ΕΛΛΗΝΙΚΗ
ΕΠΙΣΤΗΜΟΝΙΚΗ
ΕΤΑΙΡΕΙΑ
ΕΔΑΦΟΜΗΧΑΝΙΚΗΣ
& ΓΕΩΤΕΧΝΙΚΗΣ
ΜΗΧΑΝΙΚΗΣ

Τύμφη - Δρακολίμνη

Σαντορίνη - Βλυχάδα

Τα Νέα της Ε Ε Ε Ε Γ Μ

109

Αρ. 109 – ΔΕΚΕΜΒΡΙΟΣ 2017

Τα άλματα τεχνογνωσίας στον τομέα της σεισμικής μηχανικής θα συζητηθούν στο 16ο Πανευρωπαϊκό Συνέδριο Σεισμικής Μηχανικής (16ECEE – 16th European Conference on Earthquake Engineering) που διοργανώνεται (18 - 21 Ιουνίου 2018) από το Ελληνικό Τμήμα Αντισεισμικής Μηχανικής της Ευρωπαϊκής Ένωσης Σεισμικής Μηχανικής, σε συνεργασία με το Τμήμα Πολιτικών Μηχανικών του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης. Ο χρόνος του συνεδρίου θα συμπέσει με την 40η επέτειο από το μεγάλο σεισμό της Θεσσαλονίκης (20 Ιουνίου 1978), και ως εκ τούτου η επιστημονική διοργάνωση φιλοδοξεί να αποτελέσει αφορμή σύνδεσης ενός επιστημονικού γεγονότος με θέματα που αφορούν στην ίδια την πόλη, αλλά και πλατφόρμα ανάπτυξης περαιτέρω δράσεων σε τοπικό, περιφερειακό και εθνικό επίπεδο, με τη συμμετοχή του ευρύτερου κοινωνικού συνόλου, των φορέων και των πολιτών της Θεσσαλονίκης.

SIMSG ISSMGE

ISRM

Π Ε Ρ Ι Ε Χ Ο Μ Ε Ν Α

16th European Conference on Earthquake Engineering 1

Άρθρα 3

- Numerical Modelling of Tabular Excavations: Old Problems and New Solutions 9
- A Combined Experimental (MICRO-CT) and Numerical (FDEM) Methodology to Study Rock Discontinuities Subjected to Shearing

Νέα από Ελληνικές και Διεθνείς Γεωτεχνικές Ενώσεις 17

- ISSMGE: Professor Mario e. Manassero elected as ISSMGE Vice -President for Europe 17
- ISRM: Prof. Reşat Ulusay elected as the next ISRM President 2019-2023 17
- ISRM News Journal, Volume 20, December 2017 18
- Ελληνική Επιτροπή Σηράγγων και Υπογείων Έργων (Ε.Ε.Σ.Υ.Ε.) - Το νέο Διοικητικό Συμβούλιο 18
- In Memory of Prof. Richard Z.T. Bieniawski 18

Προσεχείς Γεωτεχνικές Εκδηλώσεις: 20

- ICONhIC2018 - 2nd International Conference on Natural Hazards and Infrastructure 21

Ενδιαφέροντα Γεωτεχνικά Νέα 24

- San Francisco Issues Rules for High-Rise Foundations 24

Ενδιαφέροντα - Σεισμοί 25

- World Building of the Year 2017 could help 100 million people, says Edward Ng 25
- Earthquakes in Himalaya bigger because tectonic plates collide faster 26
- Unearthing the underground effects of earthquakes and volcanoes 27

Ενδιαφέροντα - Λοιπά 28

- China Opens World's Coolest Library With 1.2 Million Books, And Its Interior Will Take Your Breath Away 28

Ηλεκτρονικά Περιοδικά 32

Λήμνος

Ζάκυνθος

Numerical Modelling of Tabular Excavations: Old Problems and New Solutions

D. F. Malan | University of Pretoria, South Africa

FRANKLIN LECTURE

INTRODUCTION

It is a great honour to have been chosen as the recipient of the ISRM Franklin Award and I am grateful to the International Society for Rock Mechanics (ISRM) for bestowing this award on me. A keen interest of mine is the rock mechanics problems posed by the deep gold mines in South Africa. A large part of my past and current research efforts have been devoted to this topic as a result. This is certainly not a new rock engineering challenge as the tabular reefs of the Witwatersrand gold mines were discovered and exploited as early as 1886. The mines achieved record breaking depths in the decades that followed and the famous ERPM Mine achieved a depth of 11,003 feet or 3353 m below surface as early as 1958 (Cartwright, 1968).

Owing to the great depth and high extraction ratios, the industry suffered from the damage caused by rock bursts since the early days of mining. Documents such as the "*Report of the Witwatersrand Rock Burst Committee*" in 1924 attempted to classify the types of rock bursts and proposed mechanisms why these seismic events occurred (Mickel, 1933). Of particular interest is that the industry already conducted extensive underground measurements in 1927 to quantify the rock burst problem. Adler (1933) describes the measurements conducted at Crown Mines. A sketch of a primitive "sag-meter" to measure convergence in stopes is shown in Figure 1. The important aspect is that significant "creep-like" movements in the rock mass were recorded, even though the host rock mainly consisted of hard, brittle rock types such as quartzite (Figure 1).

In spite of the attempts to understand the rock burst problem, the design of the mining layouts was based largely on trial and error until the 1960's. A noteworthy change that occurred in 1941 was the implementation of the longwall mining method at ERPM (Figure 2) to reduce the formation of "remnants" or small blocks of isolated ground (Deane, 1954). These remnants were prone to bursting and the longwall method reduced the formation of these blocks.

THE ELASTICITY ASSUMPTION

Following the Coalbrook Colliery disaster in 1960, systematic rock mechanics research gained momentum in South Africa (Van der Merwe, 2006). This research was mainly done by the Chamber of Mines and the CSIR (Council for Scientific and Industrial Research). A key finding during those early years was that the rock mass, far away from the fracture zone surrounding the stopes, behaved in an elastic fashion. Ryder and Officer (1964) conducted measurements in a haulage situated in the hangingwall of the reef above two advancing longwalls over a period of a year (Figure 3). The section of haulage monitored was between 75 m and 120 m above the stoping excavations and therefore remote from the fracture zone surrounding the stoping excavations. Figure 4 illustrates the downward movement of the haulage and the simulated movement predicted by elastic behaviour.

Based on these measurements, the authors concluded that:

- The rock mass at ERPM behaves essentially elastic.

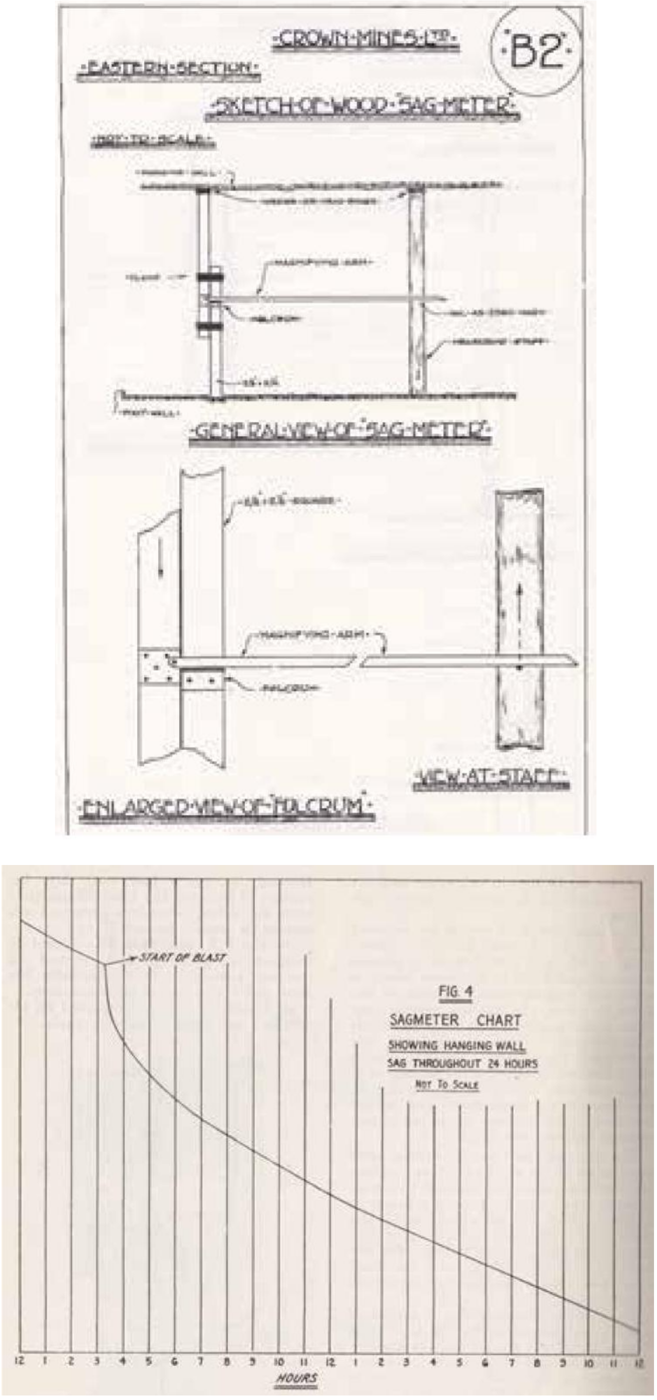


Fig. 1 - A sketch (up) of a primitive instrument to measure convergence in the South African gold mines in 1927 (after Adler, 1933). The graph (down) was recorded by an instrument that could record convergence in a continuous fashion. The convergence increases downwards. Note the creep in the rock mass after the blast occurred. This was recorded at Crown Mines in the early 1930's (after Hamilton, 1954)

- Elastic constants determined from small specimens appear to provide a realistic estimate of the properties of the solid rock underground.

Building on this foundation of elastic theory, Salamon (1963, 1964) described the "face element" principle. This implied that if convergence and ride at each element of the mined area is known, stresses and displacements at any point in an elastic rock mass can be calculated. An integral equation can be set up to compute these convergences and rides, but computers were not readily available at the time to do these simulations. As a solution, it was illustrated that the Laplace equation governed the distributions of convergence and ride for tabular type stress problems. Since the same equation also governs the flow of electricity, an electrolytic tank stress analogue was constructed. This was a breakthrough as for the first time, stresses and displacements around a complex tabular excavation could be accurately determined.

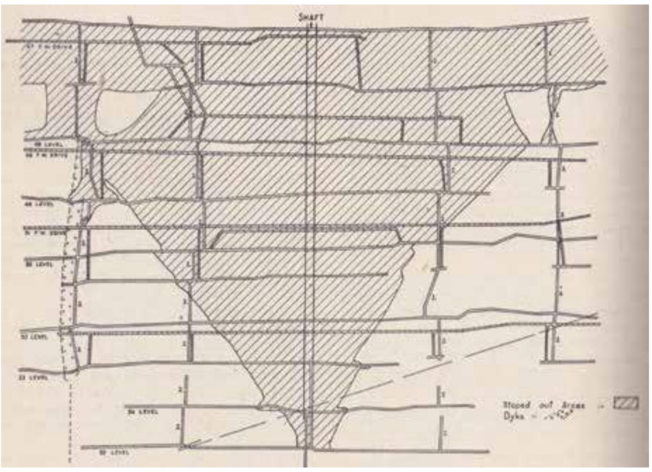


Fig. 2 - A plan view of the Hercules Longwall Area at ERPM Mine in 1943 (after Deane, 1954). The longwall method was introduced in 1941 at the mine to reduce the formation of small isolated blocks of ground or "remnants". The dip of these tabular orebodies was typically 25° to 35°. The great depth, high extraction ratio and the shallow dip of the orebody resulted in very high stress levels and seismicity ahead of the longwall faces

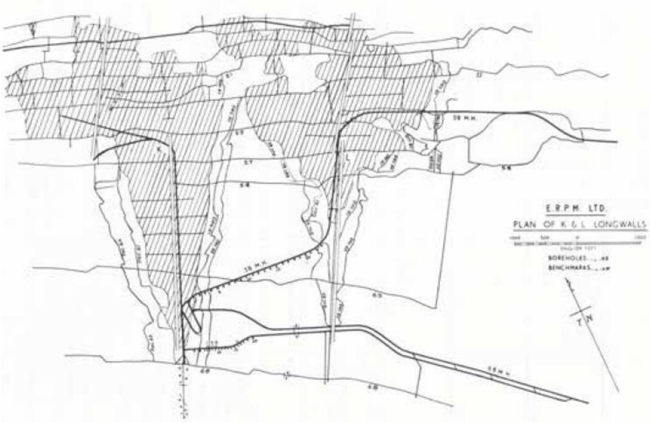


Fig. 3 - The K (left) and L (right) longwalls at ERPM Mine and the position of the 58 level hangingwall haulage where Ryder and Officer (1964) conducted measurements. This is a plan view of the mine workings

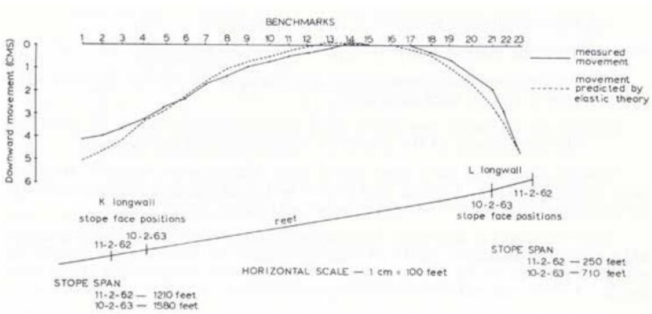


Fig. 4 - The famous measurements and elastic calculation by Ryder and Officer (1964) which indicated that the far-field rock mass behaviour can be approximated by elastic theory

As the electrolytic tank was difficult to set up, Cook and Schumann (1965) designed a practical electrical resistance analogue (Figure 5). A fixed 3D grid of resistors replaced the electrolyte and a patch board of earth pins made it easier to prepare the layout problem. A total of 10 of these analogs were constructed and the original Chamber of Mines model was upgraded as late as 1979.

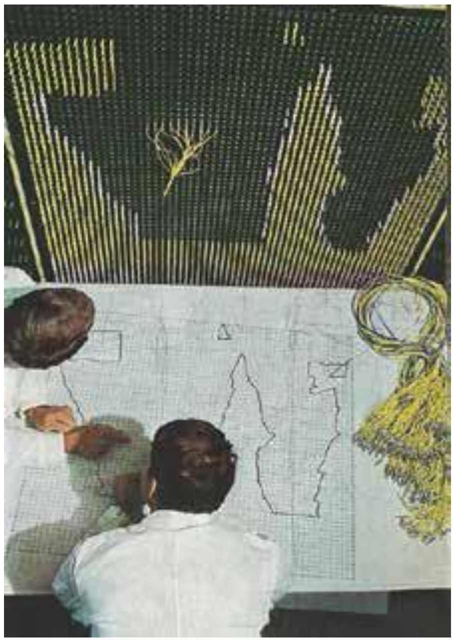


Fig. 5 - Engineers simulating a tabular layout using one of the electrical resistance analogue simulators

Plewman et al (1969) and Deist (1972) described the first MINSIM (short for Mining Simulator) type computer programme. This code was considered as a digital version of the electrolytic and resistance analogues developed earlier. Of interest was that the components of this first MINSIM refer to the "Tank generator" and the "Tank structure in memory". It typically solved a 64 x 64 element reef plane using the same principles described by Salamon (1963). This computer development was made possible when the University of the Witwatersrand acquired a computer with a faster processing unit and storage capacity than what was available in the rest of South Africa. The computer program was developed to avoid the cumbersome transfer of data from the analogues to a computer to calculate the off-reef stresses and displacements (which required a separate integration process). As described by Deist (1972), on the analogues, the reef plane was customarily represented by 60 x 60 discrete squares that were considered either fully mined or unmined. This necessitated the transfer of 3600 potentials for every solution. MINSIM was therefore the first complete digital solution of the tabular mining problem.

In 1981, the Chamber of Mines Research Organisation (COMRO) did a survey regarding the usage of MINSIM-type programs in industry. At that stage there were two distinct families of codes namely:

- MINSIMC: This was a descendant of SHAMIP, which was essentially similar to Deist's original MINSIM. MINSIMC had powerful features such as generalised co-ordinate systems and it could allow for a variable stoping width. Its main drawback was that it was non-portable and could only run on an IBM 370 computer.

- FREER/DREEF: This was developed by S.L. Crouch and extended by workers in South Africa. Many different versions of this code were available. Its big advantage was that it was transportable and could run on any large minicomputer or mainframe. In comparison to MINSIMC, it also had user-friendly graphic input-output features.

Based on this study, it was proposed that a completely new system be developed that could be run on a minicomputer. COMRO adopted a resolution in November 1981 that a modularised MINSIM-type system be developed. This development had to result in a transportable code and include a full multi-reef capability. The development and coding of this program was done by John Napier and the result was the MINSIM-D program (Figure 6).

Fig. 6 - Manuals of the historic MINSIM-D tabular simulation program

The assumption of an elastic rock mass and the development of the modelling tools to simulate the irregular layouts of the tabular stopes resulted in a much improved engineering approach to design these layouts. Various design criteria such as Energy Release Rate (ERR), Average Pillar Stress (APS) and Excess Shear Stress (ESS) are routinely used to design these layouts (Ryder and Jager, 2002). A typical modern layout is shown in Figure 7 and it illustrates the dip pillars to control regional seismicity and bracket pillars to minimize the seismic events caused by large geological structures. This layout should be compared to the much older layouts shown in Figures 2 and 3.

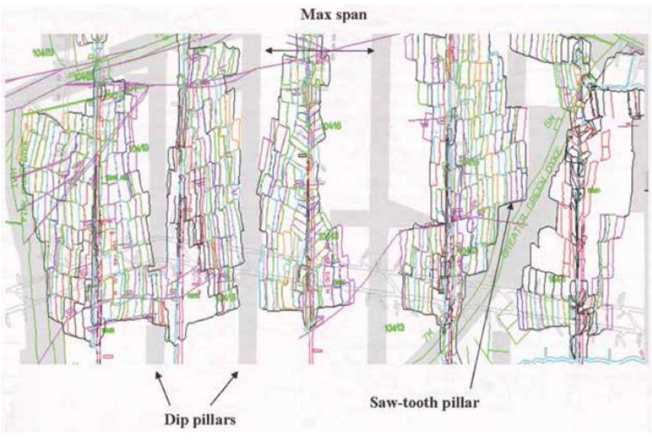


Fig.7 - A typical modern layout of a deep South African gold mine to mitigate the risk of damaging seismicity (after McGill, 2007). This is a plan view of the orebody and excavations. The spans of the stopes are limited and large dip pillars (the grey bars - typically 30 m to 40 m wide) are included in the layout. The geological structures are clamped by so-called bracket pillars.

THE LIMITATIONS OF ELASTIC MODELLING

In spite of the major advances in tabular mine layout design after the introduction of the elastic codes, some practical problems cannot be simulated. Rock engineers working on these mines, for example, commonly use mining rate as a tool to control seismicity in high risk areas. The elastic codes cannot simulate the effect of mining rate, however. Mining rate needs to be studied in more detail as it is known that the rock mass undergoes significant time-dependent deformation in some geotechnical areas (Malan et al. 2007). This effect was in fact recorded as long ago as in the 1930's (Figure 1). Another recent example is shown in Figure 8 to illustrate the significant "creep" component recorded in an intermediate depth tabular platinum mine. For the gold mines, it is proposed that the time-dependent convergence data may be useful to identify remnants that may be safely extracted. A difficulty faced with these studies is that no numerical tool readily exists that can simulate the time-dependent rock mass behaviour on a mine-wide scale. Although several types of commercial finite difference and finite element codes are available with built-in creep models, it is not practical to simulate the small mining steps of typically 1 m per blast in a tabular layout with these codes. The overall dimensions of these layouts can be in the order of kilometres in the strike and dip directions and therefore the displacement discontinuity boundary element approach is still preferred.

Although it seem attractive to use a simple viscoelastic model to simulate the behaviour shown in Figure 8, earlier work indicated that a viscoelastic model is not suitable to replicate the spatial behaviour of the convergence recorded underground (Malan and Napier, 2017). Viscoelastic theory cannot simulate the decrease in convergence rate as the distance to face increases (Figure 9). Recent studies have indicated that a limit equilibrium displacement discontinuity model with a time-dependent failure criterion may be useful to simulate on-reef time-dependent failure processes on a mine-wide scale (Napier and Malan, 2012; 2014).

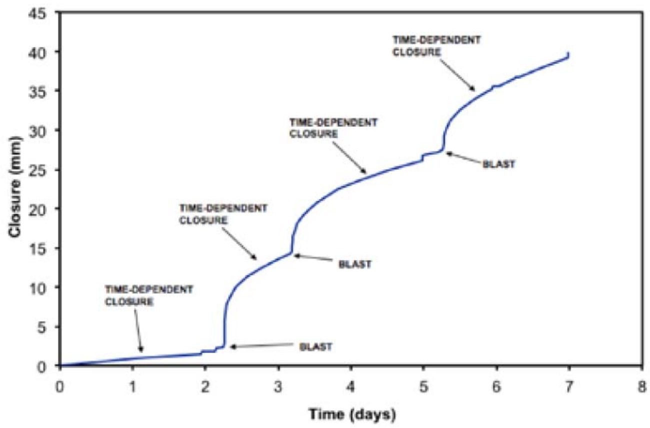


Fig. 8 - Typical convergence data recorded in deep gold mines and some of the deeper platinum mines where crush pillars are used. This particular data set was recorded in a Merensky Reef platinum stope (after Malan et al., 2007)

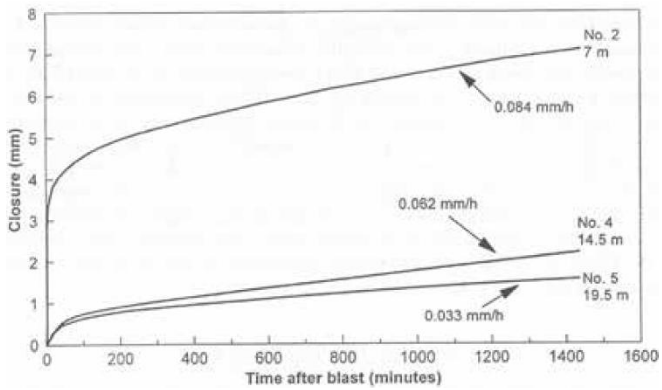


Fig. 9 - Convergence as a function of time after blasting for different distances to the face. The distance below each meter number is the distance to face before this particular blast (after Malan, 1999). This was recorded in a deep gold mine

A PROPOSED TIME-DEPENDENT LIMIT EQUILIBRIUM MODEL

As an alternative to the viscoelastic model, a time-dependent limit equilibrium model built into the displacement discontinuity code, TEXAN, was recently used to investigate the convergence behaviour described above. A description of the TEXAN code and the limit equilibrium model is given in Napier and Malan (2012, 2014). By using this approach, the fracture zone surrounding the excavations is simplified as the model restricts failure to the on-reef plane only. A key feature of the model is that the intact rock strength is differentiated from the residual strength according to specified intact and residual failure strength envelopes. The strength of the intact seam or reef material ahead of the stope face is assumed to be defined by a linear relationship of the form

$$\sigma_n = \sigma^i_c + m_i \, \sigma_s \quad (1)$$

where σ^i_c and m_i are the intercept and slope parameters respectively. σ_s is the average seam-parallel confining stress and σ_n is the seam-normal stress component. Once a point in the seam fails, the strength parameters are postulated to decrease immediately to values σ^0_c and m_0 which define an initial limit stress state in which there is a fixed limit equilibrium relationship between σ_n and σ_s of the form

$$\sigma_n = \sigma^0_c + m_0 \, \sigma_s \quad (2)$$

The limit strength parameters are then assumed to decay towards residual values σ^f_c and m_f. The strength values $\sigma_c(t)$ and $m(t)$ at an elapsed time t after failure, are defined according to the relationships:

$$\sigma_c(t) = \left(\frac{1}{2}\right)^{\frac{t}{\lambda}} [\sigma^0_c - \sigma^f_c] + \sigma^f_c \quad (3)$$

$$m(t) = \left(\frac{1}{2}\right)^{\frac{t}{\lambda}} [m_0 - m_f] + m_f \quad (4)$$

where λ is a half-life parameter. The limit stress components σ_n and σ_s at a given seam or reef position and time t are then given by an appropriate equation of similar form to equation [1]:

$$\sigma_n = \sigma_c(t) + m(t) \, \sigma_s \quad (5)$$

The distribution of the limit stress values will in general depend on the distribution of failure times at all points in the fractured material and consequently depends in a complex evolutionary manner on the planned mining sequence and extraction rate. A given mining problem must therefore be solved in a series of time steps which include mining increments that are scheduled at appropriate time step intervals. The problem time scale will be determined essentially by the chosen half-life parameter, λ.

SIMULATION OF TIME-DEPENDENT CONVERGENCE

The simplified geometry shown in Figure 10 was used to illustrate the characteristics of the time-dependent limit equilibrium model. This is a stope of size 100 m X 50 m situated at a depth of 2000 m. The stope is surrounded by a region of elements which assume the constitutive behaviour described by equation [3] to [5] once failure is initiated. Convergence profiles were recorded at the points A, B and C. These measurement positions varied slightly depending on the element sizes used, but for 1 m elements, the distances to the excavation face were A = 0.5 m, B = 4.5 m and C = 24.5 m. The model parameters are given in Table 1. These parameter values are assumed and needs to be calibrated in future.

The simulation attempted to replicate the underground convergence behaviour shown in Figure 9. The simulated results are shown in Figure 11 and the time-dependent nature of the convergence is clearly visible. The rate of time-dependent convergence decreases into the back area of the stope similar to the underground observations (Malan and Napier, 2017). This model is therefore clearly an improvement on a simple elastic model and the viscoelastic approach which could not replicate this behaviour. Figure 12 illustrates the failed limit equilibrium elements (red) and the intact elements (green).

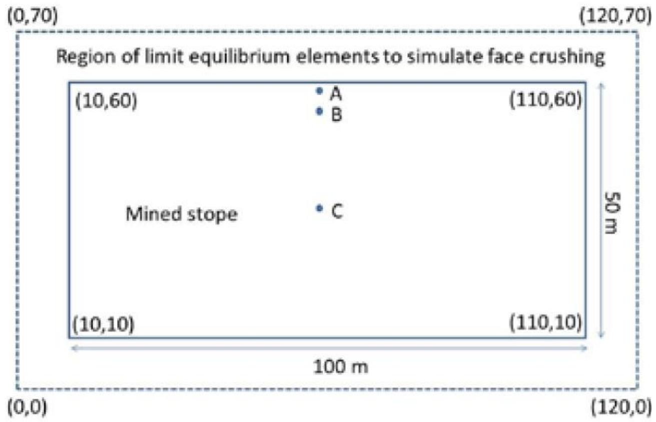


Fig. 10 - Geometry simulated

Table 1. Parameters used for the initial simulations

Parameter	Value
Depth	2000 m
Mining height	3 m
Young's modulus	70 GPa
Poisson's ratio	0.2
Intact seam strength	40 MPa
Intact seam slope parameter	7
Initial crush strength	40 MPa
Initial crush slope parameter	4
Residual strength	1
Residual slope parameter	2
Interface friction angle	20º
Seam stiffness modulus	80000 MPa/m
Half-life	20 h

Based on this initial success to simulate the time-dependent behaviour recorded in deep tabular stopes, this model is currently being investigated further. Preliminary results not described here indicate that the model appears useful to simulate practical mining problems such as the effect of mining rate (Napier and Malan, 2014) and the behaviour of crush pillars in intermediate depth platinum mines (Du Plessis et al, 2011). It is therefore a major improvement when compared to the original elastic tabular simulation tools. A major challenge remaining is calibration of all the parameters shown in Table 1 for site-specific conditions.

SUMMARY

Systematic rock mechanics research to understand the rock burst problem in the South African gold mines was only initiated in the early 1960's. The first major breakthrough was the understanding that the far-field rock mass behaviour can be approximated by elastic theory. This led to the development of a number of simulation tools to determine the stresses and displacement around these tabular excavations. The MINSIM-type codes became very popular in South Africa is it could efficiently solve irregularly shaped tabular excavations on a mine-wide scale.

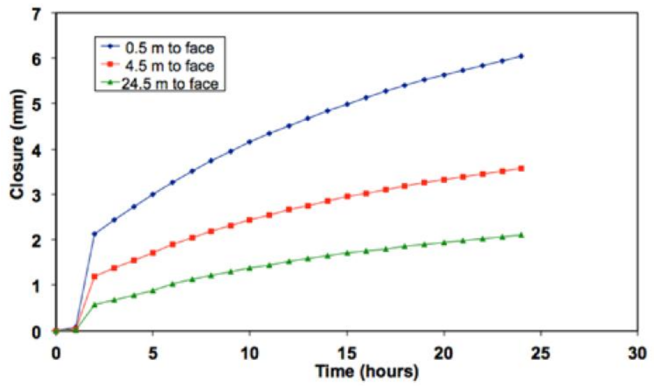


Fig. 11 - Simulated time-dependent convergence at various distances to face. This only shows the time dependent convergence and not the initial elastic convergence

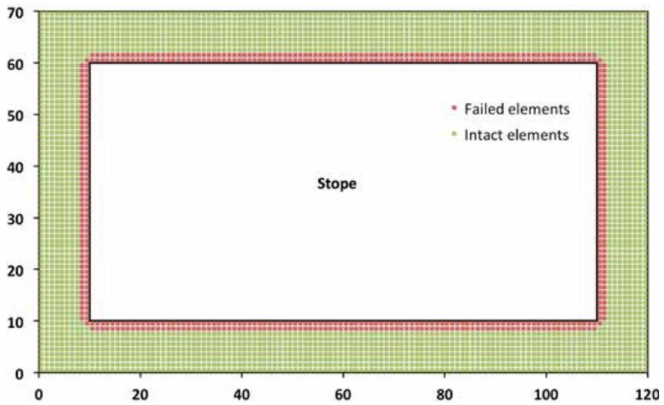


Fig.12 - Failed elements (red) at the edge of the stope for the simulation in Figure 10 at t = 24 hours. The intact elements are shown in green

A major drawback of these elastic codes was that it could not solve phenomena associated with the extensive fracture envelope surrounding the excavations. One example is the effect of mining rate as the "creep-like" behaviour of the fracture zone and associated time-dependent convergence cannot be simulated using an elastic approach.

Earlier work indicated that a viscoelastic model is not suitable to replicate the spatial behaviour of the convergence recorded underground. A time-dependent limit equilibrium model implemented in the TEXAN code appears to be a useful alternative as it can explicitly simulate the on-reef time-dependent failure of the reef seam. A key finding of recent studies is that the model gives a good qualitative agreement with the underground measurements. For both the model and actual data, the rate of time-dependent convergence decreases into the back area. It appears that such a model, where the failure is restricted to the reef plane, will provide significantly enhanced modelling capabilities to rock engineers without sacrificing too much of the inherent simplicity of an elastic tabular solver. Calibration of the constitutive failure model nevertheless remains a significant challenge.

REFERENCES

Adler, H.W. 1933. Systems and methods of support in relation to the effects of "pressure bursts" in the Crown Mines Limited, Eastern Section, Association of Mine Managers of the Transvaal, Johannesburg, 117-154.

Cartwright, A.P. 1968. Golden Age. Purnell & Sons (S.A.) (Pty) Ltd.

Cook, N.G.W. and Schumann, E. (1965). An electrical resistance analogue for planning tabular mine excavations. Chamber of Mines Research Report, No. 72/65.

Du Plessis, M., Malan, D.F. and Napier, J.A.L. 2011. Evaluation of a limit equilibrium model to simulate crush pillar behaviour. J.S. Afr. Inst. Min. Metall. 111: 875-885.

Deane, C.O. 1954. The removal of remnants in deep level mining. Journal of the Chemical, Metallurgical & Mining Society of South Africa, 204-218.

Deist, F.H. (1972). Computer applications in rock mechanics, S.Afr. Inst. Min. Metall., 265 – 272.

Hamilton, G.B. 1954. Discussion of the paper by C.O. Deane: Removal of remnants in deep level mining, Safety in Mining Symposium, Journal of the Chemical, Metallurgical & Mining Society of South Africa, 281-287.

McGill, R.B. 2007. Strategies to manage seismicity in a deep VCR environment on Mponeng (1995-2003). In: Y. Potvin, J. Hadjigeorgiou and T.R. Stacey: Challenges in Deep and High Stress Mining, Australian Centre for Geomechanics, 217-223.

Malan, D.F. 1999. Time-dependent behaviour of deep level tabular excavations in hard rock, Rock. Mech. Rock Engng. 32 (2): 123-155.

Malan, D.F., Napier, J A L. and Janse van Rensburg, A.L. 2007. Stope deformation measurements as a diagnostic measure of rock behaviour: a decade of research, J.S. Afr. Inst. Min. Metall. 107: 743-765.

Malan, D.F. and Napier, J.A.L. 2017. Reassessing continuous stope convergence data using a limit equilibrium displacement discontinuity model, In: Proceedings ISRM AfriRock Symposium, October 2017, Cape Town.

Mickel, R.E. 1933. Pressure Bursts, Association of Mine Managers of the Transvaal, Johannesburg, 161- 180.

Napier, J.A.L. and Malan, D.F. (2012). Simulation of time-dependent crush pillar behaviour in tabular platinum mines, J. S. Afr. Inst. Min. Metall., 112: 711-719.

Napier, J.A.L. and Malan, D.F. (2014). A simplified model of local fracture processes to investigate the structural stability and design of large-scale tabular mine layouts. In: 48th US Rock Mechanics / Geomechanics Symposium, Minneapolis, MN, USA, 1-4 June, 2014.

Plewman, R.P., Deist, F.H. and Ortlepp W.D. (1969). The development and application of a digital computer method for the solution of strata control problems, J. S. Afr. Inst. Min. Metall., Sept 1969, 33 – 44.

Ryder, J.A. and Jager, A.J. 2002. A textbook on rock mechanics for tabular hard rock mines, The Safety in Mines Research Advisory Committee, Johannesburg.

Ryder, J.A. and Officer, N.C. 1964. An elastic analysis of strata movement observed in the vicinity of inclined excavations. Rock Mechanics and Strata Control in Mines, J. S. Afr. Inst. Min. Metall., 168-193.

Salamon, M.D.G. (1963). Elastic analysis of displacements and stresses induced by the mining of seam and reef deposits. J. S. Afr. Inst. Min. Metall., Part I, Nov. 1963, pp 71 – 92.

Salamon, M.D.G. (1964). Elastic analysis of displacements and stresses induced by the mining of seam and reef deposits – Practical methods of determining displacement, strain and stress components from a given mining geometry. J. S. Afr. Inst. Min. Metall., Part II, pp 93 – 114.

Van der Merwe, J.N. Beyond Coalbrook: what did we really learn?. J. S. Afr. Inst. Min. Metall., 106: 857-868.

(ISRM News Journal, Volume 20, December 2017, pp. 45-52, https://www.isrm.net/fotos/gca/1521878070isrm_newsjournal_2017_site.pdf)

A Combined Experimental (MICRO-CT) and Numerical (FDEM) Methodology to Study Rock Discontinuities Subjected to Shearing

Bryan S.A. Tatone, Geomechanica Inc., Toronto
Rocha Medal Lecture

ABSTRACT

Discontinuities are prevalent in most rock masses and represent planes of preferential deformation and fluid flow. Shear displacements can significantly alter the hydromechanical properties of discontinuities and, thus, the hydromechanical properties of the entire rock mass. The importance of the network of discontinuities in controlling rock mass behavior has long been known and has led to an abundance of research on discontinuity shear strength and transmissivity. Although well-studied, key aspects of discontinuity behavior and characterization have received lesser attention, namely the evolution of asperity damage and discontinuity void space morphology as a result of shearing. In this paper, a methodology that combines the use of two recent technologies (micro-X-ray computed tomography and combined finite-discrete element modeling) is described to study these aspects of discontinuity behavior.

1. INTRODUCTION

1.1 Problem statement

The shear strength and hydraulic behaviour of rock mass discontinues have been extensively studied. However, a topic that has received lesser attention is the collective influence of shear displacement and normal stress on asperity damage and the overall fracture morphology. In particular, there remains uncertainty regarding the kinematic mechanisms responsible for the degradation of asperities and the influence of this damage on the discontinuity geometry (e.g., volume, aperture, surface area, and tortuosity).

An improved understanding of these mechanisms will be of value to several areas of rock engineering and hydrogeology, including those concerned with preventing shear displacement (e.g., excavation, slope, and dam stability analyses) and those concerned with changes in hydraulic transmissivity resulting from shear displacement (e.g. long-term radioactive waste repositories and reservoir stimulation by hydraulic fracturing).

1.2 Limitations of previous studies

Although less common, there is a collection of previous studies that have attempted to investigate asperity degradation, asperity failure mechanisms, and the overall discontinuity morphology as a result of shear displacement [1-9]. Unfortunately, these studies have been hampered in one or more of the following ways:

(i) Limited or flawed experimental/numerical scope (e.g., limited discontinuity geometries, use of weak non-rock-like replica material (UCS < 10 MPa), limited consideration of damage evolution, and minimal crossover between experimental and numerical approaches);

(ii) Inconsistent or conflicting damage mechanism identification (e.g., shearing, tensile cracking, crushing, rotation, abrasion wearing, ploughing, gliding, grinding, breaking, brittle failure, separation, and cut-off); and

(iii) Technological limitations (e.g., experimental studies required opening of discontinuity or time consuming hardening fluid injection and destructive sectioning to observe morphology; conventional numerical methods limited with respect to the ability to explicitly simulate damage).

These limitations have led to the recurring recommendation for further study of discontinuities [10-11]. In particular, the study of individual asperity failure mechanisms, changes in the spatial aperture distribution (and contact area), influences of gouge material, and the redistribution of local stresses throughout the shearing process have been noted as requiring attention.

Despite such recurring recommendations, these topics have remained largely unstudied due to the lack of appropriate tools and methodologies to adequately investigate the process. However, with experimental tools to quickly and non-destructively observe internal damage and advanced numerical tools to explicitly model fracturing becoming more widely available, such studies can proceed.

1.3 Overview of adopted approach

The methodology presented herein was developed to overcome many of the limitations of previous studies. The approach was two-facetted, including both experimental and numerical components, which together provided new insights regarding rock discontinuity asperity damage evolution and void space morphology.

As illustrated in Fig. 1, the experimental work involved the direct shear testing of replicated discontinuity specimens and subsequent μCT scanning to obtain 3D imagery depicting the geometric changes to the specimen. Meanwhile, the numerical work aimed to directly simulate the experimental tests using the combined finite-discrete element method (FDEM) to help understand the evolution of the stress state in asperities and identify different asperity failure mechanisms.

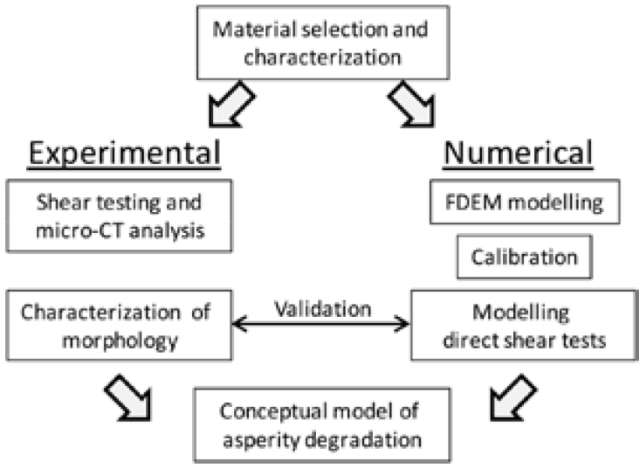


Fig. 1 - Overview of work flow

The key to this two-facetted approach was the cross-validation of the experimental and numerical results. In particular, the μCT imagery of the sheared specimens was used to validate the numerically simulated shear-displacement response and associated damage patterns. And at the same time, the numerically simulated stress conditions and fracture modes were used to help interpret the failure mechanisms responsible for damage observed in the sheared specimens. Ultimately, by considering the experimental and numerical results together, a new conceptual model for asperity degradation could be established.

2. SELECTED REPLICA MATERIAL

The investigation of asperity degradation and failure mechanisms using direct shear specimens of natural rock discontinuities is complicated by the inherent heterogeneity of rock materials and the unique surface geometry of specimens. The replication of discontinuity specimens using a plaster-based or cement-based 'rock-like' material has been a common approach to obtain multiple specimens with the same strength and surface geometry.

Although the mechanical behavior of a man-made material will always differ from that of a natural rock, some materials are mechanically more rock-like than others. One of the shortcomings of prior studies was the use of relatively weak replica materials or materials with UCS to elastic modulus and UCS to Brazilian disc strength (BDS) ratios that fell outside the normal range for rock. In contrast, the microfine mortar material employed for the current work was shown to be mechanically similar to a limestone [12-13].

Table 1. Summary of material properties of mortar material selected for rock fracture replication [12-13]

Material property	Mean ± standard deviation
Water: binder ratio	0.3
Nominal grain size (μm)	3 to 5
Brazilian disc strength, BDS (MPa)	2.6±0.53
Unconfined compressive strength, UCS (MPa)	50.3±4.17
Poisson's ratio	0.25±0.004
Dry density (g/cm3)	1.7±0.021
Internal friction angle (°)	22.9
Cohesion (MPa)	16.4
Basic friction angle (°)	25.4±3.4

The employed mortar is a commercially available product comprised primarily of a blend of sulfate cement and calcium carbonate. The material is manufactured by King Concrete Products and retails in Canada under the name Flowstone. The mechanical properties of the cured material, including the UCS, BDS, triaxial strength envelope, and basic friction angle were characterized through standard laboratory testing.

3. EXPERIMENTAL WORK

3.1 Test specimens

A suite of direct shear specimens with idealized (saw tooth) and natural discontinuity surfaces were created using the selected replica material (Fig. 2). A cylindrical shape (54 mm in diameter x 83 mm long) was adopted as it improved the quality of the resulting μCT images and, consequently, simplified image processing and analysis.

3.2 Direct shear testing

Direct shear tests of the replicated discontinuity specimens were completed under constant normal loading conditions with a displacement rate of 0.005 mm/s. For each specimen geometry, separate specimens where sheared to 6 mm, 3 mm, and to a displacement corresponding to the peak shear resistance. An example of shear test results for the serpentinite discontinuity geometry subjected to a normal load of 3 kN are shown in Fig. 3.

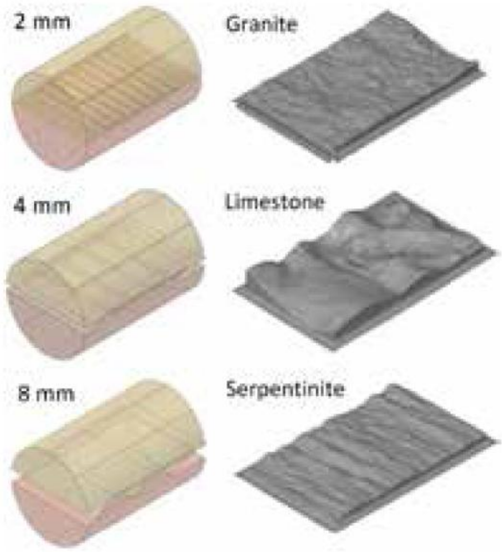


Fig. 2 - Replicated saw-tooth and natural discontinuity surfaces

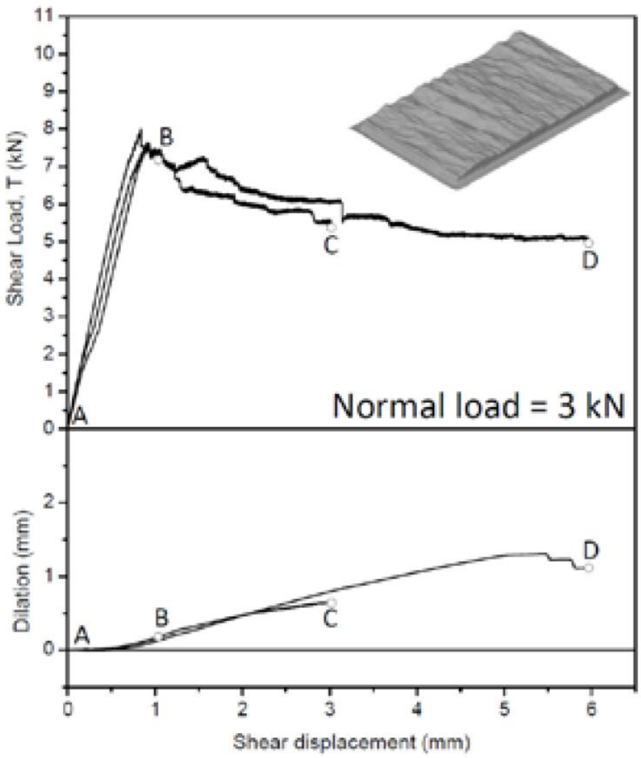


Fig. 3 - Example of incremental direct shear test results [12]

Upon reaching the desired shear displacement, and before removing the normal and residual shear load from the specimen, the 5 mm recess around the perimeter of the discontinuity surface was filled with an epoxy adhesive to effectively bond the halves of the specimen together. In doing so, the relative position of the two specimen halves could be maintained while relocating the specimen to a μCT cabinet for scanning.

3.3 μCT image acquisition and analysis

Over the last decade, μCT has emerged as a popular approach to characterize the internal structure of geomaterials. μCT images capture the internal variation of X-ray attenuation that is directly related to material thickness, density, and elemental composition. Given the sharp density contrast between intact geomaterials and void space (i.e., pores and fractures), µCT imaging is ideal for examining the discontinuities in the direct shear specimens without separating them.

The µCT system employed in the current work was a Phoenix X-ray V|tome|x system manufactured by General Electric Sensing and Inspection Technologies and located within the Department of Civil Engineering at the University of Toronto (Fig. 4.). Fig. 5 displays an example of the µCT-derived specimen damage evolution. Each image in the figure corresponds to the incremental shear displacements in Fig. 3 (i.e., pts. A–D).

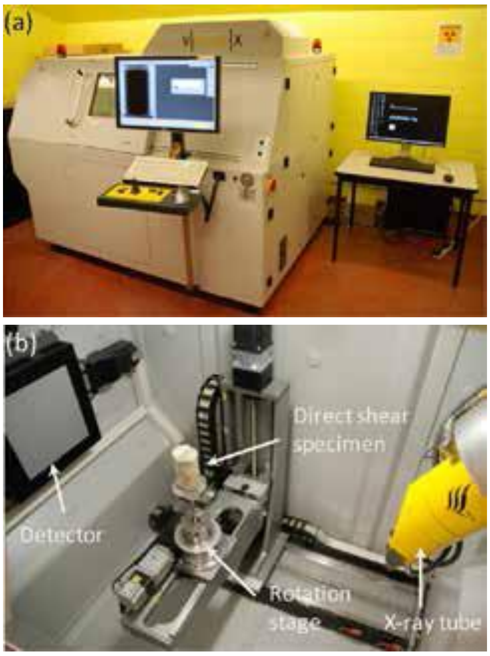


Fig. 4 - Phoenix V|tome|x µCT scanning system [12, 14]

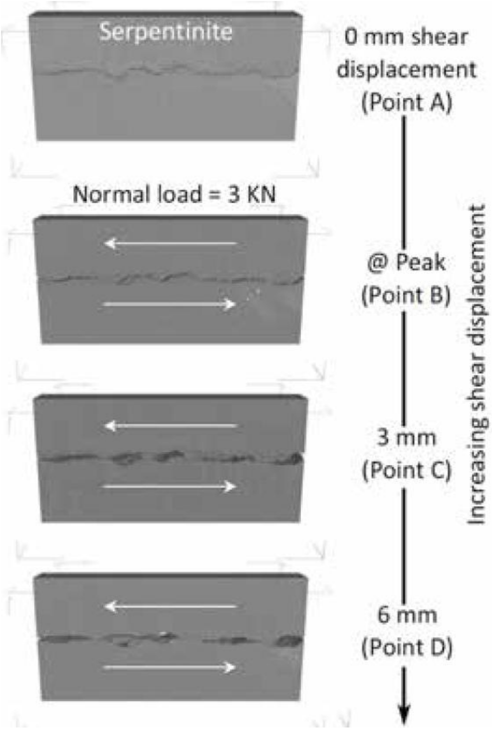


Fig. 5 - Example of damage evolution over central 10 mm width of sheared specimens, as captured via µCT imaging [12]

Through additional µCT image processing and analysis, several quantitative measurements of fracture morphology were obtained. Using a collection of new plug-ins and macros within the open-source software package FIJI, measurements of the mean fracture aperture, fracture surface area and spatial aperture distribution were obtained. Fig. 6 illustrates an example of these image-based 14 measurements for the discontinuity void space in a 'sawtooth' specimen subjected to 6 mm of shear displacement. Additional examples and details regarding the image analysis of the µCT imagery of the direct shear samples can be found in Tatone [12] and Tatone and Grasselli [14].

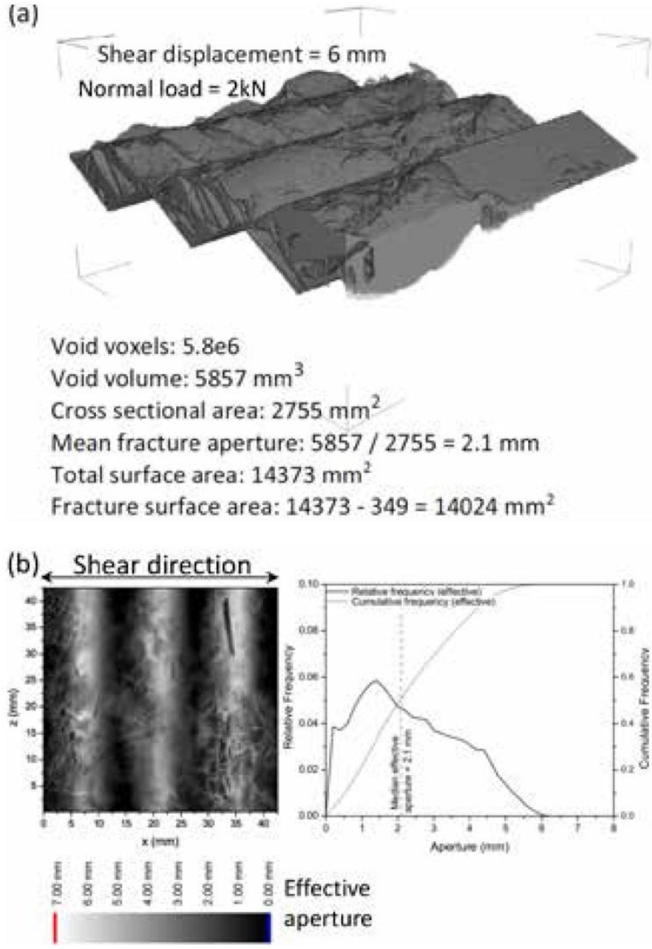


Fig. 6 - Image-based measurements for a 'saw-tooth' specimen sheared 6 mm under a normal load of 2 kN [after 14].

4. NUMERICAL WORK

4.1 FDEM

The modeling of direct shear tests was performed using the hybrid finite-discrete element (FDEM) code, Y-Geo [15-16]. The explicit formulation is capable of simulating the interaction of discrete bodies with rough surfaces, fracture initiation, and fracture propagation. It follows that complex non-linear macroscopic stress-displacement behavior emerges as the result of a collection of simple micro-scale interactions and fracturing. Thus, the need for an empirical yield criterion is eliminated [17, 7]. Further details regarding the fundamental principles of the Y-Geo FDEM code can be found elsewhere [15-16, 18].

4.2 Calibration

A comprehensive calibration procedure was employed to derive the laboratory-scale input parameters for the direct shear test simulation in Y-Geo [18]. Using a combination of UCS, BD, and biaxial simulations, a set of values for the input parameters controlling the intact strength, including the interaction of elements and the fracturing of crack elements was established. This combination of input parameters yielded simulated UCS and BD strengths and a simulated triaxial strength envelope that closely matched those measured in the laboratory (Fig. 7). Moreover, this combination of parameters resulted in fracture patterns that were in agreement with those observed in laboratory specimens.

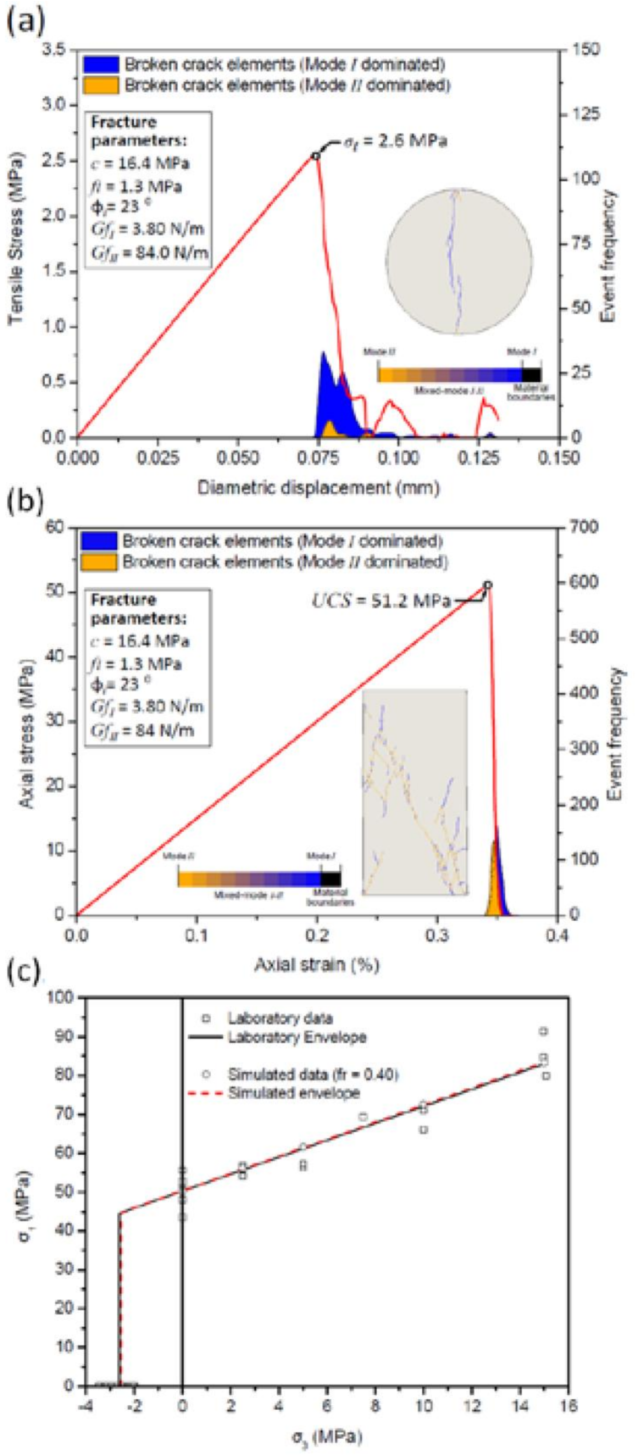


Fig. 7 - FDEM calibration results for the mortar material used to replicate discontinuity specimens [modified from 12, 18]

Using the final calibrated input parameters, subsequent forward modelling of direct shear specimens with other discontinuity geometries could be completed with much greater confidence.

4.3 Direct shear test simulations

With the intact material properties assigned via the calibration process, the laboratory direct shear simulations could be simulated numerically. In doing so, the failure pattern, failure mode, and the associated stress conditions could be further examined. To construct the 2D FDEM models, representative 2D profiles were selected from the 3D discontinuity surfaces (e.g., Fig. 8a). These profiles were obtained from locations that experienced the greatest concentrations of asperity damage in laboratory tests and, thus, dictated the overall direct shear response.

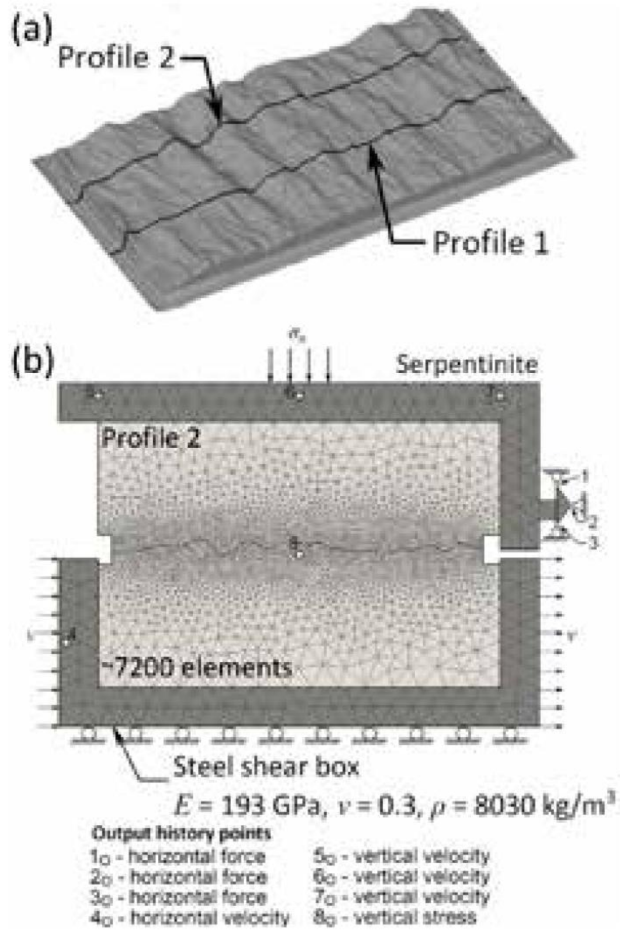


Fig. 8 - (a) Location of 2D profiles on 3D serpentinite surface; (b) Example of 2D direct shear simulation geometry, mesh topology, boundary conditions, and data output points for profile 2 [modified from 12]

Varying normal loads were simulated by applying an element surface pressure along the central portion of the upper shear box (e.g., Fig. 8b). This surface pressure was applied in gradual manner to quickly obtain a steady state stress condition. Afterwards, a constant rate of shear displacement was applied to the lower half of the direct shear box, while the upper half of the shear box was held stationary in the horizontal plane. The output history points labelled 1 through 8 were used to monitor the shearing process, including the load-displacement, and dilation-displacement response.

The simulated shear resistance, in terms of the instantaneous friction angle, and dilation as a function of shear displacement for the model depicted in Fig. 8 are displayed in Fig. 9 alongside the corresponding laboratory results. The corresponding simulated Mode-I-dominated asperity damage and void space morphology as a function of shear displacement is illustrated in Fig. 10.

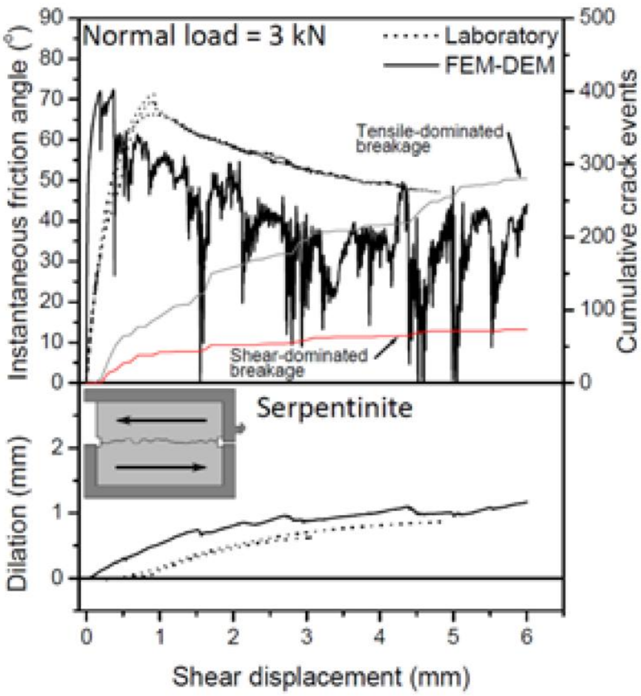


Fig. 9 - Example of simulated direst shear test results for the serpentinite discontinuity geometry displayed in Fig. 8

With regard to the similitude between numerical and laboratory results, the peak shear resistance, dilation and crack patterns were generally in good agreement for up to 2 mm of shear displacement. In contrast, the shear stiffness, post-peak shear resistance, and crack pattern at large displacements varied from that observed in laboratory specimens.

The most striking feature of the simulated shear resistance-displacement plot is the erratic nature of post-peak response beyond 2 mm of shear displacement. This response is attributed to unstable crack propagation events which rapidly release built-up asperity stresses. In the laboratory, such stresses are rapidly and nearly seamlessly redistributed to other contact areas over the width of the specimen. However, in a 2D FDEM model, stresses can only be redistributed within the modelled cross-section. Thus, the progressive formation of new fractures can result in sudden losses of shear resistance until new asperity contacts are established with continuing shear displacement.

With the redistribution of stresses occurring across the modelled cross-section only, it follows that asperity damage is also restricted to the modeled cross-section. As a result, the degree of simulated asperity damage begins to exceed that observed in laboratory specimens at shear displacements greater than 2-3 mm. This discrepancy further intensifies as shear displacement increases.

5. DISCUSSION OF ASPERITY DAMAGE EVOLUTION

With the laboratory direct shear test results and µCT imagery, it was possible to identify the limitations of adopting a 2D FDEM approach to model discontinuity shearing. Most importantly, the µCT imagery helped avoid invalid interpretations of asperity damage mechanisms based on numerical results alone. Given that the results of FDEM direct shear test simulations were in good agreement with laboratory observations over the first 2-3 mm of shear displacement, this portion of FDEM simulations could be used to help understand the evolution of asperity stress conditions and damage.

Here, the stresses within a group of elements in the center of one of the 2 mm 'saw-tooth' asperities tested under a constant normal load of 2 kN are assessed (Fig. 11a-inset). By computing the average major and minor principal stresses, σ1 and σ3, for these elements over the initial 1 mm of simulated shear displacement, the stress path up to failure for this asperity was plotted (Fig. 11a). The simulated crack patterns, principal stress distributions, and principal stress trajectories at points along this stress path are illustrated in Fig. 11b. The generality of this simulated stress and asperity damage evolution is supported by the similar asperity crack patterns observed in µCT imagery (Fig. 5 and Fig. 12)

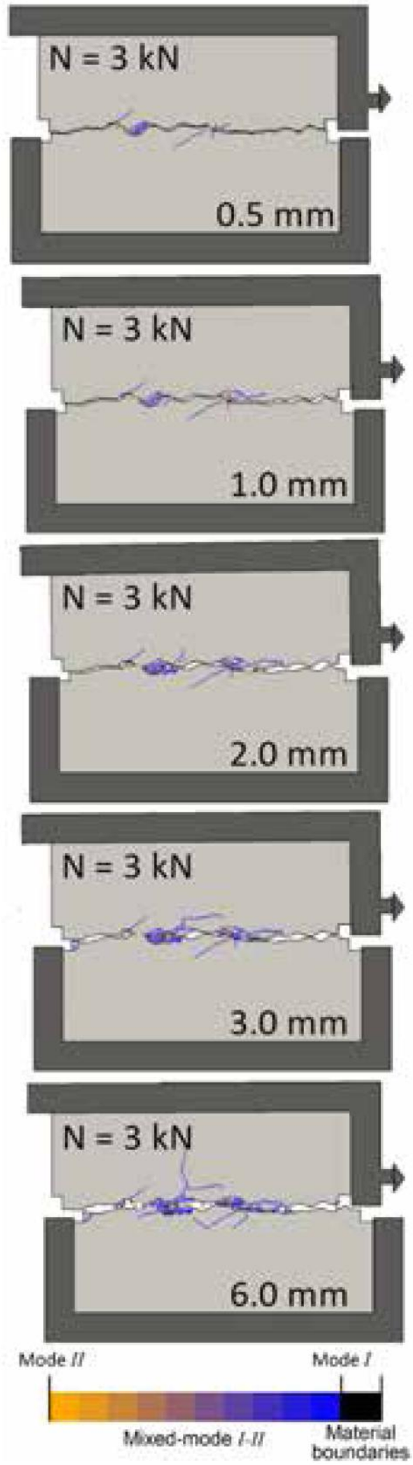


Fig. 10 - Example of simulated damage evolution in serpentinite direct shear specimen [modified from 12]

Upon initiating shear displacement, both principal stresses are compressive (Fig. 11a). However, with very little displacement, σ_3 begins to decrease and transitions from a compressive to tensile stress. As σ_3 approaches the tensile strength of the material, the first tensile fractures initiate (Fig. 11b, i). Following initiation, the stress path becomes cyclic with σ_3 alternating between tensile and compressive stress states as the asperity progressively breaks down (Fig. 11b, iii-v). Upon complete failure of the asperity (e.g., Fig. 11b, vi), the principal stresses within the selected element go to zero.

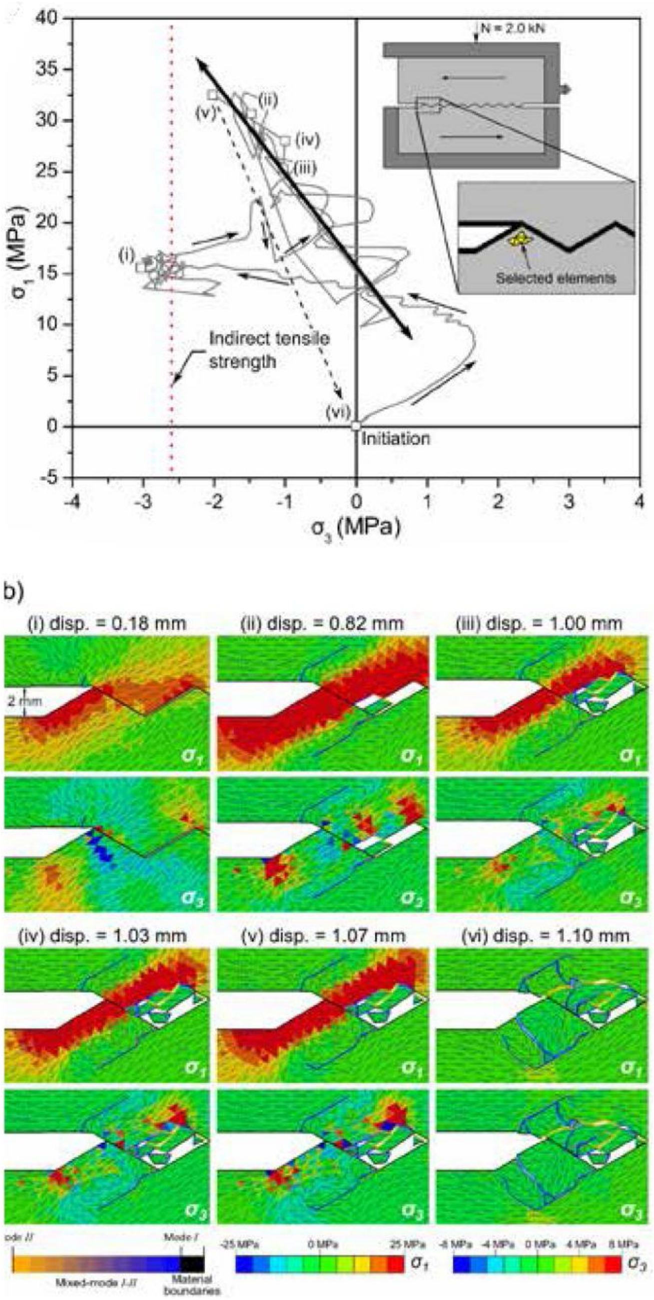


Fig. 11 - (a) Evolution of stress state and (b) asperity damage with shear displacement [modified from 12]

Inspection of the principal stress trajectories helps explain the orientation of fracturing (Fig. 11b, i-vi). Tensile fractures initially form parallel to the direction of σ_1, which is perpendicular to the contacting interface (Fig. 11b, ii). As these initial cracks propagate, the stress trajectories ahead of the crack tip begin to rotate (Fig. 11b, iii-iv). This stress rotation ahead of the crack tip causes further crack propagation to follow a new trajectory that is approximately 120 degrees counter-clockwise from the initial fracture trajectory (Fig. 11b, v). This new crack trajectory directs the propagating tensile fractures back towards the discontinuity interface. If the tensile fractures reach the discontinuity interface, the asperity becomes completely detached and subject to rotation and further breakdown with additional shear displacement. Alternatively, shear fractures continue to develop within the asperity and link the existing tensile fractures together forming a pseudo-continuous shear planes across the base of asperities.

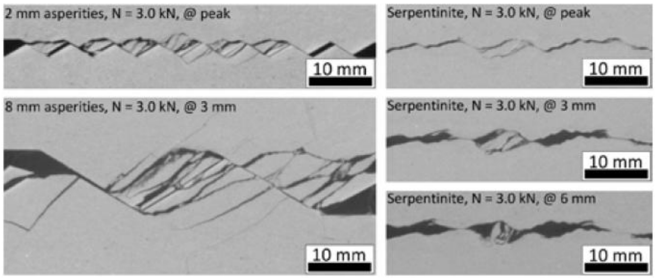


Fig. 12 - CT imagery showing fracture patterns in of specimens with 'saw-tooth' and natural discontinuity geometries [modified from 12]

6. GENERALIZED CONCEPTUAL MODEL

Based on the experimental observations together with the results of the 2D–FDEM simulations, a generalized conceptual model for the degradation of an asperity subjected to a shear loading was developed (Fig. 13). The model is comprised of Stages 0 to 5, each of which, bridge different stages of a direct shear test. The model is considered valid over an intermediate range of normal loads where shear displacement is accommodated by a combination of sliding and brittle fracturing of asperities. It should be noted that this range will vary according to the intact strength of the discontinuity walls. Descriptions of the stages of asperity degradation are as follows:

- Stage 0 – Initial configuration of the discontinuity prior to any shear displacement.
- Stage 1 – As sliding initiates, frictional forces along contacting faces generate tensile stresses within asperities. A tensile fracture perpendicular to the contact area and parallel to the maximum principal stress orientation initiates when the tensile strength is exceeded.
- Stage 2 – Increasing shear displacement leads to the development of additional tensile fractures and the extension of existing fractures.
- Stage 3 – With further shear displacement, the slender lengths of intact material delineated by tensile fractures begin to rotate. This rotation is accompanied by a rotation of the principal stress orientation ahead of the fractures which causes their trajectory to change. Concurrently, the slender lengths of intact material are compressed along their long axis, resulting in the formation of shear cracks that transect the asperities.
- Stage 4 – With additional displacement, the tensile fractures, following their new trajectory, grow until reaching the original discontinuity interface. Concurrently, shear cracks continue to link existing cracks together further reducing the ability of the asperity to resist shear displacement.
- Stage 5 – At this point, a combination of tensile and shear fracturing has extended across the base of the asperity. Hence, further shear displacement can proceed along an effectively flattened interface. At this point, the contribution of the asperity to the overall shear resistance has been reduced to the frictional resistance amongst the gouge material.

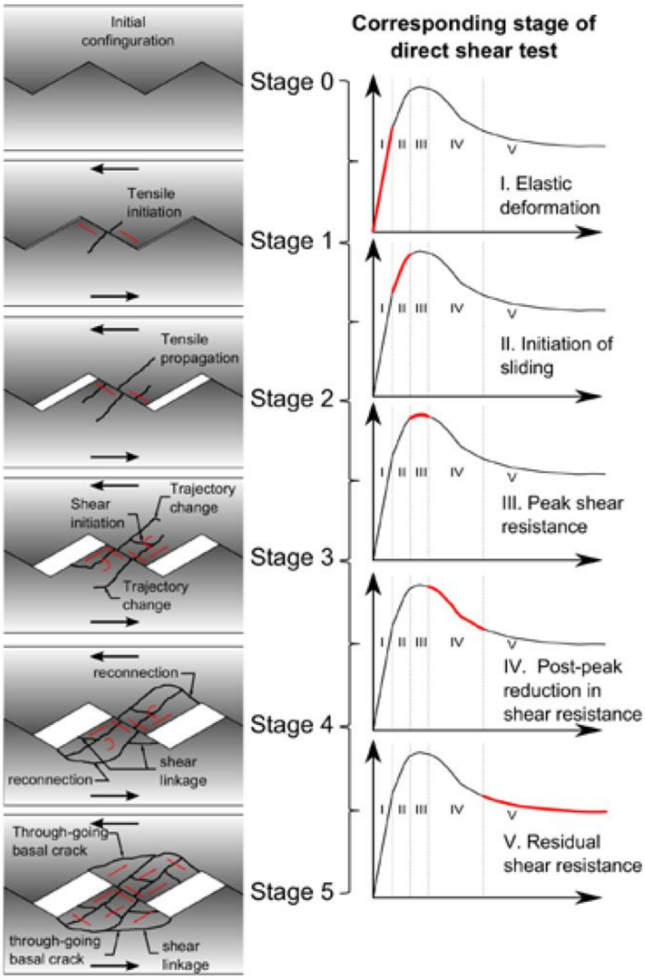


Fig. 13 - Five stage conceptual model of asperity degradation and its relationship with the different stages of a direct shear test [modified from 12]

7. CLOSING

This article has described a methodology to study rock discontinuity asperity degradation as a function of shear displacement and varying normal load. A two-facetted approach involving laboratory testing and CT image analysis combined with numerical modelling was presented.

From CT imagery of direct shear specimens sheared to different incremental shear displacements, the evolution of asperity damage and discontinuity void space geometry with shear displacement was qualitatively and quantitatively characterized. The simulation of the laboratory direct shear tests using a 2D FDEM approach revealed that this type of numerical modelling can reasonably reproduce the experimentally observed progressive degradation of asperities. The simulated shear resistances and dilations as a function of shear displacement were found to display the same general behaviour as that measured in laboratory tests. While the simulated peak shear resistance and dilations showed very good agreement with laboratory observations, the shear stiffness and gradual post-peak decrease in shear resistance displayed notable differences related to the consideration of 2D cross-sections instead of 3D surfaces.

Overall, an improvement in the understanding of the link between the damage observed in CT images and the corresponding stress conditions was achieved. In particular, the relationship between the observed asperity fracture pattern and the magnitude and orientation of the principal stresses was established. Tensile failure was identified as the dominant failure mechanism with shear failures playing a secondary role. Based on these findings, a generalized conceptual model for the breakdown of asperities was proposed.

REFERENCES

1. Aydan, O., Y. Ichikawa, S. Ebisu, S. Komura, and A. Watanabe. 1990. Studies of interfaces and discontinuities and an incremental elasto-plastic constitutive law. In Rock Joints; Proceedings of the International Symposium on Rock Joints, Leon, Norway, 4-6 June 1990, eds. N. Barton and O. Stephansson, 595-602. Rotterdam: A.A. Balkema.

2. Fishman, Y.A. 1990. Failure mechanism and shear strength of joint wall asperities. In Rock Joints; Proceedings of the International Symposium on Rock Joints, Leon, Norway, 4-6 June 1990, eds. N. Barton and O. Stephansson, 627-633. Rotterdam: A. A. Balkema.

3. Handanyan, J.M., E.R. Danek, R.A. D'Andrea, and J.D. Sage. 1990. The role of tension in failure of jointed rocks. In Rock Joints; Proceedings of the International Symposium on Rock Joints, Leon, Norway, 4-6 June 1990, eds. N. Barton and O. Stephansson, 203-210. Rotterdam: A.A. Balkema.

4. Pereira, J.P. and M.H. de Freitas. 1993. Mechanisms of shear failure in artificial fractures of sandstone and their implication for models of hydromechanical coupling. Rock Mech. Rock Eng. 26(3): 195-214.

5. Yang, Z.Y. and D.Y. Chiang. 2000. An experimental study on the progressive shear behavior of rock joints with tooth-shaped asperities. Int. J. Rock Mech. Min. Sci. 37(8): 1247-1259.

6. Huang, T.H., C.S. Chang, and C.Y. Chao. 2002. Experimental and mathematical modeling for fracture of rock joint with regular asperities. Eng. Fract. Mech. 69(17): 1977-1996.

7. Karami, A. and D. Stead. 2008. Asperity Degradation and Damage in the Direct Shear Test: A Hybrid FEM/DEM Approach. Rock Mech. Rock Eng. 41(2): 229-266.

8. Park, J.-W. and J.-J. Song. 2009. Numerical simulation of a direct shear test on a rock joint using a bonded-particle model. Int. J. Rock Mech. Min. Sci. 46(8): 1315-1328.

9. Rasouli, V. and J.P. Harrison. 2010. Assessment of rock fracture surface roughness using Riemannian statistics of linear profiles. Int. J. Rock Mech. Min. Sci. 47(6): 940-948.

10. Hopkins, D.L. 2000. The implications of joint deformation in analyzing the properties and behavior of fractured rock masses, underground excavations, and faults. Int. J. Rock Mech. Min. Sci. 37(1-2): 175-202.

11. Jing, L. 2003. A review of techniques, advances and outstanding issues in numerical modelling for rock mechanics and rock engineering. Int. J. Rock Mech. Min. Sci. 40(3): 283-353.

12. Tatone, B.S.A., Investigating the evolution of rock discontinuity asperity degradation and void space morphology under direct shear. PhD Thesis, 2014. Department of Civil Engineering, University of Toronto. Toronto, Canada.

13. Tatone, B.S.A. and G. Grasselli. 2015. A classification based on the uniaxial compressive strength to Brazilian disc strength ratio: Its development and use to evalu-

ate the likeness of a synthetic material to natural rock. Rock Mech. Rock Eng. (submitted September 2014).

14. Tatone, B.S.A. and G. Grasselli. 2015. Characterization of the effect of normal load on the discontinuity morphology in direct shear specimens using X-ray micro-CT. Acta Geotech. 10(1): 31-54.

15. Munjiza, A., The Combined Finite-Discrete Element Method. 2004, Hoboken, NJ: John Wiley & Sons. 333.

16. Mahabadi, O.K., A. Lisjak, G. Grasselli, and A. Munjiza. 2012. Y-GEO: A new combined finite-discrete element numerical code for geomechanical applications. Int. J. Geomech. 12): 676-688.

17. Potyondy, D.O. and P.A. Cundall. 2004. A bonded-particle model for rock. Int. J. Rock Mech. Min. Sci. 41(8): 1329-1364.

18. Tatone, B.S.A. and G. Grasselli. 2015. A calibration procedure for two-dimensional laboratory-scale hybrid finite–discrete element simulations. Int. J. Rock Mech. Min. Sci. 75(0): 56-72.

(ISRM News Journal, Volume 20, December 2017, pp. 53-60, https://www.isrm.net/fotos/gca/1521878070isrm_newsjournal_2017_site.pdf)

ΝΕΑ ΑΠΟ ΕΛΛΗΝΙΚΕΣ ΚΑΙ ΔΙΕΘΝΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΝΩΣΕΙΣ

Professor Mario e. Manassero elected as ISSMGE Vice -President for Europe

Dear colleagues,

It is indeed a great honour and a pleasure to be appointed Vice-President for Europe of the ISSMGE. Moreover, I hope to be up to the expectations of all the ISSMGE members, and in particular of those of the European Group. However, I would like to assure all of you that I will put the utmost commitment and dedication into doing my job over the next four years.

In order to further improve and strengthen the ISSMGE within its broad activity spectrum, it is my intent to follow the addresses that were proposed by our new president, Professor Charles Ng, and were subsequently approved by the Board during its first meeting in Seoul on the 19th of September 2017.

Three main action areas were identified during the meeting, *i.e.,* education, innovation and diversities. In light of this framework, the rest of this message will be devoted to illustrating the activities for the European Region I have planned to develop during my mandate.

I served ISSMGE from 2001 to 2014 as Chair of the Technical Committee on Environmental Geotechnics (formerly TC 205 and then TC 215). Therefore, within the Innovation Area, it will be rather straightforward for me to devote significant efforts towards promoting initiatives and events in the fields of Environmental Sustainability, Geo-Energy, Bio-Technologies, Subsoil Pollutant Control and Remediation Technologies, in order to further enhance the role of geotechnical engineering in these advanced scientific research and technology fields.

The European Region plays a pre-eminent role in the Education Area, since eleven Technical Committees are included in this ISSMGE region. Moreover, it is worth noting that the Hellenic Geotechnical Society for Soil Mechanics and Geotechnical Engineering hosts the TC 306 Technical Committee on Geo-Engineering Education. Therefore, it will be my duty, among many others in this area, to follow the TC 306 work very closely and to pay particular attention to it.

The Area of Diversities, as defined by the new president of ISSMGE, has a broad meaning, since it includes populations, societies, countries, regions, companies and, last but not least, gender and age of the ISSMGE members. Therefore, among the broad list of activities to be carried out it is worth mentioning: 1) the role that our society has played and must play in the future to provide its fundamental scientific and technical support towards updating and possibly improving the Geotechnical and Seismic Eurocodes (ETC 7 and ETC 8); 2) the organization of the annual European Young Geotechnical Engineering Conference (EYGEC), which is now approaching its 27th edition (Graz, Austria, 2018), and last but not least, 3) the highly demanding proposal of establishing and/or improving communications and relationships within the Mediterranean area, between the African and European Geotechnical Communities.

This latter purpose is closely related to one of the fundamental roles of any scientific and technical community, that is, to promote links, communications and discussions among scientists and technicians from different countries, in spite of difficult social and political situations. ISSMGE has always been very active in this field, since one of the main aims that drives Geotechnical Engineering is that of improving the safety and quality of the life of populations through natural risk mitigation, environment safeguarding and civil progress enhancement, among others.

In conclusion, with the help of the whole Geotechnical Community and, in particular, of the European Members of ISSMGE, I hope I can make good progress in all the aforementioned activities, in spite of the highly demanding targets and of the difficult social and economic conditions that still persist in some countries of the ISSMGE European Region.

Mario e. Manassero

Prof. Reşat Ulusay elected as the next ISRM President 2019-2023

Two nominations for President of the ISRM for the term 2019-2023 were received: Prof. Reşat Ulusay (nominated by Turkey) and Prof. Jian Zhao (nominated by Singapore).

The election took place during the Council meeting in October, during AfriRock 2017, and Prof. Reşat Ulusay was elected as the next ISRM President. He will start his term of office after the 14th International Congress of the ISRM, which will take place in Foz do Iguaçu, Brazil, in 2019.

ISRM News Journal, Volume 20, December 2017

Dear ISRM Member

The Volume 20, December 2017 issue of the ISRM News Journal is now online on the ISRM website. Since 2012 the ISRM distributes the News Journal to all members in electronic version, and prints copies which are available at our sponsored symposia.

The News Journal includes news from the society life, including board and regional reports, commission work, conference and symposia reports and papers from awarded members, among other content. Click here to read it directly on our website or to download it.

Best regards

Luís Lamas
ISRM Secretary General

https://www.isrm.net/fotos/gca/1521878070isrm_newsjournal_2017_site.pdf

☙ ❧

Ελληνική Επιτροπή Σηράγγων και Υπογείων Έργων (Ε.Ε.Σ.Υ.Ε.)

ΤΟ ΝΕΟ ΔΙΟΙΚΗΤΙΚΟ ΣΥΜΒΟΥΛΙΟ ΤΗΣ Ε.Ε.Σ.Υ.Ε.

Έπειτα από τις εκλογές της Γενικής Συνέλευσης της 12ης Ιουλίου 2017, κατά την 1η συνέλευση των εκλεγέντων μελών την 25η Ιουλίου 2017, ορίστηκε ομόφωνα η συγκρότηση του νέου σώματος της επιτροπής. Το νέο Διοικητικό Συμβούλιο της Ε.Ε.Σ.Υ.Ε. που προέκυψε, για τριετή θητεία, έχει την ακόλουθη οργάνωση:

Πρόεδρος: Ιωάννης Φίκιρης, Πολ. Μηχανικός

Αντιπρόεδρος: Δημήτριος Αλιφραγκής, Πολ. Μηχανικός

Γεν. Γραμματέας: Δημήτριος Λίτσας, Πολ. Μηχανικός

Ταμίας: Ευάγγελος Περγαντής, Πολ. Μηχανικός

Εκδότρια ΔΕΛΤΙΟΥ ΣΗΡΑΓΓΩΝ: Μαριλία Μπαλάση, Πολ. Μηχανικός

Μέλος: Δημήτριος Παππάς, Πολ. Μηχανικός

Μέλος Νικόλαος Ρούσσος, Μετ. Μηχανικός

Εκλέχθηκαν επίσης στις εκλογές ως "Εξελεγκτική και Εφορευτική Επιτροπή" οι:

Γιούτα-Μήτρα Παρασκευή

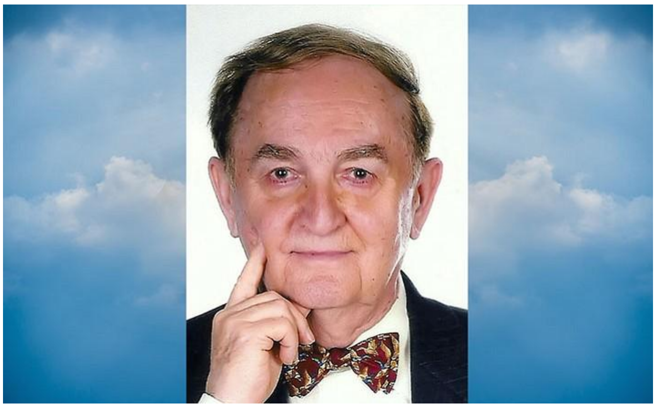
Μπακογιάννης Ιωάννης

Ραπτόπουλος Σταύρος

(Το Δελτίο των Σηράγγων / ΕΕΣΥΕ, Νοέμβριος 2017, σελ. 1, https://www.eesye.gr)

☙ ❧

In Memory of
Prof. Richard Z.T. Bieniawski



Την 11-12-2017 απεβίωσε στην οικία του ο Πολωνός καθηγητής Richard Z.T. Bieniawski (1936 – 2017). Ο R. Bieniawski υπήρξε μια από τις σημαντικότερες προσωπικότητες της βραχομηχανικής του 20 αιώνα.

Ο Bieniawski σπούδασε Μηχανικός Λιμενικών Έργων στην Πολωνία και ακολούθως συνέχισε τις σπουδές του στη Νότια Αφρική, όπου αποφοίτησε αρχικά ως Μηχανολόγος Μηχανικός και ακολούθως έλαβε διδακτορικό δίπλωμα με αντικείμενο τη μηχανική σε υπόγεια μεταλλευτικά έργα.

Ανέπτυξε το γνωστό σε όλους μας Σύστημα Κατάταξης Βραχόμαζας RMR που χρησιμοποιείται σε όλο τον κόσμο, μεταξύ άλλων, σε μελέτες σηράγγων, υπογείων έργων κτλ. Το Σύστημα RMR συνδυάζει όλες τις σημαντικές γεωλογικές / γεωτεχνικές παραμέτρους που επηρεάζουν το σχεδιασμό υπογείων έργων και τις παραμετροποιεί με τέτοιο τρόπο ώστε να μπορούν άμεσα να χρησιμοποιηθούν στο σχεδιασμό και την κατασκευή υπογείων έργων.

Δίδαξε για 20 χρόνια στο Πανεπιστήμιο της Πενσυλβανίας των ΗΠΑ και συνταξιοδοτήθηκε στα 60 χρόνια, έχοντας γίνει και Επισκέπτης Καθηγητής στο Πανεπιστήμιο του Cambridge της Αγγλίας. Δημοσίευσε περί τα 20 βιβλία, ενώ οι δημοσιεύσεις του ξεπερνούν τις 200 σε επιστημονικά περιοδικά. Μία από τις τελευταίες του διαλέξεις πραγματοποιήθηκε στο ετήσιο διεθνές συνέδριο WTC2014 της ITA στη Βραζιλία στην κεντρική ομιλία του συνεδρίου με τίτλο «QUO VADIS TUNNEL ENGINEERING? PREDICTING THE UNPREDICTABLE”.

(Το Δελτίο των Σηράγγων / ΕΕΣΥΕ, Ιανουάριος 2018, σελ. 21-22, https://www.eesye.gr)

Obituary

Prof. Richard Z.T. Bieniawski, 81, of Prescott, Arizona, died Monday, Dec. 11, 2017, at his home. He was born Oct. 1, 1936, in Krakow, Poland. Dr. Hon. Causa (Madrid, Spain), Dr. Hon. Causa (AGH, Krakow, Poland), Ph.D. M. Sc. Distinguished Professor (ret.) and President, Bieniawski Design Enterprises, Prescott, Arizona.

In 1996, Prof. Bieniawski retired from Penn State on his 60th birthday to Prescott, having become Visiting Professor of Design Engineering at the University of Cambridge, England. Recognizing his academic achievements and professional services to the engineering community, the University of Madrid, Spain, honored him with the award of Doctor Honoris Causa and Distinguished Professorship in the claustro estraordinario (council of Spanish professors) on Oct., 1, 2001 (his 65th birthday). Subsequently, a lecture hall (la Aula) was named after him by the University of Madrid, and a Scholarship and an annual Prize in his name, were established by an industrial sponsor.

In 2010, the AGH University of Science and Technology in Krakow, Poland, the city of his birth, honored him with the award of Doctor Honoris Causa and Visiting Professorship.

Prof. Bieniawski was trained as a naval architect and marine engineer in Poland, graduated in South Africa as mechanical engineer and obtained a doctorate in mining and tunnel engineering. In the process he invented a world-famous Rock Mass Rating (RMR) system used extensively today in tunnel design and construction.

The author of 12 books and over 200 research publications, Prof. Bieniawski especially enjoyed teaching during his 20 academic years at Penn State, particularly to freshman students in mechanical engineering, STS (science, technology, and society) and to seniors and graduates in mining engineering. He was named the Best Teacher at Penn State by Leonard Center for Enhancement of Engineering Education and became the only Penn State professor ever to win the academic "Triple Crown" of visiting Professorships at Stanford, Harvard, and Cambridge, England.

After his "retirement" to Prescott, which he called "renaissance living," Prof. Bieniawski wrote three new books, but none of them technical; they were: a fantasy story for his eldest grandson, a non-fiction discourse on renaissance retirement, and … a murder mystery novel in academic setting. For many years, he volunteer taught at the Yavapai College in subjects such as foreign policy and the interaction of science and religion.

A registered professional engineer, Prof. Bieniawski was also commissioned a Navy lieutenant after four years of military training. But few know that in his youth he was an actor and theater director, made two scientific movies, managed a volleyball team which won a provincial championship and became the only Distinguished Toastmaster in South Africa-excelling in communication and leadership.

Prof. Bieniawski's hobbies were genealogy, studying Spanish language and culture, foreign affairs, and hiking Prescott trails. With Elizabeth, his wife of over 50 years -- who is a historian and library science professional -- Prof. Bieniawski is the proud parent of three sons and eight grandchildren. Favorite quotation: "Enthusiasm is the greatest asset in the world; it beats money, power, and influence." (Henry Chester)

There will be a Mass of Christian Burial 10:30 a.m. on Friday. Jan. 5, 2018, at the Sacred Heart Catholic Church 150 Fleury Ave., Prescott, with burial to follow at the Heritage Memorial Park Cemetery, 12000 Heritage Memorial Lane, Dewey. Please visit www.heritagemortuary to sign Richard's online guest book. Services entrusted to Heritage Memory Mortuary.

(https://www.dcourier.com/news/2018/jan/03/obituary-prof-richard-zt-bieniawski/)

ΠΡΟΣΕΧΕΙΣ ΓΕΩΤΕΧΝΙΚΕΣ ΕΚΔΗΛΩΣΕΙΣ

Για τις παλαιότερες καταχωρήσεις περισσότερες πληροφορίες μπορούν να αναζητηθούν στα προηγούμενα τεύχη του «περιοδικού» και στις παρατιθέμενες ιστοσελίδες.

5th International Course on Geotechnical and Structural Monitoring, 22 - 25 May 2018, in Rome www.geotechnicalmonitoring.com

EUROCK 2018 Geomechanics and Geodynamics of Rock Masses, 22-26 May 2018, Saint Petersburg, Russia, www.eurock2018.com/en

4th GeoShanghai International Conference, May 27-30, 2018, Shanghai, China, http://geo-shanghai.org

micro to MACRO - Mathematical Modelling in Soil Mechanics, May 29-June 1, 2018, Reggio Calabria, Italy, www.microtomacro2018.unirc.it

GeoReinforcement Workshop, 4 - 5 June 2018, Munich, Germany, https://igs.wufoo.com/forms/q10dk31u19dx00v/

International Conference on Deep Foundations and Ground Improvement - Urbanization and Infrastructure Development: Future Challenges, June 5-8, 2018, Rome, Italy, www.dfi.org/dfieventlp.asp?13310

GeoBarrier Workshop, 6 - 7 June 2018, Munich, Germany, https://igs.wufoo.com/forms/q10dk31u19dx00v/

XVI Danube-European Conference on Geotechnical Engineering: Geotechnical Hazards and Risks: Experiences and Practices, 7 - 9 June 2018, Skopje, Former Republic of Yugoslav www.decge2018.mk

16th European Conference on Earthquake Engineering (16thECEE), 18-21 June 2018, Thessaloniki, Greece, www.16ecee.org

CPT'18 4th International Symposium on Cone Penetration Testing, 21-22 June 2018, Delft, Netherlands, www.cpt18.org

PATA DAYS 2018 - 9th International INQUA Meeting on Paleoseismology, Active Tectonics and Archeoseismology, 24-29 June 2018, Chalkidiki, Greece, www.patadays2018.org

NUMGE 2018 9th European Conference on Numerical Methods in Geotechnical Engineering, 25-27 June 2018, Porto, Portugal, www.numge2018.pt

RockDyn-3 - 3rd International Conference on Rock Dynamics and Applications, 25-29 June 2018, Trondheim, Norway, www.rocdyn.org

ICOLD 2018 26th Congress – 86th Annual Meeting, 1 - 7 July 2018, Vienna, Austria, www.icoldaustria2018.com

9th International Conference on Physical Modelling in Geotechnics (ICPMG 2018), 17-20 July 2018, London, UK, www.icpmg2018.london

ICSSTT 2018 - 20th International Conference on Soil Stabilization Techniques and Technologies, July 19 - 20, 2018, Toronto, Canada, https://waset.org/conference/2018/07/toronto/ICSSTT

GeoChine 2018 - 5th GeoChina International Conference Civil Infrastructures Confronting Severe Weathers and Climate Changes: From Failure to Sustainability, July 23-25, , HangZhou, China, http://geochina2018.geoconf.org

UNSAT2018 The 7th International Conference on Unsaturated Soils, 3 - 5 August 2018, Hong Kong, China, www.unsat2018.org

China- Europe Conference on Geotechnical Engineering, 13-16 August 2018, Vienna, Austria, https://china-euro-geo.com

CRETE 2018 6th International Conference on Industrial & Hazardous Waste Management, 4-7 September 2018, Chania, Crete, Greece, www.hwm-conferences.tuc.gr

EUCEET 2018 - 4th International Conference on Civil Engineering Education: Challenges for the Third Millennium, 5-8 September 2018, Barcelona, Spain, http://congress.cimne.com/EUCEET2018/frontal/default.asp

SAHC 2018 11th International Conference on Structural Analysis of Historical Constructions "An interdisciplinary approach", 11-13 September 2018, Cusco, Perú http://sahc2018.com

26th European Young Geotechnical Engineers Conference, 11 - 14 September 2018, Reinischkogel, Austria, www.tugraz.at/en/institutes/ibg/events/eygec

11th International Conference on Geosynthetics (11ICG), 16 - 20 Sep 2018, Seoul, South Korea, www.11icg-seoul.org

CHALK 2018 Engineering in Chalk 2018, 17-18 September 2018, London, U.K., www.chalk2018.org

International Symposium on Energy Geotechnics SEG - 2018, 25-28 September 2018, Lausanne, Switzerland https://seg2018.epfl.ch

HYDRO 2018 - Progress through Partnerships, 15-17 October 2018, Gdansk, Poland, www.hydropower-dams.com/hydro-2018.php?c_id=88

GEC - Global Engineering Congress Turning Knowledge into Action, 22 - 26 October, London, United Kingdom, www.ice.org.uk/events/global-engineering-congress

ARMS10 - 10th Asian Rock Mechanics Symposium, ISRM Regional Symposium, 29 October - 3 November 2018, Singapore, www.arms10.org

ACUUS 2018 16th World Conference of Associated research Centers for the Urban Underground Space "Integrated Underground Solutions for Compact Metropolitan Cities", 5 – 7 November 2018, Hong Kong, China, www.acuus2018.hk

International Symposium Rock Slope Stability 2018, 13-15 November, 2018, Chambéty, France, www.c2rop.fr/symposium-rss-2018

GeoMEast 2018 International Congress and Exhibition: Sustainable Civil Infrastructures, 24 - 28 November 2018, Cairo, Egypt, www.geomeast.org

WTC2019 Tunnels and Underground Cities: Engineering and Innovation meet Archaeology, Architecture and Art and ITA - AITES General Assembly and World Tunnel Congress, 3-9 May 2019, Naples, Italy, www.wtc2019.com

14th international Conference "Underground Construction", 3 to 5 June 2019, Prague, Czech Republic, www.ucprague.com

2019 Rock Dynamics Summit in Okinawa, 7-11 May 2019, Okinawa, Japan, www.2019rds.org

VII ICEGE ROMA 2019 - International Conference on Earthquake Geotechnical Engineering, 17 - 20 June 2019, Rome, Italy, www.7icege.com

ꕥ ꕥ

ICONHIC2019

2nd International Conference on Natural Hazards and Infrastructure
23-26 June 2019, Chania, Crete Island, Greece
https://iconhic.com/2019/conference

We are delighted to invite you to Chania, Greece for the "2nd International Conference on Natural Hazards and Infrastructure".

This second conference will build upon the encouragement received during ICONHIC2016 aiming to make the extra mile towards Infrastructure Resilience. It is currently well understood that protection against extreme events is not served by the "stronger is better" principle. Apart from several scientific evidence disproving the adequacy of such a concept, building stronger structures has no impact in protecting existing infrastructure. On the contrary, the latter is asked to serve more needs stemming from the expansion of populations in urbanized reasons, at a time when ageing reduces its capacity. Further to that, both the frequency and intensity of extreme natural events are augmenting.

Although it is essential to act now, ıt is obvious that no single discipline can undertake the action. That is why ICONHIC2019 aims to bring all stakeholders on the same floor. We need to work together and understand each other. Engineers, financers, insurers, and policy makers must exchange experience in order to set a robust and viable trace towards our future actions.

To achieve this goal, our conference will include panel discussions among different stakeholders, excellent keynote lectures, special and theme sessions in what we hope to be a most lively event encouraging discussion on challenging topics.

CONFERENCE HIGHLIGHTS

- **Infrastructure Protection** is an international headline and every developed economy acknowledges the issue – but the bigger question is, **are there practical solutions?**
- **Promoting a Game shift:** Protecting infrastructure from extreme events calls for an integrated approach considering the correlated nature of hazards and cascading effects.
- **In a time of augmented need for interdisciplinary effort** this conference aims to bring together actors from different fields in order to promote "out of the box" thinking and cross-fertilization.
- **Disruptive Panel Discussions, Stimulating Sessions, and a plethora of bilateral meetings** are expected to create a unique environment to promote pioneering ideas

CONFERENCE THEMES

CROSS-CUTTING TOPICS

Hazard Prediction, Warning and Risk Management
Strengthening Tools & Mitigation Strategies
Vulnerability Assessment, Risk Planning & Uncertainties
Multi-Risk Decision Support Methodologies
Assessment and Prediction of Natural Hazards from Satellite Imagery
Remote sensing for natural disasters: Challenges and Opportunities
Moving Towards Climate-Resilient and adaptive Infrastructure Systems
Integrating Disaster Risk into Life-Cycle Management of Infrastructure Systems
Resilience of infrastructure networks: from perturbation to recovery

EARTHQUAKES & LANDSLIDES

Engineering Seismology & Ground Motion Simulation
Assessment, Analysis and Retrofitting of Structures
Aging Infrastructure and future Earthquakes: Concrete, Steel and Masonry Structures
Seismic Design of Foundations and Underground Structures
Soil-Structure Interaction
Ground Failure & Liquefaction: Analysis and effects on Structures and Lifelines
Isolation and Energy Dissipation Devices
Protection of Historical Structures against Seismic Hazards
Landslides Prevention and Mitigation: Design Practice and New Concepts
Instrumentation and Remote Sensing
Offshore Landslides and effects on submarine Structures and Pipelines
Earthquake/Flood induced Landslides: Analysis and Modeling

CLIMATE CHANGE & FLOODING

Flood Risk Management and Risk Reduction Strategies
Flood Forecasting, Modelling and Flood Control
Natural & Engineered Defenses and Vulnerabilities
Urban Drainage Infrastructure and Performance
Dikes, Levees and Dams: studying Failures and proposing Strategic Solutions
Storm Surges, Tsunamis and Sea Level Rise
Strong Winds, Storms, Hurricanes and Tropical Cyclones
Impact of Extreme Weather on Critical Infrastructure
Drought impacts on Infrastructure Service Delivery

Contact:

The 2nd International Conference on Natural Hazards & Infrastructure
ICONHIC Co.
Efesou 15, 11252 Athens, GREECE
Tel. +30 210 7723383
email: secretary@iconhic.com

ꕥ ꕥ

IS-GLASGOW 2019 - 7th International Symposium on Deformation Characteristics of Geomaterials, 26 - 28 June 2019, Glasgow, Scotland, UK, https://is-glasgow2019.org.uk cmn 2019 -Congress on Numerical Methods in Engineering, July 1 - 3, 2019, Guimarães, Portugal, www.cmn2019.pt

For additional information, please contact the secretariat of the congress, Ms. Lara Leite

CMN2019, Universidade do Minho, Departamento de Engenharia Civil, 4800-058 Guimarães - Portugal
Email: cmn2019@civil.uminho.pt
Telephone: +351 253 510 748
Fax: +351 253 510 217

The 17th European Conference on Soil Mechanics and Geotechnical Engineering, 1st - 6th September 2019, Reykjavik Iceland, www.ecsmge-2019.com

14th ISRM International Congress, 13-18 September 2019, Iguassu Falls, Brazil, www.isrm2019.com

☙ ❧

XVII African Regional Conference on Soil Mechanics and Geotechnical Engineering
07-10 October 2019, Cape Town, South Africa

The South African Institution of Civil Engineering cordially invites all our colleagues from Africa and beyond to attend the 17th African Regional Conference on Soil Mechanics and Geotechnical Engineering.

Hosted in one of the continent's most iconic cities, this conference will serve practitioners, academics and students of all geotechnical backgrounds. The conference will take place at the Cape Town International Convention Centre (CTICC) offering world class conferencing facilities in the heart of South Africa's mother city and will offer extensive opportunities for Technical Committee Meetings, Workshops, Seminars, Exhibitions and Sponsorships. Exciting Technical Visits, including tours to the famous Robben Island, await.

The 7th African Young Geotechnical Engineers' Conference (8 – 10 October 2019) will commence on 8 October 2019, the day following the African Regional Conference (ARC) opening. The conference venue will be shared with the ARC delegates to initiate dialogue between junior and senior engineers while young geotechnical engineers acquaint themselves with the industry standards, new geotechnical developments and resources available to further their careers. The YGE conference provides an approachable audience within a vibrant environment where young presenters under the age of 35 are encouraged to exercise their presentation and technical writing skills on a continental platform.

Organiser: SAICE
Contact person: Dr Denis Kalumba
Email: denis.kalumba@uct.ac.za

☙ ❧

XVI Asian Regional Conference on Soil Mechanics and Geotechnical Engineering, 21 - 25 October 2019, Taipei, China www.16arc.org

XVI Panamerican Conference on Soil Mechanics and Geotechnical Engineering, 18-22 November 2019, Cancun, Quintana Roo, Mexico, http://panamerican2019mexico.com/panamerican

☙ ❧

YSRM2019 - the 5th ISRM Young Scholars' Symposium on Rock Mechanics
and
REIF2019 - International Symposium on Rock Engineering for Innovative Future
1-4 December 2019, Okinawa, Japan

Contact Person: Prof. Norikazu Shimizu, jsrm-office@rocknet-japan.org

☙ ❧

Nordic Geotechnical Meeting
27-29 May 2020, Helsinki, Finland

Contact person: Prof. Leena Korkiala-Tanttu
Address: SGY-Finnish Geotechnical Society,
Phone: +358-(0)50 312 4775
Email: leena.korkiala-tanttu@aalto.fi

☙ ❧

EUROCK 2020
Hard Rock Excavation and Support
June 2020, Trondheim, Norway

Contact Person: Henki Ødegaard, henki.oedegaard@multiconsult.no

☙ ❧

www.eurogeo7.org

We are pleased to invite you to the 7th EuroGeo conference, to be held in Warsaw, Poland in 2020. Poland is a country with more than a thousand years of recorded history and has a strong European identity. The country was first to free itself from communist domination in 1989 and is now fully democratic and a member of the European Union. Poland is a leader in infrastructure development in the region, which has resulted in many extraordinary projects. Warsaw, with its central location, is an ideal base for exploring the country. Today, the city is a dynamic cultural and business centre, with strong links not only to Western Europe but also to the East. PSG-IGS, a Polish Chapter of IGS is young but thriving organization successfully cooperating with several chapters within Central Europe. It is an honour to host such a prestigious conference in Warsaw and We sincerely believe that the sessions will prove to be a success. Come to Warsaw, bring your family and enjoy your stay in our capital and help us to make this Conference not only scientifically profitable but also an unforgettable event.

Contact: eurogeo7inpoland@gmail.com

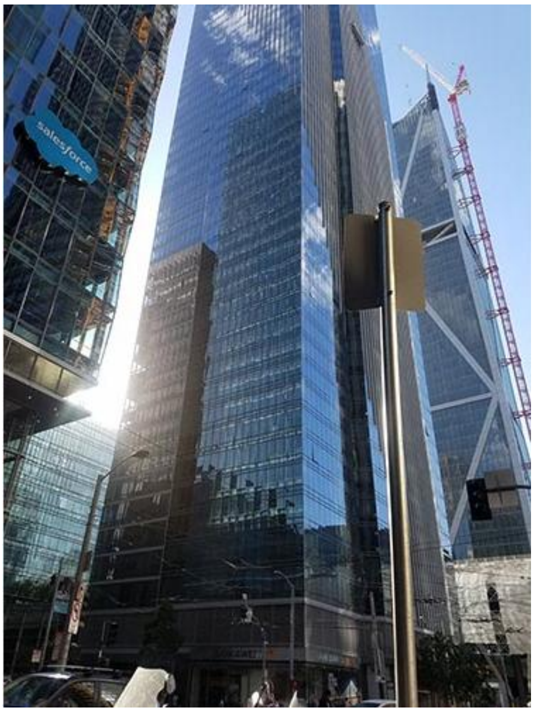
6th International Conference on Geotechnical and Geophysical Site Characterization
07-09-2020 ÷ 11-09-2020, Budapest, Hungary
www.isc6-budapest.com

Organizer: Hungarian Geotechnical Society
Contact person: Tamas Huszak
Address: Muegyetem rkp. 3.
Phone: 0036303239406
Email: huszak@mail.bme.hu
Website: http://www.isc6-budapest.com
Email: info@isc6-budapest.com

ΕΝΔΙΑΦΕΡΟΝΤΑ ΓΕΩΤΕΧΝΙΚΑ ΝΕΑ

San Francisco Issues Rules for High-Rise Foundations

Projects sited in areas with the worst soil, in a high-risk seismic zone and subject to liquefaction, would require more than one geotechnical engineer on the peer review team.



Problems with differential settlement at Millennium Tower prompt San Francisco to issue guidelines for foundation peer review and monitoring of new tall buildings.

In the wake of the settlement of San Francisco's 645-ft-tall Millennium Tower, which sank at least 16 in. and tilted at least 2 in. to the northwest, the city and county Dept. of Building Inspection issued interim guidelines and procedures for structural, geotechnical and seismic-hazard engineering design review for new buildings, 240 ft or taller. All tall buildings, whether designed using the city's prescriptive code or performance-based design, qualify under the new guidance.

The guidelines, issued Nov. 9, require an additional participant or two on a building's peer review panel. That person must be either a geotechnical engineer or a civil engineer with "substantially" demonstrated geotechnical experience. Both must be registered professionals in the state.

Projects sited in areas with the worst soil, in a high-risk seismic zone and subject to liquefaction, would require more than one geotechnical engineer on the peer review team, according to the city.

The guidelines also require that project sponsors hire monitoring surveyors and instrumentation engineers, in advance of completion of the project, to "monitor the effects of settlement" on their buildings and foundations for 10 years after completion. The monitor must submit a report annually to the city.

The peer reviewer also is required to meet with the engineer-of-record and with the building inspection staff throughout the design process and submit a report after completion of the review.

The report must cover 10 subject areas, including the design of a building's shallow and/or deep foundation systems; an interpretation of geotechnical and geological investigations; soil-foundation-structure interaction under gravity and seismic loading; liquefaction, landslides and other geological site hazards; ground improvement; static and dynamic earth pressures; effects of dewatering; foundation or building settlement and more.

It is unclear how much this will cost the building sponsor and whether the monitoring requirements mean that all buildings must be equipped with sensors to record any settlement, says one engineer, who declines to be identified.

(Engineering News Record / eNewsletters, December 11, 2017, https://www.enr.com/articles/43621-san-francisco-issues-rules-for-high-rise-foundations)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΣΕΙΣΜΟΙ

World Building of the Year 2017 could help 100 million people, says Edward Ng

This award-winning prototype house developed for a Chinese village destroyed by earthquake could protect millions of people around the world, claims architecture professor Edward Ng in this movie Dezeen filmed at World Architecture Festival 2017.

The house in the Chinese village of Guangming was rebuilt using a new earthquake-proof construction method

https://www.youtube.com/watch?v=g_E0GwL4qDI

The rammed-earth house was designed by the Chinese University of Hong Kong (CUHK) and a team of seismic design experts at the University of Cambridge. The construction techniques developed through the prototype aim to help the residents of Guangming Village in Zhaotong rebuild their homes following the Ludian earthquake in 2014.

Speaking exclusively to Dezeen after the project was named World Building of the Year at the World Architecture Festival 2017, CUHK professor Ng claims the anti-seismic construction method used to build the house could help people all over the world.

"Earthquakes are not a Chinese problem, they're a worldwide problem," he says in the movie, which Dezeen filmed at the World Architecture Festival 2017 in Berlin.

"A lot of people live in mud houses. So if you can find a way to help these people by designing a safer structure for them then we are solving a problem for maybe 100 million people."

The house was developed for an elderly couple in Guangming Village using construction methods that could be taught to other residents to rebuild their homes affordably using locally available materials.

Most of the village was originally built using rammed earth. The residents had attempted to reconstruct it using more earthquake-resistant materials such as brick and concrete, but the price of these materials proved unaffordable and construction came to a halt.

So Ng and his team sought to find a method of constructing houses using the traditional rammed-earth technique, which would be far more resistant to seismic activity.

The Ludian earthquake in 2014 causes great devastation to the village of Guangming where the traditional method of building makes use of rammed-earth structures

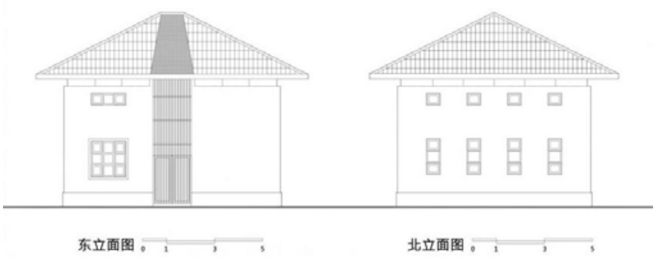
"I think it's more than just a house that we were trying to work on. It is a prototype that allow us to solve many other problems in many parts of the world. Now we have a workable prototype that we can disseminate," says Ng.

The house is a square structure with a pyramid shaped roof, which Ng says is a stable structure that is easy to construct.

The research behind the project aimed to provide local residents with a easy and affordable method of construction that was resistant to seismic activity

"It is a very simple house. It has to be simple because villagers have to know how to build it," he added.

"For seismic resistance design it is important that the geometry is simple. A square form is always stronger so we started our design with a square block. The roof is also a very simple pyramid structure."



The house was constructed in a simple, square format which is a more resilient structure during an earthquake

Researchers from CUHK worked to improve the quality of the earth used in the construction in order to enhance its resistance.

"Together with our seismic design expert we started to improve the earth mixture they had on site. We applied some scientific principles to it so that it is stronger and more workable," Ng tells Dezeen.

The rammed earth walls of the house were reinforced with concrete and steel bars to make them stronger

Window openings in the building are reinforced with concrete frames to keep the windows intact in the case of an earthquake.

"Every time you form an opening in an earth wall you weaken it, so for big windows like ours we had to surround it with a structure so that the wall became integral," says Ng.

"The window frame is made of concrete so that when the wall shakes the concrete will hold the window intact."

A central atrium space divides the house and is lit with natural light from an above skylight

The square structure was divided into two blocks separated by a central atrium space flooded with natural light from above, which remains cool in the summer and warm in the winter due to the high thermal mass of the rammed-earth walls.

"One of the more important things is not just to build a house but to build a house that the inhabitants can enjoy," says Ng.

Dezeen was media partners for the World Architecture Festival 2017, which this year took place in Berlin in conjunction with Inside festival of interior design. We will be publishing more videos about the winning projects in the coming weeks.

(Sebastian Jordahn / dezeen, 1 December 2017, https://www.dezeen.com/2017/12/01/movie-waf-world-building-of-year-winner-earthquake-resistant-video)

Earthquakes in Himalaya bigger because tectonic plates collide faster

Earthquakes that happen in densely populated mountainous regions, such as the Himalaya, spell bigger earthquakes because of a fast tectonic-plate collision, according to a new study in Earth and Planetary Science Letters. Researchers from Geophysical Fluid Dynamics – ETH Zürich in Switzerland, say their findings give people a more complete view of the risk of earthquakes in mountainous regions.

The new study shows that the frequency and magnitude of large earthquakes in the densely populated regions close to mountain chains – such as the Alps, Apennines, Himalaya and Zagros – depend on the collision rate of the smaller tectonic plates.

In 2015, a magnitude 7.8 earthquake struck Gorkha-Nepal, and a year later, Norcia, Italy suffered a magnitude 6.2 earthquake. Previous research has attempted to explain the physical causes of earthquakes like these, but with ambiguous results. For the first time, the new study shows that the rate at which tectonic plates collide controls the magnitude of earthquakes in mountainous regions.

"The impact of large earthquakes in mountain belts is devastating," commented Luca Dal Zilio, lead author of the study from Geophysical Fluid Dynamics – ETH Zürich. "Understanding the physical parameters behind the frequency and magnitude of earthquakes is important to improve the seismic hazard assessment. By combining classical earthquake statistics and newly developed numerical models, our contribution addresses a crucial aspect of the seismic hazard, providing an intuitive physical explanation for a global-scale problem. Our scientific contribution can help the society to develop a more complete view of earthquake hazard in one of the most densely populated seismic zones of the world and ultimately take action accordingly."

There are seven large tectonic plates and several smaller ones in the earth's lithosphere – its outermost layers. These plates move, sliding and colliding, and that movement causes mountains and volcanoes to form, and earthquakes to happen.

The researchers developed 2D models that simulate the way the tectonic plates move and collide. The seismo-thermo-mechanical (STM) modelling approach utilises long-time scale processes to explain short time scale problems namely replicate the results observed from the historical earthquake catalogues. Also, it shows graphically the distribution of earthquakes by their magnitude and frequency that are caused by movement in the orogeny – a belt of the earth's crust involved in the formation of mountains.

The simulations suggest that the magnitude and frequency of the earthquakes in mountainous regions are directly related to the rate at which the tectonic plates collide. The researchers say this is because the faster they collide, the cooler the temperatures and the larger the areas that generate earthquakes. This increases the relative number of large earthquakes.

The team confirmed the link by comparing earthquakes recorded in four mountain ranges: the Alps, Apennines and Himalaya and Zagros. Their results imply that the plate collisions in the Alps are more ductile than those in the Himalaya, reducing the hazard of earthquakes.

(Steven Young / TheWatchers, December 04, 2017, https://watchers.news/2017/12/04/earthquakes-in-himalaya-bigger-because-tectonic-plates-collide-faster/?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+adorraeli%2FtsEq+%28The+Watchers+-+watching+the+world+evolve+and+transform%29)

Seismic behaviour of mountain belts controlled by plate convergence rate

Luca Dal Zilio, Ylonav an Dinther, Taras V. Gerya, Casper C. Pranger

Highlights

- First simulation bridging long- to short-term in a continent–continent collision zone.
- Larger convergence rates results in lower b value and large MWmax.
- This also promotes seismic over aseismic and on- over off-megathrust behaviour.
- This results from cooler temperatures that promote wider brittle strength sections.
- Gutenberg–Richter statistics are comparable to observations from four orogens.

Abstract

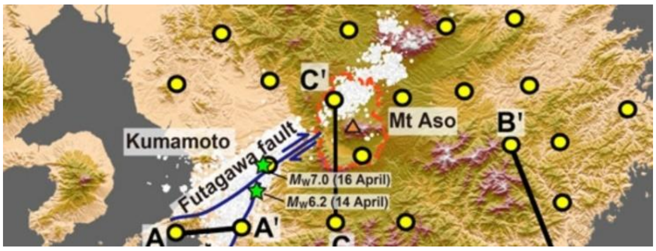
The relative contribution of tectonic and kinematic processes to seismic behaviour of mountain belts is still controversial. To understand the partitioning between these processes we developed a model that simulates both tectonic and seismic processes in a continental collision setting. These 2D seismo-thermo-mechanical (STM) models obtain a Gutenberg–Richter frequency–magnitude distribution due to spontaneous events occurring throughout the orogen. Our simulations suggest that both the corresponding slope (*b* value) and maximum earthquake magnitude (MWmax) correlate linearly with plate convergence rate. By analyzing 1D rheological profiles and isotherm depths we demonstrate that plate convergence rate controls the brittle strength through a rheological feedback with temperature and strain rate. Faster convergence leads to cooler temperatures and also results in more larger seismogenic domains, thereby increasing both MWmax and the relative number of large earthquakes (decreasing *b* value). This mechanism also predicts a more seismogenic lower crust, which is confirmed by a transition from uni- to bi-modal hypocentre depth distributions in our models. This transition and a linear relation between convergence rate and *b* value and MWmax is supported by our comparison of earthquakes recorded across the Alps, Apennines, Zagros and Himalaya. These results imply that deformation in the Alps occurs in a more ductile manner compared to the Himalayas, thereby reducing its seismic hazard. Furthermore, a second set of experiments with higher temperature and different orogenic architecture shows the same linear relation with convergence rate, suggesting that large-scale tectonic structure plays a subordinate role. We thus propose that plate convergence rate, which also controls the average differential stress of the orogen and its linear relation to the *b* value, is the first-order parameter controlling seismic hazard of mountain belts.

Earth and Planetary Science Letters, Volume 482, 15 January 2018, Pages 81-92

http://www.sciencedirect.com/science/article/pii/S0012821X17306210?via%3Dihub

ꕥ ꕥ

Unearthing the underground effects of earthquakes and volcanoes



Japanese researchers find predictive potential in underground changes associated with 2016 Kumamoto earthquake and subsequent volcanic eruptions.

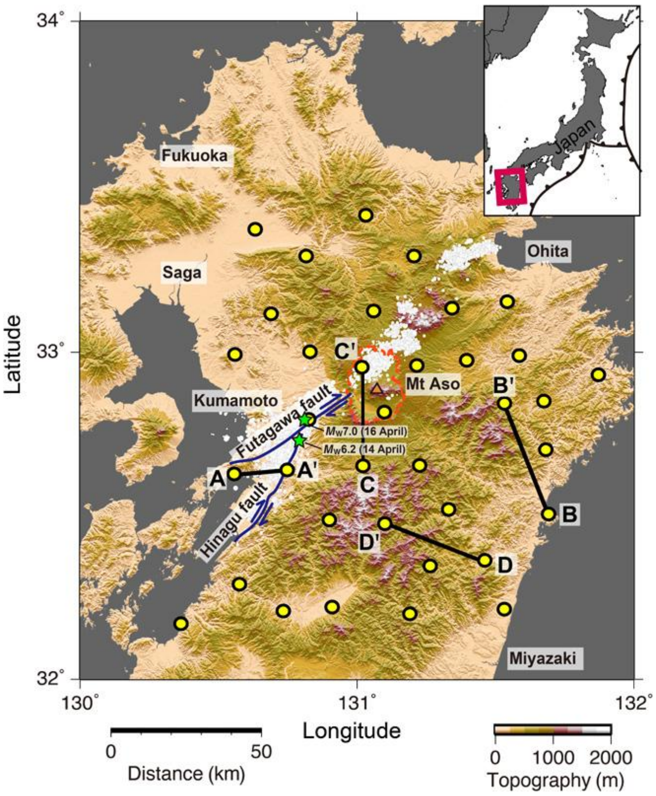
Most of what we know about earthquakes and volcanoes is based on what we can observe at the Earth's surface. However, most of the action - especially early activity that could help with disaster prediction and preparedness - occurs deep underground.

Developing a clearer picture of changes in subsurface conditions, together with continuous monitoring, could provide life-saving information in advance of future disasters. In earthquake-prone Japan, especially, there is an ongoing need for effective means of foreseeing seismic activity.

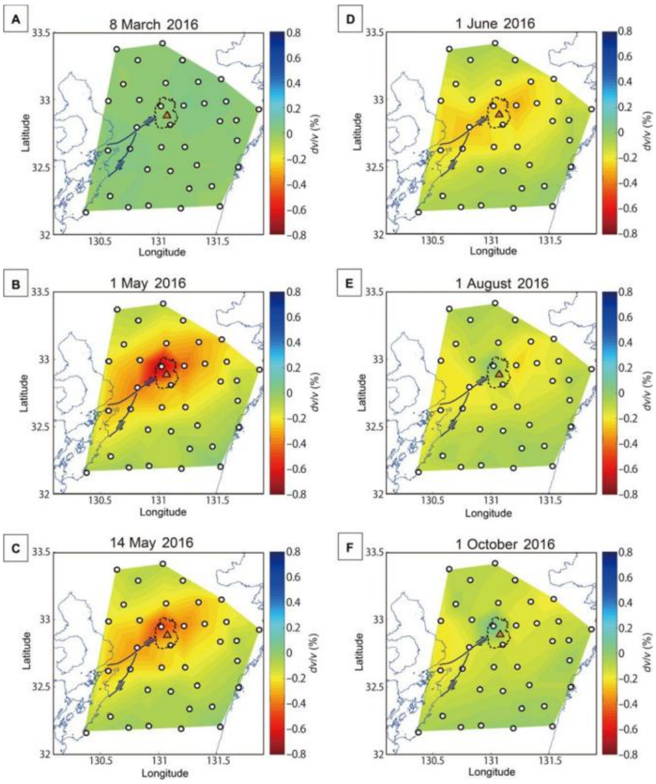
Japan's National Research Institute for Earth Science and Disaster Prevention (NIED) has developed the Hi-net network of hundreds of high-sensitivity seismographs evenly distributed across the country. High-resolution seismic data from Hi-net shed light on the workings far below the country's surface. A key source of information from Hi-net is the velocity of seismic waves as they travel between stations. Faults, fractures, and fluids in the subsurface, among other factors, can influence seismic velocity. Thus, changes in seismic velocity can signal changes occurring underground but not yet apparent at the surface.

Until recently, little variation in seismic velocity had been detected in central Kyushu, Japan's southernmost major island. However, in April 2016, the MW 7.0 Kumamoto earthquake struck the region, shortly after a MW 6.2 foreshock. These destructive earthquakes were followed by eruptions of Japan's largest active volcano, Mount Aso, in April, May, and October of the same year.

A trio of researchers at Kyushu University and its International Institute for Carbon-Neutral Energy Research (I2CNER) investigated Hi-net seismic velocity data, collected continuously from December 2015 to November 2016, to better understand the subsurface conditions associated with these disasters. They reported their findings in Science Advances.



Map of central Kyushu Island, Japan, with locations of Hi-net stations (yellow dots).



Spatial and temporal variation of seismic velocity in central Kyushu during the 2016 Kumamoto earthquake. Credit: Hiro Nimiya, Tatsunori Ikeda and Takeshi Tsuji

"We applied seismic interferometry to the ambient noise recorded at 36 Hi-net seismic stations," Tatsunori Ikeda explains. "We found that during the earthquake, velocity slowed significantly, which may have been related to damage and pressure changes around the deep rupture fault. This was followed by gradual 'healing' of the fault over the following months, although different areas recovered to different extents."

The earthquakes also may have mobilized fluids around Aso's magma body. Velocity below the caldera decreased when the earthquake struck, but recovered relatively rapidly after the eruptions; this may have released pressure.

"Although past studies have used similar approaches for velocity estimation, the higher spatial resolution we achieved over a broad area allowed us to identify the spatial distribution of the damage zone or stress state," the corresponding author Takeshi Tsuji says. "Denser deployment allows local anomalies to be more accurately resolved. Velocity changes thus identified could be useful in the estimation of future earthquakes and volcanic activity."

(Steven Young / THE WATCHERS, December 08, 2017, https://watchers.news/2017/12/08/unearthing-the-underground-effects-of-earthquakes-and-volcanoes/?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+adorraeli%2FtsEq+%28The+Watchers+-+watching+the+world+evolve+and+transform%29)

ΕΝΔΙΑΦΕΡΟΝΤΑ - ΛΟΙΠΑ

China Opens World's Coolest Library With 1.2 Million Books, And Its Interior Will Take Your Breath Away

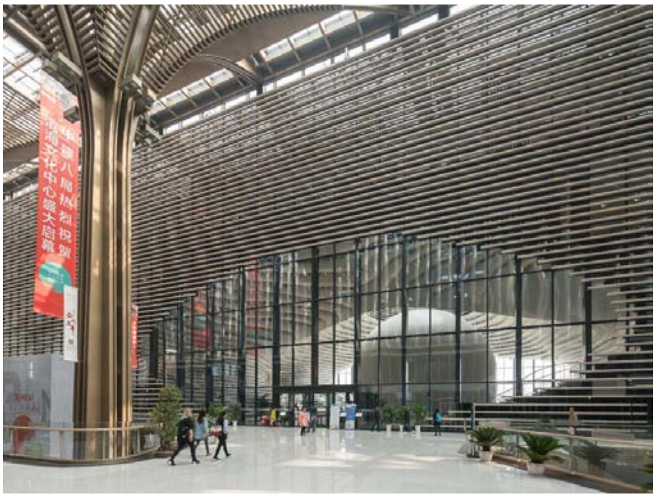
Nobody likes to be watched while they're trying to read a book, but we're willing to make an exception if it means getting to visit this stunning new library in China, because as you can see below, the incredible structure has a giant spherical auditorium in the middle that looks just like a giant eye.

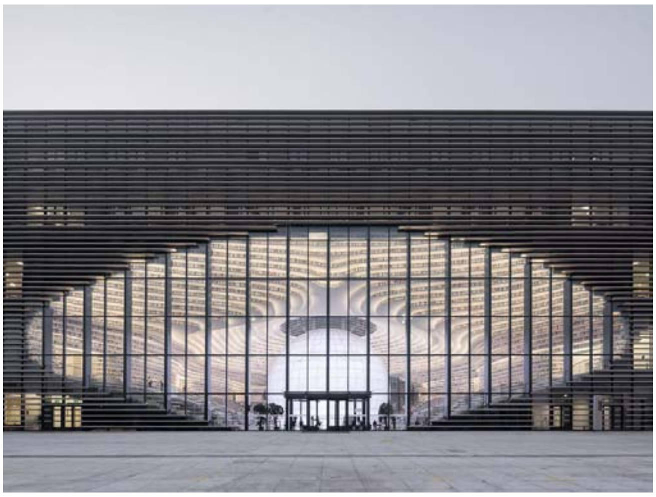
Located in the Binhai Cultural District In Tianjin, the five-story library, which was designed by Dutch design firm MVRDV in collaboration with the Tianjin Urban Planning and Design Institute (TUPDI) and has since been dubbed "The Eye of Binhai", covers 34,000 square metres and can hold up to 1.2 million books. Taking just three years to complete, the library features a reading area on the ground floor, lounge areas in the middle sections and offices, meeting spaces, and computer/audio rooms at the top. We're not sure how much studying we'd get done though – we'd be far too busy marveling at the awesome architecture!

Update: Turns out, most of these futuristic-looking floor to ceiling shelves are painted to look like they're full of books, but in reality, much of the covers in the hall are printed images. The real books are stored in other rooms in the building.









Watch the video for more info:

https://rumble.com/v3y12n-amazing-newly-opened-library-in-chinas-tianjin-becomes-internet-sensation.html

(James Gould-Bourn / boredpanda, 09.12.2017, https://www.boredpanda.com/tianjin-binhai-library-china-mvrdv/?utm_source=newsletter&utm_medium=link&utm_campaign=Newsletter)

ΗΛΕΚΤΡΟΝΙΚΑ ΠΕΡΙΟΔΙΚΑ

www.geoengineer.org

Κυκλοφόρησε το Τεύχος #151 του **Newsletter** του **Geoengineer.org** (Δεκέμβριος 2017) με πολλές χρήσιμες πληροφορίες για όλα τα θέματα της γεωτεχνικής μηχανικής. Υπενθυμίζεται ότι το Newsletter εκδίδεται από τον συνάδελφο και μέλος της ΕΕΕΕΓΜ Δημήτρη Ζέκκο (secretariat@geoengineer.org).

Ενδεικτικά περιεχόμενα του τεύχους:

- Iran-Iraq border earthquake is the deadliest of 2017 (video)
- Mass evacuations ordered as highest alert is issued for Bali volcano
- Floods and landslides leave at least 11 dead in Indonesia
- The optimal ground improvement solutions
- Severe flash floods hit Western Attica, Greece: 15 killed, several missing (video)
- Special Geo-Trends issue: Local Geotechs post about Iran-Iraq MW 7.3 earthquake in GeoWorld
- Report highlights 'seismic gaps' in tsunami risk areas
- Fifty simulations show how a magnitude 9.0 Cascadia earthquake could play out
- Typhoon "Damrey" hits Vietnam, leaving at least 61 dead
- Scientists determine source of world's largest mud eruption (video)
- Mudslide in Colombia results in 3 dead and 32 injured (video)

http://campaign.r20.constantcontact.com/render?m=1101304736672&ca=30405b99-9a92-4219-8618-2f91d2fe2bf2

International Journal of Geoengineering Case Histories

We are pleased to announce the **Issue #2 of Volume #4 of the International Journal of Geoengineering Case Histories**, an official Journal of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE).

In this issue

Geotechnical Damage Caused by the 2016 Kumamoto Earthquake, Japan, Takashi Kiyota, Takaaki Ikeda, Kazuo Konagai, Masataka Shiga, pp. 78-95

A High Rock Cut Stabilization in Muscat City, Oman, Tahir M. Hayat, Tariq J. Bhatti, Robert Goldsmith, pp. 96-112

St. Isaac Cathedral (St. Petersburg, Russia): A Case History, Anna Shidlovskaya, Jean Louis Briaud, Mehdi Mohammadrajabi, pp.113-133

Uplift of an Underground Tank in Northern Malabar Region, India, Nilesh P. Shirode, Kedar C. Birid, S. R. Gandhi, Rajesh Nair, pp.134-146

Κυκλοφόρησε το Τεύχος No. 40 (Δεκέμβριος 2017) του Newsletter της International Society for Rock Mechanics and Rock Engineering με τα παρακάτω περιεχόμενα:

- ISRM name change - International Society for Rock Mechanics and Rock Engineering
- ISRM President's New Year Address
- Prof. Reşat Ulusay elected as the next ISRM President 2019-2023
- 20th ISRM online lecture by Prof. Milton Kanji
- The 2018 ISRM International Symposium - ARMS10, 29 Oct. - 3 Nov.
- European Rock Mechanics Symposium - Eurock 2018, Saint-Petersburg, Russia, 22-26 May
- ISRM Vice Presidents receive important awards
- Prof. Reşat Ulusay received the 2016 Hans Cloos Medal Award of the IAEG
- Invitation to TuniRock2018, Hammamet, Tunisia, 29-31 March, an ISRM Specialised Conference
- Invitation to RocDyn-3, 25-29 June 2018, Trodheim, Norway, an ISRM Specialised Conference
- Four new Fellows of the ISRM inducted last October
- ISRM Rocha Medal 2018 - winners were selected
- ISRM Sponsored meetings
- Best Performing ISRM National Group Award conferred to China and Japan
- Serbia and Bosnia and Herzegovina visited by ISRM delegation
- GEO-EXPO 2017 Scientific and Expert Conference in Sarajevo, Bosnia and Herzegovina, October 2017
- ISRM Sponsored meetings

ITA @ news

https://about.ita-aites.org/news

Κυκλοφόρησε το Τεύχος 64 των ITA@news της International Tunnelling Association με τα παρακάτω περιεχόμενα:

Message from Tarcisio Celestino, ITA President

WTC 2018 Registration is open

ITA Awards 2017 winners revealed

Awards 2017 Photos

Prof Einar Broch (Norway) receives the ITA Award 2017 for his Lifetime Achievement

ITA Tunnelling Awards 2017 video

Tunnelling the world 2017 video

ITACUS is active during AFTES Paris 2017

ITACUS joined the Think Deep UK workshop on the future of transport last week in London

Issue 7 of the ITA-CET newsletter

ExCo members participated in the Wroclaw Conference

ITA Executive Council visited the Brunel Museum

EDUCATION AND TRAINING : ITA focus on skilling future tunnellers

Muir Wood Lecture 2017

WTC 2017 - Opening Ceremony

WTC 2017 - General Assembly

WTC 2017 - Closing Ceremony

CS 80

IGS NEWS igs

NEWSLETTER OF THE INTERNATIONAL GEOSYNTHETICS SOCIETY

Dedicated to the scientific and engineering development of geotextiles, geomembranes, related products, and associated technologies

VOLUME 33, No. 3 2017

www.geosyntheticssociety.org/wp-content/uploads/2018/01/IGS-News-Vol.-33-Issue-3.pdf

Κυκλοφόρησε το Τεύχος 3 του Τόμου 33 των IGS NEWS της International Geosynthetics Society με τα παρακάτω περιεχόμενα:

General Information for IGS Members 2

Call for Candidates for IGS Council: Term 2018 to 2022 2

REMINDER: IGS Awards: Call for Nominations 2014 – 2017 3

Obituary for Andre Rollin (1941 – 2017) 4

Technical Committees IGS-TC 5

New IGS Technical Committee on Stabilization using Geosynthetics 5

IGS TC-H Activities Report 6

IGS TC-B Activities Report..8

IGS TC-R Activities Report..9

New Technical Committee of IGS – TC-Stabilization.....10

IGS Young Members...11

Down to Earth – An Interview with Professor Neil Dixon...11

Update from the Young IGS Committee.....................12

Reports about Conference with IGS Auspices..........12

GeoMEast 2017 12

Announcement of the International Conference of IGS 13

11th ICG International Conference on Geosynthetics ...13

Announcements of Conferences under the Auspices of IGS 17

5th International Conference on Geofoam Blocks in Construction Applications (EPS'18) Kyrenia, Northern Cyprus, 09 – 11 May 2018......................................17

GeoMEast 2018 International Congress and Exhibition.17

News from the IGS Chapters and the Membership...18

Update from the CEN Technical Committee CEN/TC 189 Geosynthetics 18

Rencontres Géosynthétiques 2017 The 11th French Speaking Conference on Geotextiles, Geomembranes and Related Products..21

XXVI National Conference on Geotechnical Engineering...22

Interdisciplinary Geotechnical Forum (incorporating the 16th FS-KGEO)...23

SARDINIA 2017 - 16th International Waste Management and Landfill Symposium.......................23

1st Portuguese Seminar on Transportation Geotechnics "Improvement, Reinforcement and Rehabilitation of Transport Infrastructures" 25

Geosynthetic Materials and their Use in Infrastructure Projects 26

Geosynthetic Application EtE Event organized by the Indonesian Chapter of IGS...27

IGS UK Symposium - Use of Geosynthetics in Rail: Towards 2025 29

Geosynthetic Conference for Young Professionals in combination with "Educate the Educators".....................29

List of IGS Chapters 30

Official Journals of the IGS...................................32

Geosynthetics International...32

Geotextiles & Geomembranes 33

Geotextiles and Geomembranes: Best papers in 2016...36

Corporate Membership 36

Report on Corporate Committee Meeting at GeoAfrica 2017...36

Case Studies – Use the Chance! 37

Subsidiary Revetment Construction of Desilting Tunnel Zengwun Reservoir, Tainan, Taiwan, ROC..................38

Subgrade Stabilization at Santa Ana, CA...................39

Temporary Slope Stabilisation, Wastewater Treatment Works Manchester, England 40

Innovative access road design to reach Glenchamber Wind Farm (Scotland) on soft, peaty ground...............41

Geosynthetics solve problem at Strubens Valley, South Africa...42

Corporate Members of the IGS 43

Corporate Profile – G and E Company Limited 50

IGS News Publisher, Editor and Chapter Correspondents...51

IGS Council 52

IGS Officers...52

Calendar of Events 53

www.icevirtuallibrary.com/toc/jgein/24/6

Κυκλοφόρησε το Τεύχος 6 του Τόμου 24 του περιοδικού GEOSYNTHETICS INTERNATIONAL με τα παρακάτω περιεχόμενα:

[Natural weathering of polypropylene geotextiles treated with different chemical stabilisers](), J. R. Carneiro, M. L. Lopes, pp. 544–553

[Soil reinforcement through addition and subsequent carbonation of wollasonite microfibres](), S. Pourakbar, M. H. Fasihnikoutalab, R. J. Ball, N. Cristelo, B. K. Huat, pp. 554–564

[Zoning of reinforcement forces in geosynthetic reinforced cohesionless soil slopes](), J. Chen, W. Zhang, J. Xue, pp. 565–574

[Bearing capacity of reinforced and unreinforced sand beds over stone columns in soft clay](), P. Debnath, A. K. Dey, pp. 575–589

[Steady flow in mechanically stabilised earth walls using marginal soils with geocomposites](), D. Bui Van, A. Chinkulkijniwat, S. Horpibulsuk, S. Yubonchit, I. Limrat, A. Arulrajah, C. Jothityangkoon, pp. 590–606

[Gas advection-diffusion in geosynthetic clay liners with powder and granular bentonites](), A. Bouazza, M. A. Rouf, R. M. Singh, R. K. Rowe, W. P. Gates, pp. 607–614

[Improved analytical solution of vertical pressure on top of induced trench rigid culverts](), X. Qin, P. Ni, M. Zhou, pp. 615–624

[Liquefaction resistance of sand reinforced with randomly distributed polypropylene fibres](), B. Ye, Z. R. Cheng, C. Liu, Y. D. Zhang, P. Lu, pp. 625–636

[Note of appreciation to paper reviewers](), pp. 637

www.sciencedirect.com/journal/geotextiles-and-geomembranes/vol/45/issue/6

Κυκλοφόρησε το Τεύχος 6 του Τόμου 45 του περιοδικού Geotextiles and Geomembranes με τα παρακάτω περιεχόμενα:

[Geotextiles and Geomembranes: Best papers in 2016](), R. Kerry Rowe, p. 557

[Numerical evaluation of the performance of a Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) under different loading conditions](), Allam Ardah, Murad Abu-Farsakh, George Voyiadjis. pp. 558-569

[An analytical method for predicting load acting on geosynthetic overlying voids](), Shi-Jin Feng, Shu-Gang Ai, H.X. Chen, Hai-Jian Xie, pp. 570-579

[Applied bearing pressure beneath a reinforced soil foundation used in a geosynthetic reinforced soil integrated bridge system](), Majid Talebi, Christopher L. Meehan, Dov Leshchinsky, pp. 580-591

[Using fiber and liquid polymer to improve the behaviour of cement-stabilized soft clay](), Mohamed Ayeldeen, Masaki Kitazume, pp. 592-602

[Scale effect on the behaviour of geogrid-reinforced soil under repeated loads](), Gh. Tavakoli Mehrjardi, M. Khazaei, pp. 603-615

[Fully coupled solution for the consolidation of poroelastic soil around geosynthetic encased stone columns](), Boštjan Pulko, Janko Logar, pp. 616-626

[Design of geosynthetic-reinforced slopes in cohesive backfills](), Akram H. Abd, Stefano Utili, pp. 627-641

[Limit state design framework for geosynthetic-reinforced soil structures](), Dov Leshchinsky, Ben Leshchinsky, Ora Leshchinsky, pp. 642-652

[Bearing capacity of geogrid reinforced sand over encased stone columns in soft clay](), Prasenjit Debnath, Ashim Kanti Dey, pp. 653-664

[Effect of ammonium on the hydraulic conductivity of geosynthetic clay liners](), Melissa C. Setz, Kuo Tian, Craig H. Benson, Sabrina L. Bradshaw, pp. 665-673

[Rapid prototyping of geosynthetic interfaces: Investigation of peak strength using direct shear tests](), Gary John Fowmes, Neil Dixon, Liwei Fu, Catalin Alexandru Zaharescu, pp. 674-687

Technical Notes

[Model geogrids and 3D printing](), Dionysios Stathas, J.P. Wang, Hoe I. Ling, pp. 688-696

Numerical simulation of geomembrane wrinkle formation, Ping Yang, Shou-Bao Xue, Li Song, Xue-wen Zhu, pp. 697-701

Development and management of geomembrane liner hippos, Fred Gassner, pp. 702-706

ΕΚΤΕΛΕΣΤΙΚΗ ΕΠΙΤΡΟΠΗ ΕΕΕΕΓΜ (2015 – 2018)

ΕΕΕΕΓΜ
Τομέας Γεωτεχνικής
ΣΧΟΛΗ ΠΟΛΙΤΙΚΩΝ ΜΗΧΑΝΙΚΩΝ
ΕΘΝΙΚΟΥ ΜΕΤΣΟΒΙΟΥ ΠΟΛΥΤΕΧΝΕΙΟΥ
Πολυτεχνειούπολη Ζωγράφου
15780 ΖΩΓΡΑΦΟΥ

Τηλ. 210.7723434
Τοτ. 210.7723428
Ηλ-Δι. secretariat@hssmge.gr , geotech@central.ntua.gr
Ιστοσελίδα www.hssmge.org (υπό κατασκευή)

«ΤΑ ΝΕΑ ΤΗΣ ΕΕΕΕΓΜ» Εκδότης: Χρήστος Τσατσανίφος, τηλ. 210.6929484, τοτ. 210.6928137, ηλ-δι. ctsatsanifos@pangaea.gr, editor@hssmge.gr, info@pangaea.gr

«ΤΑ ΝΕΑ ΤΗΣ ΕΕΕΕΓΜ» «αναρτώνται» και στην ιστοσελίδα www.hssmge.gr