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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Véronique Arroyo

University of Vienna
Martin Schöpfer
The Conference and Event Management Team

Itasca Consulting Group, Inc.
Jim Hazzard
Michele Nelson
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Vienna University of Technology
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Heinz Konietzky
TU Bergakademie Freiberg

Hannes Lagger
ARUP

José Lemos
Laboratório Nacional de Engenharia Civil

Adrien Saitta
Egis
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 colleague 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 geotechnical 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 colleague 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.
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

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
Martin Schöpfer 1:30 - 5:00

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

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

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 redistribution under geological lateral pressures (17-03) – W.C. Chang & W.J. Shiu

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

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


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Coffee Break (Main Ceremonial Chamber) 10:15 - 10:30
### Session D1 - Masonry

**Session Chair:** Peter Cundall


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

**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

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


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

### Session D1 - Mining

**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


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

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**Small Ceremonial Chamber**

**Session D1-2A – Tunneling - 2**

**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

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

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

**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


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

**Small Ceremonial Chamber**

**KEYNOTE ADDRESS—José Lemos—Dynamic analysis of masonry structures with DEM**

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**Coffee Break (Main Ceremonial Chamber)**

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**Small Ceremonial Chamber**

**Session D1-3A – Masonry**

**Session Chair:** Peter Cundall


**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


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

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**Senate Hall**

**Session D1-2B – Mining - 2**

**Session Chair:** Sebastian Hortberg

**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


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

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**Small Ceremonial Chamber**

**Session D1-3B – Tunneling - 2**

**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


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

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**Coffee Break (Main Ceremonial Chamber)**

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**Small Ceremonial Chamber**

**Session D1-4A – Tunneling - 2**

**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


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

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**Senate Hall**

**Session D1-4B – Mining - 2**

**Session Chair:** Sebastian Hortberg

**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


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

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**Coffee Break (Main Ceremonial Chamber)**

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**Session D1-4A – Tunneling - 2**

**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


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

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**Coffee Break (Main Ceremonial Chamber)**

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**Session D1-4B – Mining - 2**

**Session Chair:** Sebastian Hortberg

**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


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

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**Coffee Break (Main Ceremonial Chamber)**

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**Session D1-4A – Tunneling - 2**

**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


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

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**Coffee Break (Main Ceremonial Chamber)**
**Session D1 - 4A – Slope Stability**

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


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**Session D1 - 4B – Hydraulic Fracturing**

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

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**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


8:45 - 9:10

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**CONCURRENT SESSIONS**

**Small Ceremonial Chamber**

**Session D2-1A – Caverns and Large Excavations - 1**

Session Chair: Hannes Lagger

9:15 - 10:15

**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

**Coffee Break (Main Ceremonial Chamber)**

10:15 - 10:30

**Senate Hall**

**Session D2-1B – Material Behavior - 1**

Session Chair: Charles Fairhurst

9:15 - 10:15

**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

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### CONCURRENT SESSIONS

#### Small Ceremonial Chamber

**Session D2-2A – Caverns and Large Excavations - 2**

**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. Yildirim
- 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

**Lunch (Main Ceremonial Chamber)**

12:00 - 1:30

**Group Photo (location to be announced)**

1:00 - 1:20

#### Senate Hall

**Session D2-2B – Material Behavior - 2**

**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

**Coffee Break (Main Ceremonial Chamber)**

3:45 - 4:00

### CONCURRENT SESSIONS

#### Small Ceremonial Chamber

**Session D2-3A – Soil/Rock Structure Interaction**

**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

**Session D2-3B – Damage Mechanics - 1**

**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

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<th>Small Ceremonial Chamber</th>
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<td><strong>Session D2-4A – Rockfall/Debris Flow and Dynamic Analysis</strong></td>
<td><strong>Session D2-4B – Damage Mechanics - 2</strong></td>
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<td><strong>Session Chair:</strong> Dina D’Ayala</td>
<td><strong>Session Chair:</strong> Gregor Schweppe</td>
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<td>4:00 - 5:40</td>
<td>4:00 - 5:40</td>
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<tr>
<td><strong>Civil (Rockfall/Debris Flow)</strong></td>
<td><strong>Micromechanics of hydro-thermal damage and fracturing in rocks based on DEM modeling with thermal convection</strong> (03-06) – M. Gutierrez &amp; I. Tomac</td>
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<td><strong>Impact on barriers: single rock fall vs rock mass fall</strong> (14-01) – A. Preh, M. Illeditsch, P. Pamminger &amp; M. Schmidt</td>
<td><strong>Numerical modeling of thermal stimulation for geothermal core studies</strong> (03-07) – M.C. Villeneuve &amp; P.A. Siratovich</td>
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<td><strong>Simulation of impacts on a rockfall protection wall made of interconnected concrete blocks</strong> (14-02) – A. Furet, S. Lambert, P. Villard &amp; J.-P. Jarrin</td>
<td><strong>Numerical modelling of the quasi-brittle behavior of materials by considering microcracks effect</strong> (03-08) – F. Asadi, D. André, S. Emam, P. Doumalin &amp; M. Huger</td>
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<tr>
<td><strong>Impact assessment of debris flows on structures using discrete numerical modelling</strong> (14-03) – R. Chehade, B. Chevalier, F. Dedecker &amp; P. Breul</td>
<td><strong>DEM modelling of grain crushing in element tests</strong> (03-09) – J. Lin, M. Kriechhammer, W. Wu &amp; L. te kamp</td>
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<td><strong>Dynamic Analysis</strong></td>
<td><strong>Comparison of DEM and experimental results for evaluation of ground surface displacement due to fault movement below architectural structures</strong> (03-10) – A. Oya, N.</td>
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<td><strong>Dynamic analysis of fault-slip in longwall mining using a linear slip weakening law</strong> (05-02) – C. Wei, C. Zhang &amp; I. Canbulat</td>
<td><strong>DEM analysis of intact rock strength under confined tension</strong> (02-02) – H. Huang &amp; Y. Ma</td>
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<tr>
<td><strong>Banquet Dinner (Melker Stiftskeller)</strong></td>
<td><strong>Prediction of field sand cyclic resistance in terms of relative state parameter index using numerical experiments</strong> (02-03) – Z. Cheng</td>
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### Thursday, February 20

**Symposium Presentations**

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<td><strong>Authors Breakfast Meeting w/ Session Chairs</strong> (Main Ceremonial Chamber)</td>
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<td>7:30 - 8:30</td>
<td>9:15 - 10:15</td>
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<tr>
<td>Welcome &amp; Introduction – Rainer Poisel/Martin Schöpfer</td>
<td><strong>Session Chair:</strong> Ayaka Oya</td>
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<tr>
<td>8:30 - 8:45</td>
<td><strong>Session D3-1A – Dams and Retaining Walls</strong></td>
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<tr>
<td><strong>KEYNOTE ADDRESS</strong> – Peter Cundall—<em>The art of numerical modelling in geomechanics</em></td>
<td>9:15 - 10:15</td>
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<tr>
<td>8:45 - 9:10</td>
<td><strong>Session Chair:</strong> Christine Detournay</td>
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<tr>
<td><strong>Coffee Break (Main Ceremonial Chamber)</strong></td>
<td><strong>Session D3-1B – Constitutive Models - 1</strong></td>
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<tr>
<td>10:15 - 10:30</td>
<td>9:15 - 10:15</td>
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<tr>
<td></td>
<td><strong>3D anisotropic modelling of deep drifts at the Meuse/Haute-Marne URL</strong> (02-01) – M. Souley, M.N. Vu &amp; G. Armand</td>
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<td></td>
<td><strong>DEM analysis of intact rock strength under confined tension</strong> (02-02) – H. Huang &amp; Y. Ma</td>
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## CONCURRENT SESSIONS

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<tr>
<td><strong>Session D3-2A – Fluid-Mechanical Analyses</strong> 10:30 - 12:00</td>
<td><strong>Session D3-2B – Constitutive Models - 2</strong> 10:30 - 12:00</td>
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<tr>
<td><strong>Session Chair:</strong> Christian Missal</td>
<td><strong>Session Chair:</strong> Zhao Cheng</td>
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<tr>
<td><em>Fluid flow model in fractured rock by Finite Volume Black Oil Simulator (FVBOSS) and 3DEC (06-01)</em> – S. Nazary Moghadam, N. Deisman, G. Zambrano-Narvaez, J. Hazzard &amp; R. Chalaturnyk</td>
<td><em>Critical plane anisotropy adapted for general 3D stress conditions (02-04)</em> – E.M. Dawson &amp; W.H. Roth</td>
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<tr>
<td><em>Modelling the water injection induced fault slip in an argillaceous rock (06-03)</em> – W.J. Shiu, W.C. Chang &amp; F.Y. Hsiao</td>
<td><em>Viscous ubiquitous joint in Comba user defined model for FLAC3D/3DEC (02-06)</em> – C. Detournay, Meng &amp; P. Cundall</td>
</tr>
<tr>
<td><em>Geo-mechanical and flow modeling of Paradox Valley Unit (06-04)</em> – C. Detournay, E. Dzik &amp; C. Wood</td>
<td><em>Cost/benefit analysis of constitutive laws and DEM approach for geotechnical simulations under various loading paths (02-07)</em> – T. Mohamed, J. Duriez &amp; L. Peyras</td>
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### Lunch (Main Ceremonial Chamber) 12:00 - 1:30

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<tr>
<th>Small Ceremonial Chamber</th>
<th><strong>KEYNOTE ADDRESS – Kurt Mair am Tinkhof &amp; Nedim Radončić – Practical use of FLAC3D in tunneling (08-02)</strong> 1:30 - 1:55</th>
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<tr>
<td><strong>Session Chair:</strong> Bruno Figueiredo</td>
<td><strong>Session Chair:</strong> Jesse Finken</td>
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Small Ceremonial Chamber
Session D3-4A – Nuclear Waste - 2
Session Chair: Fabian Dedecker

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
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
Future plans for Itasca software (18-01) – J. Hazzard (presented by David Russell)

5:00 - 5:30
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.

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.
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

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

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
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.

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.