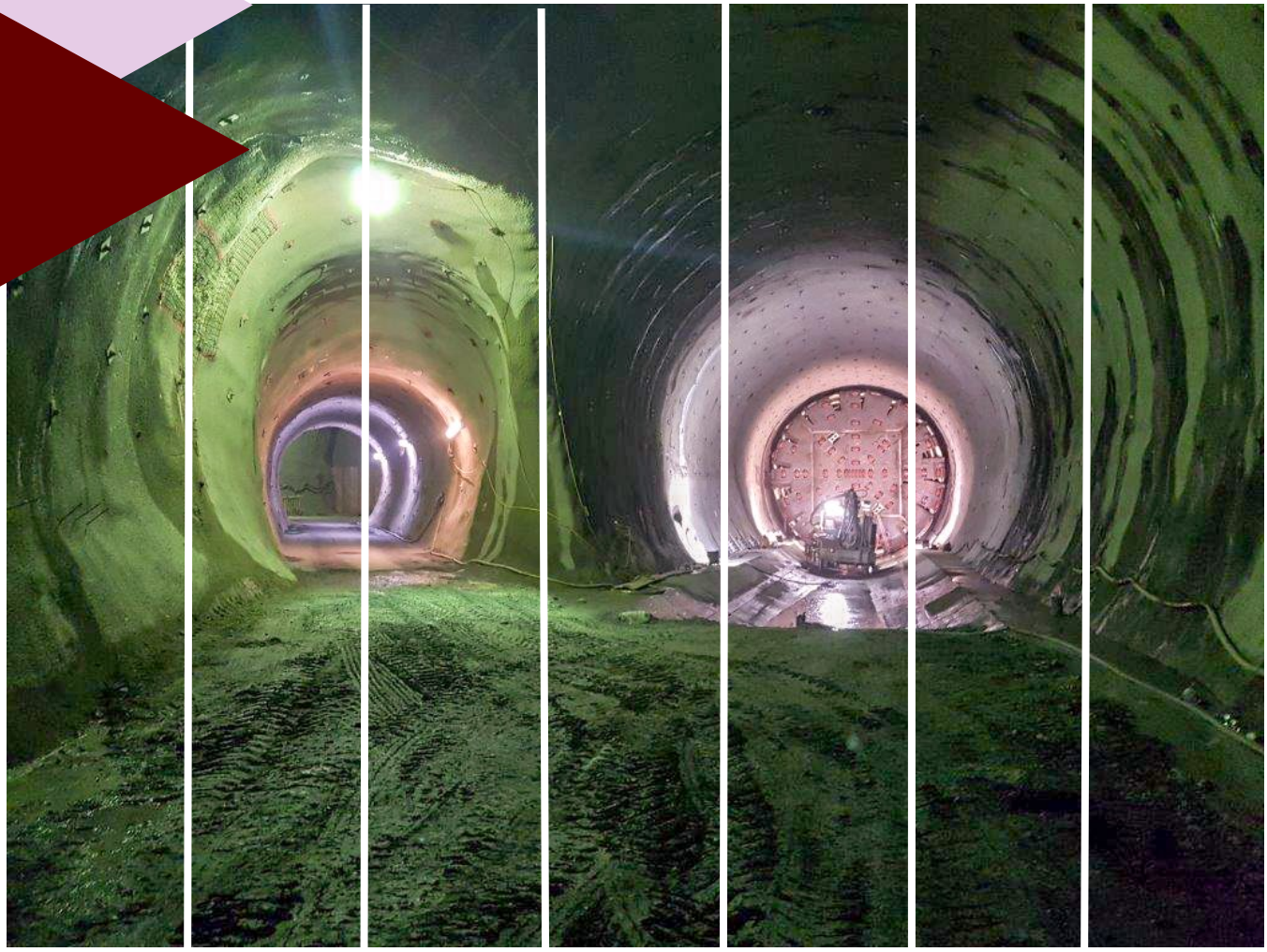
FIFTH INTERNATIONAL ITASCA SYMPOSIUM

ON APPLIED NUMERICAL MODELING IN GEOMECHANICS—2020



University of Vienna, Main Building

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ITASCA™

FIFTH INTERNATIONAL ITASCA SYMPOSIUM 2020 VIENNA, AUSTRIA

*Start of excavation for tunnel boring machines. Semmering Base Tunnel, Austria, a railway tunnel under construction with a final length of 27.3 km, expected to enter operational service in 2026. (Photo courtesy of OEBB Infra – Austrian Federal Railways – infrastructure.)

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WELCOME

Itasca was formed in 1981 by faculty members of the University of Minnesota to provide services in rock mechanics, numerical modeling of geotechnical environments, and underground space use. Since then, Itasca has striven to maintain a strong connection with academia and to continue promoting and engaging in research and development in these fields.

Consistent with this spirit, Itasca has organized eleven conferences (in nine countries) for users of the software they develop. To date, those conferences have been held in Australia, Canada, China, France, Germany, Japan, Peru, Spain and the USA. The first seven symposia focused on *FLAC/FLAC3D*, *UDEC/3DEC* and *PFC2D/3D* independently. Beginning in 2008, the symposia brought together users of all Itasca software in one setting where the emphasis was on the range of applications rather than individual software.

After successful conferences in China (2013) and Peru (2016), this year's symposium is held in the heart of Europe, specifically, the beautiful city of Vienna, Austria, which is one of the world's top destinations for international congresses. In addition to being a cultural center, the 'City of Music' also has played a pivotal role in the areas of geoscience and geotechnics.

Eduard Suess (1831 – 1914) is the most internationally recognized Austrian geologist and was Professor at the University of Vienna, the host of this year's symposium. Suess was not only a great scientist, but also an applied geologist, starting as a consultant working toward regulation of the Danube River. Later, as a politician and member of the city council, he pushed the plan for a spring water supply for Vienna by an approximately 95 km long aqueduct-supported pipeline from the Alps, which is still operational today and delivers pristine tap water!

Karl von Terzaghi (1883 – 1963) was one of the leading civil engineers of the last century and is widely known as the 'father of soil mechanics and geotechnical engineering'. Terzaghi was Professor at the Vienna University of Technology (TU Wien), which is co-organizing the symposium. During his time as professor in Vienna, Terzaghi built up a trendsetting soil mechanics laboratory; some of the testing equipment installed by Terzaghi and his students (e.g., Hubert Borowicka) is still in use at the TU Wien today!

We are certain that you will enjoy your visit to Vienna and we give all participants the warmest welcome. Hopefully time permits you to visit some of Vienna's highlights, such as St. Stephen's Cathedral or the Vienna Giant Wheel, which are both featured in the Symposium's logo. We hope that this conference will fully meet your expectations and may your stay in the 'City of Music' be an unforgettable experience.

The Organizing Committee

ORGANIZING COMMITTEE

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Egis

KEYNOTE SPEAKERS

Dr. Peter Cundall performed his doctoral work at Imperial College, London, where, in 1971, he originated the Distinct Element Method for modeling jointed rock and granular material. In addition to being an independent consultant for several years, he worked for Dames and Moore for five years, was a faculty member at the University of Minnesota for seven years, at which he is now Adjunct Professor. He was employed by Itasca for more than 20 years, and continues involvement as an Associate. Dr. Cundall is the original author of many computer codes, including *TRUBAL*, *FLAC*, *FLAC3D*, *UDEC*, *3DEC* and *PFC*, which all enjoy widespread use. His main interest is in applied computer modeling, particularly in the areas of micromechanics, seismic analysis, plasticity, fracture damage, localization, shock waves and coupled problems. He has written many papers, including the most-cited paper for the journal Géotechnique: “A Discrete Numerical Model for Granular Assemblies”. Dr. Cundall has received several awards for his work in rock mechanics, and is Fellow of the Royal Academy of Engineering and Member of the National Academy of Engineering.

Dr. Caroline Darcel is a principal engineer at Itasca Consultants SAS. She specializes in Discrete Fracture Network (DFN) modeling framework, with applications to geothermal, mining and nuclear waste industries. She has been involved in many projects on site scale DFN characterization and Synthetic Rock Mass (SRM) modeling, including flow channeling characterization and rock mass mechanical and hydraulic effective properties assessment.

Dr. José Lemos holds a PhD in Rock Mechanics from the University of Minnesota, Minneapolis. He has been involved in the development of Itasca's DEM codes *UDEC* and *3DEC* since the '80s. Presently he is a Principal Researcher at LNEC (Civil Engineering National Laboratory) in Lisbon, Portugal. His research interests include safety assessment of dam foundations in rock, seismic analysis of masonry structures, and discrete element modelling.

KEYNOTE SPEAKERS

Kurt Mair am Tinkhof, a geotechnical engineer with a Master's degree in Civil Engineering from the Vienna University of Technology, is an employee of Amberg Engineering AG, working on projects related to conventional, TBM and cut and cover tunneling. He has extensive expertise in numerical modeling of tunnel constructions and mass movements, especially using the Itasca's *FLAC3D* in conjunction with all its *FISH* abilities and the meshing tool *Griddle* in case of complicated model structure. Kurt is also interested in research and development and currently working on completing his PhD Thesis. He will present a joint keynote with his collegue Nedim Radoncic on the practical use of *FLAC3D* in tunneling.

Dr. Nedim Radončić holds a PhD in Geotechnics from the Graz University of Technology, Austria, focusing on support design in weak ground using Itasca's *FLAC3D*. He has been involved in tunneling projects as geoetechnical site engineer where he gathered experience in applying numerical analysis to tackle on-site problems, e.g. large faults and TBM stop, cross section design, etc. Since 2015 he works as international project manager for Amberg Engineering AG, focusing primarily on geotechnical/tunneling problems. Nedim regards *FLAC3D*, due to its *FISH* abilities and recently-available *Griddle* mesher, as one of the most powerful and comfortable tools for geotechnical analysis. He will present a joint keynote with his collegue Kurt Mair am Tinkhof on the practical use of *FLAC3D* in tunneling.

Dr. Martin Schöpfer, recipient of the Peter A. Cundall award at the 3rd Itasca *FLAC*/DEM Symposium, is a geologist at the University of Vienna with extensive experience in the application of *PFC* to model a wide range of geological structures, such as rock joints, tectonic faults and volcanic collapse. Over the past years he has been working on numerous, mainly petroleum industry funded, projects. In his keynote Martin will present state-of-the-art modelling of salt tectonics with a coupled *PFC*/*FLAC* approach.

PETER CUNDALL AWARD WINNERS

Distinct Element Method (DEM) for fibrous composites: Toward computational guided manufacturing

"We are exploring the new application of DEM to fibrous composites (FCs). For FCs, the optimal discontinuous fiber architecture are not known, but can be proposed by advanced DEM computations which has the potential to advance the manufacturing of carbon fiber reinforced polymers, carbon nanotube polymer composites, and textiles."

Keynote to be presented Wednesday February 19, 8:45am

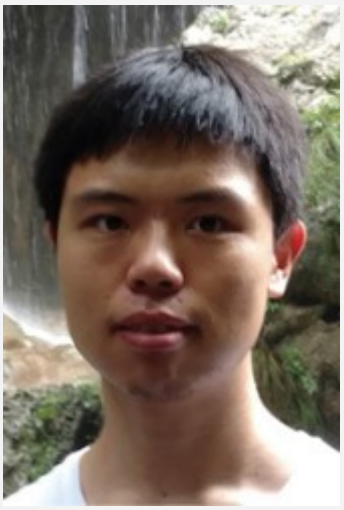
Traian Dumitrica

Traian Dumitrica is a Professor of Mechanical Engineering at the University of Minnesota. His major research interests are in the modeling and simulation of materials. He uses DEM to develop computational technologies for guiding the development of composite fibrous materials. The focus is on materials for aerospace, where excellent mechanical properties and mass saving are key. He has authored or co-authored over 100 technical journal articles, and has received numerous awards, including the 2008 National Science Foundation CAREER and 2019-2020 Fulbright U.S. Scholar Awards.

Yuezhou Wang

Yuezhou Wang holds a Ph.D. in Materials Science from the University of Minnesota. Currently, he is an Assistant Professor at Minnesota State University, Mankato, where his research focuses on DEM simulations of large deformation mechanism in carbon nanotube yarns.

Hoa Xu



Hoa Xu holds a Ph.D. in Aerospace Engineering from the University of Minnesota. His research interest is in the development of multiscale simulations frameworks, where DEM is used for bridging atomic-level and macroscopic length scales.

Grigorii Drozdov

Grigorii Drozdov is a Ph.D. candidate in Scientific Computation at the University of Minnesota. Grigorii has a Master degree in Computational Mathematics from Skoltech, Moscow and Bachelor degree in Mechanics from Novosibirsk State University. He is working on the development and implementation of mesoscopic DEM for the carbon nanotube composites.

Igor Ostanin

Igor Ostanin has received his Ph.D. in mechanics of materials from the University of Minnesota. His thesis has established the possibility of DEM modeling of nanofibrillar materials. As an intern at Itasca Consulting Group, Minneapolis, he contributed to the development of *PFC* code. As a Research Scientist at Skoltech, Russia and the University of Twente, Netherlands, he continues his work on few projects dealing with scalable and parallel computing, including massively parallel DEM simulations of fibrous materials and DEM modeling of acoustic metamaterials.

Honorable Mentions

In recognition of their outstanding work, Itasca is also awarding honorable mentions to these extended abstracts:

DEM analysis of the Wolf Rock interlocked masonry lighthouse under extreme wave impacts
Athanasios Pappas, Alessandro Antonini, Darshana T. Dassanayake, Alison Raby, and Dina D'Ayala

3D anisotropic modelling of deep drifts at the Meuse/Haute-Marne URL
M. Souley, M.N. Vu, and G. Armand

PROGRAM

Monday, February 17
Pre-Symposium Workshops

Workshop Check-in (Octagon outside the Small Ceremonial Chamber) **8:00 - 8:30**

Seminar Room 2

Conventional tunneling using *FLAC3D* **8:30 - 12:00**
Marco Camusso, Pedro Velasco and Montse Senis

Dynamic modeling in FLAC and FLAC3D **1:30 - 5:00**
Augusto Lucarelli

Seminar Room 3

Microseismic monitoring and modeling **8:30 - 12:00**
Matthew Purvance and Juan Reyes-Montes

Application of the Particle Flow Code (PFC) in Structural Geology **1:30 - 5:00**
Martin Schöpfer

Lunch (on your own) **12:00 - 1:30**

Symposium Registration & Check-in (Octagon outside the Small Ceremonial Chamber) **4:30 - 6:30**

Ice-Breaker Welcome Reception (Main Ceremonial Chamber) **7:00 - 9:30**

Tuesday, February 18
Symposium Presentations

Authors Breakfast Meeting w/ Session Chairs (Main Ceremonial Chamber) **7:30 - 8:30**

Symposium Check-in (Octagon outside the Small Ceremonial Chamber) **7:30 - 8:30**

Small Ceremonial Chamber

Welcome & Introduction – Charles Fairhurst/Martin Schöpfer **8:30 - 8:45**

KEYNOTE ADDRESS – Martin Schöpfer—*The rocky path to geomechanics: A geologist's tale* **8:45 - 9:10**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D1-1A—Tunneling - 1 **9:15 - 10:15**
Session Chair: Rainer Poisel

Tunneling underneath a heritage-listed building in the heart of Sydney (17-01) – J. Rabanser, C.J. Wang & H. Lagger

Application and research of soil tunnel face stability and reinforcement in Israel K project (17-02) – A. Cao, J. Wu, W. Chu, Q. Xu & J. Liu

Optimized stability assessment of tunneling stress redistribu-tion under geological lateral pressures (17-03) – W.C. Chang & W.J. Shiu

Senate Hall

Session D1-1B—Mining - 1 **9:15 - 10:15**
Session Chair: Heinz Konietzky

Influence of pit wall stability on underground planning and design when transitioning from open pit to sublevel caving (11-01) – A. Mapuranga & R. Mitra

The application of PFC to simulate longwall top coal caving (11-02) – Z. Song, H. Konietzky & M. Herbst

Investigation of the effect of critical parameters affecting caveability using numerical modelling (11-03) – K. Suzuki Morales, F. Suorineni, B. Hebblewhite & J. Oh

Coffee Break (Main Ceremonial Chamber) **10:15 - 10:30**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D1-2A – Tunneling - 2 **10:30 - 12:00**
Session Chair: Montse Senis

Long-term behavior of lined tunnels excavated in squeezing ground (17-04) – Y. Liu, J. Sulem, D. Subrin & H. Tran-Manh

Progressive rock deformation and rock-casing contact around borehole in Bingham viscoplastic rock (17-05) – X. Xie & E. Fjær

Accounting for long term effects for the structural design of deep tunnels in claystones (17-06) – V. Ribeiro, J.F. Bruchon & S. Burlon

Numerical analysis to evaluate repair work of swelling-rock damaged tunnels in the mountains using FLAC (17-07) – K. Ota, A. Arai, Y. Ozaki, Y. Nakamura, M. Watanabe & T. Kyoya

Senate Hall

Session D1-2B – Mining - 2 **10:30 - 12:00**
Session Chair: Pedro Velasco

Using rigid block/FLAC3D coupling in mine-scale simulations (11-04) – M.D. Purvance & T. Garza-Cruz

Integrating laser scanning with Discrete Element Modeling for improving safety in underground stone mines (11-05) – J.J. Monsalve, A. Soni J. Hazzard & N. Ripepi

Determination of stoping methodology for mining secondary stopes by FLAC3D (11-06) – B.N.V.S. Prasad, S.R. Naik, B.H.V. Sekar & R. Bhusan

A numerical modeling approach for estimating the rock mass post-peak deformation modulus near a mine drift (11-07) – N. Bahrani & J. Hadjigeorgiou

Lunch (Main Ceremonial Chamber) **12:00 - 1:30**

Small Ceremonial Chamber

KEYNOTE ADDRESS—José Lemos—*Dynamic analysis of masonry structures with DEM* **1:30 - 1:55**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D1-3A – Masonry **2:00 - 3:45**
Session Chair: Peter Cundall

DEM analysis of the Wolf Rock interlocked masonry lighthouse under extreme wave impacts (09-01) – A. Pappas, A. Antonini, D.T. Dassanayake, A. Raby & D. D'Ayala

3DEC analysis of crosswise tension resistance in masonry structures (09-02) – S. Chen & K. Bagi

Archaeoseismological investigation of the deformation of the ruin of the crusader fortress Ateret, Israel with 3DEC (09-03) – G. Schweppe, K.-G. Hinzen & S. Marco

Macro- and micro-scale modelling of masonry structures using the Discrete Element Method (09-04) – V. Sarhosis, T. Forgács & J. Lemos

3D analysis of masonry arch bridges taking into account the spandrel walls (09-05) – T. Forgács, V. Sarhosis & S. Ádány

Senate Hall

Session D1-3B – Mining – 3 **2:00 - 3:45**
Session Chair: Sebastian Hortberg

Practical estimates of rock block unconfined strength (11-08) – A. Stavrou, I. Vazaios, W. Murphy & N. Vlachopoulos

Simulation of paste backfill material with FLAC3D at Kittilä (11-09) – A. Ouellet, T. Lavoie, A. Pyy, L.-P. Gélinas, V. Falmagne & P. Andrieux

FLAC-based modelling of tailings deposition and consolidation (11-10) – A. Amodio, H. Zhou & N. Boylan

Modelling of the influence of salt creeping on shaft lining (11-12) – A. Kisse, D. Oellers & J. Greinacher

Coffee Break (Main Ceremonial Chamber) **3:45 - 4:00**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D1-4A – Slope Stability **4:00 - 5:20**
Session Chair: Alexander Preh

Wedge failure analyses of the rock slope influenced by foliations (15-01) – V. Mwang Bowa

3D stability analysis of left and right abutment cut slopes of a hydroelectric project in Himalaya (15-02) – S.R. Naik, R. Nair & S. Kadiyala

Optimization of soil slope stabilization with evolution algorithm (15-03) – K.-N. Kang, K.-I. Song, J.-S. An & B.-C. Kim

Senate Hall

Session D1-4B – Hydraulic Fracturing **4:00 - 5:20**
Session Chair: Sacha Emam

Passive seismic imaging of Discrete Fracture Networks (07-01) – J.M. Reyes-Montes & E. Hughes

Hydraulic fracture multi-cluster simulation using FLAC3D (07-02) – J. Diessl, W. Wang & M.S. Bruno

Numerical simulation of laboratory experiment of hydraulic fracture initiation monitored by acoustic emission (07-03) – A. Mehrabifard, E. Eberhardt & B. Damjanac

Microseismic structure evolution due to variation of liquid injection rate (07-04) – V.V. Nazimko, I.A. Saleev, M.O. Iliashov & L.M. Zakharova

Wednesday, February 19
Symposium Presentations

Authors Breakfast Meeting w/ Session Chairs (Main Ceremonial Chamber) **7:30 - 8:30**

Small Ceremonial Chamber

Welcome & Introduction – Jason Furtney/Martin Schöpfer **8:30 - 8:40**

Presentation of Peter A. Cundall Awards – Peter Cundall **8:40 - 8:45**

KEYNOTE ADDRESS – **Traian Dumitrica** – *Distinct Element Method for fibrous composites: Toward computational guided manufacturing* (08-01) – T. Dumitrica, Y. Wang, H. Xu, G. Drozdov & I. Ostanin **8:45 - 9:10**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D2-1A – Caverns and Large Excavations - 1 **9:15 - 10:15**
Session Chair: Hannes Lagger

Large-scale 3D modeling of a realistic cavern field within a salt dome – combined application of Griddle, FLAC3D & Python (01-01) – M. Knauth

Convergence-induced stresses on casing and cementation due to salt cavern operation (01-02) – B. Horváth & D. Zander-Schiebenhöfer

Method of determining grading deformation alert index of underground cavern complex and its application (01-03) – J. Wu, Q. Xu, W. Chu, A. Cao & J. Liu

Senate Hall

Session D2-1B – Material Behavior - 1 **9:15 - 10:15**
Session Chair: Charles Fairhurst

Simulation of triaxial compression test with PFC3D (10-01) – Y. Zhao & H. Konietzky

Paths of force chains at the cyclic threshold shear strain in sand (10-02) – V. Pavlic & T. Ivsic

PFC3D simulation of a compressed steel column (10-03) – G. Forlati, A. Gajo & L. Simeoni

Coffee Break (Main Ceremonial Chamber) **10:15 - 10:30**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D2-2A – Caverns and Large Excavations - 2 **10:30 - 12:00**
Session Chair: Lothar te Kamp

Calculation of infiltration-cracks in the edge zone of gas storage caverns with FLAC3D (01-04) – D. Zapf, R.B. Rokahr & S. Yıldırım

Support assessment and 3D stress analysis of large underground excavations: A case study with 3DEC (01-05) – R. Bhusan, S.R. Naik & B.H.V. Sekar

Design of support system for surge shaft and powerhouse complex using FLAC3D (01-06) – B.H.V. Sekar, S.R. Naik & R. Bhusan

PFC2D modelling of sinkhole clusters in karstic depressions (01-07) – D. Al-Halbouni, S. Emam, E. P. Holoan, A. Taheri, M. Schöpfer & T. Dahm

Senate Hall

Session D2-2B – Material Behavior - 2 **10:30 - 12:00**
Session Chair: David Potyondy

Effect of particle elongation on shearing behavior of soil (10-04) – Z.-L. Ren, Y.P. Cheng, X. Xu & N. Duan

Microscopic calibration of rolling friction to mimic particle shape effects in DEM (10-05) – R. Rorato, M. Arroyo, A. Gens & E. Andò

A DEM study on the rate-dependent volumetric response of non-crushable sand (10-06) – S. Kumar Das & A. Das

Lunch (Main Ceremonial Chamber) **12:00 - 1:30**

Group Photo (location to be announced) **1:00 - 1:20**

Small Ceremonial Chamber

KEYNOTE ADDRESS— Caroline Darcel – *Estimating rock properties based on DFN methods* **1:30 - 1:55**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D2-3A – Soil/Rock Structure Interaction **2:00 - 3:45**
Session Chair: Augusto Lucarelli

A numerical study of a pin foundation on hard, rocky seabed (16-01) – E. Nicolini, F. Dedecker & R. Coquet

FLAC3D modelling of rock support arches (16-02) – D. Saiang & A. Nyström

Verification of pile modeling technique in FLAC3D (16-03) – A. Maheetharan & A. Jaen-Toribio

Application of temporal and spatial characteristics of shotcrete mechanics in Middle East pumping storage project (16-04) – Q. Xu, J. Wu, W. Chu, A. Cao & J. Liu

FLAC3D modeling of geocell reinforced foundation beds (16-05) – A. Hegde & H. Venkateswarlu

Senate Hall

Session D2-3B – Damage Mechanics - 1 **2:00 - 3:45**
Session Chair: Matthew Purvance

Simulating spalling with a flat-jointed material (03-01) – D. Potyondy & D. Mas Ivars

DEM modeling of high strain rate wellbore fracturing via high pressure pulsed gas combustion (03-02) – J. Hinkey, T. Elder & J. Andersen

Three-dimensional numerical simulation of drilling-induced core damage using bonded block model (03-03) – N. Bahrani & B. Valley

Application of PFC3D to study railroad ballast breakage response under train loading (03-04) – B. Dahal, D. Mishra & D. Potyondy

Using machine learning, experimental observations, and numerical modeling to better understand the crushed zone in rock blasting (03-05) – J.K. Furtney, D. Blanksma & I.A. Onederra

Coffee Break (Main Ceremonial Chamber) **3:45 - 4:00**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D2-4A – Rockfall/Debris Flow and Dynamic Analysis **4:00 - 5:40**
Session Chair: Dina D'Ayala

Civil (Rockfall/Debris Flow)

Impact on barriers: single rock fall vs rock mass fall (14-01) – A. Preh, M. Illeditsch, P. Pamminger & M. Schmidt

Simulation of impacts on a rockfall protection wall made of interconnected concrete blocks (14-02) – A. Furet, S. Lambert, P. Villard & J.-P. Jarrin

Impact assessment of debris flows on structures using discrete numerical modelling (14-03) – R. Chehade, B. Chevalier, F. Dedecker & P. Breul

Dynamic Analysis

FLAC3D-PFC3D coupled simulation of triaxial Hopkinson bar (05-01) – W. Hu, D.O. Potyondy & Q. Zhang

Dynamic analysis of fault-slip in longwall mining using a linear slip weakening law (05-02) – C. Wei, C. Zhang & I. Canbulat

Senate Hall

Session D2-4B – Damage Mechanics - 2 **4:00 - 5:40**
Session Chair: Gregor Schweppe

Micromechanics of hydro-thermal damage and fracturing in rocks based on DEM modeling with thermal convection (03-06) – M. Gutierrez & I. Tomac

Numerical modeling of thermal stimulation for geothermal core studies (03-07) – M.C. Villeneuve & P.A. Siratovich

Numerical modelling of the quasi-brittle behavior of materials by considering microcracks effect (03-08) – F. Asadi, D. André, S. Emam, P. Doumalin & M. Huger

DEM modelling of grain crushing in element tests (03-09) – J. Lin, M. Kriechhammer, W. Wu & L. te kamp

Comparison of DEM and experimental results for evaluation of ground surface displacement due to fault movement below architectural structures (03-10) – A. Oya, N.

Banquet Dinner (Melker Stiftskeller) **7:00 - 10:00**

Thursday, February 20
Symposium Presentations

Authors Breakfast Meeting w/ Session Chairs (Main Ceremonial Chamber) **7:30 - 8:30**

Small Ceremonial Chamber

Welcome & Introduction – Rainer Poisel/Martin Schöpfer **8:30 - 8:45**

KEYNOTE ADDRESS – Peter Cundall—*The art of numerical modelling in geomechanics* **8:45 - 9:10**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D3-1A – Dams and Retaining Walls **9:15 - 10:15**
Session Chair: Ayaka Oya

Non-linear straining of foundation soils in the progressive failure of the Mount Polley TSF embankment (04-01) – E. Zabolotnii, R.N. Morgenstern & G.W. Wilson

Verification of the mitigation measures for preventing the concrete face failure of a 210m CFRD (04-03) – F. Andrian, J.-R. Lherbier & M. Monkachi

Senate Hall

Session D3-1B – Constitutive Models - 1 **9:15 - 10:15**
Session Chair: Christine Detournay

3D anisotropic modelling of deep drifts at the Meuse/Haute-Marne URL (02-01) – M. Souley, M.N. Vu & G. Armand

DEM analysis of intact rock strength under confined tension (02-02) – H. Huang & Y. Ma

Prediction of field sand cyclic resistance in terms of relative state parameter index using numerical experiments (02-03) – Z. Cheng

Coffee Break (Main Ceremonial Chamber) **10:15 - 10:30**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D3-2A – Fluid-Mechanical Analyses **10:30 - 12:00**
Session Chair: Christian Missal

Fluid flow model in fractured rock by Finite Volume Black Oil Simulator (FVBOS) and 3DEC (06-01) – S. Nazary Moghadam, N. Deisman, G. Zambrano-Narvaez, J. Hazzard & R. Chalaturnyk

Iterative coupling of single-phase reservoir flow and geomechanics (06-02) – Y.N. Saraiva, H.A.V. Haro & L.G. Rodrigues

Modelling the water injection induced fault slip in an argillaceous rock (06-03) – W.J. Shiu, W.C. Chang & F.Y. Hsiao

Geo-mechanical and flow modeling of Paradox Valley Unit (06-04) – C. Detournay, E. Dzik & C. Wood

Senate Hall

Session D3-2B – Constitutive Models - 2 **10:30 - 12:00**
Session Chair: Zhao Cheng

Critical plane anisotropy adapted for general 3D stress conditions (02-04) – E.M. Dawson & W.H. Roth

A multiscale approach for cohesive and unsaturated soils as a constitutive model designed for FLAC3D (02-05) – M. Miot, G. Veylon, A. Wautier, S. Emam, F. Nicot & P. Philippe

Viscous ubiquitous joint in Comba user defined model for FLAC3D/3DEC (02-06) – C. Detournay, G. Meng & P. Cundall

Cost/benefit analysis of constitutive laws and DEM approach for geotechnical simulations under various loading paths (02-07) – T. Mohamed, J. Duriez & L. Peyras

Lunch (Main Ceremonial Chamber) **12:00 - 1:30**

Small Ceremonial Chamber

KEYNOTE ADDRESS – Kurt Mair am Tinkhof & Nedim Radončić – *Practical use of FLAC3D in tunneling* (08-02) **1:30 - 1:55**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D3-3A – Nuclear Waste - 1 **2:00 - 3:30**
Session Chair: Bruno Figueiredo

A numerical investigation of the mechanical response of dual-purpose canisters to internal pressurization (12-01) – J. Furtney, A. Riahi, B. Damjanac & E. Hardin

Modeling degradation of Dual-Purpose Canisters using 3DEC (12-02) – Varun, A. Riahi, B. Damjanac & E. Hardin

Structural control on stress variability at Forsmark (12-03) – M. Hakala, J. Valli & J. Ström

Anisotropic permeability in the EDZ of drifts in rock salt – A numerical approach (12-04) – C. Missal & J. Stahlmann

Senate Hall

Session D3-3B – Numerical Methods and Techniques - 1 **2:00 - 3:30**
Session Chair: David Russell

An introduction to StopeX- a plug-in to simplify and fast-track FLAC3D numerical modelling for mining applications (13-01) – A. Vakili, B. Abedian & B. Cosgriff

Griddle generation of FLAC3D models for the Baihetan dam project (13-02) – G. Meng, J. Xu, A. Shi & C. Detournay

Pre-processing and meshing FE models with griddle/Rhino: Applications on complex geometries from salt mine drifts (13-03) – G. Maniatis & S. Fahland

DFN.lab: Software platform for Discrete Fracture Network models (13-04) – R. Le Goc, B. Pinier, C. Darcel, E. Lavoine, D. Doolaeghe & P. Davy

Coffee Break (Main Ceremonial Chamber) **3:30 - 4:45**

CONCURRENT SESSIONS

Small Ceremonial Chamber

Session D3-4A – Nuclear Waste - 2 **3:45 - 5:00**
Session Chair: Fabian Dedecker

Application of PFC in earthquake modelling and seismic hazard assessment of an underground nuclear waste repository (12-06) – J.S. Yoon, A. Zang, O. Stephansson, C.-H. Pettersson & F. Lanaro

CIGEO radioactive waste repository project – Modelling of claystone behavior and analysis of thermomechanical induced effects based on FLAC3D simulations (12-07) – M. Camusso, A. Saitta, O. Ozanam & M. Vu

Use of a fully tensorial approach to characterize the stress variability at Forsmark (12-08) – B. Figueiredo, J. Sjöberg & D. Mas Ivars

Underground Research Laboratory of Bure – Prediction of tunnel behavior during excavation in the short- and long-term based on FLAC3D simulations (12-09) – X.P. Nguyen, M. Monfared, O. Bril & G. Armand

Senate Hall

Session D3-4B – Numerical Methods and Techniques - 2 **3:45 - 5:00**
Session Chair: Jason Furtney

Implementation of advanced numerical solvers in FLAC3D thermal and fluid implicit formulation (13-05) – A.V. Pyatigorets & D.B. Russell

Implementation of joint roughness and waviness into DEM simulations (13-06) – A. Mortazavi

Incorporating surface roughness into DEM models of crushable soils (13-07) – N. Zhang, M. Arroyo, M. Ciantia & A. Gens

Modeling transport of corrosion products in Multi-Purpose Canisters using PFC3D (12-05) – Varun, B. Damjanac & E. Hardin

Small Ceremonial Chamber

Symposium Closure — Charles Fairhurst/Martin Schöpfer/David Russell **5:00 - 5:30**
Future plans for Itasca software (18-01) – J. Hazzard (presented by David Russell)

ABOUT THE VENUE

Main building © University of Vienna

The Main Building of the University of Vienna is located within Vienna's historic center, directly on Vienna's Ringstrasse Boulevard. The building, designed by Heinrich Ferstel, was built in the Italian Renaissance style and inaugurated in 1884. In the heart of the Main Building is the green Arcaded Courtyard. In the middle of the Courtyard, you can find the Castalia fountain, which is surrounded by the Arcaded Courtyard's walkways with numerous busts and monuments erected to honor former University staff, including Nobel Prize winner Erwin Schrödinger, and other notable scientists, such as Ludwig Boltzmann, Christian Doppler and Sigmund Freud.

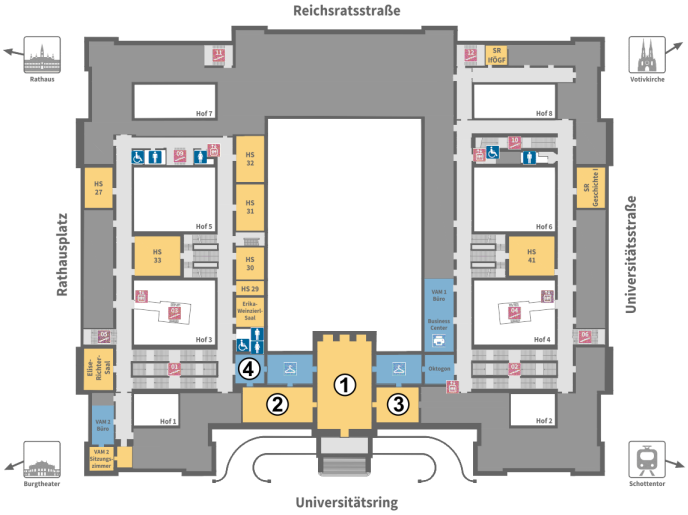
Main Ceremonial Chamber, ceiling paintings by Gustav Klimt © University of Vienna

The Main Ceremonial Chamber, where the icebreaker reception and breaks are held, is the heart of the ceremonial hall area at the Main Building of the University of Vienna. The famous reproductions of Gustav Klimt's ceiling paintings and the statues of Duke Rudolf IV and Maria Theresa provide an impressive atmosphere and befit festive occasions.

MAPS

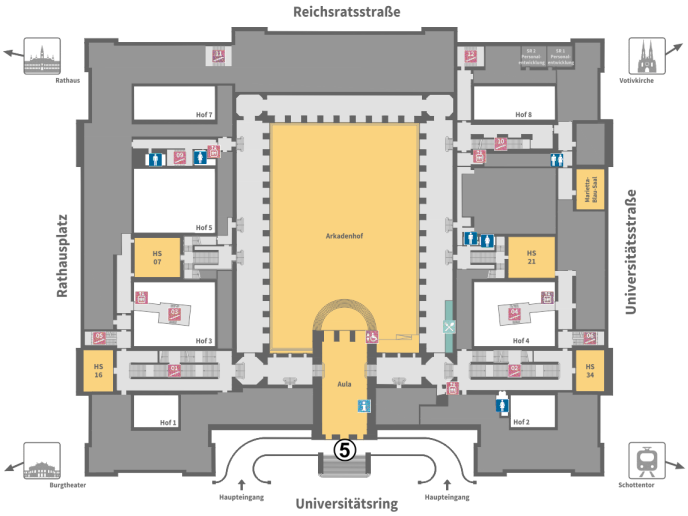
Main building of the University of Vienna

First Floor



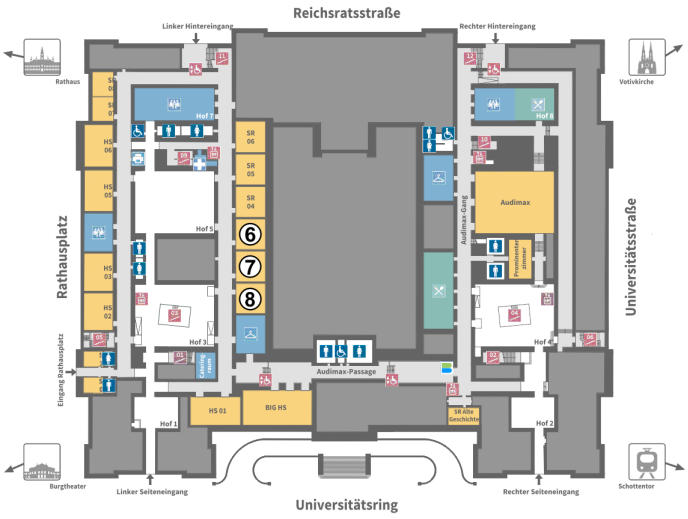
1. **Main Ceremonial Chamber** (*Grosser Festsaal*)
   - Icebreaker Reception
   - Coffee breaks and lunches
2. **Small Ceremonial Chamber** (*Kleiner Festsaal*)
   - Keynotes
   - Concurrent sessions
3. **Senate Hall** (*Senatssaal*)
   - Concurrent sessions
4. **Registration desk**

Raised ground floor



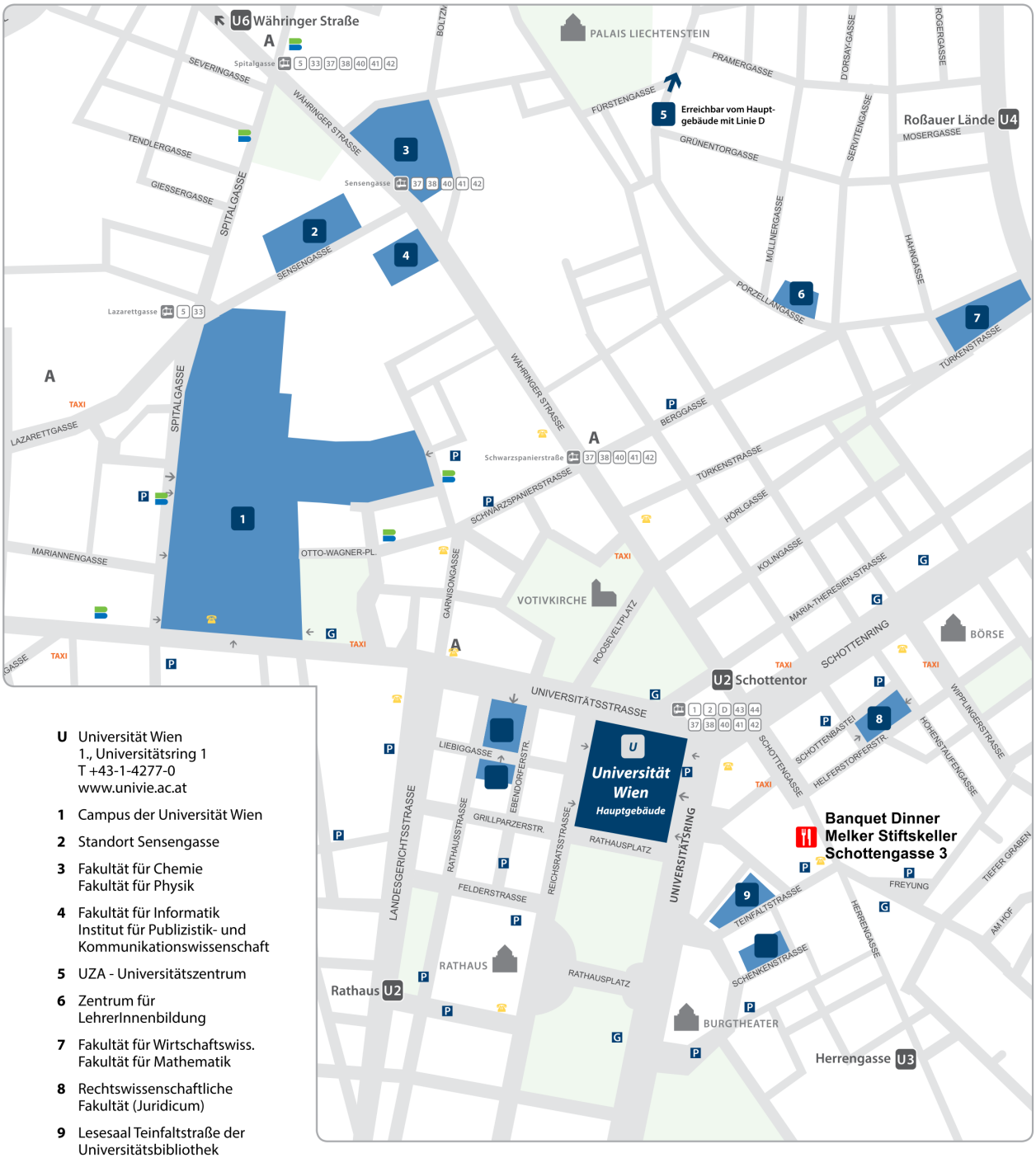
5. **Main entrance**
   - Use stairs 01 or 02 or lift to reach first floor

Basement



6. **Seminar Room 3 (Workshops)**
   - Microseismic monitoring and modeling
   - Applications of the Particle Flow Code
7. **Seminar Room 2 (Workshops)**
   - Conventional tunneling using *FLAC3D*
   - Dynamic modeling in *FLAC* and *FLAC3D*
8. **Seminar Room 1**
   - Coffee Breaks during workshops

MAPS



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1 Campus der Universität Wien

2 Standort Sensengasse

3 Fakultät für Chemie
Fakultät für Physik

4 Fakultät für Informatik
Institut für Publizistik- und Kommunikationswissenschaft

5 UZA - Universitätszentrum

6 Zentrum für LehrerInnenbildung

7 Fakultät für Wirtschaftswiss.
Fakultät für Mathematik

8 Rechtswissenschaftliche Fakultät (Juridicum)

9 Lesesaal Teinfaltstraße der Universitätsbibliothek

Standort Schenkenstraße

Fakultät für Psychologie

Neues Institutsgebäude (NIG)

Bankomat | ATM
Sehenswürdigkeit | Sights
G Parkgarage | Parking garage

A Apotheke | Pharmacy
Eingang | Entrance
P Behinderten-Parkplatz | Disabled parking spot

Telefonzelle | Telephone booth
U2 U-Bahn | Underground

ABOUT THE LOGO

The Romanesque and Gothic style St. Stephen's Cathedral — referred to by the Viennese as Steffl (meaning Stevie) — is one of Vienna's most recognizable symbols. The massive south tower, an architectural masterpiece with a construction time of 75 years, is a dominant feature of the Vienna skyline. The originally planned equivalent north tower was not completed for financial, political and religious reasons, giving the cathedral its characteristic asymmetric appearance. The oldest part of the cathedral is the Romanesque west portal (built 1230-1250), with the main entrance called Giant's Door, presumably because mammoth bones were found during excavation of the foundation. Various rock types from over a dozen quarries were used as building stones, including limestones and calcareous sandstones. Preservation and repairs have been a continuous process since the original construction in 1147, which, today, is assisted by a digital 3D virtual model of the cathedral, used by the permanent staff of the on-site workshop, located at the cathedral's north wall.

St. Stephen's Cathedral, with 136 m tall south tower (right), two 65 m tall Romanesque towers (left), and roof of glazed tiles. © Cathpress.

Mammoth femur found during excavation (inscription reads 1443), thought to be from a giant. The bone was mounted above the main portal, giving rise to its name, Giant's Door. Today, the bone is in the University of Vienna archive. © NHM Wien.

The Vienna Giant Wheel (Wiener Riesenrad), one of Vienna's most popular tourist attractions. It was constructed in 1897 to celebrate the Golden Jubilee of Emperor Franz Josef I and was the world's tallest extant Ferris wheel from 1920–1985. The wheel is a triacontagon with a radius of 100 ft, reflecting that it was designed by British engineers. The original wheel held 30 gondolas, one at each vertex of the triacontagon, but due to severe damage during WWII, it was rebuilt with 15 gondolas. The Vienna Giant Wheel has appeared in numerous movies, such as The Third Man (1949) and James Bond: The Living Daylights (1987). © Wiener Riesenrad.