

The 3rd International Conference on Rock Dynamics and Applications
(RocDyn-3), 25-29 June 2018, Trondheim, Norway

RocDyn-3

Conference Program

Organisers

Norwegian University of Science & Technology (NTNU)
University of Oulu

Supporters

International Society for Rock Mechanics and Rock Engineering (ISRM)
Norwegian Association of Rock Mechanics (NBG)

Gold Sponsors



WELCOME MESSAGE

Dear Colleagues and Friends,

Welcome to the Third International Conference on Rock Dynamics and Applications (RocDyn-3). It is held on 25-29 June 2018 in Trondheim, Norway. RocDyn-3 is a specialised symposium of the International Society for Rock Mechanics (ISRM) and supported by the Norwegian National Group of Rock Mechanics (NBG).

The conference accepted 102 full papers among which 38 papers are on rockburst, dynamics rock support and seismic monitoring, 34 papers on dynamic testing and theoretical and numerical studies, 20 papers on earthquake-related topics and rock blasting, and 10 papers on other relevant topics. The topics of the papers reflect the recent developments in experiments and theories of dynamic rock testing, rockburst, seismic management, dynamic rock support, blasting, earthquake damage, etc. In addition to technical sessions for the presentation of the papers, two forums are held for invited speeches and open discussions on (1) rockburst and dynamic rock support and (2) dynamic testing of rock and blasting.

On behalf of RocDyn-3 organisers, we would like to welcome scientists and engineers (including the future ones) working on rock dynamics research and practice to join us in Trondheim, to share the updated knowledges of the subject.

Charlie Li, Kristoffer Vik-Langlie and Zong Xian Zhang
Chairs, RocDyn-3 Organising Committee

CONFERENCE ORGANISATION

Organisers

Norwegian University of Science and Technology (NTNU), Norway
University of Oulu, Finland

Co-Organisers

Monash University, Australia
University of Toronto, Canada
Central South University
Southeast University, China

Institute of Rock and Soil Mechanics, CAS, China
Nanyang Technological Univ., Singapore
Southwest Jiaotong University, China
ISRM Commission on Rock Dynamics

Supporters

International Society for Rock Mechanics and Rock Engineering (ISRM)
Norwegian Association of Rock Mechanics (NBG)

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Yuri PETROV, Russia
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Timo SAKSALA, Finland

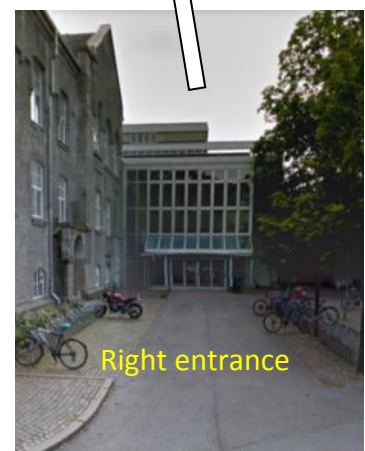
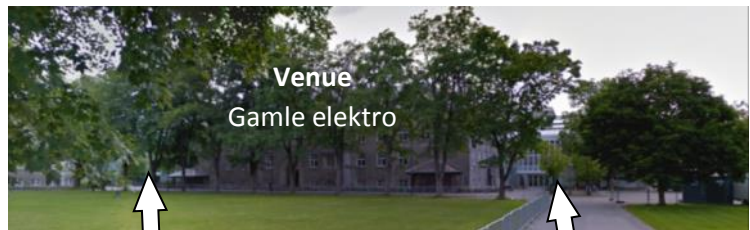
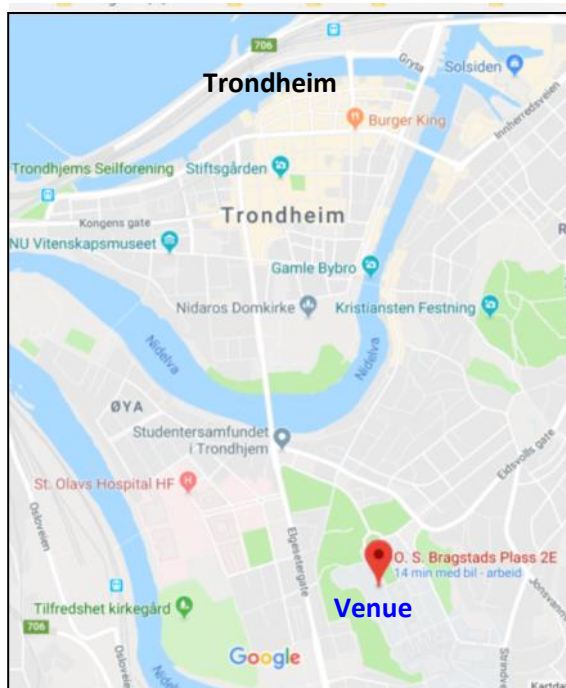
Brad SIMSER, Canada
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Chun'An TANG, China
Wenge Qiu, China
Ernesto VILLAESCUSA, Australia
Lili WANG, China
Qizhi WANG, China
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Mike YAO, Canada
Paul YOUNG, Canada
Qianbing ZHANG, Australia
Zongxian ZHANG, Finland
Zhiye ZHAO, Singapore
Yingxin ZHOU, Singapore
Zilong ZHOU, China
Jianbo ZHU, Hong Kong
Wancheng ZHU, China

CONFERENCE INFORMATION

Conference Venue

The conference is held on the Gløshaugen campus of Norwegian University of Science and Technology (NTNU), Trondheim, Norway.

The conference venue is Auditorium EL5 in building Gamle elektro in the campus. The address: O. S. Bragstads Plass 2E, 7034 Trondheim.



Transportation from Airport to hotels

It is convenient to take shuttle buses from the airport of Trondheim (Værnes) to the city centre of Trondheim. It is 30 km from the airport to Trondheim and takes approximately 35 min by shuttle bus. It is a shuttle bus every 10 minutes. There are two shuttle busses, Flybussen and Værnes Expressen, which take different routes. The recommended shuttlebus and take-off station are given in the table below. You buy one-way or two-way tickets on bus with credit card. Taxi is also available outside of the arrival hall.

Hotel	Shuttlebus	Take-off station
Trondheim Vandreheim	Flybussen	Rosendal
Quality Hotel Augustin	Flybussen	Dronningens gate D2
Comfort Hotel Park	Flybussen	Prinsen kino
Scandic Baklandet	Værnes Expressen	Bakkegata



Flybussen



Værnes Expressen

Hotel Locations

The following are the hotels reserved for the conference participants and the Youth Hostel:

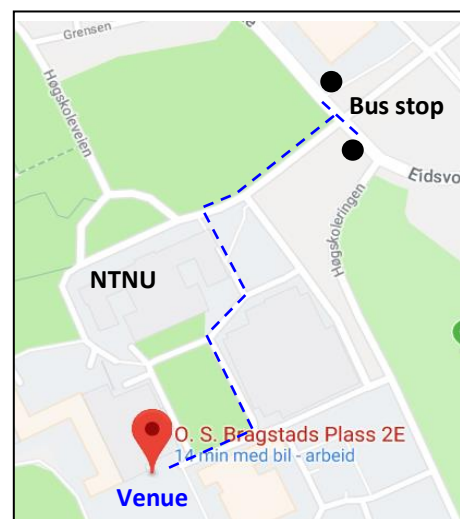
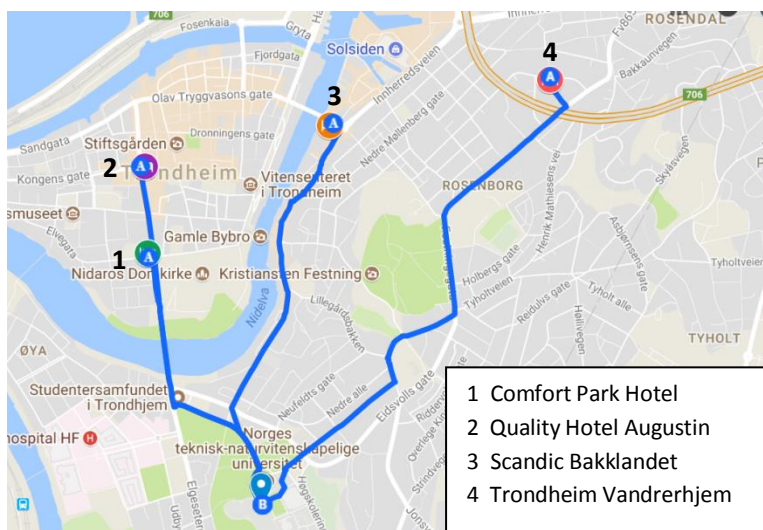
1) Comfort Hotel Park. Address: Prinsens Gate 4A, 7012 Trondheim. 2) Quality Hotel Augustin. Address: Kongens gate 26, 7011 Trondheim. 3) Scandic Baklandet. Address: Nedre Baklandet 60, 7014 Trondheim. 4) Trondheim Vandreheim (Youth hostel). Address: Weidemanns vei 41, 7043 Trondheim.

All the hotels are located in walking distances for 18 - 25 min.

https://drive.google.com/open?id=1a7H5f3xO4NcD_grbebMx50mHAQDiGUU4&usp=sharing.

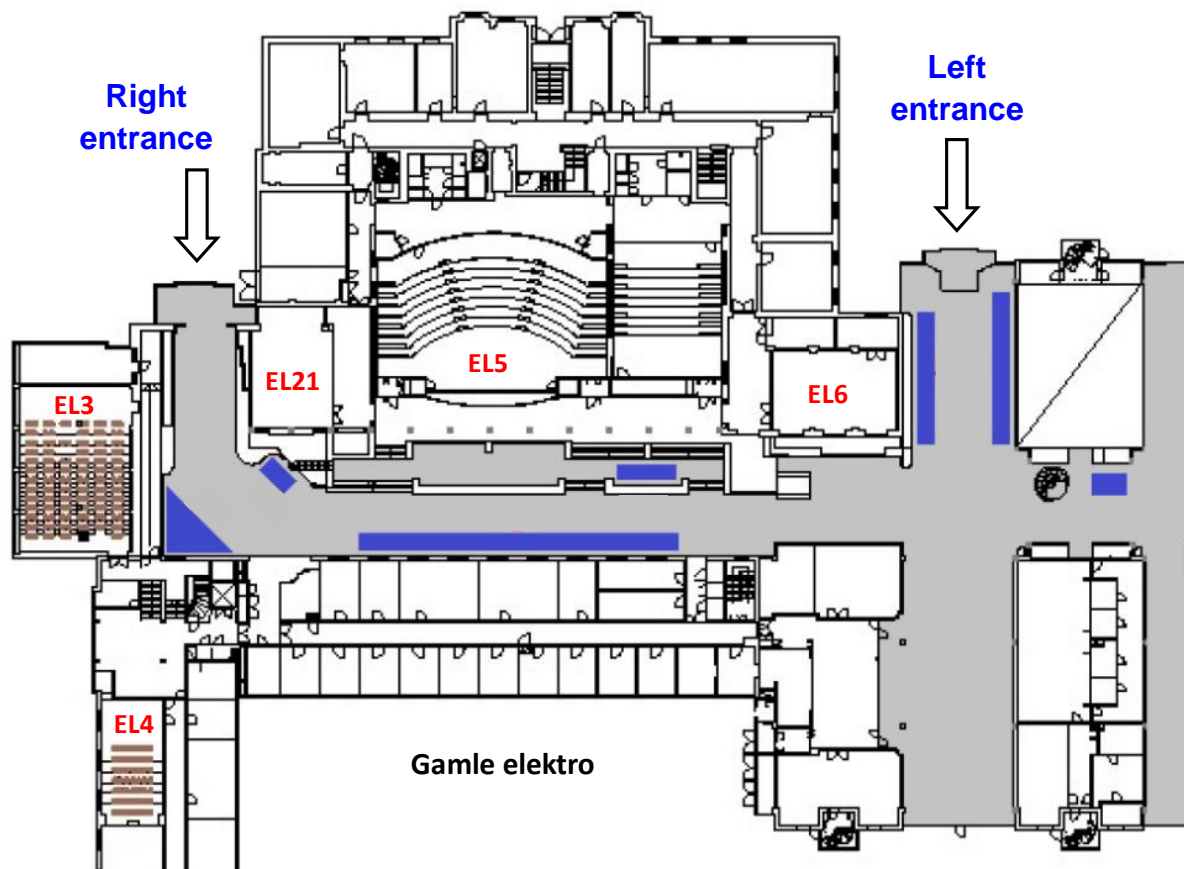
One can also take buses to the conference Venue. You take off bus at bus stop **Høgskoleringen** and then walk approximately 400 m to the Venue: 1) Take Bus 5 from Comfort Hotel Park and Quality Hotel Augustin. 2) Take Bus 22 from Scandic Baklandet. 3) Take Bus 63 from Trondheim Vandreheim.

Bus tickets can be purchased on bus only with CASH. The ticket is valid for 45 min for bus transfer. 24-hour and 7-day tickets are purchased either in the AtB Service Centre (address: Kongens gate 34, Trondheim) or in 7-Eleven shops (addresses: Munkegata 46, Øvre Baklandet 66 and Elgesetergate 2), either with cash or credit card. One-way ticket: adult 60 kr, senior (> 67 years old) 30 kr. 24-hour ticket: adult 111 kr, senior 56 kr. 7-day ticket: adult 259 kr, senior 105 kr.



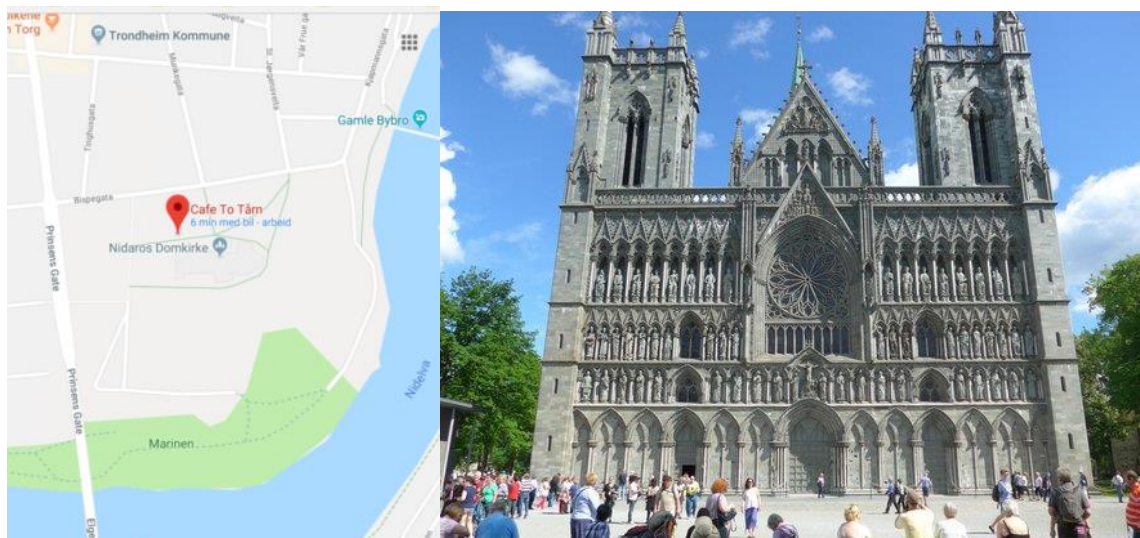
Conference Rooms

All the conference sessions are held in the building of Gamle elektro in the Gløshaugen campus of NTNU. Conference plenary sessions and the Forums are held in Auditorium EL5. Parallel sessions are held in EL3, EL4, EL5 and EL6. The conference office is in EL21.



Reception concert and reception

Reception concert is 19:00-19:30 on 25 June in Nidaros Cathedral. Reception is in Cafe To Tårn beside Nidaros Cathedral (address: Bispegata 5, Nidarosdomens Besøkscenter, 7013 Trondheim). The reception concert and reception are included in the registration.



Conference dinner

The conference dinner is in Lian Restaurant on 26 June. Buses depart from the city centre at 19:00 pm and the dinner starts at 19:30. Folk music will be performed during the dinners. The dinner is excluded in the registration.

Coffee and Tea

Coffee and tea are available during the morning and afternoon breaks at the conference venue. Drinking water is available throughout the conference period.

Lunches

Lunches are served in the canteen in the building of the conference venue, Gamle electro on 26 and 27 June. Lunches are included in the registration.

Registration and Package Collection

Registration starts in the early morning of the first day of the conference, that is, on 26 June. Those who pre-registered and pre-paid on-line can collect the conference package at the registration in the conference venue from 8.00 am on 26 June throughout the conference duration.

On-site registration and payment can be done at the registration desk in the conference venue from 8.00 am to 12.00 am on 26 and 27 June. On-site registration payment can be made by credit cards or by cash.

Name Tags

All delegates are issued with a name tag upon registration. Please wear the name tag when attending the conference and conference functions. Lost name tags can be replaced at the registration desk.

Conference Proceedings

The conference proceedings volume is published in the form of eBook by Publisher CRC. The proceedings volume contains all the full-length papers accepted and presented by the conference. Every participant with standard registration gets a token with which the eBook can be accessed via CRCnetBASE. The papers can be downloaded. The proceedings are available for an indefinite period of time.

Speaker Preparation

Speakers should have their presentation on a USB stick. Speakers are required to meet with their session chairs and upload their presentation onto the conference computer in the session room during the break prior to their session or earlier. IT and AV assistants are available during the whole conference.

WiFi

Free WiFi is available in the conference venue. The network is "ntnu guests".

Tourist Information

Tourist information is available at: <http://visittrondheim.no/en/see-do>. The conference organiser will provide advices for sightseeing tours, but tickets for city sightseeing have to be booked online or in the office of Tourist Information on Nordre gt. 11, Trondheim.

CONFERENCE AWARDS

Best Paper Awards

Best Paper Awards are to be given to the best oral presentations made at the RocDyn-3 Conference. The awards are in two categories, Best Paper in General and Best Paper for Youth. The award winners will be selected by the conference organising committee and two evaluation committees. The award winners will receive certificates of the Best Paper Award.

RocDyn-3 Conference Program

25 June 2018

18:45 Arrival in Nidros Cathedral
19:00 - 19:30 Reception concert in Nidros Cathedral
19:30 - 21:00 Reception in To Tårn beside Nidros Cathedral

26 June 2018

Venue Gamle elektro
08:00 - 16:00 Registration
09:00 - 09:20 Welcome & Opening (Auditorium EL5)
09:20 - 10:40 **Plenary keynote session** (Auditorium EL5)
Chair: Charlie Li
B. Simser: Rockburst observations from hard rock mines – failures, successes, lessons learned
X.B. Li: Dynamic and coupled static-dynamic loading theory and method in deep hard rock mining
10:40 - 10:55 Coffee Break
10:55 - 12:15 **Parallel sessions** A1, A2, A3, A4
12:15 - 13:10 Lunch
12:15 - 17:00 **Poster session 1**
13:10 - 14:20 **Parallel sessions** B1, B2, B3, B4
14:20 - 14:40 Coffee Break
14:40 - 17:00 **Forum 1 Rockburst and dynamic rock support** (Auditorium EL5)
Chair: Charlie Li
Invited speakers: *Gary Peach, Peter Mikula and William Jougain*
Panel members: *Heinz Konietzky, Meifeng Cai, Manchao He, Chun'An Tang, Bruce Hebblewhite, Ugur Ozbay, Lars Malmgren*
19:00 Buses to Lian Restaurant
19:30 - 22:30 Conference dinner in Lian Restaurant

27 June 2018

Venue Gamle elektro
08:30 - 16:30 Registration
09:00 - 10:20 **Plenary keynote session** (Auditorium EL5)
Chair: Zong-Xian Zhang
C.A. Tang: Spalling in extreme ground motion and evidence from the 2008 Wenchuan earthquake
F. Ouchterlony: A review of the development of better prediction equations for blast fragmentation
10:20 - 10:40 Coffee Break
10:40 - 12:30 **Parallel sessions** C1, C2, C2
12:30 - 13:30 Lunch
12:30 - 17:40 **Poster session 2**
13:30 - 15:20 **Parallel sessions** D1, D2, D3
15:20 - 15:40 Coffee Break
15:40 - 17:40 **Forum 2: Dynamic testing of rock and blasting** (Auditorium EL5)
Chair: Kaiwen Xia
Invited speakers: *Sangho Cho, Ajay Kumar Jha and Chris Braithwaite*
Panel members: *Jian Zhao, Qihu Qian, Xibing Li, Finn Ouchterlony, Zilong Zhou, Timo Sakasla, Diyuhan Li, Nuowen Xu, Xinpeng Li*
17:50 - 18:15 Best paper awards and Closing (Auditorium EL5)

28-29 June 2018: An excursion to the western coastline - road tunnels, a subsea tunnel, mountain slides, etc.

INVITED FOURM SPEAKERS

Speaker	Title
	Forum 1 Rockburst and dynamic rock support
<i>Gary Peach:</i>	Rockburst and rockburst management in twin TBM tunnels in the Lower Himalayas
<i>Peter Mikula</i>	Dynamic rock support in Australian metal mines
<i>William Joughin</i>	Rockburst and rockburst management in Southern African deep mines
	Forum 2 Dynamic testing of rock and blasting
<i>Sangho Cho</i>	Dynamic tests of rocks
<i>Ajay Kumar Jha</i>	Blasting techniques and designs
<i>Chris Braithwaite</i>	Shock wave (Hugoniot) testing

SESSION ROOMS

Room	EL6	EL5	EL3	EL4	EL21
26 June					
Sessions	A1	A2	A3	A4	Conf. office
Themes	Laboratory dynamic testing of rock	Dynamic rock support	Theoretical study and numerical modelling	Other relevant topics	
Sessions	B1	B2	B3	B4	
Themes	Laboratory dynamic testing of rock	Rockburst, seismicity & seismic monitoring	Theoretical study and numerical modelling	Laboratory dynamic testing of rock	
27 June					
Sessions	C1	C2	C3		
Themes	Earthquake damage & blasting	Rockburst, seismicity and seismic monitoring	JRDC-SS1: Experimental studies & wave propagation		
Sessions	D1	D2	D3		
Themes	Laboratory dynamic testing of rock	Dynamic rock support	JRDC-SS2: Earthquake related topics		

POSTER PRESENTATIONS (Poster size: 1.2 m width × 0.9 m height)

Poster session 1 (26 June 2018)

- Poster 1 Rockburst prediction mechanics and analysis on typical cases based on microseismic monitoring technique in tunnelling . *T.H. Ma & C.A. Tang*
- Poster 2 Monitoring of mining-induced seismicity in the Khibiny rock massif. *A.A.Kozyrev, E.V.Kasparyan & Iu.V.Fedotova*
- Poster 3 Fracture characteristics of rock under coupled static pre-load and impact disturbance
F.Q. Gong, S. Luo, L. Zhang & D.H. Lu
- Poster 4 Assessment of the damage of metro tunnel precise delay blasting to building structures. *D. Zhang & S. Huan*

Poster session 2 (27 June 2018)

- Poster 5 Effects of the joint density and joint dip angle on the fracture energy in coal mass
C. Zhang, F. Tahmasebinia, I. Canbulat, O. Vardar & S. Saydam
- Poster 6 A study on the dynamic feedback characteristics of the slip body during sliding .
L.G. Wang, G.C. Zhao, Y.H. Xi & Q. Chen
- Poster 7 Collapse experiment and numerical simulation of a slope under strong earthquake
X.F. Liu, N. Zhao & W.B. An
- Poster 8 Determination of the specific rock failure energy at various structural-scale levels
A.V. Zemtsovskii, N.N. Kuznetsov & K.N. Konstantinov

ORAL PRESENTATIONS

* **Bold name** is the presenter.

* **Presentation time** is 15 min for ordinary presentations and 20 min for theme speeches.

26 June 2018

Parallel session A1 (10:55 – 12:15 in Room EL6): Laboratory dynamic testing of rock

Chair: *Dr. Wenge Qiu / Dr. Zilong Zhou*

- 10:55 - 11:15 **Theme speech:** Shear behavior of planar rock joints under dynamic normal load (DNL) conditions
W. Dang, H. Konietzky & T. Frühwirt
- 11:15 – 11:30 Experimental characterization of Himalayan limestone
S. Mishra, T. Chakraborty, V. Matsagar & D. Basu
- 11:30 – 11:45 Monitoring of damage evolution in granite under uniaxial compression by AE and P-wave velocity
T. Zhou & J.B. Zhu
- 11:45 – 12:00 Dynamic increase factors of rock strength
K. Liu, Q.B. Zhang & J. Zhao
- 12:00 – 12:15 Dynamic Mode II fracture toughness determination of rocks with short cores in compression method
S.W. Oh, G. J. Min, S.W. Park, S. H. Cho & Y. H. You

Parallel session A2 (10:55 – 12:15 in Auditorium EL5): Dynamic rock support

Chair: *Dr. Bruce Hebblewhite*

- 10:55 - 11:15 **Theme speech:** Monitoring pillar behaviour while driving towards a Shear Zone in highly stressed ground at Vale's Creighton Mine.
A. Punkkinen, B. Forbes, A. Hyett & J. Whitmore
- 11:15 – 11:30 The need for additional dynamic testing methods for ground support elements
P. Mikula & B.M. Brown
- 11:30 – 11:45 Dynamic test of flexi-bolts reinforcement system and its performance in hard rock underground mining
F. Sengani & T. Zvarivadza
- 11:45 – 12:00 Increased agility for the research and development of dynamic roof support products
G. Knox & A. Berghorst
- 12:00 – 12:20 **Theme speech:** Relationship between energy per impulse and dynamic capacity of a rockbolt
K. Bosman, M. Cawood & A. Berghorst

Parallel session A3 (10:55 – 12:15 in Room EL3): Theoretical study and numerical modelling

Chair: *Dr. Ömer Aydan*

- 10:55 - 11:15 **Theme speech:** Numerical study on the strain-rate sensitivity of rock: meso-mechanical approach
T. Saksala
- 11:15 – 11:30 Application of dominant crack algorithm (DCA) to dynamic tensile failure of rocks
B. Wu, Q. Wang & K. Xia
- 11:30 – 11:45 Dynamic rock slope stability analysis using UDEC software
B.H.V. Sekar & S. R. Naik
- 11:45 – 12:00 DEM analysis of the effect of discontinuities on coal mass brittleness
O. Vardar, C. Zhang, F. Tahmasebinia, I. Canbulat & B. Hebblewhite
- 12:00 – 12:15 A numerical study of spalling under different dynamic loads using PNMM
X. Li, Q.B. Zhang, J. Zhao & J.C. Li

Parallel session A4 (10:55 – 12:15 in Room EL4): Other relevant topics

Chair: *Dr. Caichu Xia*

- 10:55 - 11:15 **Theme speech:** Experimental protocol for stress corrosion cracking for full-size cable bolts
S. Wu, H. L. Ramandi, P. C. Hagan, S. Saydam & B. Hebblewhite
- 11:15 – 11:30 Support Mechanism of 4D Force-transferring Block Set
Z.G. Ma, N. Cui & P. Gong
- 11:30 – 11:45 The performance of mechanical anchors in South African mechanized deep level gold mining
F. Sengani & T. Zvarivadza

- 11:45 – 12:00 Evaluation of in-stope pillar failure: a case study of deep to ultra-deep level gold mining in South Africa
T. Zvarivadza & F. Sengani
- 12:00 – 12:15 Case studies related to real time geotechnical monitoring systems for an open pit coal mine in Western Canada.
G. Bonci

Parallel session B1 (13:10 - 14:20 in Room EL6): Laboratory dynamic testing of rock

Chair: *Dr. Tanusree Chakraborty*

- 13.10 – 13:30 **Theme speech:** Dynamic tests of marble specimens with artificial defects under impact loading by SHPB
D.Y. Li, Z.Y. Han, X.B. Li, X.L. Sun, Y. Shi, & T. Zhou
- 13:30 – 13:45 Stress redistribution of dynamic loading incident through a pre-stressed cavity
M. Tao, H.T. Zhao, Z.W. Li, A. Ma, Z.X. Hong & S.F. Ren
- 13:45 – 14:00 Experimental study of strength characteristics of coal specimens under static and dynamic loadings
W. Wang, H. Wang, H.Z. Zang, H.M. Li & D.Y. Li
- 14:00 – 14:15 Dynamic characteristic of rock under in-situ stress and blast loading
C.L. He & J. Yang

Parallel session B2 (13:10 - 14:20 in Auditorium EL5): Rockburst, seismicity and seismic monitoring

Chair: *Dr. Jian Deng*

- 13.10 – 13:30 **Theme speech:** Inducing mechanism of rockburst with its prediction and prevention principle in metal mines
M.F. Cai
- 13:30 – 13:45 Practice of face-perpendicular preconditioning for safe remnant extraction
T. Zvarivadza & F. Sengani
- 13:45 – 14:00 Rock fracturing related to strain burst in quartzite rock mass
C.C. Li, D. Sandström & A. Nyström
- 14:00 – 14:20 **Theme speech:** Stress evolution and induced seismicity in mining: lab test, observation and modelling
L.A. Nazarova, V.N. Zakharov, L.A. Nazarov, V.L. Shkuratnik, M.I. Protasov & P.V. Nikolenko

Parallel session B3 (13:15 - 14:20 in Room EL3): Theoretical study and numerical modelling

Chair: *Dr. Xing Li*

- 13.15 – 13:30 A dynamic stress state analysis at the pressure tunnel of Upper Tamakoshi HPP, Nepal
K.K. Panthi & C.B. Basnet
- 13:30 – 13:45 Research on the dynamic behaviour of rock material: rate dependency and pulverization
X.F. Li, H.B. Li, Q.B. Zhang & J. Zhao
- 13:45 – 14:00 Analysis of elastic wave attenuation in different rock samples
X.L. Liu, G.Y. Zhao, J.H. Cui, X.B. Li & Q. Guo
- 14:00 – 14:15 Sensitivity analysis of block stability under seismic loading
A. Bolin & R. Ghazal

Parallel session B4 (13:15 - 14:20 in Room EL4): Laboratory dynamic testing of rock

Chair: *Dr. Jianbo Zhu*

- 13.15 – 13:30 Deformation characteristics of Beishan granite under low-cyclic loading
L. Shi, X. Zhang & C.C. Li
- 13:30 – 13:45 Rock energy evolution under triaxial cyclic loading-unloading compression
M.W. Zhang, S.D. Liu, Q.B. Meng, D.Y. Qian & N. Zhang
- 13:45 – 14:00 Dynamic shear (Mode II) fracture toughness testing of brittle rock with punch-through cylindrical specimens
Q.H. Rao, W.D. Liang & H.L. Zhao
- 14:00 – 14:15 Study on rock breakage by disc cutter under coupled static and dynamic loads
Q.B. Lin, P. Cao & Y. Chen

27 June 2018

Parallel session C1 (10:40 - 12:30 in Room EL6): Earthquake damage & blasting

Chair: *Dr. Tawanda Zvarivadza*

- 10:40 – 11:00 **Theme speech:** Seismic effect and aseismic in mountain tunnels
W.G. Qiu
- 11:00 – 11:15 A case study of determining the safety threshold of blasting vibration for tunnel lining
C.C. Xia, F. Xue & J.K. Gao
- 11:15 – 11:30 An experimental investigation on dynamic responses of granite blocks under blast loading
L. Chi, A. Aalberg, Z.X. Zhang & C.C. Li
- 11:30 – 11:45 Seismic response of a tunnel embedded in compacted sand through large-scale shake table testing
H. Zhou & X.H. Wang
- 11:45 – 12:00 Dynamic response of a shallow tunnel with imperfect interface in anisotropic medium
X.P. Zhang & Y.J. Jiang
- 12:00 - 12:15 Seismic response of shallow buried rock tunnel: shaking table test and numerical simulation
J.T. Chen, H.T. Yu & Y. Yuan
- 12:15 – 12:30 Strain and energy parameters of burst-prone rocks: study and analysis
N.N. Kuznetsov, I.V. Fedotova & A.K. Pak

Parallel session C2 (10:40 - 12:30 in Auditorium EL5): Rockburst, seismicity and seismic monitoring

Chair: *Dr. Diyuan Li*

- 10:40 – 11:00 **Theme speech:** Dynamic buckling mechanism of pillar rockbursts induced by stress waves
J. Deng
- 11:00 – 11:15 Microseismic monitoring in twin TBM tunnels in the Lower Himalayas
A.K. Khan, G. Peach, G.A. Rosario, H.-S. Xiong, X.-T. Feng, B. Chen, Y. Xiao & G. Feng
- 11:15 – 11:30 Comparison of microseismic monitoring and actual rockbursts in twin TBM tunnels in the lower Himalayas
G. Peach, G.A. Rosario, H.-S. Xiong & X.-T. Feng
- 11:30 – 11:45 A numerical modeling methodology for assessing rock failure stabilities
Z. Khademian & U. Ozbay
- 11:45 – 12:00 Forecast the deformation of the surrounding rock using MS monitoring
N.W. Xu, F. Dai, T. Zhao, Z. Zhou & C. Sha
- 12:00 - 12:20 **Theme speech:** Triggering mechanism of fault-slip rockburst induced by dynamic disturbances
Q.H. Qian

Parallel session C3 (10:45 - 12:30 in Room EL3):

JRDC-SS1: Experimental studies and wave propagation

(JRDC-SS = Japan Rock Dynamic Commission Special Session)

Chair: *Dr. K. Kamemura*

- 10:45 – 11:00 Two-ways dynamic shear testing of rock discontinuities
Ö. Aydan, N. Tokashiki, N. Z. Nasiry, N. Iwata & R. Kiyota
- 11:00 – 11:15 Numerical simulations on failure and stress wave propagation in solid materials using a 3D lattice spring model
T. Nishimura, M. Kohno & K. Fumimura
- 11:15 – 11:30 Dynamic response of support systems during the excavation of underground openings
Ö. Aydan, F. Ito & T. Ito
- 11:30 – 11:45 Dynamic stability of rock slopes and the effect of reinforcement against planar sliding
Y. Takahashi, N. Iwata, R. Kiyota, K. Adachi, Ö. Aydan & N. Tokashiki
- 11:45 – 12:00 Stick-slip behavior of rock discontinuities by difference in rock types
R. Kiyota, N. Iwata, Y. Takahashi, K. Adachi & Ö. Aydan
- 12:00 - 12:15 Experimental study on seismic stability of foundation rocks under critical facilities
M. Ishimaru, A. Sekiguchi, T. Okada, K. Hiraga & K. Ozawa
- 12:15 – 12:30 Validation of a mathematical model for evaluating the dynamic shear strength of rock
T. Okada & T. Naya

Parallel session D1 (13:30 - 15:20 in Room EL6): Laboratory dynamic testing of rock

Chair: *Dr. Timo Saksala*

- 13:35 – 13:50 Development of impact loading test device for gas-containing coal
Z. Q. Yin, Z. D. Wei, Z. Zhang, J. C. Chang, C. M. Li, H. F. Ma, G. M. Zhao, X. Y. Zhang, W. B. Shi & M. Tu
- 13:50 – 14:05 Effects of water-filled rock joints on ultrasonic P-wave propagation
H. Yang, H.F. Duan & J.B. Zhu
- 14:05 – 14:20 A preliminary study of using high-speed digital image correlation (DIC) to characterize the penetration on geomaterial
H.Z. Xing, G.LN. Wu, Q.B. Zhang, J. Zhao & S. Dehkhoda
- 14:20 – 14:35 Simple rock cutting testing
S. Yasar
- 14:35 – 14:50 Dynamic fracture behavior of dry and saturated sandstone
X. Cai, Z.L. Zhou, D. Ma, X.B. Li & G.Y. Zhao
- 14:50 – 15:05 Shear behavior and acoustic emission characteristics of regular dentate joint
C.D. Su, H.Z. Zang, J.Q. Guo, Y.N. Sun, C.S. Song & W. Wang

Parallel session D2 (13:30 - 15:20 in Auditorium EL5): Dynamic rock support

Chair: *Dr. Serkan Saydam*

- 13:30 – 13:50 **Theme speech:** Development of the MDX Bolt and in-situ dynamic testing at Telfer Gold Mine
B. Darlington, M. Rataj, G. Balog & D. Barnett
- 13:50 – 14:05 Towards improved design of rock reinforcement systems in burst-prone rock masses
W. Breure, D.J.M. Ngan-Tillard & C.C. Li
- 14:05 – 14:20 Mechanical response of fully bonded bolts under cyclic loading
X.W. Feng
- 14:20 – 14:35 Garford hybrid dynamic bolt reinforcement system on trial in deep level gold mines of South Africa
T. Zvarivadza & F. Sengani
- 14:35 – 14:50 Dynamic response of rock bolts to blasting vibrations
S.H. Chen & S.W. Hu
- 14:50 – 15:05 Application of the MD bolt in the Fosterville Gold Mine
A. Stiehl, B. Darlington, M. Rataj & P. Young
- 15:05 – 15:20 The development and optimization of face-perpendicular preconditioning technique for development ends
F. Sengani & T. Zvarivadza

Parallel session D3 (13:30 - 15:20 in Room EL3):

JRDC-SS2: Earthquake related topics

(JRDC-SS = Japan Rock Dynamic Commission Special Session)

Chair: *Dr. T. Nishimura*

- 13:35 – 13:50 Seismic characteristics of field measurements and numerical analyses of an underground quarry in Oya
T. Seiki, T.K.M. Dintwe, R. Yamaguchi, S. Noguchi & T. Ohmura
- 13:50 – 14:05 Some considerations on the stability and design of underground structures during earthquakes
K. Kamemura & Ö. Aydan
- 14:05 – 14:20 Damage to rock engineering structures induced by the 2016 Kumamoto earthquakes
Ö. Aydan, J. Tomiyama, H. Matsubara, N. Tokashiki & N. Iwata
- 14:20 – 14:35 Dynamic response and stability of some historical masonry structures subjected to ground shaking
N. Tokashiki, Ö. Aydan, N. Z. Nasiry, T. Ito & M. Geniş
- 14:35 – 14:50 Simulation of strong motions and surface rupture of the 2014 Northern Nagano Earthquake
N. Iwata, R. Kiyota, et al. K. Adachi, Y. Takahashi, Ö. Aydan, F. Miura & T. Ito
- 14:50 – 15:05 Status of rock dynamics study in Horonobe Underground Research Laboratory, Japan
T. Sato, K. Aoyagi, Y. Matsuzaki, N. Miyara & K. Miyakawa
- 15:05 – 15:20 Design and performance of the foundation of the tsunami protection wall at the Hamaoka Nuclear Power Station
Masaaki Wani