SFB 837 & EURO TUN 2022

International Conference on

Computational Methods and Information Models in Tunneling (EURO:TUN)

2022, June 22nd - 24th, Bochum, Germany

incorporating

Interaction Modeling in Mechanized Tunneling (SFB 837)

2022, June 21st, Bochum, Germany

eurotun2021.rub.de

CONFERENCE PROGRAM

SFB 837 & EURO:TUN is a special event, merging the traditional EURO:TUN conference originally scheduled for 2021 and the SFB 837 workshop, where results from 12 years of experimental and numerical research of the Collaborative Research Center on Interaction Modeling in Mechanized Tunneling are presented. While the SFB 837 workshop takes a holistic view on mechanized tunneling, combining experimental and computational approaches, the EURO:TUN conference has a strong focus on computational methods and information models in tunneling. Previous successful EURO:TUN conferences have been organized as ECCOMAS Thematic Conferences (2007, 2009, 2013 & 2017). SFB 837 & EURO:TUN aims to provide a forum for scientists, developers and engineers to review and discuss novel research findings and to assess the suitability and robustness of advanced computational methods and information models for the design, construction and maintenance of tunnels.

Computational methods and information models have experienced increasing application in the design and construction of underground infrastructure. Tunneling is characterized by a high degree of uncertainty and complex interactions between the tunneling process and its environment. In addition, new tunneling technologies and changing requirements for the construction of tunnels (e.g., larger diameters, tunneling in difficult ground conditions, safety concerns, life time prognoses) are constituting new challenges for adequate computational methods to be used for prognoses and decisions to be made in the design, construction, service and maintenance of tunnels. Information models and BIM concepts are increasingly used and combined with computational models for a seamless workflow in digital design and construction. These challenges need continuous research and new solutions in the field of information and computational modeling in tunneling.

Beyond advances in computational methods for the simulation of the logistics and construction processes of tunnels and model-based lining designs also applications of information modeling, sensing and monitoring technologies, methods of machine learning and big data analytics in tunneling and underground infrastructure will be topics of SFB 837 & EURO:TUN.

We would like to express our sincere thanks to the members of the Scientific Advisory Committee as well as to all supporting organizations for their continuous support and helpful suggestions. Also, we thank all plenary speakers for accepting our invitation and for their efforts in preparing plenary presentations. Special thanks are due to the members of the local organizing committee of SFB 837 & EURO:TUN, B.T. Cao, S. Freitag and B. Schößer, as well as to M. Breyer, E. Köster, S. Kunter, N. Overkamp, J. Sahlmen and S. Schützner for their great and competent assistance in the preparatory phase of the conference.

Finally, we thank all participants of SFB 837 & EURO:TUN. Needless to say, that their papers and their contributions to the discussions will be the basis of the success, as we are hoping for.

G. Meschke, G. Hofstetter, B. Pichler, M. Thewes, H. Zhu
Conference Chairmen

Conference Chairmen

G. Meschke	Ruhr University Bochum, Germany
G. Hofstetter	University Innsbruck, Austria
B. Pichler	TU Wien, Austria
M. Thewes	Ruhr University Bochum, Germany
H. Zhu	Tongji University, China

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J. Yan	Int. Tunnelling & Underground Space Ass. (ITA)
Y. Yuan	Tongji University, China
Q. Zhang	Monash University, Australia
J. Zhao	Monash University, Australia

Conference Venue and footpath

The conference will be held at the conference center („Veranstaltungszentrum") of the Ruhr University Bochum, Germany. To reach the „Veranstaltungszentrum" from the metro station „Ruhr University" turn right towards the university campus. Then pass the library and the „Audimax" on the right side. You are now directly facing the mensa/cafeteria building. Enter the building and take the elevator to floor number 04.

How to get to Ruhr University Bochum by metro and bus

The Ruhr University can easily be reached by public transport. Metro line U35 connects the University to Bochum's city center and the main station (Bochum Hauptbahnhof). From the metro station at Bochum Hauptbahnhof take line U35, direction „Ruhr-Universität / Bochum Hustadt (TQ)" and leave the train at „Ruhr-Universität" metro station.

Going back to the city center or main station, take line U35, direction „Herne Schloss Strünkede" or „Riemke Markt" and leave the train at „Bochum Hauptbahnhof" for the main station and at „Bochum Rathaus" for the city center.

For the 10-min trip to and from the University, a one-way-ticket „Preisstufe A3" (3€) or a „9 Euro-Ticket"(see further information below), which is valid for one month, is needed. Both are available at vending machines at each metro station. On weekdays the metro line U35 leaves every 5 minutes.

From the Ruhr University bus terminal, several bus lines leave that connect other parts of Bochum and neighbouring cities to the University. Local and long distance trains, connecting Bochum to other cities in the Ruhr Area and also to Düsseldorf, Cologne, Frankfurt and their airports leave at „Bochum Hauptbahnhof". The schedule of all public transport in the Ruhr Area can be found online at: www.vrr.de. For long distance trains, consult the website of Deutsche Bahn www.db.de.

For those of you who will travel from Duesseldorf Airport to Bochum we recommend the following special offer: the „**9 Euro-Ticket**", which is valid for one month. This ticket is valid on all forms of public transport across Germany, including buses, U-Bahns, S-Bahns, trams, and local and regional trains. With the 9-euro ticket you can use these forms of transport nationwide, but long-distance transportation services, such as ICE, IC and EC trains run by Deutsche Bahn, and FlixTrains and FlixBuses, are not covered. You can purchase these tickets online via the mobil.nrw-App (www.mobil.nrw/9-euro-ticket) or at the ticket machines at the train stations.

How to get to Ruhr University Bochum by car

The Ruhr University is located south-east of the city center of Bochum (Universitätsstr. 150, 44780 Bochum). To get there by car, the most convenient route is the A43 motorway (Münster-Wuppertal). Leave the motorway at exit 19 („Bochum-Querenburg / Ruhr Universität") and take the express way towards „Ruhr University / BO-Zentrum".

Please drive from Universitätsstraße into Max-Imdahl-Straße. At the roundabout, take the exit towards „Uni-West" and continue on Max-Imdahl-Straße. Turn right into Weststrasse. At the end of the street you can only turn left into G-Südstraße. Here are the parking lots. Signs show you the footpath to the conference center („Veranstaltungszentrum") of the Ruhr University Bochum.

Coronavirus Protection
Wearing an FFP2 mask is still an effective action of protecting yourself and others from coronavirus infection. Therefore, we urgently recommend to wear a FFP2 mask during the event and in public areas (like rooms, corridors, staircases, elevators, etc.).
Safety distance to other persons and hygiene measures are also still advisable during your attendance at the Ruhr University Bochum.

A test center on the campus is offering free Covid-19 tests. The test center is located at the „Studierenden-Service-Center" (SSC).

Photography and filming at the event
During the event, photos and videos for marketing purposes will be taken. If you do not agree with this, please inform to the photographer or the organizers.

Internet Access
Access to the internet is provided via a secured WiFi connection using your own notebook, mobile phone or tablet. Please find an instruction in the conference bag (login and password are inside your name tag; written on the back of your name.) If you are already using Eduroam, you can also use it to get internet access.

Lunch Breaks
Lunch is served in the „Mensa" of the University. Just take the elevator to Floor 02. The „Mensa" is a self-service restaurant. Please feel free to choose from the variety of meals and drinks offered. The offerings include a vegetarian meal as well as a meal without pork. Please use one of the lunch coupons included in your conference badge at the counter. A seating area has been reserved for the event.

Welcome reception
A welcome reception will be held after the last conference session on Wednesday, June 22nd at 17:00 h at the foyer of the VZ.

Visit Henrichshütte
Prior to the conference banquet a guided tour of „Henrichshütte", a former industrial site, will be offered at 17:00 h on Thursday, June 23rd. A bus transfer has been organized starting from the main bus station of Ruhr University Bochum. Meeting point is the foyer of the conference center at 16:40 h from where you will be guided to the bus station.

Banquet
The conference banquet will be held on Thursday, June 23rd from 18:30 h at „Henrichshütte", following the guided tour. After the banquet, bus transfer has been organized to Bochum central station (Hauptbahnhof, close to your hotels) at 22:00, 22:30 and 23:00 h.

Delegates not participating in the guided tour of the „Henrichshütte", may take a taxi to the venue of the banquet: Henrichshütte Hattingen – Werksstraße 31-33 – 45527 Hattingen.

Wednesday, 2022 June 22nd:

DIGITALISATION IN TUNNELLING – INDUSTRY ORGANISATION A FACILITATOR

9:30 - 10:15 h
Location: Room 2a

Lars Babendererde

International Tunnelling and Underground Space Association (ITA);
BabEng GmbH, Germany

KEY FEATURES OF CONSTITUTIVE MODELS FOR THE NUMERICAL SIMULATION OF DEEP TUNNEL ADVANCE BY THE NATM

14:00 - 14:45 h
Location: Room 2a

Günter Hofstetter

Universität Innsbruck, Austria

Thursday, 2022 June 23rd: :

ADVANCES IN MACHINE LEARNING PREDICTION OF EARTH PRESSURE BALANCE TBM PERFORMANCE

9:30 - 10:15 h
Location: Room 2a

Mike Mooney

Colorado School of Mines, USA

Friday, 2022 June 24th:

BIM FOR UNDERGROUND METRO STATIONS: INTEROPERABILITY AND DESIGN-TO-DESIGN ENHANCEMENT

9:30 - 10:15 h
Location: Room 2a

Qianbing Zhang

Monash University, Australia

MS-01	**Computational and information models for tunnel planning, design and construction**	J. Ninić, Q. Zhang, G. Meschke
MS-02	**Data driven models and machine learning in subsurface engineering**	T. Marcher, B. T. Cao, Z. Li
MS-03	**Modeling of excavation and transport processes in mechanized tunneling**	A. Bezuijen, M. Thewes
MS-04	**Model based analysis of stability of tunnels and other underground openings**	C. Callari, A. Alsahly
MS-05	**Computational modeling and design of segmented tunnel linings**	P. Mark, G. Plizzari
MS-06	**Numerical modeling in NATM tunneling**	G. Hofstetter
MS-07	**Constitutive modeling of soils and rocks**	A. Lavasan, M. Taiebat
MS-08	**Sensitivity analysis, uncertainty modelling and risk analysis in tunneling**	K. K. Phoon, S. Freitag
MS-09	**Monitoring-data-informed analysis of tunnel linings**	B. Pichler, C. Hellmich, J. Zhang
MS-10	**Advance exploration, parameter identification, inverse analysis**	W. Friederich
MS-11	**Interactions & innovations in mechanized tunneling**	B. Schößer

Time	Wednesday, 22. June 2022			Thursday, 23. June 2022	
8:30 - 9:15	Registration				
9:15 - 9:30	**Conference Opening** - Location: Room 2a				
9:30 - 10:15	Keynote lecture **Lars Babendererde** Location: Room 2a			Keynote lecture **Mike Mooney** Location: Room 2a	
10:15 - 10:50	Coffee Break			Coffee Break	
10:50 - 11:10	**Parallel Session 1** Location: Room 2a	**Parallel Session 1** Location: Room 1	**Parallel Session 1** Location: Seminar Room	**Parallel Session 3** Location: Room 2a	**Parallel Session 3** Location: Room 1
11:10 - 11:30					
11:30 - 11:50					
11:50 - 12:10					
12:10 - 12:30					
12:30 - 14:00	Lunch Break			Lunch Break	
14:00 - 14:45	Keynote lecture **Günter Hofstetter** Location: Room 2a			**Parallel Session 4** Location: Room 2a	**Parallel Session 4** Location: Room 1
14:45 - 15:15	Coffee Break				
15:20 - 15:40	**Parallel Session 2** Location: Room 2a	**Parallel Session 2** Location: Room 1	**Parallel Session 2** Location: Seminar Room		
15:40 - 16:00					
16:00 - 16:20				Coffee Break	
16:20 - 16:40					
16:40 - 17:00				**Bus to Henrichshütte** Meeting point: Foyer	
17:00 - 18:30	**Welcome Reception**			**Tour Henrichtshütte**	
18:30 - 19:00				**Conference Dinner**	
19:00 - 23:00					

	Friday, 24. June 2022			Time
				8:30 - 9:15
				9:15 - 9:30
	Keynote lecture **Qianbing Zhang** Location: Room 2a			9:30 - 10:15
	Coffee Break			10:15 - 10:50
Parallel Session 3 Location: Seminar Room	**Parallel Session 5** Location: Room 2a	**Parallel Session 5** Location: Room 1	**Parallel Session 5** Location: Seminar Room	10:50 - 11:10
				11:10 - 11:30
				11:30 - 11:50
				11:50 - 12:10
	Closing Session - Location: Room 2a			12:10 - 12:30
	Lunch Break			12:30 - 14:00
Parallel Session 4 Location: Seminar Room				14:00 - 14:45
				14:45 - 15:15
				15:20 - 15:40
				15:40 - 16:00
				16:00 - 16:20
				16:20 - 16:40
				16:40 - 17:00
				17:00 - 18:30
				18:30 - 19:00
				19:00 - 23:00

8:30 – 9:15	Registration	Foyer
9:15 – 9:30	**Conference Opening – Günther Meschke**	Room 2a
9:30 – 10:15	**Keynote Lecure 1**	Room 2a
	Chairman: Günther Meschke	
	Digitalisation in Tunnelling – Industry Organisation a Facilitator? Lars Babendererde International Tunnelling and Underground Space Association (ITA)	
10:15 – 10:50	Coffee Break	Foyer
10:50 – 12:30	**Parallel Sessions**	
MS-02a	**Data driven models and machine learning in subsurface engineering**	Room 2a
	Chairman: Thomas Marcher	
10:50 – 11:10	**Automated crack classification for underground tunnel infrastructure using deep learning** Aohui Ouyang[1], Darragh O ,Brien[1], John Osborne[2], Eliseo Perez-Duenas[2], Zili Li[1] [1]Civil, Structural & Environmental Engineering, [2]University College Cork, Cork, Ireland; [3]European Centre for Nuclear Research, CERN, Geneva, Switzerland	
11:10 – 11:30	**GPR data synthesisation and deep learning-based damage detection of tunnel lining** Huamei Zhu[1], Mengqi Huang[1], Jing Wang[2], Qianbing Zhang[1] [1]Department of Civil Engineering, Monash University, Australia [2]Institute of Control Science and Engineering, Shandong University, China	
11:30 – 11:50	**A novel integrated approach of concrete spalling evaluation in tunnel linings using mobile laser scanning data** Wen Cheng[1], Mingliang Zhou[1], Hongwei Huang[1], Yu Yu[1], Shuyi Liu[1] [1]Key Laboratory of Geotechnical and Underground Engineering, Department of Geotechnical Engineering, Tongji University, China	
11:50 – 12:10	**Automated multi-objective design optimization with an application to the design of rigid inclusions** Luan Nguyen[1], Sai Sri Harsha Vallurupalli[2], Fadi Haddad[1], Pablo Forgoso[1], Raoul Hölter[2], Arash Lavasan[2], Torsten Wichtmann[2] [1]BAUER Spezialtiefbau GmbH, Germany [2]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany	

MS-03a	Modeling of excavation and transport processes in mechanized tunnelling	Room 1
	Chairman: Markus Thewes	
10:50 – 11:10	**Modelling the penetration length of foam into saturated sand** Dongzhu Zheng[1], Adam Bezuijen[1,2] [1]Department of Civil Engineering, Ghent University, Ghent, Belgium [2]Deltares, Delft, The Netherlands	
11:10 – 11:30	**Numerical investigation of the transient support pressure transfer at the tunnel face during slurry shield drive: Case A – tool cutting depth exceeds shallow slurry penetration depth** Zdenek Zizka[1], Sebastian Kube[2], Britta Schoesser[2], Markus Thewes[2] [1]METROPROJEKT PRAHA, Prague, Czech Republic [2]Institute for Tunnelling Construction Management, Ruhr University Bochum, Germany	
11:30 – 11:50	**Simulation of crack propagation as major contributor to wear in hard metals using real microstructure data** Dennis Wingender[1], Daniel Balzani[1] [1]Chair of Continuum Mechanics, Ruhr-University Bochum, Germany	
11:50 – 12:10	**An exploratory study on normal indentation of rock specimens with lateral confinement** Hongwei Yang[1], Nils Dahlhaus[1], Jörg Renner[1] [1]Institute for Geology, Mineralogy and Geophysics, Ruhr University Bochum, Germany	
12:10 – 12:30	**Influence of cutting disc blunting on the tunnelling efficiency and penetration rate in hard rock** Lukas Brackmann[1], Sahir Butt[2], Arne Röttger[3], Günther Meschke[2], Sebastian Weber[1] [1]Chair of Materials Technologies, Institute for Materials, Ruhr University Bochum, Germany [2]Institute for Structural Mechanics, Ruhr University Bochum, Germany [3]Chair for New Production Technologies & Materials, Bergische University Wuppertal, Germany	

MS-05	**Computational modeling and design of segmented tunnel linings**	Seminar Room
	Chairmen: Peter Mark / Giovanni Plizzari	
10:50 – 11:10	**Optimized hybrid topology of segmental tunnel linings** Diego N. Petraroia[1], Filippo Medeghini[1], Peter Mark[1], Giovanni A. Plizzari[2] [1]Institute of Concrete Structures, Ruhr University Bochum, Germany [2]DICATAM, University of Brescia, Italy	
11:10 – 11:30	**Model-based design of segmental linings under uncertainty** Gerrit Emanuel Neu[1], Günther Meschke[1] [1]Institute for Structural Mechanics, Ruhr University Bochum, Germany	
11:30 – 11:50	**Optimization of the hydraulic circuit for energy tunnels** Elisa Rosso[1], Alessandra Insana[1], Riccardo Vesipa[2], Marco Barla[1] [1]Department of Structural, Geotechnical and Building Engineering, Politecnico di Torino, Italy [2]Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, Italy	
12:30 – 14:00	Lunch Break	Mensa
14:00 – 14:45	**Keynote Lecture 2**	Room 2a
	Chairman: Bernhard Pichler	
	Key features of constitutive models for the numerical simulation of deep tunnel advance by the NATM Günter Hofstetter University Innsbruck, Austria	
14:45 – 15:20	Coffee Break	Foyer
15:20 – 17:00	**Parallel Sessions**	
MS-02b	**Data driven models and machine learning in subsurface engineering**	Room 2a
	Chairman: Zili Li	
15:20 – 15:40	**Real-Time prediction for EPBM-induced ground deformation by a hybrid modeling approach** Haotian Zheng[1], Rajat Gangrade[1], Mike Mooney[1] [1]Center for Underground, Colorado School of Mines, United States of America	
15:40 – 16:00	**Introducing reinforcement learning to tunneling** Georg H. Erharter[1], Tom F. Hansen[2], Zhongqiang Liu[2], Thomas Marcher[1] [1]Institute for Rock Mechanics and Tunnelling, Graz University of Technology, Graz, Austria [2]Norwegian Geotechnical Institute, Oslo, Norway	

16:00 – 16:20	**Eliminating subjective labelling for improved accuracy in geological predictions** Paul Johannes Unterlas[1], Alla Sapronova[1], Thomas Dickmann[2], Jozsef Hecht-Méndez[2], Thomas Marcher[1] [1]Institute for Rock Mechanics and Tunnelling, Graz University of Technology, Graz, Austria [2]Business Unit Geophysics, Amberg Technologies AG, Switzeland
16:20 – 16:40	**Simulation-based surrogate models for real-time tunnel lining behavior predictions** Yaman Zendaki[1], Ba-Trung Cao[1], Abdullah Alsahly[1], Steffen Freitag[2], Günther Meschke[1] [1]Institute for Structural Mechanics, Ruhr University Bochum, Germany [2]Institute for Structural Analysis, Karlsruhe Institute of Technology, Germany

MS-03b	**Modeling of excavation and transport processes in mechanized tunneling**	Room 1
	Chairman: Markus Thewes	

15:20 – 15:40	**Predictive machine learning in EPB TBM tunnelling for main drive torque estimation** Kathrin Glab[1], Gerhard Wehrmeyer[1], Markus Thewes[2], Wout Broere[3] [1]Herrenknecht AG, Schwanau, Germany [2]Ruhr University Bochum, Germany [3]TU Delft, Netherlands
15:40 – 16:00	**Front-face pressure decrease during standstill in EPB tunnelling: analytical predictions and monitoring data** Diego Sebastiani[1,2], Giovanna Bellizzi[1], Armando de Lillis[1], Salvatore Miliziano[1,2] [1]Sapienza University of Rome, Italy [2]GEEG, Geotechnical and Environmental Engineering Group, Rome, Italy
16:00 – 16:20	**Investigation of cutting wheel-soil interaction by means of miniaturized model tests and numerical simulations** Maximilian Schröder[1], Marius Milatz[1], Jürgen Grabe[1] [1]Institute of Geotechnical Engineering and Construction Management, Hamburg University of Technology, Germany
16:20 – 16:40	**Electrical resistance measurements of materials relevant in tunnelling to detect porosity and particle deposits in non-cohesive soil** Sebastian Kube[1], Britta Schoesser[1], Markus Thewes[1] [1]Institute for Tunnelling Construction Management, Ruhr University Bochum, Germany
16:40 – 17:00	**Using Artificial Neural Networks to predict the torque on a TBM** Paulo Cachim[1], Adam Bezuijen[2] [1]RISCO and Department of Civil Engineering, University of Aveiro, Portugal [2]Department of Civil Engineering, University of Ghent, Belgium

MS-09	Monitoring-data-informed analysis of tunnel linings	Seminar Room
	Chairman: Bernhard Pichler	
15:20 – 15:40	**Nonlinear hybrid analysis of a real-scale test of a segmental tunnel ring** Jiao-Long Zhang[1], Herbert Mang[1,2], Xian Liu[1], Yong Yuan[1], Bernhard Pichler[2] [1]College of Civil Engineering, Tongji University, Shanghai, China [2]Institute for Mechanics of Materials and Structures, TU Wien, Vienna, Austria	
15:40 – 16:00	**Structural health assessment of segmental lining** Nicola Gottardi[1], Steffen Freitag[2], Günther Meschke[1] [1]Institute for Structural Mechanics, Ruhr University Bochum, Germany [1]Institute for Structural Analysis, Karlsruhe Institute of Technology, Germany	
16:00 – 16:20	**Asymmetric serviceability limit states of segmental tunnel rings: Structural analysis of displacement-monitored real-scale tests** Zijie Jiang[1,2], Xian Liu[2], Thomas Schlappal[1], Jiaolong Zhang[2], Herbert Mang[1], Bernhard Pichler[1] [1]Institute for Mechanics of Materials and Structures, TU Wien, Vienna, Austria [2]College of Civil Engineering, Tongji University, Shanghai, China	
16:20 – 16:40	**A hybrid structural analysis for internal forces of segmental tunnel linings** Yumeng Zhang[1,2], Xian Liu[1,3], Jurij Karlovsek[2] [1]College of Civil Engineering, Tongji University, China [2]School of Civil Engineering, The University of Queensland, Australia [3]State Key Laboratory for Hazard Reduction in Civil Engineering, Tongji University, China	
16:40 – 17:00	**Experimental and numerical investigation on mechanical behavior of DOT tunnel lining under a column removal scenario** Xian Liu[1], Zhen Liu[1], Zipeng Zhao[1], Yihai Bao[2] [1]College of Civil Engineering, Tongji University, China [2]National Institute of Standards and Technology, United States of America	
17:00 – 19:00	Welcome Reception	Foyer

9:30 – 10:15	**Keynote Lecure 3**	Room 2a
	Chairman: Günther Meschke	
	Advances in machine learning prediction of Earth Pressure Balance TBM performance Mike Mooney Colorado School of Mines, USA	
10:15 – 10:50	Coffee Break	Foyer
10:50 – 12:30	**Parallel Sessions**	
MS-07a	**Constitutive modeling of soils and rocks**	Room 2a
	Chairman: Arash Lavasan	
10:50 – 11:10	**A gradient enhanced transversely isotropic damage plasticity model for rock** <u>Thomas Mader</u>[1], Magdalena Schreter[1], Günter Hofstetter[1] [1]Institute of Basic Sciences in Engineering Sciences, University of Innsbruck, Austria	
11:10 – 11:30	**Study on the damping technology of non-water reacted polymer damping layer for mountain tunnel in the high-intensity earthquake area** Bo Sun[1,2], Chengchao Guo[1,2], Chenyang Zhao[1,2], <u>Arash Lavasan</u>[3] [1]School of Civil Engineering, Sun Yat-sen University, China [2]Guangdong Key Laboratory of Oceanic Civil Engineering, China [3]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany	
11:30 – 11:50	**A constitutive model for swelling rocks subjected to complex hydro-mechanical loading** <u>Antonia Nitsch</u>[1,2], Jan Machacek[1,3], Torsten Wichtmann[1], Carlos Eduardo Tavera[2] [1]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany [2]Chair of Soil Mechanics and Foundations/Geotechnical Engineering, Brandenburgische Technische Universität Cottbus-Senftenberg, Germany [3]Institute of Geotechnics, Technische Universität Darmstadt, Germany	
11:50 – 12:10	**Temperature effect on in-situ THM behaviour of COx claystone** <u>Hangbiao Song</u>[1], Frédéric Collin[1] [1]Geomechanics and Engineering Geology, University of Liège, Belgium	
12:10 – 12:30	**Adequate numerical analysis of mechanized tunneling in natural clay – the influence of soil's structure** <u>Thomas Barciaga</u>[1,2], Emily Thele[1,2], Maria Datcheva[1,3], Arash Lavasan[1], Mahdi Taiebat[4], Torsten Wichtmann[1] [1]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany [2]Dr. Spang Ingenieurgesellschaft für Bauwesen, Geologie und Umwelttechnik GmbH, Germany [3]Institute of Mechanics, Bulgarian Academy of Sciences, Bulgaria [4]Department of Civil Engineering, University of British Columbia, Canada	

MS-06a	**Numerical modeling in NATM tunnelling**	Room 1
	Chairman: Günter Hofstetter	
10:50 – 11:10	**Numerical modeling of nonlinear creep of shotcrete** Alexander Dummer[1], Matthias Neuner[1], Stefan Smaniotto[1], Günter Hofstetter[1] [1]University of Innsbruck, Austria	
11:10 – 11:30	**Probabilistic finite element investigation of the structural performance of composite tunnel linings** Konstantinos Mitroulis[1], Panagiotis Spyridis[2], Theodoros Rousakis[1] [1]Faculty of Civil Engineering, Democritus University of Thrace, Greece [2]Faculty of Architecture and Civil Engineering, Technical University of Dortmund, Germany	
11:30 – 11:50	**Experimental and numerical investigations on optimised spile spacing as an advance support measure** Barbara Schneider-Muntau[1], Iman Bathaeian[2] [1]Institute of Infrastructure, University of Innsbruck, Austria [2]ILF Consulting Engineers, Austria	
11:50 – 12:10	**Numerical analyses to determine the bearing capacity of existing tunnels during construction for a new building located above** Benno Ring[1] [1]Ring - Consultancy in Tunneling, Germany	
12:10 – 12:30	**Applications of design strategies for sprayed concrete linings** Erich Saurer[1], Maximiliano Vergara[1] [1]Skava Consulting ZT-GmbH, Austria	
MS-04	**Model based analysis of stability of tunnels and other underground openings**	Seminar Room
	Chairman: Carlo Callari	
10:50 – 11:10	**A displacement-based approach for a face pressure assessment in mechanized tunnelling** Luca Flessati[1], Claudio di Prisco[1] 1Department of Civil and Environmental Engineering, Politechnico di Milano, Italy	
11:10 – 11:30	**Simulation of the fracture zone around underground excavations in claystone** Miguel Mánica[2], Antonio Gens[1], Jean Vaunat[1], Gilles Armand[3], Minh-Ngoc Vu[3] [1]Institute of Engineering, National Autonomous University of Mexico, Mexico [2]Universitat Politècnica de Catalunya, Spain [3]Meuse/Haute-Marne Underground Research Laboratory, ANDRA R&D, France	
11:30 – 11:50	**Numerical tunnel face stability in purely cohesive medium** Thomas Pferdekämper[1], Georgios Anagnostou[1] [1]Institute for Geotechnical Engineering, Swiss Federal Institute of Technology, Switzerland	

11:50 – 12:10	**Numerical simulation on opposite driving of twin shield tunnels** Jingkang Shi[1,2], Hongwei Huang[1], Günther Meschke[2] [1]College of Civil Engineering, Tongji University, China [2]Institute for Structural Mechanics, Ruhr University Bochum, Germany	
12:30 – 14:00	Lunch Break	Mensa
14:00 – 16:00	**Parallel Sessions**	
MS-01a	**Computational and information models** **for tunnel planning, design and construction**	Room 2a
	Chairman: Qianbing Zhang	
14:00 – 14:20	**Interactive design of urban alignments based on a visual steering tool** Markus Obel[1], Lukas Heußner[1], Peter Mark[1] [1]Institute of Concrete Structures, Ruhr University Bochum, Germany	
14:20 – 14:40	**Study into enhancing interoperability between BIM and** **geotechnical numerical modelling** Mengqi Huang[1], Huamei Zhu[1], Jelena Ninić[2], Qianbing Zhang[1] [1]Department of Civil Engineering, Monash University, Australia [2]Centre for Structural Engineering & Informatics, The University of Nottingham, UK	
14:40 – 15:00	**Integration of the tunnel design process through** **the use of GIS to BIM in conventional tunneling** Mansour Hedayatzadeh[1], Jamal Rostami[2], Vasilis Sarhosis[1], Mojtaba Nematol-lahi[3], Nabiollah Hajiantilaki[4], Abouzar Shafiepour[5] [1]University of Leeds, Leeds, UK [2]Colorado school of mines, USA [3]University of Minho, Braga, Portugal [4]General Mechanic Company, Tehran, Iran [5]Ettehadrah Consulting Engineers, Tehran, Iran	
15:00 – 15:20	**Real-time tunneling-induced damage prediction** **of brittle structures using ANNs integrated with BIM** Ali Gamra[1], Jelena Ninić[1] [1]Centre for Structural Engineering & Informatics, The University of Nottingham, UK	
15:20 – 15:40	**Finite cell method for Stokes and Navier-Stokes flow simulations** **for tunnel boring machines** S. Saberi[1], Günther Meschke[2], Andreas Vogel[1] [1]High Performance Computing, Ruhr University Bochum, Germany [2]Institute for Structural Mechanics, Ruhr University Bochum, Germany	
15:40 – 16:00	**Computational approaches for optimum fire-ventilation control in under-** **ground infrastructures** Marco Bettelini[1] [1]Amberg Engineering, Switzerland	

MS-11	Interactions & innovations in mechanized tunneling	Room 1
	Chairwoman: Britta Schößer	
14:00 – 14:20	**Continuous advance – developments for a new Herrenknecht concept TBM** Johannes Tröndle[1], <u>Gerhard Wehrmeyer</u>[1], [1]Herrenknecht AG, Germany	
14:20 – 14:40	**Modelling of the penetration behaviour of bentonite slurries** <u>Peyman Mianji</u>[1], Wiebke Baille[1], Arash Alimardani Lavasan[1], Torsten Wichtmann[1] [1]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany	
14:40 – 15:00	**Practical experience and new calculation studies on selected annular gap grouting materials** <u>Matthias Hausmann</u>[1], Christoph Budach[1,2], Dietmar Mähner[3] [1]ELE Beratende Ingenieure, Essen, Germany [2]Institut für Baustoffe, Geotechnik, Verkehr und Wasser (IBGVW), TH Köln, Germany [3]Insitut für unterirdisches Bauen, FH Münster, Germany	
15:00 – 15:20	**Artificial defect detection of lab-scale TBM cutting systems** <u>Sebastian Priebe</u>[1], Lukas Brackmann[2], Arne Röttger[3], Günther Meschke[1], Inka Mueller[4] [1]Institute for Structural Mechanics, Ruhr University Bochum, Germany [2]Institute for Materials, Ruhr University Bochum, Germany [3]Chair for New Production Technologies & Materials, Bergische University Wuppertal, Germany [4]Institute for Mechanics, Bochum University of Applied Sciences, Germany	
15:20 – 15:40	**Full-scale experiment on EPBS-pile-soil interaction in Parisian subsoil** <u>Wassim Mohamad</u>[1], Emmanuel Bourgeois[1], Alain Le Kouby[1], Fabien Szymkiewicz[1], Agathe Michalski[2], Denis Branque[3], Nicolas Berthoz[2], Charles Kreziak[4] [1]Gustave Eiffel University, France [2]French centre for tunnel studies (CETU), France [3]National School for Publics Works (ENTPE), France [4]Société du Grand Paris, France	
15:40 – 16:00	**Cementitious materials with high compressibility for deformation-tolerant tunnel lining** <u>Sven Plückelmann</u>[1], Christina Krikelis[1], Rolf Breitenbücher[1] [1]Institute for Building Materials, Ruhr University Bochum, Germany	

MS-08	Sensitivity analysis, uncertainty modelling and risk analysis in tunneling	Seminar Room
	Chairman: Steffen Freitag	
14:00 – 14:20	**Reliability measures updating in urban mechanised tunnelling using subset simulation** Elham Mahmoudi[1], Markus König[1] [1]Institute for Computing in Engineering, Ruhr University Bochum, Germany	
14:20 – 14:40	**Dynamic response of tunnels crossing inactive fault** Ruohan Li[1], Xu Zhao[2], Yong Yuan[1] [1]Department of Geotechnical Engineering, Tongji University, China [2]Key Laboratory of Urban Security & Disaster Engineering of Ministry of Education, Beijing University of Technology, China	
14:40 – 15:00	**Shaking table test of TBM tunnel in soil-rock transition zone under transverse excitation** Siming Li[1], Zhiming Guo[2], Guangqiao Xue[3], Yong Yuan[1] [1]Department of Geotechnical Engineering, Tongji University, China [2]Public Works Construction Center, China [3]China Railway Siyuan Survey and Design Group Co. Ltd., China	
15:00 – 15:20	**Assessing the failure potential of underground works** Dallavalle Marco[1], Chrysothemis Paraskevopoulou[1], Spyridon Konstantis[2], Panagiotis Spyridis[2], Andreas Benardos[3] [1]School of Earth and Environment, University of Leeds, Leeds, United Kingdom [2]Ruler Consult, London, United Kingdom [3]School of Mining & Metallurgical Engineering, National Technical University of Athens, Greece	
15:20 – 15:40	**Seismic interaction among tunnels and buildings in highly populated cities** Juan Manuel Mayoral[1], Daniel De La Rosa[1], Jose Mauricio Alcaraz[1], Enrique Barragan[1] [1]Institute of Engineering, National Autonomous University of Mexico, Mexico	
15:40 – 16:00	**Risk assessment of tunneling induced building damage: A real-time prediction considering polymorphic uncertain data** Steffen Freitag[1], Ba Trung Cao[2], Markus Obel[3], Lukas Heußner[4], Peter Mark[4], Günther Meschke[2] [1]Institute for Structural Analysis, Karlsruhe Institute of Technology, Germany [2]Institute for Structural Mechanics, Ruhr University Bochum, Germany [3]ILF Consulting Engineers, Germany [4]Institute of Concrete Structures, Ruhr University Bochum, Germany	
16:00 – 16:40	Coffee Break	Foyer
16:40 – 17:00	Bus to Henrichshütte (Meeting point: Foyer)	
17:00 – 18:30	Tour Henrichshütte	
18:30 – 23:00	Conference Dinner	

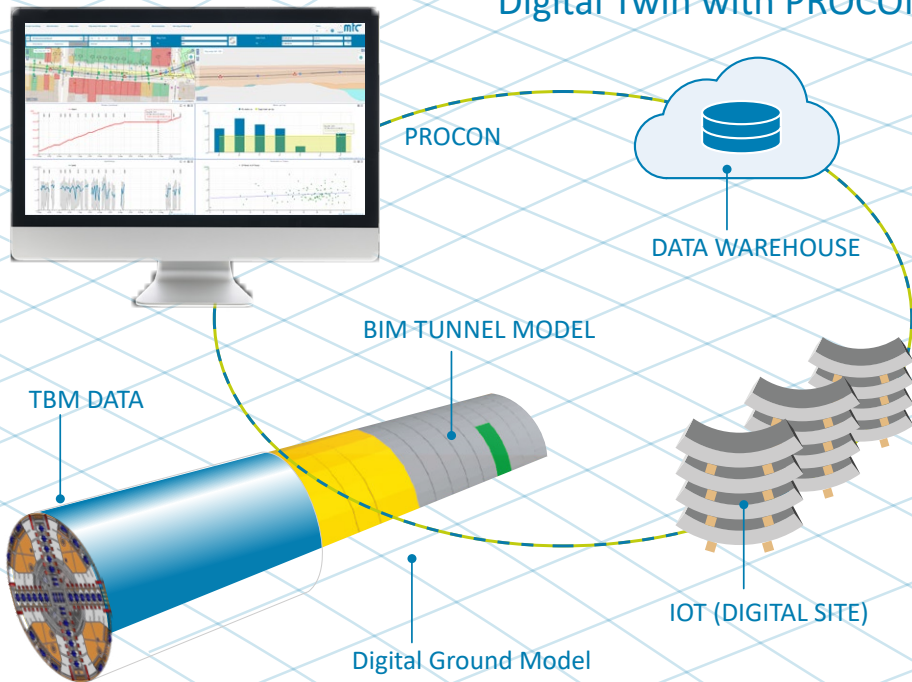| 9:30 – 10:15	**Keynote Lecure 4**	Room 2a
	Chairman: Günter Hofstetter	
	BIM for underground metro stations: interoperability and design-to-design enhancement Qianbing Zhang Monash University, Australia	
10:15 – 10:50	Coffee Break	Foyer
10:50 – 12:30	**Parallel Sessions**	
MS-01b	**Computational and information models for tunnel planning, design and construction**	Room 2a
	Chairwoman: Jelena Ninić	
10:50 – 11:10	**Numerical simulation of mechanized tunnelling driven through frozen soil** Rodolfo Javier Williams Moises[1], Abdullah Alsahly[1], Günther Meschke[1] [1]Institute for Structural Mechanics, Ruhr University Bochum, Germany	
11:10 – 11:30	**Parametric modelling of prefabricated underground stations** Xilin Chen[1], Mengqi Huang[1], Qianbing Zhang[1] [1]Department of Civil Engineering, Monash University, Australia	
11:30 – 11:50	**Numerical simulation of the effect of cross passage excavation on surface settlement** Ibtissem Siad[1], Mustapha Akchiche[1], Panagiotis Spyridis[2] [1]Faculty of civil engineering USTHB, Algeria [2]Faculty of Architecture and Civil Engineering, TU Dortmund, Germany	
11:50 – 12:10	**Real-time simulation-based interactive design for tunnel alignments** Hoang-Giang Bui[1], Ba-Trung Cao[2], Abdullah Alsahly[2], Steffen Freitag[3], Günther Meschke[2] [1]Institute of Mechanics of Materials, Ruhr University Bochum, Germany [2]Institute for Structural Mechanics, Ruhr University Bochum, Germany [3]Institute for Structural Analysis, Karlsruhe Institute of Technology, Germany	
MS-07b	**Constitutive modeling of soils and rocks**	Room 1
	Chairman: Torsten Wichtmann	
10:50 – 11:10	**Modelling of defective pipe behaviour and surrounding soil response** Qinglai Zhang[1], Zhipeng Xiao[1], Zili Li[1] [1]Civil, Structural & Environmental Engineering, University College Cork, Cork, Ireland	
11:10 – 11:30	**Influence of the rate of tunnel excavation on an existing tunnel** Sai Sri Harsha Vallurupalli[1], Arash Lavasan[1], Luis Felipe Prada[1] [1]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany	

11:30 – 11:50	**Influence of tunneling parameters on the geometry of the excavation damaged zone** Maximilian Schoen[1], Arash Lavasan[1], Frederic Collin[2] [1]Chair of Soil Mechanics, Foundation Engineering and Environmental Geotechnics, Ruhr University Bochum, Germany [2]Geomechanics and Engineering Geology, University of Liège, Belgium	
11:50 – 12:10	**Simplified assessment of swelling loads on underground structures in southern Ontario shales** Abdullah Alsahly[1], Dominic Reda[2], Vojtech Ernst Gall[2] [1]Institute for Structural Mechanics, Ruhr University Bochum, Germany [2]Gall Zeidler Consultants, New York, NY, USA	
MS-06b	**Numerical modeling in NATM tunnelling** Chairman: Günter Hofstetter	Seminar Room
MS-10	**Advance exploration, parameter identification, inverse analysis** Chairman: Wolfgang Friederich	Seminar Room
10:50 – 11:10	**Analysis of seismic performance of tunnel-group subway station in rock sites** Ruozhou Li[1], Weiguo He[2], Qingfei Li[2], Xin Gao[2], Yong Yuan[3] [1]Department of Geotechnical Engineering, Tongji University, China [2]China Railway Liuyuan Group Co. Ltd., China [3]State Key Laboratory for Disaster Reduction in Civil Engineering, Tongji University, China	
11:10 – 11:30	**Complex numerical simulation of a running tunnel – cross-passage intersection of the Semmering Base Tunnel exposed to high swelling pressures** Mattheus Borgers[1], Alexander Poisel[1], Thomas Stoxreiter[1] [1]IGT Geotechnics and Tunnelling, Austria	
11:30 – 11:50	**Full waveform inversion during mechanized tunneling – non-gradient approaches validated on laboratory-generated data** Maximilian Trapp[1], Nestorović Tamara[1] [1]Mechanics of Adaptive Systems, Ruhr University Bochum, Germany	
11:50 – 12:10	**Full waveform inversion in mechanized tunneling by means of frequency domain modeling** Christopher Riedel[1], Khayal Musayev[1], Matthias Baitsch[2], Klaus Hackl[1] [1]Institute of Mechanics of Materials, Ruhr University Bochum, Germany [2]Bochum University of Applied Sciences, Germany	
12:10 – 12:30	**Closing Session – Markus Thewes**	Room 2a
12:30 – 14:00	Lunch Break	Mensa

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