperation

… please contact us in case we forgot you here

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