NEW ZEALAND GEOTECHNICAL SOCIETY INC

DECEMBER 2010 issue 80

NZ GEOMECHANICS NEWS

Newsletter of the New Zealand Geotechnical Society Inc.

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NEW ZEALAND GEOMECHANICS NEWS

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Cover image: Darfield Earthquake Liquefaction, Tonkin & Taylor Ltd.

CHAIRMAN'S CORNER

He mihi mahana ki a koutou katoa! Warm greetings to all of you.

Welcome to the final issue of the NZ Geomechanics News for 2010. This issue is also my last as NZGS Management Committee Chair. 2010 has been a very busy year, and I would like to take this opportunity to highlight several of the activities your Committee and members have been involved in.

NZ Geomechanics News

NZ Geomechanics News has been a valuable forum for NZGS and its members. The NZ Geomechanics News published in December 2009 was a critically acclaimed Special Edition. Its focus was the 30th Anniversary of Abbotsford Landslide. June 2010 was a similarly outstanding issue. We have produced a CD containing the entire back catalogue of NZ Geomechanics News in searchable format. All current members should have received a copy, and all new NZGS member will receive a copy upon joining.

Seismic Guidelines

A subcommittee of the NZGS launched Module 1 of *NZ Geotechnical Earthquake Engineering Practice*. They have begun to work on Module 2 of the guidelines which relates to retaining walls. Also, a working group has been formed to collate and record recent information relating to the earthquake in Canterbury that could probably lead to future code and/or guideline revision.

Young Geotechnicals

The NZGS Young Geotechnical Professionals group had an active year with a quiz night, branch events, and an entire day scheduled with activities during the 11th IAEG Congress in Auckland.

The 11th IAEG Congress

The NZGS proudly hosted the 11th Congress of the International Association for Engineering Geology and the Environment (IAEG) in Auckland in September 2010. Over 700 international and local delegates feasted on 5 days worth of presentations and field trips. As part of our sponsorship we received several registrations which we were able to gift to retired/life members of NZGS. At the Congress, we were very proud to see Ann Williams begin her term as the Vice President of the International Association of Engineering Geology and the Environment (IAEG) for Australasia.

The New Logo

We held a concept design competition to find a new, identifiable, intelligent, and eye-catching logo. We selected a winner and awarded $1000 for the design. The new logo has been fully implemented and we are very pleased with our new look.

Philip is a Senior Geotechnical Engineer at Golder Associates based in Nelson. Philip graduated more than 20 years ago from the University of Natal, Durban, with a BSc in Civil Engineering. After working in the field of civil/geotechnical engineering for a few years, Philip returned to study at the University of California, Davis leaving with a MSc in Geotechnical Engineering and a focus on earthquake engineering. Philip is a Member of IPENZ and a Chartered Professional Engineer (CPEng). He has been involved in the design and construction of major infrastructure projects in New Zealand, California, Hong Kong and Southern Africa.

Local Branches

Wellington was the shining star. At the 10th August 2010 meeting there were 60 attendees. Well done to the local branch coordinators. We hope to see increasing numbers of attendees from other locations.

Visiting Dignitaries and Courses

NZGS and NZSEE jointly hosted Professor Shamsher Prakash, an Emeritus Professor from Missouri, USA, in Wellington in November 2009. His presentation was entitled, *Performance Based Aseismic Design of Rigid Retaining Walls*. Also in that month, Clyde Baker, the current Terzaghi Lecturer and recipient of the United States Premier award, presented a talk on *Uncertain Geotechnical Truth and Cost Effective High Rise Design*. Professor Warwick Prebble presented a Field Mapping Short Course on site at Beachlands, Auckland in December 2009. The course offered hands-on experience in engineering geological mapping. It was a huge success and will be repeated again. NZGS offered a one-day short course series in Auckland, Wellington and Christchurch, in May 2010 on *Unsaturated Soils and Ground Movement Control in Deep Excavations and Tunneling* by Professor Antonio Gens of Spain. In August 2010, Professor Scott Burns (USA) presented Lessons Learned from Landslides. The British Geotechnical Association's 50th Rankine Lecture was jointly presented by NZGS and ICE in Auckland in October 2010 by Professor Chris Clayton on Stiffness at Small Strain – Research and Practice.

Closure

I have thoroughly enjoyed my term as Chairman of NZGS. Thank you to so many people who have shared their wisdom and support during my tenure. I would like to specifically thank Amanda for all of her efforts and dedication to making this society and the NZ Geomechanics News top notch. I would also like to thank all of the committee members for their time and efforts that have made our accomplishments over the past years possible. Thank you for giving me the opportunity to serve as Chairman of your Society.

Philip Robins
Chairman, NZGS
Email: probins@golder.co.nz

EDITORIAL

Since the last issue, New Zealand has suffered its costliest ever natural disaster with the Darfield (Canterbury) Earthquake in the early hours of 4 September 2010, although miraculously there were no deaths. In June's editorial we reflected on Haiti's catastrophic magnitude 7.0 earthquake and, ironically, noted "One thing is certain, events of this magnitude or greater will continue to occur and sooner or later will happen in New Zealand",

The rebuilding costs from this magnitude 7.1 event will be huge, and lessons will no doubt be learned, but overall the nation's response has been outstanding and the wisdom of establishing the Earthquake Commission Fund 65 years ago (which currently sits at $5.6 billion, backed up by reinsurance and a Government Guarantee) has proven itself.

In this issue we look at some of the first hand accounts of the earthquake and the geotechnical response underway. NZGS is currently discussing the formation of a sub-committee to officially comment on the earthquake. Further technical analysis and comment on design issues will no doubt be forthcoming from the many on-going studies in Canterbury and we hope to include some of these in future issues.

Incredibly, the earthquake happened the day before the 11th IAEG Congress ("Geologically Active") started in Auckland - a major once-every-4-year gathering of many of the world's leading engineering geologists and geotechnical practitioners - and an the event sponsored by the Earthquake Commission. While some delegates' plans had to change, the Congress provided a unique forum to discuss the earthquake. The Congress was an outstanding success, reflecting the many hours the organising committee and other volunteers put in, and we've included several reviews of the Congress and some thoughts from overseas visitors about the event. NZGS was also a major sponsor of the Congress and our members can be proud of their contribution.

Kate is an Engineering Geologist with Tonkin & Taylor Ltd in Auckland. She graduated with a BSc in Earth Science at the University of Waikato before completing a MSc in Geology at Auckland University in 2000. Kate is now working in Christchurch as a part of the EQC Recovery Team following the Darfield Earthquake.

Paul is an Engineering Geologist and Hydrogeologist at URS Auckland. He studied Engineering Geology at Auckland University and after completing his MSc in 1993 worked for Earthtech Consulting for 3 years. Since then he has worked for URS, including 6 years in their Santa Ana, California office. He currently leads the URS Auckland Geotechnical Team.

Technical papers in this issue include: a paper on numerical modelling, which serve as a great introduction for younger practitioners and a good reminder to all of the limitations of models; report on seismic dilatometers, including their use in liquefaction assessments; and a review of RQD and its applicability, and limitations, in characterising some NZ rock masses.

On p64 are the results of a straw poll currently running on the NZGS web-site asking "Should Engineering Geologists be registered in NZ?" (130 people have voted so far, over 90% think "yes" . This topic was highlighted in the June issue and remains on the Management Committee's list of items to consider. On the competitive front: results of the Student Awards are on p84, results of the photo competition are on p96, a new geotechnical teaser is on p19, and to date we have not heard of anyone completing the crossword unassisted!

As always, if you have comments you feel should be aired to the whole NZGS community, please send them as letters to the editor.

As 2010 wraps up we wish you a safe, happy and natural-disaster-free Christmas break.

Paul Salter, NZ Geomechanics News Co-editor
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On behalf of
Kate Williams, NZ Geomechanics News Co-editor
kwilliams@tonkin.co.nz

LETTERS TO THE EDITOR

The Inclined Drainpipe effect

In the June edition of NZ Geomechanics News the words "Reported by John Hawley" were added at the end of my paper on the inclined drainpipe effect. They are inappropriate.

The essence of the paper is ANALYSIS not reporting.

Some observations and photographs were included to illustrate aspects of the analysis but were not the foundations of the analysis.

The foundations of the analysis are in reasoning rather than in observation.

Since drafting that paper it has come home to me that the issue of pore water head at a depth "d" within a slope knocks out quantitative analysis of ALL soil slopes subjected to rainfall – not only those where the drainpipe effect is present and not only slopes in natural ground and not only situations where the soil has all become saturated. In ALL soil slopes subjected to rainfall pore water heads at depths "d" below the surface are not limited to "d".

The issue arises wherever rainfall is the origin of (or a major contributor to) the pore water – rather than where the dominant issue is seepage from a lake or loads applied to a slope.

For soils in the natural environment, rainfall is usually the trigger of failure, though other things (such as soil weathering and changes in soil surface infiltration rates) may contribute by making the situation more susceptible to such triggering.

Emphasis was given in my paper to natural slopes in natural ground but:

(a) pore water heads greater than "d" at depth "d" could arise in dams and embankments, and

(b) the situation could arise before the soils above "d" become saturated.

The issue should more properly be headed – Slope Instability under Rainfall. Drainpipe conditions just make it more likely to acquire significance.

Determination of pore water heads behind a slope subjected to rainfall requires knowledge of:

- Infiltration rates, particularly through the soil surfaces above the slope, and
- ex-filtration rates through the soil on the lower parts of the slope, and
- spatial patterns of soil permeability (uniform, "drainpipe" or whatever) within the soil behind the slope, ie.:
- the "flow net" which develops under rainfall.

Rainfall precipitation rates in major rainstorms are usually larger than soil infiltration rates – and surface runoff occurs. The concept of runoff coefficients is familiar to civil engineers because it is central to design of stormwater systems. A knowledge of precipitation rates is therefore not required – infiltration rates (or their reciprocal runoff coefficients) are more relevant.

The "knowledge" noted above is extremely unlikely to be available at sufficient accuracy to allow distinction between "sure to fail" and "unlikely to fail".

With reluctance I am forced therefore to the conclusion that – with regard to soil slopes subjected to rainfall, stability analyses based on soil strengths are not applicable and "the literates have it".

Quantitative consideration of the stability of slopes using values of cohesion and internal friction obtained by back-figuring from failures in similar soils and climates is also unlikely to be "sound". The four bullet points of knowledge listed above would have to be known to be the same in the unfailed slope as in the failed one for any linking to be rational.

To put it bluntly, soil strengths (values of cohesion and internal friction) are generally irrelevant to the development of failure conditions in soil slopes where the conditions develop as a result of rainfall.

John Hawley
John Hawley Consulting Ltd, Warkworth

Canterbury Residential Foundation Design Issues Post-Darfield Earthquake – Colin Ashby

While in Canterbury, I attended a couple of joint structural/geotechnical meetings at Canterbury School of Engineering. Which I found interesting. Minutes should be available on http//quake.canterbury.ac.nz/

My principal concern was that on one hand the Council (in LIM's) warns that the areas subject to liquefaction and on the other hand considered the ground to be "Good Ground" in terms of NZS 3604 (which is not) and has therefore been accepting unreinforced concrete slabs on 300 mm of uncompacted washed river gravel (marbles). Numerous houses have either written off or in need of extensive remedial work as a result.

I had approached Council about this recommending that they put a stop work notice new projects due for construction where slabs are not reinforced, but at the time they were sitting on their hands waiting for a decision from DBH, who were waiting a decision from the NZS 3604 committee who were waiting a decision from the Australian code committee and in the meantime, local builders like "lemmings" were continuing to build the same old floors doomed to failure.

Within NZS 3604 for single-storey buildings on "Good Ground" a slab on grade may be able to be constructed as an unreinforced concrete slab.

However, as the ground has proven not to be "Good Ground", and as Council's own LIM Reports proclaim that it may be subject to liquefaction, it is not "Good Ground", therefore the provisions of NZS 3604 are not applicable and Council does in fact have the power to act. Council does not have to wait for the DHB. The determination is already made! The ground does not meet the "Good Ground" requirements of NZS 3604. And I would respectfully suggest that they take prompt appropriate action.

Although I have had more positive discussions with Council officers since initially raising the issue, the message still does not seem to have got through. An reinforced concrete slabs on grade for houses should be outlawed in Canterbury and probably everywhere else in New Zealand. If your roof blows to bits or wall is damaged, it can be economically replaced or repaired, but when the floor slab and foundations are badly damaged the whole house can be a write-off.

I appreciate that 665 mesh which is commonly used in slabs is frowned upon as it has limited yield, but it is certainly better than nothing. While in Christchurch I inspected a property 4 km from the epicentre which would have been subject to ground accelerations estimated at 0.5g. Cracking in an exterior concrete driveway had occurred but was arrested part way through the slab. On checking with a metal detector I found that owner had had some extra 665 mesh left over when pouring the garage floor, and had placed this within the driveway, and this is exactly where the cracking stopped.

In that particular instance the owner of his own volition had determined to reinforce his concrete floor slab

continued on page 105 >

EDITORIAL POLICY

NZ Geomechanics News is a biannual newsletter issued to members of the NZ Geotechnical Society Inc. It is designed to keep members in touch with matters of interest within the geo-professions both locally and internationally. The statements made or opinions expressed do not necessarily reflect the views of the New Zealand Geotechnical Society Inc. The editorial team are happy to receive submissions of any sort for future editions of *NZ Geomechanics News*. The following comments are offered to assist potential contributors. Technical contributions can include any of the following:

- technical papers which may, but need not necessarily be, of a standard which would be required by international journals and conferences
- technical notes
- comments on papers published in *NZ Geomechanics News*
- descriptions of geotechnical projects of special interest

General articles for publication may include:

- letters to the NZ Geotechnical Society
- letters to the Editor
- articles and news of personalities
- news of current projects
- industry news

Submission of text material in Microsoft Word is encouraged, particularly via email to the editor or on CD. We can receive and handle file types in most formats. Contact us if you have a query about format or content.

Diagrams and tables should be of a size and quality appropriate for direct reproduction. Photographs should be good contrast, black and white gloss prints or high resolution digital images. Diagrams and photos should be supplied with the article, but also saved seperately as 300 dpi JPGs. Articles need to be set up so that they can be reproduced in black and white, as colour is limited.

NZ Geomechanics News is a newsletter for Society members and articles and papers are not necessarily refereed. Authors and other contributors must be responsible for the integrity of their material and for permission to publish. Letters to the Editor about articles and papers submitted by members will be forwarded to the contributing member for a right of reply.

Persons interested in applying for membership of the Society are invited to complete the application form in the back of the newsletter. Members of the Society are required to affiliate to at least one International Society and the rates are included with the membership information details.

THE SECRETARY'S NEWS

NZGS has had a very eventful six months. The Branch events have been varied and plentiful, the membership still growing, Canterbury still shaking – but finally, the sun is starting to shine. And of course we hosted the IAEG 2010 Congress that conquered all!

NZGS at IAEG 2010 Congress

Our Chairman, Philip Robins, suggested that we should provide, as hosts, a meeting place in the midst of the learning and lectures, the networking and negotiating, the busy hustle and bustle of 700 people attending the 11th IAEG Congress at Sky City in Auckland in September. Smart move! The NZGS lounge area was a great hit – we had plenty of visitors ranging from delegates, presenters and exhibitors, all using or commenting on our wonderful welcoming and relaxing environment.

The large on-screen presentation of fantastic images of local geotechnical projects and geological landforms was prepared from images supplied by our members. We received many comments about the photos and it was good to promote our Society through this medium - thanks to all of you for assisting with that mammoth task.

Thanks too must go to Branch Co-ordinators for their assistance at the stand, particularly Joyce Seale, and to Lucy Coe for assistance with the photo show.

I really enjoyed meeting lots of our members and talking to many overseas delegates about their experiences and impressions of their visit to NZ – including a large number that were in Christchurch during the earthquake. The Congress Dinner was a particular highlight, having never tried muttonbird or kina – and what lovely pina coladas! Congratulations to the organising committee, you worked so hard and really did a fantastic job. Ka pai!

Darfield Earthquake

The M7.1 Darfield (Canterbury) Earthquake that struck early on the first morning of the pre-Congress meetings certainly was a crude reminder of how geologically active it really is here in Aotearoa. A large amount of technical information has been, and will continue to be, generated, and many NZGS members are contributing directly in their professional capacities to help benefit those affected by the devastation during and post-quake. We hear that the aftershocks are slowing becoming less frequent and trust that rebuilding and re-establishing infrastructure, homes, businesses and daily life becomes easier for everybody in Canterbury over the coming months.

On a personal note, during a quick family break to Christchurch 4 weeks after the earthquake I was inspired again by how beautiful the City is – thanks for the fine weather, gorgeous spring gardens, lovely cafes and hospitality, and the 'exciting' and nerve jangling M5.0 aftershock.

Committee

A call for nominations for three NZGS Management Committee members for 2011 will go out in early December (just as this issue of NZ Geomechanics News is released). Please take some time over the Christmas break to consider standing for a role on the Committee. There will be a new Chair, Vice-Chair and Treasurer next year, as Philip Robins completes his chairmanship and these responsibilities are reallocated on a two year rotation.

Student Awards

There were many applicants for the 2010 Student Awards. Not all candidates were selected to present their topics, as the Committee chose to invite 3 or 4 students from each of the North and South Islands to the final showdown! Congratulations to both the North and South Island winners and thanks to our wonderful judges and Branch coordinators who assisted with preparations for these events.

New Members

Welcome to you all! The overall membership is now at 760 members and it is a pleasure to welcome the following new members since June 2010:

Daniel Wyatt (Hamilton); Derek Stewart (Auckland); Glen Budden (Auckland); Muhamad Yusa (Christchurch); Matthew Knox (Wellington); Nima Ghafari (Phillipines); Namir Asmaro (Auckland); Doug Harbutt (Tauranga); Miles Thompson (Hamilton); David Rowland (Hamilton); David Molnar (Wellington); James Johnson (Auckland); David Lander (Christchurch); Sally-Ann Marshall (Wellington); Ralf Konrad (Auckland); Daniel Strang (Christchurch); Sophie Bainbridge (Christchurch); Jeremy Eade (Auckland); Richard Griffiths (Auckland); Salen Shankar (Auckland); Andrew Smith (Nelson); Laura Foster (Auckland); Zhaodong Du (Hamilton); Richard Mould (Australia); Salah Al Dilimi (Dubai); James Barratt-Boyes (Auckland); Brian Benson (Wellington); Steven Cooke (Hamilton); Roger Evans (Auckland); Tony Harker (Wellington); Parmil Prakash (Auckland); Sally Roberts (Auckland); Christopher Foote (Auckland)

Please feel free to contact me for assistance with any queries you might have, and to update address and contact details as required.

Amanda Blakey
Management Secretary
secretary@nzgs.org

INTERNATIONAL SOCIETY REPORTS

International Association for Engineering Geology and the Environment Australasia VP Report: November 2010

IAEG EXECUTIVE AND COUNCIL MEETINGS

The IAEG Executive and Council meetings were held in Auckland on 4 and 5 September immediately prior to the opening of the 11th IAEG Congress in Auckland. Major items discussed included presentation and discussion of the modernisation plan (a plan to streamline and improve the efficiency and efficacy of IAEG), selection of Torino, Italy as the venue for the 12th International Congress in 2014, and election of the new Executive. Carlos Delgado was elected as President (Fred Baynes will remain on the Executive as the Immediate Past President); the new Secretary-General is Faquan Wu from China, who served as VP Asia on the Executive over the last 4 years. Giorgio Lollino has been identified as the new Web-Editor for the period 2010 to 2013. Giorgio is leading a team that will create a new modern interactive website to replace the existing one once it is complete. There are 12 active IAEG Commissions and it is expected that the commissions will report their findings on the website for members to download and interact with. Brian Hawkins will continue in his role as Editor of the Bulletin and it is planned that authors will be able to also submit and have published abstracts in their native language. Ann Williams will be VP Australasia from January 2011.

IAEG LIAISON REPRESENTATIVE IN AUSTRALIA

Mark Eggers will be the IAEG Liaison Representative in Australia for the term of the next IAEG Executive (2011 to 2014). Mark's role will be to support Ann in her role as Vice President for Australasia, attend and contribute to AGS National Committee Meetings and take an active role in promoting engineering geology in the region. Apart from being a busy consultant Mark has been teaching engineering geology and an active member of the AGS for many years. One of his latest activities has been involvement in the development and teaching of the new 7 day field based course AGS course in engineering geology based in Wollongong. Mark has agreed to lead organisation of the Engineering Geology Session at the 34th IGC (International Geological Congress) to be held in Brisbane in 2012 with support from Francisco de Jorge (Brazil), Paul Marinos (Greece) and myself.

FEDIGS (Federation of International Geo-engineering Societies)

There was an extraordinary meeting of the FedIGS Board on 28 May this year. At the meeting it was agreed that FedIGS would continue to operate within the Co-operation agreement endorsed by the sister societies but it will change to become a smaller, less powerful organisation. Professor William van Impe's resignation as FedIGS President was accepted and Professor Nielen van der Merve will chair the Board for the next 12 months. JTC1, JTC2 and JTC3 (geoengineering data, landslides and education) will continue to exist and be managed by the FedIGS Board but all other JTCs will be disbanded. The Liaison Committee (made up of industry representatives) will also be disbanded.

Ann Williams
Incoming IAEG Vice President (Australasia)

NZGS ON THE WEB

> The NZGS has a very informative, easily navigable, and stunningly laid out website to keep you up to date.

> Our web manager and Branch Coordinators have been successfully updating events and presentations on the website and we are now adding even more new features, including rss feed, a blog with latest news from NZGS and an option to subscribe to email alerts for new updates.

> Please go to www.nzgs.org and have a look. Send us your comments, tell us your news, and remind us about events that we should be sharing with other members.

www.nzgs.org

International Society for Rock Mechanics

Australasia VP Report: November 2010

1 BOARD AND COUNCIL MEETINGS

The meetings for the Board and Council were held in New Delhi, India in October in conjunction with the 6th Asian Rock Mechanics Symposium. 36 of the 47 National Groups were either present or represented in the Council meeting. Three of the Past Presidents; Ted Brown (1983-1987), Shunsuke Sakurai (1995-1999) and Nielen van der Merwe (2003-2007) also attended the Council meeting. Issues discussed in the meetings are presented in the following sections.

2 MEMBERSHIP

The Society now has 6,312 Members; the number having increased by 5.3% since the previous meeting. This is the highest number of members ever. 48% of members come from Europe but Asia has been the fastest growing region in the past few years; Indian and Chinese membership increased by 76% and 10% respectively in the past year. Australasia's membership increased by 5% over the year.

Bolivia was welcomed as the latest National group to join the Society. Ghana, Hungary and Mexico were removed due to non-payment of fees for 3 years.

3 FINANCES

The finances of the Society have become less robust and a deficit is expected this year. The fees that the National Groups pay to the Society have remained the same since 1994, with no increases for inflation. The Society is however now offering Members significantly more benefits than it did previously and expenses have increased at a rate greater than income. Income has been reduced by the non-receipt of payments from some National Groups and Corporate members. The fees are lower than those of other International Societies e.g. ISSMGE and IAEG.

The Treasurer proposed that the fees paid by National Groups be as follows. Groups with:

- 10 individual members or less: €45
- more than 10 and less than 40 members: €3.5 x number of members + €10
- 40 members or more: €150.

Although the increase would have represented a very small additional cost to National Groups, the proposal was defeated.

4 MÜLLER AWARD

The Müller Award is made every four years in recognition of distinguished contributions to the profession of rock mechanics and rock engineering.

Three nominations for the 6th Müller Award were received: Dr Nick Barton, Prof. Richard Goodman and Prof. Peter Kaiser.

A vote took place during the Council meeting and Dr Nick Barton was selected as the winner. He will receive the award and deliver the Müller lecture at the 12th ISRM International Congress in Beijing in October 2011.

5 13th ISRM INTERNATIONAL CONGRESS

Two nominations were received to host the Congress: Montreal, Canada and Agra, India.

A vote took place during the Council meeting and Montreal was selected as the winner. The Congress hosted by the Canadian Rock Mechanics Association, CARMA, to be titled *Innovations in Applied and Theoretical Rock Mechanics* will take place from 29 April to 6 May, 2015.

A request for papers from Australasia will be made later.

6 ROCHA MEDAL

The Council was informed that the Board awarded the 2011 Rocha Medal to Dr Dohyun Park from the Republic of Korea for the thesis titled *Reduction of Blast Induced Vibration in Tunnelling using Barrier Holes and Air Decking*. He will receive the award at the Beijing Congress.

The Board also awarded a runner up certificate to Dr Li Bo from China for the thesis titled *Coupled Shear-Flow Properties of Rock Fractures*.

Nominations for the 2012 Rocha Medal are to be received by the ISRM Secretariat by 31 December 2010. The winner will be announced during the Beijing Congress. The winner will be invited to receive the award and deliver a lecture at the 2012 ISRM International Symposium likely to be held in Stockholm.

7 DIGITAL LIBRARY

The development of a digital library represents a significant product of the ISRM modernisation plan being undertaken by the current Board. It will eventually contain all of the papers published at ISRM Congresses and Sponsored Symposia, thereby making the papers available to all Members.

The library has now been launched. Members registered to use the Members only section of the ISRM website are able to download at no cost up to 100 papers per annum. ISRM Corporate members can download 250 papers per annum at no cost.

The library is hosted by OnePetro, a large online library managed by the Society of Petroleum Engineers, SPE. To register on their site (www.onepetro.org), the only information necessary are the Member's username and

password assigned to gain access to the ISRM website.
The library currently has 2000 pages from 9 conferences uploaded and this number is expected to double in the next 6 months.

Any Member that does not have an ISRM username and password should contact the Regional VP who will organise to have them sent to the member by the Secretariat.

8 REVISION OF STATUTES

Three aspects of the statutes were revised:

- French and German will no longer be used as official languages of the Society which from now on will be only English.
- Specialised Conferences, focussing on specific topics, were introduced as a new type of ISRM Sponsored Event.
- The membership category of Fellow was created. This category will be conferred on individual Members who have achieved outstanding accomplishments in rock Mechanics and/or rock Engineering and who have contributed to the professional community through the ISRM.

9 COMMISSIONS

ISRM Commission reports represent a major product of the Society. The Commissions currently active are:

- Application of geophysics to rock engineering
- Rock engineering design methodology
- Preservation of ancient sites
- Radioactive waste disposal
- Testing methods
- Mine closure
- Rock dynamics
- Education
- Spalling

Interim reports were presented by each Commission to Council. Final reports are required in 2011 when the Council meets during the Beijing Congress.

Two new commissions are being formed and they will officially commence in October 2011:

- Crustal stress and earthquakes
- Petroleum geomechanics

10 MEMBER COMMUNICATION

WEBSITE

The ISRM website is the main source of information about the Society and most benefits available to members are obtained from a password protected area.
Several videos were recently uploaded:

- The keynote lectures presented at EUROCK 2009 held in Cavtat, Croatia

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- The 1st Müller lecture delivered by Evert Hoek in 1991
- The 2nd Müller lecture delivered by Neville Cook in 1995
- Lectures on Geological Engineering by John Franklin

The keynote lectures presented at the recent Asian Rock Mechanics Symposium in New Delhi will soon be uploaded.

NEWSLETTER

The digital newsletter is emailed to all Members quarterly and is available to members from the website. It includes news about the Society and other news related to rock mechanics. The newsletter is the medium through which individual or corporate members can communicate to the general membership on any aspect of rock mechanics. Hence short contributions are very welcome. These contributions could be on, for example:

- issues at a mining site or on a civil project;
- a recent high-tech development;
- a recent 'rock' related incident; for example a disaster, issue of a report on an incident, or implementation of new regulations relating to 'rock' issues;
- findings from cutting edge 'rock' research;
- a summary of a local 'rock' related meeting, symposium or conference;
- interesting developments in 'rock' related education;
- a summary of developments in the local job market for 'rock' practitioners.

11 FedIGS

At the London meeting in May, the three Presidents of the ISRM, ISSMGE and IAEG made a series of agreed recommendations for re-configuring FedIGS to a leaner more effective Federation. Due to the resignation of Prof. William van Impe as FedIGS President, the Board unanimously agreed that the Immediate Past president of ISRM, Prof. Nielen van der Merwe, will act as chairman of the federation until October 2011 when a new president will be elected.

12 SECRETARIAT

The Secretariat of the ISRM is staffed by one full time secretary, Sophia Meess, and the part-time Secretary General, Luis Lamas. The work of the Secretariat includes all of the tasks of the Society: administrative (correspondence, filing etc.), financial (payments, receipts and accounting), secretarial (drafting documents, minuting, letters) and communication (website, Newsletter, News Journal).

The Secretariat has been based at the Laboratório Nacional de Engenharia Civil – LNEC in Lisbon Portugal since 1966. The LNEC makes offices available to the Society at no cost. It also provides, at no cost, secretarial and book keeping assistance and telephone and computing facilities.

13 UPCOMING EVENTS

2nd to 4th December 2010. Lima, Peru. VII South American Congress on Rock Mechanics

16th to 21st October 2011. Beijing, China. *Harmonizing Rock Mechanics and the Environment*. The 12th ISRM International Congress.

15th to 17th October 2011. Beijing, China. 2nd International Young Scholars Symposium on Rock Mechanics. An ISRM Specialised Conference.

27th to 30th May 2012. Stockholm, Sweden. 2nd EUROCK 2012. *Rock Engineering and Technology*. An ISRM Regional Symposium and likely to be the 2012 ISRM International Symposium.

21st to 26th September 2013. Wroclaw, Poland. 2nd EUROCK 2013. *Application of Rock Mechanics to Civil and Mining Engineering*. An ISRM Regional Symposium.

29th April to 6th May 2015. Montreal, Canada. *Innovations in Applied and Theoretical Rock Mechanics*. The 13th ISRM International Congress.

Tony Meyers
ISRM Vice President (Australasia)

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TASPIE+ & TASPLAQ

TERRASOL has developed 2 new calculation modules as part of FOXTA software.

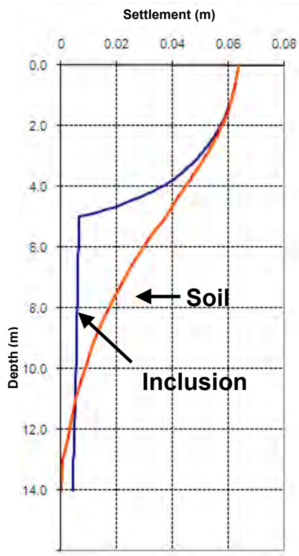
These 2 modules are not yet integrated into the present user interface of FOXTA. They will be marketed initially with a stand-alone and very user-friendly data interface using Microsoft Excel® for the data input as well as results output.

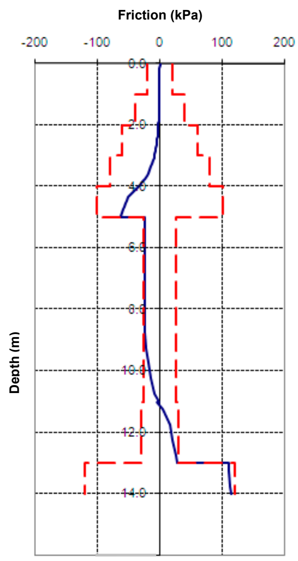
Taspie+ and Tasplaq modules will be integrated later on into the next major update of FOXTA (v3).

TASPIE+

Design of single piles, pile groups, rigid inclusion networks and piled-raft foundations

- t-z model (friction and end-bearing capacity) according to Frank and Zhao, Monnet or other user-defined models.
- Taking into account interaction between the pile and the surrounding soil (negative and positive friction, soil settlement, pile settlement).
- Rigid inclusion networks calculated with imposed displacement (slab foundations) or imposed stress (fills). Automatic determination of the converged solution (slab foundations).
- Evaluation of the group effect within a soil volume reinforced by piles.





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- Coupling of plate finite elements and Boussinesq formulas.
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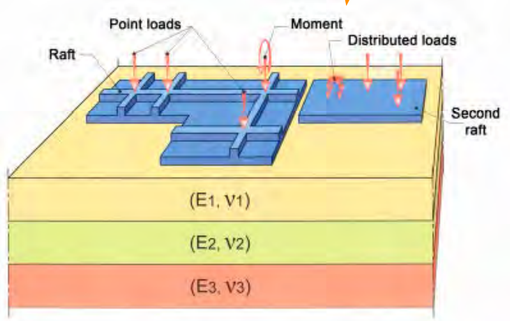
- Calculations validated by numerous finite element and finite difference computations.



For more information please contact :
Techsoft Australasia Pty Ltd
Lev 12, 37 Bligh St, Sydney, NSW 2000
Tel : 02 8257 3337 email : nicolas.vass@techsoft.com.au

NZGS BRANCH ACTIVITIES

Auckland Branch Activity Report

Over the last three months, the Auckland Branch has successfully hosted the following lectures:

July 2010: Design and construction of temporary support for low cover driven tunnels (CLEM7 Tunnel, Brisbane)

Andrew Campbell from AECOM presented a very interesting lecture on the recently opened Brisbane's Clem7 Tunnel. The design included approx. 3km of roadheader tunnels, with the balance being TBM tunnels. Andrew summarised the ground conditions encountered at the southern portal area, the construction sequence for the tunnel structures and the methodology adopted for the design of the excavation and initial support of the tunnels. The monitoring regime for the southern portal area was outlined, including how the monitoring results were reviewed and confirmed by the tunnel designers.

October 2010 - 50th Rankine Lecture: Stiffness at Small Strain, Research and Practice

ICE and NZGS were proud to present the British Geotechnical Association's 50th Rankine Lecture: Stiffness at Small Strain – Research and Practice by Professor Chris Clayton, University of Southampton, U.K.

This lecture reviewed what is now known about the complex stiffness behaviour of soil and weak rocks in the context of elasticity. Drawing on experience gained through field observation and numerical modelling, the case was made for the routine use of non-linear anisotropic stiffness. The determination of the parameters required was then explored, and the usefulness of advanced triaxial testing, and dynamic laboratory and field testing examined.

Upcoming Events

Looking forward to the end of the year, we have an exciting programme:

November 2010: North Island Student Prize

On 17th of November, the four finalists for the North Island Student Prize made their presentations to NZGS members on a wide variety of topics.

The winning abstract of the prize is announced later in NZ Geomechanics News.

December 2010: Professor John Atkinson Course and Christmas Function

We are currently planning a short course and lecture followed by our branch Christmas Celebration on the 2nd of December.

Lucy Coe
Auckland Branch Coordinator
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Lucy Coe is a Geotechnical Engineer with Beca Infrastructure Ltd. After graduating from the University of Canterbury, Lucy moved up to Auckland and as been here ever since. Lucy has undertaken geotechnical investigations, design and construction monitoring on major infrastructure projects such as CMJ, Upper Harbour Bridge, Northern Busway and New Lynn Rail Trench.

Pierre Malan
Auckland Branch Coordinator
Tonkin & Taylor Ltd
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Pierre is a Geotechnical Engineer with Tonkin & Taylor Auckland. Pierre graduated from the University of Canterbury with a M.Eng and has subsequently worked around Auckland and throughout the United Kingdom and Ireland. He has worked on major infrastructure work, design and build contracts as well as a range of small to medium projects.

Luke Storie
Auckland Branch Coordinator
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Luke is a Geotechnical Engineer with Coffey Geotechnics (NZ) Limited. He graduated from the University of Auckland with a BE(Hons) and Arts conjoint degree in 2009 and has worked in the Silverdale office of Coffey Geotechnics since then. Luke has worked on a range of small to large scale projects across Auckland and also on secondment in Australia.

Professor John Atkinson will present a course on the Fundamentals of Soil Mechanics.

The Christmas Celebration will be held at the University's Business School Spicers Restaurant. This will provide an opportunity for geotechnical professionals within Auckland to catch up after an exciting and busy year, with drinks and nibbles provided. All members are welcome, so we hope to catch up with you there!

Bay of Plenty/Waikato Branch Activity Report

Recent Activity

After the IAEG Symposium early in September we got back on track with two very different but equally relevant and interesting local branch activities as outlined below:

On 22 September Geotech Systems Limited hosted a tour and practical presentation at their Tauranga depot followed by a top-notch BBQ and drinks. Being a long standing local and national supplier, Geotech Systems also provide proprietary product support and design assistance. Graham Jenkins, Graeme and Malcolm Bell gave an informative and interesting run-down of construction and geotechnical products, applications, issues and solutions. Further information is now available on their recently launched website www.geotechsystems.co.nz. The evening was very well attended by both consultants and contractors, plus a Hamilton contingent made the trip over the Kaimai too.

On 14 October Laurie Wesley presented on the influence of water on slope instability and the mechanics of groundwater flow. This presentation focused on Western Bay of Plenty volcanic soils, but delved into sound soil mechanics theory applicable to any geological setting. Laurie described the mechanisms by which seepage and pore pressures in the ground change as a result of external effects such as rainfall or excavation below the water table. The way in which these mechanisms are handled by both analytical solutions (of limited scope) and computer programs such as ModFlow and SEEP/W was explored. Laurie made specific comments on the Tauranga situation (including observations after the May 2005 storm) and a worked example was given of the way in which the programs SEEP/W and SLOPE/W can be used to gain a theoretical understanding of the way in which rainfall influences stability. Once again, this presentation was very well received with a good number of attendees from the Bay of Plenty and Waikato regions.

Laurie also made available two technical papers to attendees. An earlier paper Slope Behaviour in Otumoetai,

Kori Lentfer
Bay of Plenty Branch Coordinator
Coffey Geotechnics (NZ) Ltd
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Kori took over the role of Waikato/Bay of Plenty Branch Co-ordinator in June 2009.

Kori is a consulting Engineering Geologist who works for Coffey Geotechnics. He graduated in 1998 with a BSc(Tech) in Geology, followed by Masters study at Waikato University and an MSc thesis in Engineering Geology from Auckland University in 2007. Kori has worked for consultants based in the UK, Europe and the Middle East. On return to the homeland he joined Foundation Engineering in Orewa, which was acquired by Coffey Geotechnics in 2007. In April 2008 Kori transferred to the Tauranga office for the lifestyle and diverse geotechnical challenges.

Ken Read
Waikato Branch Coordinator
Opus International Consultants
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Email: ken.read@opus.co.nz

Ken is a Senior Engineering Geologist with Opus International Consultants in Hamilton. He graduated in 1982 with a BSc in Geology from Edinburgh University, followed by an MSc in Engineering Geology from Newcastle University in 1984. He has worked primarily for consulting engineers but has also worked in site investigation contracting and environmental consultancy in the UK. His work has taken him to Jamaica, Malaysia, Nigeria and Croatia before moving to New Zealand in 2006. He is a Chartered Engineer (CPEng) and a UK Chartered Geologist.

Tauranga was published in the NZ Geomechanics News, December 2007 edition. A recent unpublished paper provided more detail and on the presentation topic. For references or presentation notes contact: Kori Lentfer.

Upcoming Events

Date/Time	Location	Details
December, 2010 (TBC)	Aecom Office, 121 Rostrevor Street, Hamilton	Glen Buddon of Pile Tech and Adam Plimner of Foster Construction on Screw Piling - joint presentation with local IPENZ branch
Later in 2010	Te Uku, TBC	Te Uku Windfarm tour (subject to logistics)
Late 2010 early 2011	Hamilton, TBC	First night – a series of short presentations from younger members
Late 2010 early 2011	Hamilton, TBC	Contaminated land issues
Early 2011	Tauranga, TBC	Laurie Wesley – TBC, but involving laboratory consolidation testing and interpretation

Wellington Branch Activity Report

The second half of the year has been a quieter period for NZGS Wellington Branch meetings with only one talk, partially due to the (highly successful) IAEG Congress that was held in Auckland at the start of September, and most potential presenters focus on finalising their presentations for that.

However there was plenty of talks and events in the region by other societies and organisations including the Geoscience Society of NZ, Victoria University, and IPENZ. The Wellington Branch page of the NZGS website does endeavour to update members of talks in the area by these other societies and organisations, so keep an eye on the branch news section of the website.

The NZGS branch meeting that did eventuate was on 10 August with Russ Van Dissen of GNS giving an update on the "It's out Fault" project, the talk focused on primarily the 3D geological and geotechnical characterisation of central Wellington and the Hutt Valley, and mapping of NZS 1170.5 subsoil classes, where the venue was filled to capacity with barely any standing room left.

At the time of writing 2 more branch meetings are scheduled:

30 November – *"When size doesn't matter – The effects of thin clay seams on deep-seated rock slides in the Neogene marine sediments of West-central North Island"* by Chris Massey of GNS Science

8 December – Two talks :

– *"An embankment on peat. MacKays crossing road over rail bridge, SH1, Wellington, NZ"* by Stuart Palmer of Tonkin & Taylor Limited.

– *"Geotechnical Issues Associated with Construction on Soft Ground in New Zealand"* by Alexei Murashev of Opus International Consultants Limited.

Next year meetings will resume in February with a scheduled presentation by Stuart Read from GNS Science on Closely Jointed Rock Masses.

David Stewart
Wellington Branch Coordinator
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David is a Senior Geotechnical Engineer/Engineering Geologist with Opus International Consultants in Wellington. David completed an MSc in Engineering Geology at Canterbury University and then worked in site investigations in the UK, returning to NZ to work on the Cromwell Gorge Landslides project. He then worked as an engineering geologist for GNS in Dunedin, followed by 2 years at Macraes Gold Mine. After a stint in Auckland picking up a BE, he joined Duffill Watts & Tse in Wellington in 2001 and has been at Opus since mid-2004.

Beverley Curley
Wellington Branch Coordinator
GHD
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Email: Beverley.Curley@ghd.com

Beverley is a Senior Engineering Geologist with GHD Ltd in Wellington. She graduated in 1998 with a BSc(Hons) in Geology from Kingston University, UK, followed a few years later in 2002 by an MSc in Geohazard Assessment from Portsmouth University, UK. Prior to January 2010 she was with Opus International Consultants in Wellington since her arrival in NZ in November 2004. In the UK she worked for Mouchel Parkman. Beverley loves being in NZ and finds working here excellent as, being so young geologically and seismically active, slopes tend to fall down quite regularly.

Canterbury Branch Activity Report

The Canterbury Branch has been very active and had met its goal of at least one presentation every six weeks prior to the September Darfield (Canterbury) earthquake. There were four presentations and one short course for Canterbury Branch members along with interested engineering and engineering geology students. We have continued to use the University of Canterbury facilities with refreshments served in the Engineering Commons Room and the presentation in the adjacent up to date lecture hall E10.

On 17 June Iain Haycock, General Manager of McMillan Specialist Drilling presented "Ground Anchor Design and Construction from a Contractor's Perspective". About 35 people attended and enjoyed both an entertaining and informative talk on ground anchor design and installation for three different wind farm projects in the Islands. The talk touched on French methods of corrosion protection, the pitfalls of insufficient ground investigation, the benefits of appropriate anchor testing and why to pad out your executive summary to achieve a better engineer's summary: disclaimer ratio. Thanks to McMillans for providing the refreshments.

On 4 August Dr Trevor Orr from the Graduate School of Professional Engineering Studies, Trinity College Dublin presented "Eurocode 7 – Harmonising Geotechnical Design in Europe and Worldwide". Thanks to Maccaferri NZ Limited for providing the refreshments and John Clarke, Mike van den Arend and Gordon Stevens for organising the speaker.

On 26 August Professor Scott Burns from Portland State University, USA presented "Lessons Learned from Landslides". Scott was on his way to attend the IAEG Congress and was visiting old friends in Christchurch. More than 40 of us enjoyed his vivacious talk. Thanks to Coffey Geotechnics for providing the refreshments.

Reported by: Joyce Seale

Nick Harwood
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Nick is a consulting Geotechnical Engineer who works for Coffey Geotechnics. He graduated in 1990 with a BEng(Hons) degree in Engineering Geology & Geotechnics, followed by a MSc in Soil Mechanics & Engineering Seismology from Imperial College in 1994. Nick started out as a graduate working for British Waterways before moving onto Brown & Root (London) and Buro Happold (Bath) before finally escaping to New Zealand in 2002. He loves living and working in New Zealand, a place that combines sublime scenery and diverse assignments.

Joyce Seale
Canterbury Branch Coordinator
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Joyce is an environmental scientist working for Pattle Delamore Partners Limited in Christchurch. She graduated from the University of Canterbury in 2002 with a BSc in Geology followed by a MSc in Engineering Geology in 2006. This is Joyce's "third" career, her first being a teacher and the second a mum. She is enjoying applying engineering geological principles to contaminated site investigations.

Canterbury Branch Earthquake Report

You will all be aware of the wee shake that we experienced in Canterbury in early September and subsequent aftershocks. The seismic activity initiated a maelstrom of activity across the engineering industry and many other professional sectors. I won't go into details here partly because that would take up the entire newsletter and also because our understandings and advice continue to evolve. We have inspected with amazement the reality of the aftermath of a large earthquake. The ground (non) performance we observed is what we diligently investigate, analyse and design to accommodate or mitigate or avoid. Now we have had a large-scale test of Canterbury's soils and many questions were thrown up, many of which are not solely seated in the geotechnical camp to answer.

In terms of branch activity the earthquake has created a wonderful opportunity for debate and discussion within the geotechnical community and also between engineering disciplines. Initially, the Canterbury Structures Group (CSG) and the NZGS/NZSEE held separate meetings as this was the established (pre-earthquake) format. However, it very quickly dawned that debate was needed across the disciplines and we have had a number of joint meetings co-hosted by John Snook (CSG chair), Bruce Deam (New Zealand Society of Earthquake Engineering) and myself (NZGS Christchurch Branch) that have been very well attended. Attendees and presenters come from a wide range of organisations including ECan, GNS, EQC, the three district councils (Selwyn, Christchurch and Waimakariri), geotechnical, structural and groundwater consultants, DBH, Universities of Canterbury and Auckland, ground engineering contractors, the list goes on.

In addition to the forums we have also been holding a weekly geotechnical discussion group to discuss details of issues that affect our daily working practices. These include, for example, the need to consider earthquake events in addition to the SLS and ULS events in our analysis, and the methods of analysis we commonly employ to predict earthquake-induced deformation. One of the intriguing aspects of the earthquake is the comparison of predicted verses observed deformation, and the reasoning behind the often found significant disparity. How can we derive any real risk assessment when the predictions seem to be so far from observation? I acknowledge contributions from friends from Geotech Consulting, Eliot Sinclair, Golder Associates, URS, MWH and Coffey Geotechnics to these meetings. Thank you.

The forums and other meetings have brought out a great aspect of our human nature – the willingness to meet and share knowledge, and to put aside commercial constraints that would otherwise potentially prevent free discourse. The engineering community has really pulled together to support one another, collectively discuss and solve problems and improve the way we go about our work. I am certainly a lot wiser and I have no doubt many of you are too.

Reported by: Nick Harwood

Otago Branch Activity Report

David Barrell and Simon Cox gave a presentation on "The Canterbury Earthquake" and the investigations completed by the immediate response team as well as preliminary results outlining the current fault trace and methods used for investigation. There was a great turnout from both members of the NZGS as well people from the University of Otago (largely Geology Department). The talk was informative and showed some fantastic photos of the displacement which really gave an appreciation for the amount of energy that must have been involved in the main event. Drinks and nibbles were sponsored by NZGS and Macaferri and the venue provided by Opus Constultants. As always, I'm looking for the next people keen to give a talk so if you've got something you want to share, please contact me.

Shane Greene
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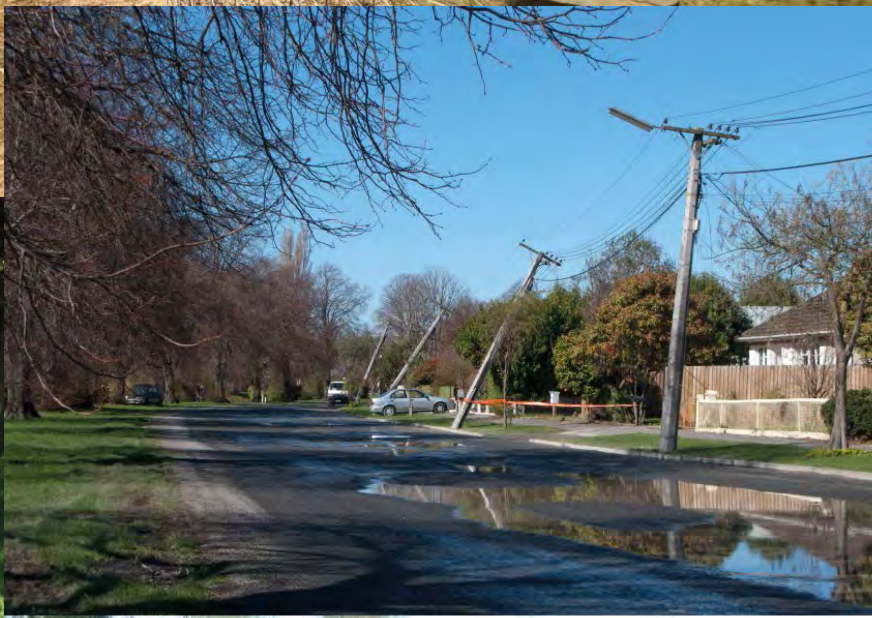
Shane is an Engineering Geologist with Opus International Consultants in Dunedin. Shane came to New Zealand from Canada in January 2006 and has been working with the Opus Geotechnical Team since that time. Shane has specialisations in Hydrogeology and Contaminated Land Assessment however since coming to New Zealand has turned his hand to everything from foundations to slope stability investigations.

THE DAY CANTERBURY **rocked** and ***ROLLED!!!***



Images courtesy of "Tonkin & Taylor Ltd EQC Response Team"

Some Personal Accounts of the Earthquake – collated by Charlie Price and Paul Salter

"I live in Hororata and was woken by the first earthquake - at first it was an intense roar, then a grinding, similar to gravel sliding. I was initially lifted up and hit the light shade above my bed, about a metre up, then dropped down again and the bed screwed around. Interestingly, it was not a back and forth motion. It felt similar to being on a ship in a storm, or in a washing machine. The effects came in waves". **J. Carter, Vicar of Hororata Church**

"I was thrown out of bed". **J. Grear, Hororata**

"I live next to some wetlands next to the Hororata River. It felt like a Boeing landing on the roof". **O. Webb, Hororata**

"Our bed is on castors on a chipboard floor. The bed ran around all over the floor and we just held onto it". **B. Rodger, Hororata**

"We live 150 to 200 m from the fault line. The first impression was just how violent the shaking was. The shaking was predominantly horizontal and parallel to the fault. It felt similar to being on a train but we wouldn't have been able to walk to the door of house. Our single storey house was completed in 2002 but didn't suffer any damage. Not everything came off the shelves either. A well on our property is virtually on the fault line. The pump lifted and came off at the surface, then fell back into the well. The well seems okay after redevelopment". **J & A Gray, Hororata**

"I was bringing cows into milking at the time. The fault line passes through the milking shed. I was stationary on a quad bike and held onto a fence. There was a noise like wind in the trees. Everything seemed to be happening at once. The bike moved around and all the cows - all 500 to 600 – fell over but none were injured.

The movement seemed horizontal, not vertical. There is a crack across the milking shed floor now". **F. Casagrande, Hororata**

"Daddy, why is the house is doing Zumba?" **Anonymous, Christchurch**

"I have a stone Buddha on a plinth in the garden. It was cracked through, head to toe, but is still sitting on the plinth which wasn't damaged?" **Anonymous, Christchurch**

"My son was complaining of sore feet the next morning.

Images courtesy of
Tonkin & Taylor Ltd
EQC Response Team
and URS NZ Ltd

I looked at his feet and he had purple stripes on them. He'd run down the hallway during the earthquake and the wooden floor boards were opening up and pinching his feet". **Anonymous, Christchurch**

"I have friends where one partner was in the doorway and the other one was holding the new flat screen TV". **Bev Curley, Wellington**

"I lived through the 1931 Hawkes's Bay Earthquake - it was my first day at school and we were playing out on the grass when I was thrown to the ground. I couldn't stand up. My father's shoe shop and our house were ruined; we had to sleep in a tent until we moved to Invercargill. We never went back to Hastings. Luckily, I was visiting Auckland when the Canterbury earthquake happened, I had a heart bypass 20 years ago and I don't think my heart would have survived another big quake when I remember what happened in 1931. My house here is only 5 years old, but the slab is cracked and tilted, it feels like I'm walking up hills. My doors don't stay open now either. I have to use old shoe laces – from by father's old shop actually – to keep some of the doors open. I never thought I'd have to go through this again". **Gladys, 86 years old, Burwood.**

A sleeping friend was so frightened by the earthquake - being woken up didn't help - that he jumped out the window. Naked. **Anonymous, Christchurch**

"I met a taxi driver in Bexley, just home from the night shift, who was playing a new war game on his computer when the house started moving, he was seriously impressed with the special effects until he realised that they were for real". **R. Simonds, Auckland**

"None of my delicate ornaments fell off their shelves, but my house foundations are cracked". **Anonymous, Christchurch**

"My fish pond rocked so much it threw the goldfish out. When I went outside the water was still in the pond but the fish were lying beside it. I dropped them back in and they seem fine". **Anonymous, Richmond, Christchurch**

"Our rabbit has been stressed since the earthquake, and our dog may need to go on doggy Prozac too". **Anonymous, Styx Rd, Christchurch**

Reported by: Charlie Price & Paul Salter, URS NZ Ltd

PLAXIS

essential for geotechnical professionals

PLAXIS 2D Dynamics

The most used tool for geo-engineering

PLAXIS 2D inculding PLAXIS Dynamics and PLAXIS PlaxFlow makes up a finite element package intended for the two dimensional analysis of deformation and stability in geotechnical engineering. It is a robust and user-friendly finite element package, developed for Geotechnical Engineering. It offers the tools professionals need in today's and tomorrow's world of high-tech building, to analyse complex projects.

Geotechnical applications require advanced constitutive models for the simulation of the non linear, time dependent and anisotropic behaviour of soils and/or rock. Although the modelling of the soil itself is an important issue, many projects involve the modelling of structures and the interaction between the structures and the soil.

The PLAXIS Dynamics Module is an extension to PLAXIS 2D. It offers the tools to analyse the propagation of waves through the soil and their influence on structures. This allows for the analysis of seismic loading as well as vibrations due to construction activities. PLAXIS Dynamics offers the possibility to perform dynamic calculations in individual calculation phases. ($M\ddot{u} + C\dot{u} + Ku = f(t)$)

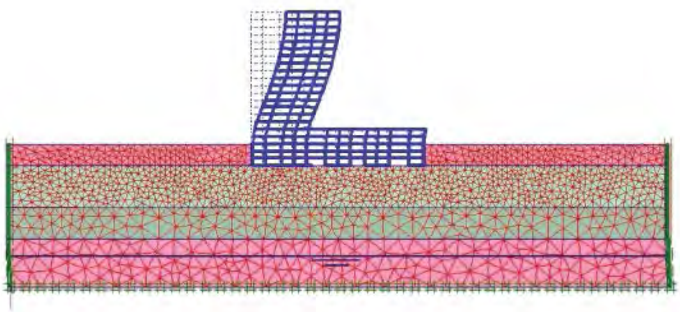
Modelling:
- Time-dependent dynamic load systems for point loads, distributed loads and prescribed displacements (velocities, acceleration)
- Independent application of horizontal and vertical displacement (velocity, acceleration) components
- Absorbent (viscous) boundaries to absorb waves at the model boundaries
- Rayleigh damping (α_R and β_R) per material data set for soil layers and structures)
- Smooth meshes, to prevent numerical oscillations and internal reflections
- HSsmall model including small-strain stiffness, modulus reduction and hysteretic damping
- Upon request: UBCSAND liquefaction model (available as User-Defined Soil Model)

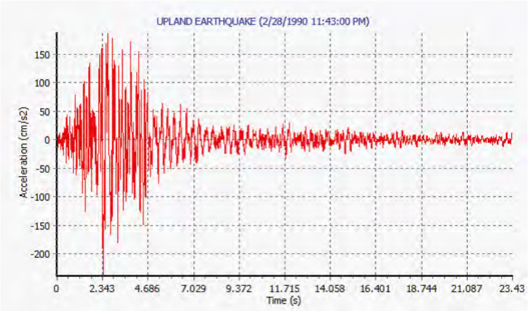
Calculations:
- Automatic time stepping using dynamic sub-steps
- Selection of Newmark time integration scheme (α_N and β_N)
- Free vibration analysis
- Harmonic loads
- Import of SMC files for time-dependent dynamic loading

Results:
- Velocities and acceleration in addition to displacements
- Envelopes of structural forces and displacements
- Time-displacement, Time-velocity, Time-acceleration curves
- Switch from time-curves to frequency-curves using Fast Fourier Transform
- Pseudo Spectral Acceleration response spectrum
- Animations (creation of AVI files)

Applications:
- Single source vibrations
- Earthquake simulation
- Dynamic soil-structure interaction
- Evaluation of natural frequencies and resonance
- Embankment stability under dynamic loading
- Machine and traffic vibrations
- Impact loading
- Structural response under earthquake loading
- Racking of tunnel lining

These features are available in PLAXIS 2D 2010.





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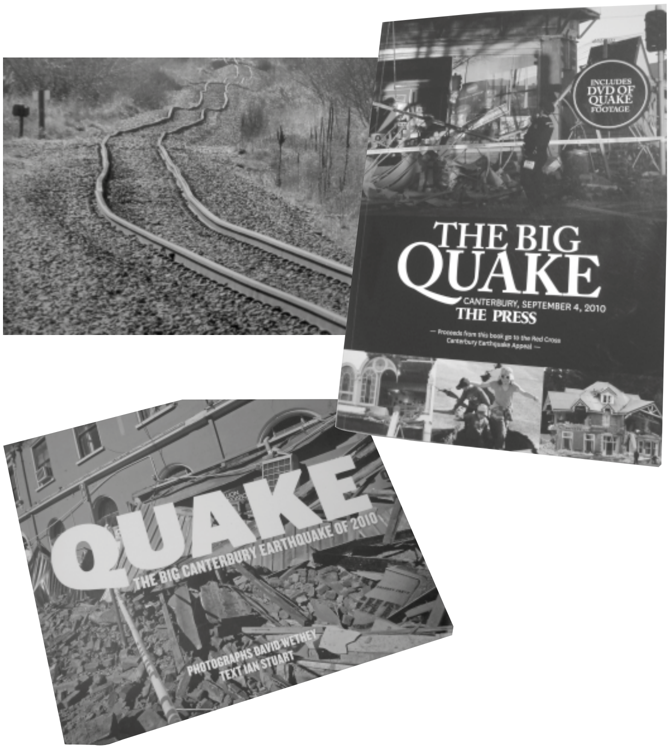
Two Books Documenting the Earthquake



Two recent publications provide photographic records of the aftermath of the Darfield Earthquake and the subsequent aftershocks.

The first, "The Big Quake" is a collection of photographs taken by staff of The Press, the largest daily newspaper in the South Island. Admirably, the first page of this 96 page book notes "Proceeds from this book go to the Red Cross Canterbury Earthquake Appeal". The pictures in this book are outstanding and really capture the impact of the event. The book includes a forward by Bob Parker, the Mayor of Christchurch, and chapters on: The Quake; After the Quake; The Science of the Quake; The Day the Quake Hit The Press; and several blank pages at the end to record "My Story". The book is more than just pictures and each chapter includes a reasonable amount of informative text. The Science of the Quake chapter draws on discussions with GNS scientists, including Kelvin Berryman, although technically it is rather basic – obviously to cater to a wide audience. Overall, this is a great coffee table book. It also comes with a DVD with 30 minutes of news footage on the quake sourced from The Press' web-site (www.stuff.co.nz. The initial print run of 12,000 sold out after a day since then additional runs have been printed. The Press website is taking pre-orders for the book (although I found a copy in The Warehouse for $30)

The second book is "Quake, the Big Canterbury Earthquake of 2010" by Ian Stuart with photographs by David Wethey. Stewart is the Auckland bureau chief of the New Zealand Press Association, and Wethey is a professional photographer from Christchurch. The book has a forward by Prime Minister, John Key, and includes some great photographs. Wethey has captured the human element of the damage well. The accompanying text is informative and makes brief reference to other notable NZ earthquakes. One on-line reviewer has suggested this book focuses on Central Christchurch too much, with very few photos of the suburbs and the surrounding farming areas – while this is somewhat of an exaggeration, it is probably a reflection of the area Wethey could realistically cover compared to The Press' contingent of staff photographers. A percentage of proceeds from this book also go to the earthquake relief fund. There are some reports this book is hard to find in Christchurch bookshops, but it is readily available on the Internet.

Reviewed by: Paul Salter
URS NZ Ltd

Title	The Big Quake. Canterbury, September 4, 2010
Author	The Press
Publisher	Random House
Year Published	2010
Softcover	96pp
ISBN	978-1-86979-509-2
Web shopping	www.mags4gifts.co.nz/the-press-special-gifts
Price	(including postage): $34.99 (subscribers) $39.99 (non-subscribers)

Title	Quake, the Big Canterbury Earthquake of 2010
Author	Ian Stuart
Publisher	Harper Collins
Year Published	2010
Softcover	128pp
ISBN	978-1-86950-915-6
Web shopping	www.fishpond.co.nz
Price	NZD $26.97

Darfield (Canterbury) Earthquake, 4 September 2010

– Earthquake Commission Engineering Assessments

A magnitude 7.1 earthquake which occurred near Darfield, 40 kms west of Christchurch City at 4:36 am on 4 September 2010 caused extensive ground liquefaction, in localised areas of particular suburbs of the Canterbury region. The liquefaction resulted in major ground settlement (more than 300 mm in places) and lateral spreading and, to a lesser extent, foundation support failure, with consequential building damage.

The Earthquake Commission (EQC) engaged Tonkin & Taylor Limited (T&T) to identify the nature and cause of land damage associated with residential property, in particular those areas affected by liquefaction. In undertaking this work the EQC and T&T have engaged with and acknowledge the inputs and observations from a wide team of local and international experts including GNS Science, the Natural Hazards Platform, local authority recovery teams, universities, New Zealand and overseas research teams (USA, Japan and Australia), councils, the insurance industry, other local experienced geotechnical consultants, the New Zealand government and the community.

Land beneath the urbanised areas of Christchurch City and Waimakariri District, and parts of the Selwyn District, is susceptible to ground liquefaction from strong earthquakes. Liquefaction hazard maps prepared by Environment Canterbury published in 2004 (and a number of previous similar studies), indicate that large areas have the potential to liquefy in a moderate to large earthquake event, such as the recent Darfield Earthquake. That some of these areas did not liquefy in the recent earthquake does not mean that they are not at risk under future earthquake events. Every earthquake is unique, as is the ground response. These liquefaction hazard maps remain an appropriate general indication of liquefaction risk from future earthquake events.

T&T has undertaken, for EQC private residential property insurances purposes, a preliminary regional and local mapping assessment of the main urban land areas in the Canterbury region that have been significantly affected by land damage. The initial report presented to the public on 20 October 2010, titled "Darfield Earthquake 4 September 2010 Geotechnical Land Damage Assessment & Reinstatement Report Stage 1 Report" was to address the land damage and categorise these preliminary assessments. Options for the development of land remediation concepts were also considered. Further ongoing investigations and reporting are continuing.

The EQC have received over 120,000 private residential insurance claims with over approximately 12,000 properties that are expected to have some degree of land damage from minor to very severe.

In parallel to the above work T&T are providing the coordinating role on behalf of the EQC for the Christchurch EQC Engineering Land Claims Team which involves the individual land damage claim assessments of all land damage for the EQC. The T&T team are coordinating geotechnical engineering resources from all over New Zealand across various other consultancies (e.g. URS, Golder, LDE, Coffey, Aecom, Beca, Geoscience Ltd, Auckland UniServices Ltd, MWH, GHD, Terra Firma and Riley) to be a part of this assessment team. Working together and organising various engineering resources from across the country has been challenging. However the cross consultancy teamwork, common response and commitment to the Canterbury region has been outstanding and something we should all be proud of.

A Geotechnical Engineering Field Office has been set up in Christchurch to undertake this work. Relevant training has been provided to 80 plus individuals to date with teams of approximately 20-30 Field Engineers undertaking the work in any week. Over 5,500 claims have been assessed at the time of writing this report. Typically the teams work on a rotation basis of two weeks of assessments before heading back to their respective companies for a week or so depending on other work demands. Engineers from nine medium/large Geotechnical engineering consultancies and three small consultancies have been undertaking the work to date. It is expected that the Christchurch EQC Engineering Land Claims Team will be inspecting individual property claims well into 2011.

Academic research teams from Auckland and Christchurch universities and GNS Science have also been undertaking investigations separately. Published results from other research teams can be found on various websites: http://db.nzsee.org.nz:8080/web/lfe-darfield-2010/home http://www.geonet.org.nz/earthquake/historic-earthquakes/top-nz/quake-13.html

Reported by: Kate Williams and Amy Macdonald
Tonkin & Taylor Ltd
23 November, 2010

The Darfield Earthquake: Personal observations and a bit of technical trivia

I thought a note for all the non-Christchurch people might be useful to explain a bit of what happened 'that' weekend in Christchurch.

I travelled to Christchurch last Sunday (5 September, 2010) to help clean up my old family home in Avonside Drive, now my sisters home. My old home was in one of the hot spots, where the ground liquefied and, because it was located next to a riverbank, it was subject to the additional geotechnical hazard of lateral spreading, that is, all the liquefied ground tried to, and succeeded in moving horizontally towards the Avon River. Attached are a few photos showing the quirky side of things and hopefully below is an explanation of why the damage in much of Christchurch was as it was.

I start with the inside of the garage, Photo 1. The inside of the garage served as a useful seismograph and accelerometer. At my sisters house none of the precariously stacked useful stuff tipped over or fell down during the shaking (Photo 1). Closer examination of the old valve radio in the top of photo 1 (Photo 2) that I used to listen to morning stories on at 7am on Sundays... a long time ago... revealed 12 impact marks from a plank of wood that lay across the ceiling joists. The plank was located 10 mm from the radio and appears to have shuffled sideways during the quake leaving a separate mark during each shaking cycle where more than 10 mm of movement occurred.

I downloaded from GNS Science plots of peak ground acceleration and displacement from a recording site 1 km away (see on next page). It showed 12 cycles of displacement >10 mm during the 50-second quake with the biggest displacement corresponding with the second cycle (the biggest mark on the radio!).

The peak horizontal acceleration is commonly used in the design of structures and slopes. For those of us who were not in Christchurch at 4.35 last Saturday morning the peak horizontal acceleration that we felt was zero (that is why we don't normally fall sideways – alcohol though, is known to have a strange chemical affect on gravity). At my sisters house the horizontal acceleration of the ground was 0.22 g, that is 22 percent of the acceleration of Earth's gravity, which is equivalent to the gravity on the Moon, acting horizontally (or ten double gin & tonics!)

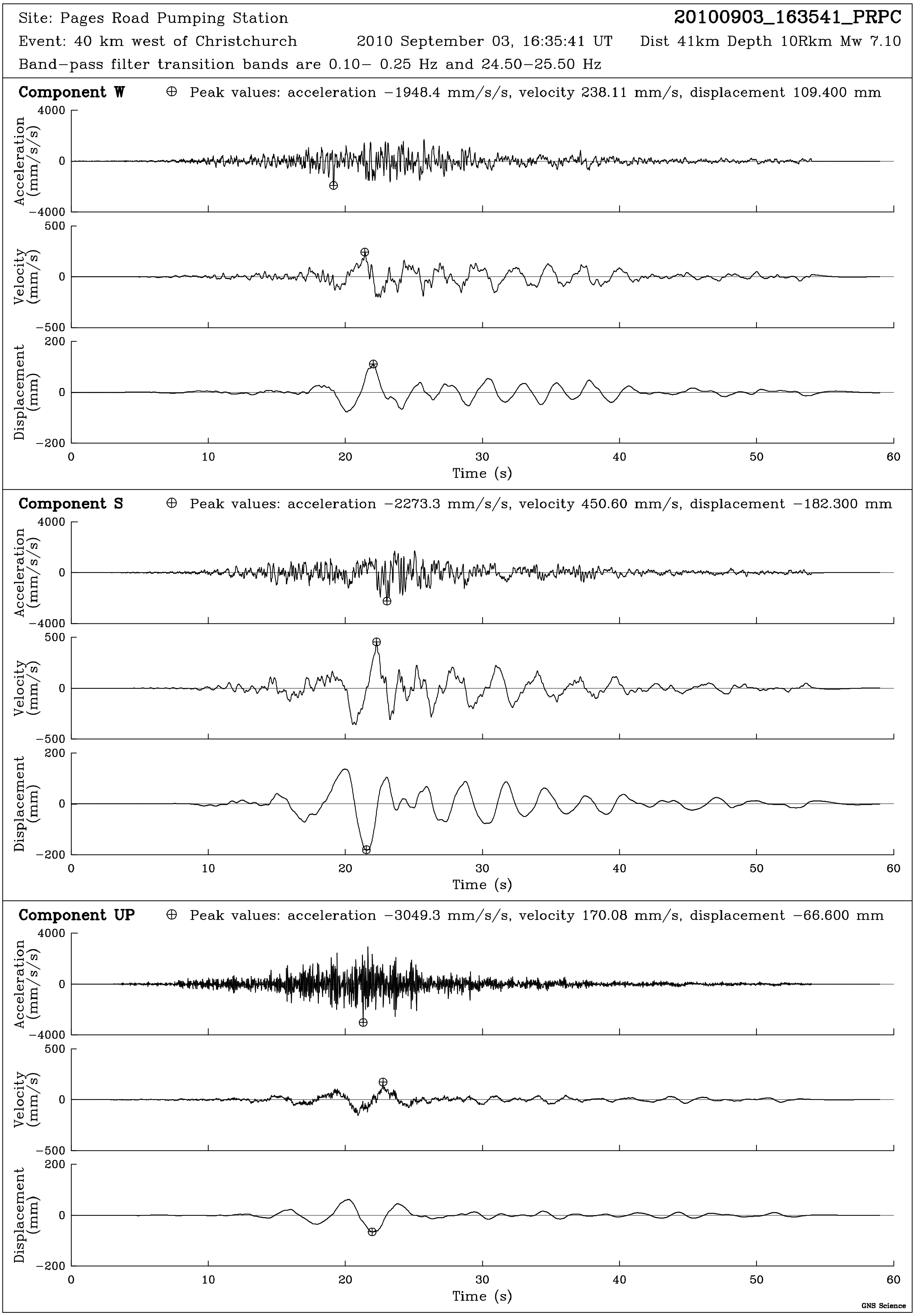
Thankfully GNS Science brought the software to calculate displacement from acceleration and their plots tell me that the acceleration experienced produced a number of displacement cycles – that is, back and forth motions, and at its peak produced a peak displacement of 187 mm movement in one cycle. This is typical of the cycles of acceleration and displacement recorded on the deep soft soils that underlie much of Christchurch. But this type of

Top: Photo 1; **Bottom:** Photo 2

ground movement experienced near the rivers contrasts significantly with that felt in the Heathcote Valley, where rock is at shallow depth. In that part of Christchurch the acceleration was three times that felt at my sister's house (0.6 g) but the peak displacement was only 89 mm which is less than half felt at my sister's house. At Heathcote I would expect there was a lot of broken crockery, but no liquefaction. Both sites are at the same distance from the epicentre.

The downside for my old home is a few foundation cracks, sunken piles and a rather warped interior, meaning that no doors now close. We will have to see what the experts say about that, but on the plus side the property is now 400 mm longer than it used to be.

The most visible features of ground deformation are open cracks and sand volcanoes. I actually was in raptures to see the sand volcanoes. They are just beautiful (Photos 3 and 4), and erupted along lines of minor ground extension cracks. We removed about 6 cubic metres of sand that covered about 50 percent of the unbuilt-on



Peak ground acceleration and displacement plots (Source: GNS Science)

Left to right: Photos 3, 4 and 5

property. Photo 4 shows about 0.7 cubic metres of sand in a cone ejected though a 1-2 mm construction joint in the concrete drive. I found it hard to visualise the pressure needed to eject this volume of sand in this way, but my sister told me that for a considerable time following the earthquake, the only sound she heard was the gurgling of the sand and water that was still erupting. She said it was like being in the middle of a mud pool in Rotorua!

It took four hours to open a door to get out of the house on that Saturday, a day of digging away a 150 mm blanket of sand to get to the garage and open the garage door. It was the Wednesday after the earthquake before downed power lines running to the house were lifted temporarily, thanks to a couple of tent poles, to get the car out of the driveway. The power company is too scared to try to move power poles until the ground solidifies a bit more (Photo 5).

The water was reconnected on Thursday and the house was yellow stickered on Friday, meaning it is OK to live in if you have nowhere else to go. Goodness knows where the waste water is going and when it will be reconnected. It is a lonely place now as only three of the nearest 12 neighbours have remained in their homes. Already the burglars have done over one home and the army now patrols the street, and the house continues to move. The land has sunk and islands have been born in the river (Photo 6), significantly affecting the ability to drain the area, so flooding risk is now high. Still, my old family home has fared better than many of its neighbours (Photo 7).

After a week of work the garden is starting to look itself again, that is a Christchurch thing. Everyone is talking to each other and asking "How are you?"… . and meaning it. This is life now for thousands of Cantabrians. They are a tough breed and will come out of it OK.

Above: Photo 6

Above: Photo 7

Reported by: Mark Foley, Nelson
Tonkin & Taylor Ltd

TECHNICAL ARTICLES

State of the Art Site Investigation Techniques – Introducing the Seismic Dilatometer (sDMT) – Marco Holtrighter and Andy O'Sullivan

Introduction

Geotechnical engineers constantly struggle with the complex nature of soils and the ability to obtain test results which reliably capture both soil characterisation and in-situ stress state.

While conventional techniques such as drilling and, more recently, the electric piezocone (CPTu) have greatly improved, no single method has been available in New Zealand which stands out as providing reliable results for both characterisation and in-situ stress state.

This has recently changed, however, with the introduction of a state-of-the-art Marchetti seismic dilatometer (sDMT), which has the capability to do both.

The flat dilatometer (DMT) has been used extensively throughout Europe and other parts of the world over the past 30 years. It can measure soil parameters such as density, undrained shear strength, modulus values, overconsolidation ratio and the coefficient of at-rest (K_0) earth pressure. The test also gives an indication of soil type by way of a material index (Marchetti 1980).

When combined with a seismic module (sDMT), the full potential of the device is realised. The sDMT can measure stiffness at both small strain, via shear wave velocity (v_s), and engineering strain via constrained modulus (M). This allows for a representative G-γ curve to be generated over the strain range of most engineering problems.

References in the literature refer to the sDMT being in the order of three times more sensitive than a conventional CPT probe. The dilatometer is particularly sensitive to stress history, pre-straining, aging, cementation/bonding and structure. These are factors that are often difficult to measure in a soil, but can greatly affect its behaviour.

This paper will provide background information on the capabilities of the sDMT and will briefly outline three projects for which the sDMT has already been used in New Zealand. These are (a) liquefaction potential assessment (b) settlement prediction and (c) identification of potential shear zone in slow moving landslide affecting a road embankment.

Background

The flat dilatometer (DMT) is an in-situ soil test device developed in Italy by Marchetti (1980). A seismic module was later added in combination with the standard DMT to create the seismic dilatometer (sDMT).

The DMT blade is a stainless steel blade approximately 15 mm thick and 96 mm wide with a 60 mm diameter circular membrane on one side (Figure 1). The blade is connected to a pneumatic-electric tube that runs through the penetration rods to connect to a control box at the surface. Nitrogen gas is connected to the control box, which controls and records the pressure delivered to the blade.

Figure 1: DMT blade

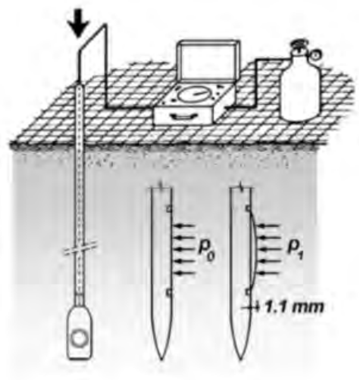


Figure 2: Schematic of DMT test

The DMT blade is pushed into the ground using a CPT rig. The test is typically carried out at 200 mm depth intervals, but this can be adjusted locally, to less than 100 mm, in zones of particular interest. At each location, penetration is stopped and the membrane inflated. Two pressure readings are taken:

p_0 = the pressure required to lift the membrane from its seating in the blade (the 'lift-off' pressure), and:

p_1 = the pressure required to expanded the membrane a distance of 1.1mm from the blade (the 'expansion' pressure)

Figure 3: Control box, laptop computer and DMT blade with seismic attachment

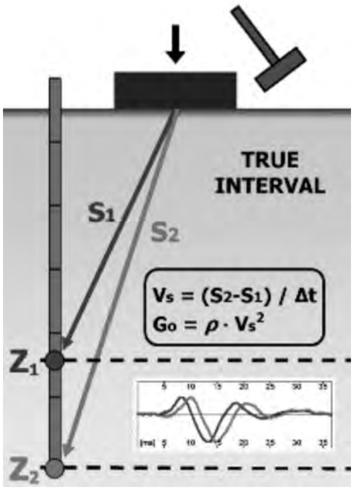


Figure 4: Schematic of seismic test

The unique wedge shape of the dilatometer ensures that disturbance is kept to an absolute minimum. This is illustrated in Figure 5 below (after Marchetti 1980)

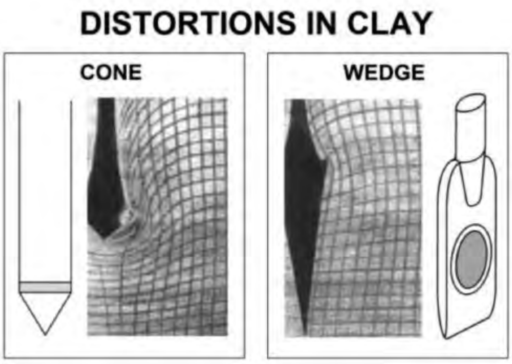


Figure 5: Comparison between level of soil disturbance in clay for CPT (left) and DMT (right)

The seismic part of the equipment is a separate add-on test carried out in combination with the DMT test. Figure 3 shows the seismic module attached to the DMT blade. The red and blue marks on the photo in Figure 3 represent the geophones, which are 500 mm apart on the module, with the centre point between the two geophones being 500 mm above the centre of the membrane on the DMT blade.

The seismic test is carried out at 500 mm depth intervals. The test is illustrated schematically in Figure 4. A beam on the ground surface is struck with an automatic hammer to generate a shear wave that propagates through the ground. The shear waves are recorded by the geophones in the seismic module.

The sDMT tests presented in this paper have been carried out using a Pagani TG63-150 track mounted CPT rig (Figure 6).

Figure 7 shows the sDMT set up on the rig, with the DMT blade and seismic module ready for insertion into the ground. The yellow box on the left hand side of the rig is an electrically operated Autoseis Hammer (Mayne and McGillivray 2008), which is designed to optimise shear wave generation and provide consistent energy for each hammer activation. A pressure transducer seismic box is used with the DMT control box connected to a laptop computer for fully automatic recording of the DMT and seismic tests. For each test a full report is generated automatically. An example of this is provided in Figure 8 below.

Figure 6: Pagani TG63-150 CPT rig

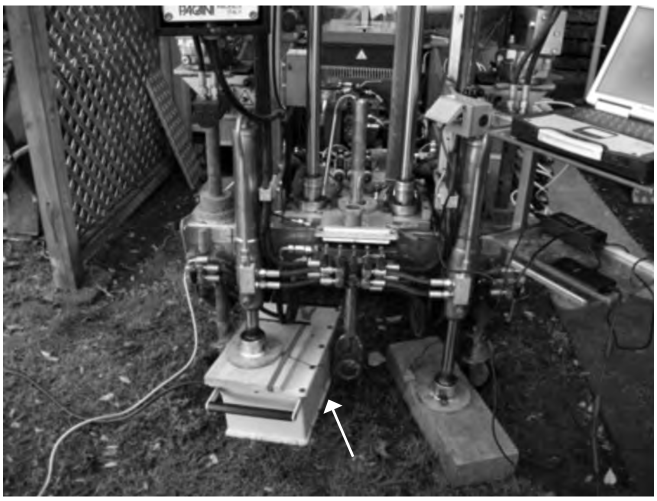


Figure 7: sDMT set up on rig, yellow box

One of the main advantages of the sDMT is that the extent of disturbance is minimal.

Underlying Theory

The two pressure readings from the DMT test (p_0 – 'lift-off' pressure and p_1 – 'expansion' pressure) are used to determine three basic index values (Marchetti 1980):

Material Index: $I_D = (p_1 - p_0)/(p_0 - u_0)$ Eqn 1

Horizontal Stress Index: $K_D = (p_0 - u_0)/\sigma_v'$ Eqn 2

Dilatometer Modulus: $E_D = 34.7(p_1 - p_0)$ Eqn 3

,where u_0 = the insitu porewater pressure prior to insertion of the DMT blade.

σ_v' = insitu effective vertical overburden pressure.

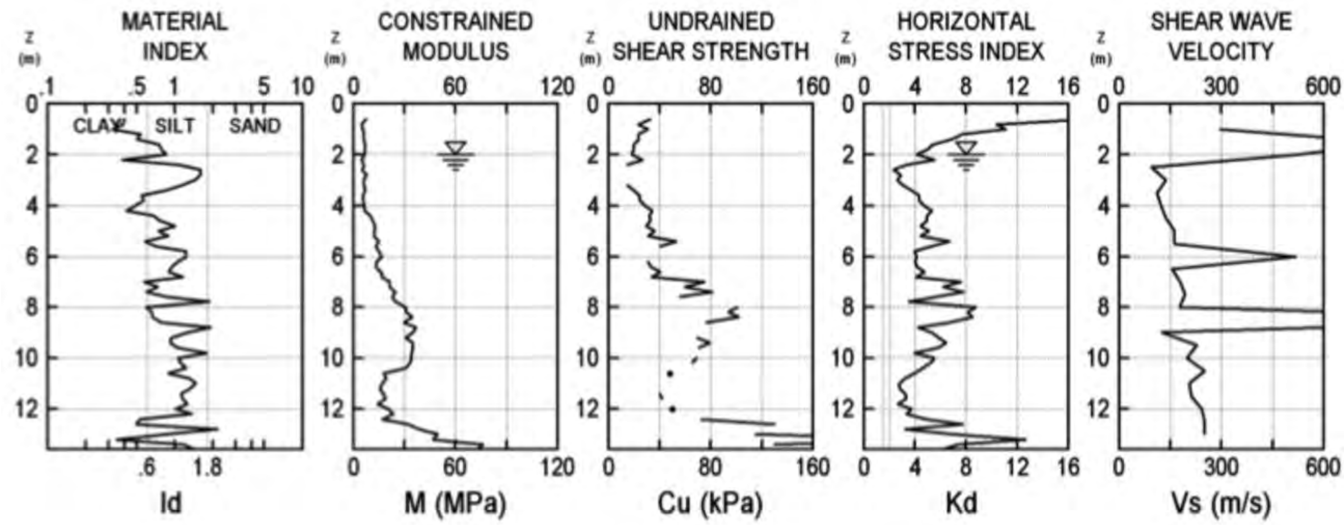


Figure 8: Typical sDMT report

Over the past thirty years extensive research has been carried out by Marchetti as well as Monaco, Robertson, Schmertmann and Maugeri. All of the relevant research papers are available for free download from the www.marchetti-dmt.it website.

On the basis of the extensive research carried out, the ISSMGE convened a special committee (TC 16) to develop a technical report summarising the dilatometer work to date. This report was published in 2001. Two of the main interpretation charts are shown in Figures 9 a&b.

SYMBOL	DESCRIPTION	BASIC DMT REDUCTION FORMULAE	
p_0	Corrected First Reading	$p_0 = 1.05\,(A - Z_M + \Delta A) - 0.05\,(B - Z_M - \Delta B)$	Z_M = Gage reading when vented to atm. If ΔA & ΔB are measured with the same gage used for current readings A & B, set $Z_M = 0$ (Z_M is compensated)
p_1	Corrected Second Reading	$p_1 = B - Z_M - \Delta B$	
I_D	Material Index	$I_D = (p_1 - p_0) / (p_0 - u_0)$	u_0 = pre-insertion pore pressure
K_D	Horizontal Stress Index	$K_D = (p_0 - u_0) / \sigma'_{v0}$	σ'_{v0} = pre-insertion overburden stress
E_D	Dilatometer Modulus	$E_D = 34.7\,(p_1 - p_0)$	E_D is NOT a Young's modulus E. E_D should be used only AFTER combining it with K_D (Stress History). First obtain $M_{DMT} = R_M E_D$, then e.g. $E \approx 0.8\,M_{DMT}$
K_0	Coeff. Earth Pressure in Situ	$K_{0,DMT} = (K_D / 1.5)^{0.47} - 0.6$	for $I_D < 1.2$
OCR	Overconsolidation Ratio	$OCR_{DMT} = (0.5\,K_D)^{1.56}$	for $I_D < 1.2$
c_u	Undrained Shear Strength	$c_{u,DMT} = 0.22\,\sigma'_{v0}\,(0.5\,K_D)^{1.25}$	for $I_D < 1.2$
Φ	Friction Angle	$\Phi_{safe,DMT} = 28° + 14.6° \log K_D - 2.1° \log^2 K_D$	for $I_D > 1.8$
c_h	Coefficient of Consolidation	$c_{h,DMTA} \approx 7\ cm^2 / t_{flex}$	t_{flex} from A-log t DMT-A decay curve
k_h	Coefficient of Permeability	$k_h = c_h\,\gamma_w / M_h$ ($M_h \approx K_0\,M_{DMT}$)	
γ	Unit Weight and Description	See chart in Figure	
M	Vertical Drained Constrained Modulus	$M_{DMT} = R_M E_D$ if $I_D \le 0.6$ $R_M = 0.14 + 2.36 \log K_D$ if $I_D \ge 3$ $R_M = 0.5 + 2 \log K_D$ if $0.6 < I_D < 3$ $R_M = R_{M0} + (2.5 - R_{M0}) \log K_D$ with $R_{M0} = 0.14 + 0.15\,(I_D - 0.6)$ if $K_D > 10$ $R_M = 0.32 + 2.18 \log K_D$ if $R_M < 0.85$ set $R_M = 0.85$	
u_0	Equilibrium Pore Pressure	$u_0 = p_2 \approx C - Z_M + \Delta A$	In free-draining soils

Figure 9a: Marchetti DMT Interpretation Formulae (TC16 2001)

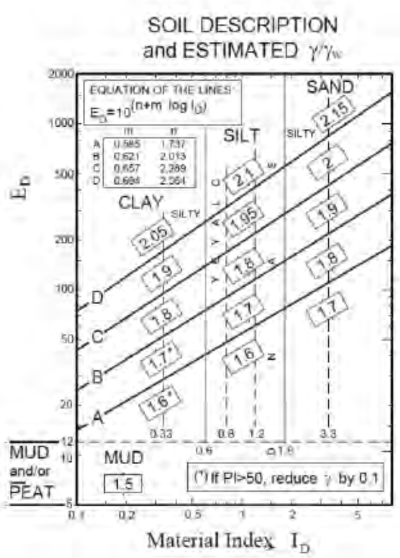


Figure 9b: Chart for Estimating Soil Type and Unit Weight (Marchetti and Crapps 1981)

Seismic Inerpretation

The addition of the seismic module to the standard DMT equipment allows shear wave velocity (V_S) to be obtained. The seismic module is equipped with two geophones spaced at 500 mm vertical distance. The 'true-interval' test configuration avoids possible inaccuracy in the determination of the 'zero time' at the hammer impact, sometimes observed in 'pseudo-interval' one-receiver configurations. Furthermore, the two seismograms recorded by the two geophones at a given depth correspond to the same hammer blow and not to different blows in sequence, which are not necessarily identical. Hence the accuracy and repeatability of V_S measurements are considerably improved with observed V_S repeatability typically 1-2% (Marchetti et al. 2008).

The shear wave velocity is calculated simply as:

$V_S = (S_2 - S_1)/t$ Eqn 4

Where, $(S_2 - S_1)$ = different in distance between the source and the two geophones
t = the delay time in the arrival of the impulse from the first to the second geophone

The small-strain shear modulus (G0) is determined from the relationship:

$G_0 = \rho(V_s^2$ Eqn 5

where, $\rho = \gamma_T/g_a$, γ_T = total soil unit weight, ga = gravitational acceleration (9.81)

The seismic test in combination with the DMT test allow both small strain modulus values (G_0) and larger strain ('working strain') modulus (M_{DMT}) to be determined from the sounding.

New Zealand Case Histories

The use of the dilatometer, thus far, has been limited to only a small number of projects in New Zealand. However, these early results are promising. Further work is, however, required to fully calibrate the sDMT for many of our complex soils. The following is intended to provide a brief outline of some of the applications to date.

CASE STUDY 1: Liquefaction assessment

The use of SPTs, CPTs and normalised shear wave velocity (V_{s1}) for the assessment of liquefaction potential are well documented in the literature, particularly since the publication of the NCEER report in 1997. Within the context of these various NCEER methods, it is widely acknowledged that the V_{s1} method provides the best assessment, as V_s is directly related to small strain stiffness through the relationship $V_s^2 = G_0/\rho$. One major shortcoming of all of these methods, however, is that none of them take account of in-situ stress state.

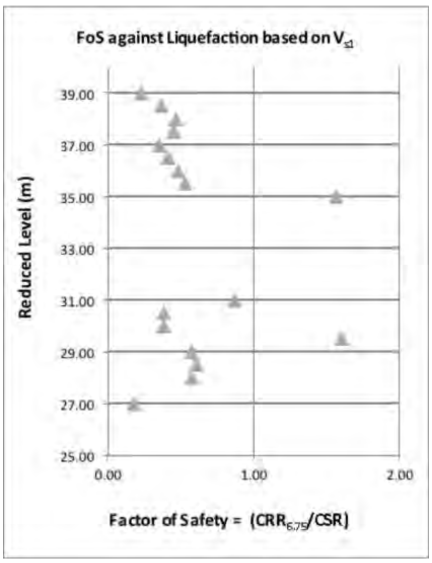
Using the sDMT, Monaco et al (2005) proposed the following tentative conservative correlation using the horizontal stress index, k_D, on which to base an assessment thus:

$CRR_{7.5} = 0.0107\ k_D^3 - 0.0741\ k_D^2 + 0.2169\ kD - 0.1306$ Eqn 6

This approach was recently used on a site in Hamilton, where the k_D profile was used to refine the liquefaction assessment. A comparison between the v_{s1} and k_D profiles is shown in Figure 10 below.

As can be seen, the horizontal stress index was sufficiently high within the top 8 m to indicate that liquefaction was unlikely to occur under the design earthquake load. Further guidance on this is given in the ISSMGE TC16. Note that the results in Figure 10 have not been adjusted for fines content, cementation or aging.

For the site in Hamilton, CPTu's



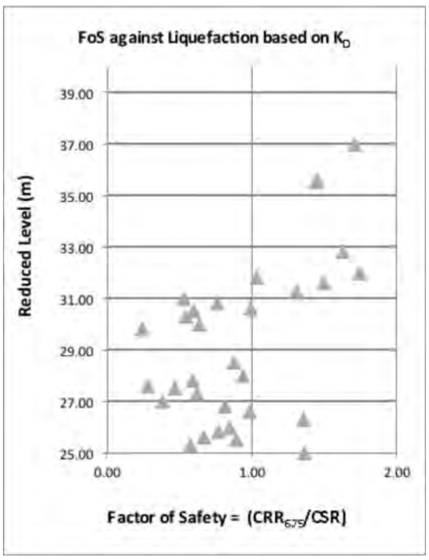


Figure 10: Comparison between liquefaction potential assessment based on vs1 and kD approach.

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URS

were carried out adjacent to the sDMT locations. This provided a 3rd method on which to base a liquefaction assessment. In general liquefaction was ruled out on a weighted basis, where the results of at least two out of the three methods (q_c/f_r;V_{s1} & k_D) broadly concurred.

For a comprehensive review the use of the sDMT in liquefaction assessment, Kung & Tsai published a landmark paper earlier this year, which is also available on the www.marchetti-dmt.it website.

CASE STUDY 2: Settlement Prediction

Obtaining settlement predictions for foundations is remarkably straight forward using the sDMT, as the constrained modulus (M) is obtained directly. Settlement can then be calculated using the basic equation

settlement = $\Delta\sigma'_v/M * z$, where z is the thickness Eqn 7

Monaco et al (2006) published a summary of sDMT/ settlement correlations. The paper is entitled "DMT-predicted vs. observed settlements: a review of the available experience" and is also available on the www.marchetti-dmt.it website.

This method was recently used at a site in Auckland to assess settlement underneath a proposed embankment, which is underlain by recent alluvium. Using a conventional approach (based on SPT/CPT correlations) the predicted settlement was estimated to be in the order of 280 mm for an embankment load of 104 kPa. A comparison between the CPT, SPT and sDMT profile is provided in Figure 11 below. Note the very high horizontal stress index (k_D) values, even in the soft layers. For the constrained modulus (M), a minimum value was 4 MPa was obtained. Using this value in the formula above, based on a 6m thick soft layer, the predicted settlement is 156 mm.

As part of the tender design, numerical modelling was carried out using the finite element programme Plaxis. Two constitutive models were used for the analysis, namely the Hardening Soil Small Strain (HS_{small}) model and the Soft Sofil Creep (SSC) model.

Two scenarios were modelled. Both used the in-situ stiffness parameters obtained from the sDMT. However, different initial stresses were selected for each model. The first used a standard K_0 = 0.5, whereas the second used K_0 values obtained from the sDMT. With K_0 = 0.5, the predicted settlement was around 300 mm. However, when the K_0 was adjusted to match the sDMT results (between 1.5-2), the predicted settlement reduced to 165 mm. Results were similar for both constitutive models. The project is currently under construction so the final settlement results are yet to be confirmed.

CASE STUDY 3: Slope Stability

The sDMT can also be used in slope stability scenarios to determine where a slip plane may have developed. The underlying theory being that once a shear band (or "slip plane") develops in a slope, the horizontal stresses are reduced locally along this band as the material begins to mobilise (unloading). This is reflected in a local reduction in K_D. The concept is illustrated in Figure 12 below.

Figure 12: The use of an sDMT to detect slip surfaces in a

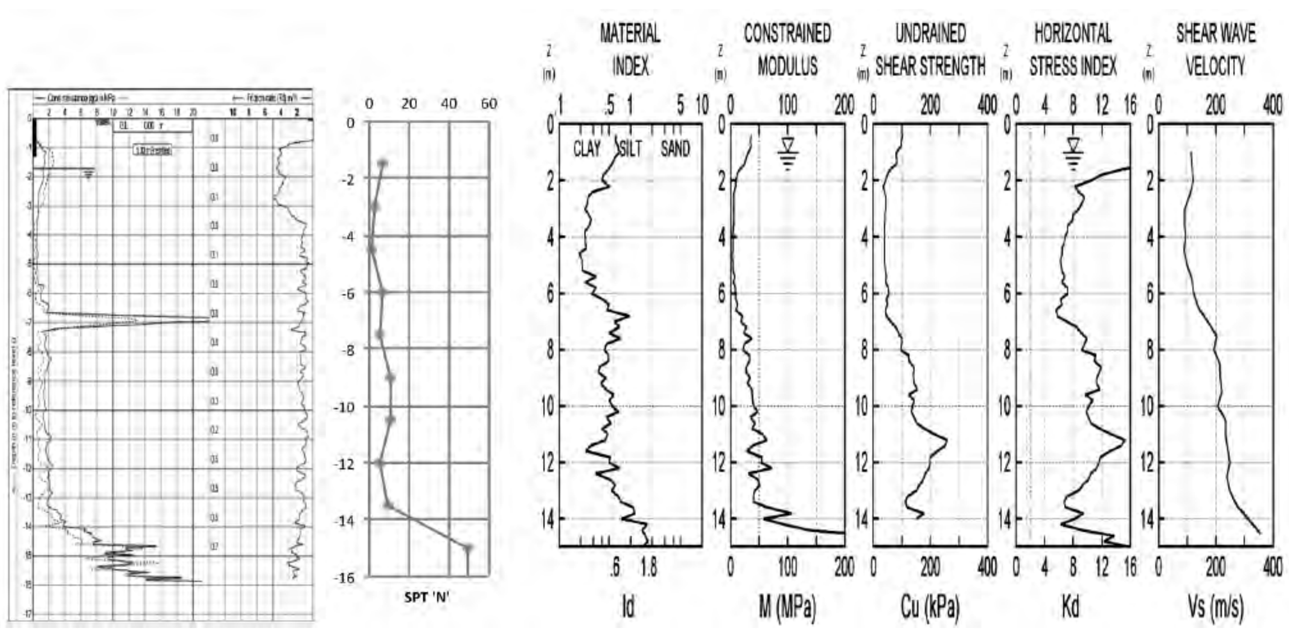
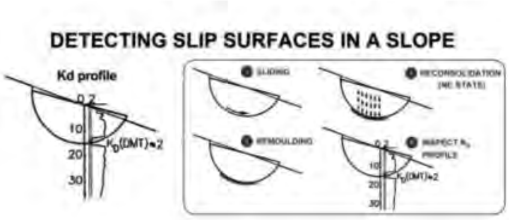


Figure 11: Comparison between CPT; SPT 'N' and sDMT results for site in Auckland



slope.

This concept was recently used as part of design analysis carried out following a site investigation in Northland on a road embankment underlain by completely weathered Waitemata sandstone. The cross-sectional profile is illustrated in Figure 13.

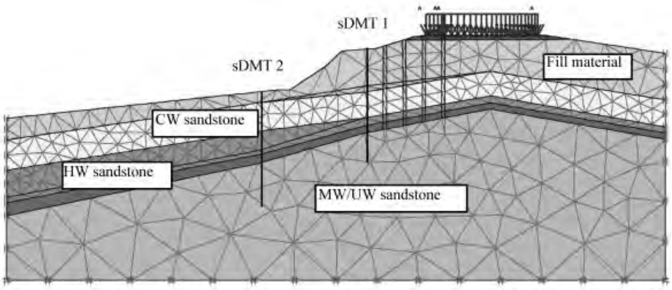


Figure 13: Geological Profile at site in Northland

Two sDMT tests were performed on site. The first (sDMT 1) was performed immediately adjacent to an existing inclinometer. Figure 14 compares the k_D profile for sDMT 1 with the results of the inclinometer readings taken at the site and also the results of the numerical model whose parameters were based on the sDMT results. For the numerical analysis, the HS_{small} model was used in Plaxis.

As can be seen, the k_D profile correlated very well with the results of the inclinometer. In addition, when the sDMT parameters were entered into a finite element model and one cycle of seasonal groundwater fluctuation was modelled, the results of the model also correlated very well with the inclinometer results.

Conclusions

The seismic dilatometer has been proven internationally to be a reliable and cost effective method for obtaining a range of in-situ soil parameters. While still early days, the technology has already proven its potential in New Zealand on a range of different applications.

The authors are not, however, suggesting that the sDMT is site investigation's silver bullet and that it is the only technique which should be used in the future investigations. On the contrary, the sDMTs should be used carefully and in contexts where the parameters can be verified by other means such as boreholes, test pits or lab testing.

The sDMT can be used either at an early stage in site investigations, to provide a broad outline of likely ground conditions or during secondary investigation stages, where it can be used to refine specific aspects of a detailed design.

The rig is highly manoeuvrable and the tests are quick to carry out. In addition, full test reports are available immediately upon completion.

Given the wide range of geotechnical issues practitioners face during the course of their work, it is likely that the sDMT will prove a very valuable resource during the site investigation and testing phases of engineering projects in New Zealand.

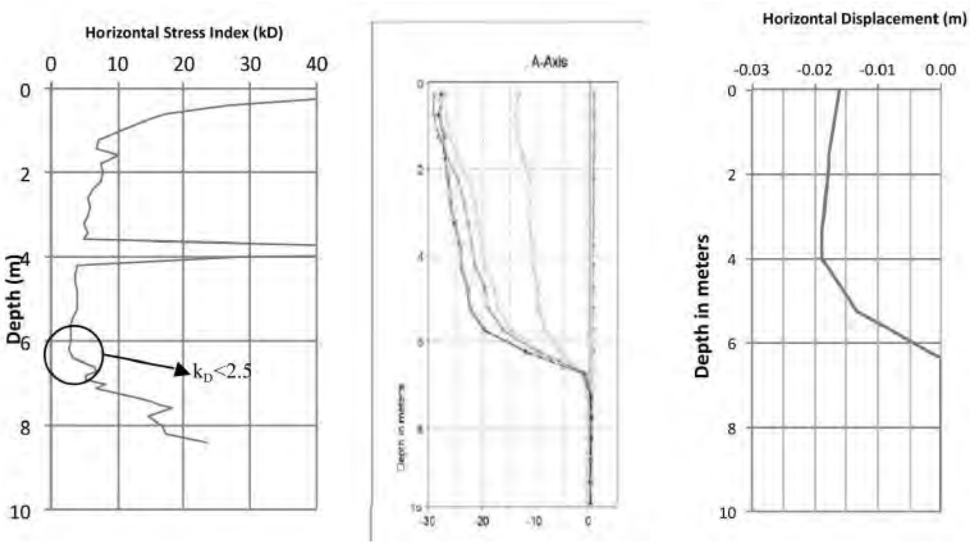


Figure 14: Comparison between K_D profile, actual inclinometer profile and predicted profile in Plaxis model (after one loading cycle)

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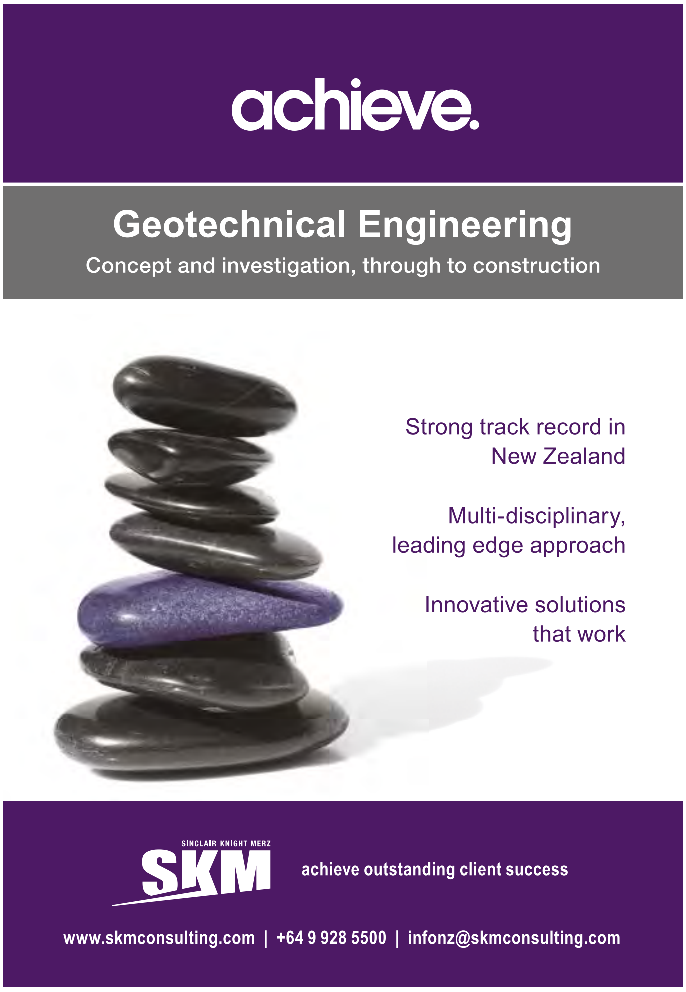

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www.marchetti-dmt.it website dedicated to publications relating to the sDMT

Marco Holtrighter – Director
Ground Investigations Ltd

Andy O’ Sullivan – Senior Geotechnical Engineer
Hiway Geotechnical Ltd

GROUND IMPROVEMENT

In recent years Brian Perry Civil has completed a number of ground improvement works for major infrastructure projects across New Zealand and the South Pacific region. A wide variety of techniques have been used to meet the project needs; these include:

- Wick drains
- EQ Drains
- Dynamic compaction
- Vibrocompaction
- Vibroreplacement (stone columns)
- Jet grouting
- Piles (concrete, timber & steel)
- Barrettes

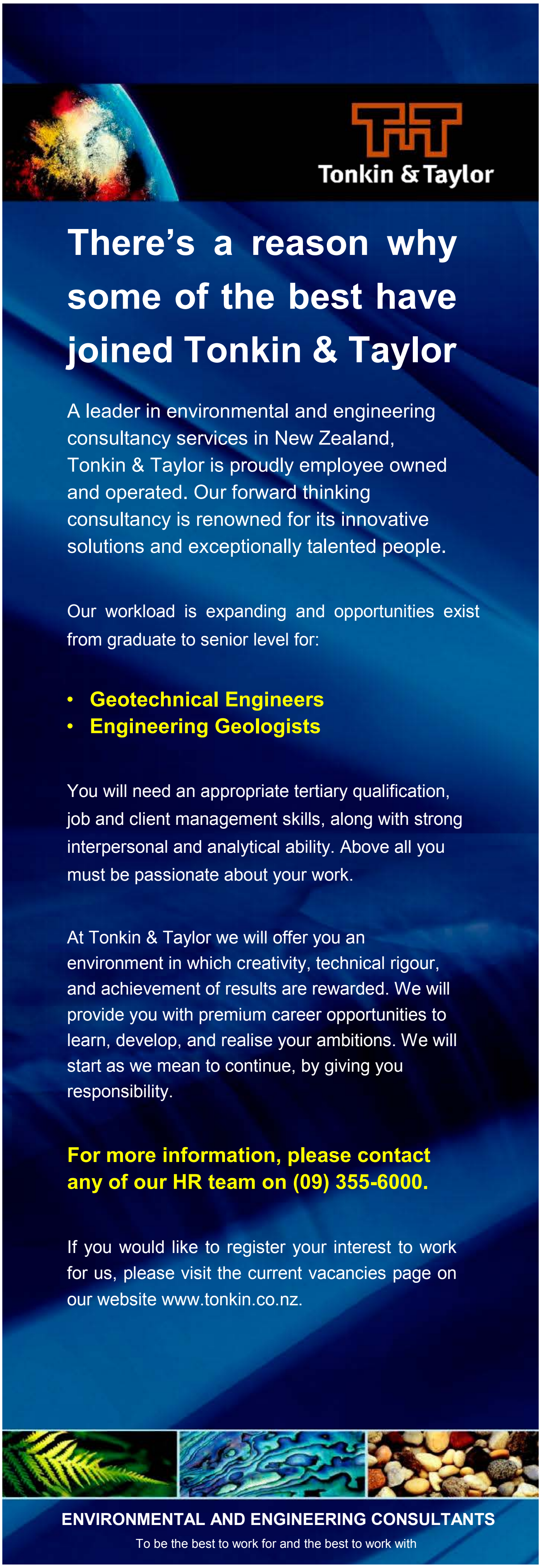
Brian Perry Civil has worked successfully in joint venture with Keller Ground Engineering for a number of years to deliver ground improvement solutions on a project by project basis. A formal agreement is in place to develop and deliver such projects allowing Brian Perry Civil to access the most up to date techniques being used around the world.

In addition to the techniques listed above and the technical support that Keller Ground Engineering provides, further technologies will be available to ensure a cost effective solution is developed such as:

- Dynamic replacement
- Compaction Grouting
- Wet soil mixing
- Dry soil mixing
- Dam Grouting
- Bottom Feed (Displacement) Stone Columns

If you require advice on ground improvement techniques or require input in developing a solution contact:

Nick Wharmby 027 276 7722 / nickw@fcc.co.nz



Numerical Modelling is Not My Cup of Tea – Wataru Okada

We hear the words "numerical modelling", or "FE", more and more as advanced analytical software slowly gains acceptance as an acceptable tool to support geotechnical design amongst the geotechnical community. "FE", strictly speaking, is a commonly used acronym for "finite element" which is only one form of a family of numerical modelling techniques, but many people loosely use the term to refer to numerical modelling in general. In this article, both terms are used almost interchangeably, but where possible the most appropriate term is selected to suit the context.

When it comes to numerical modelling, we get quite a wide scatter of reactions from NZ geotechnical practitioners; there are die-hard staunch advocates (the author is not necessarily professing to be one), routine FE users, those who want to know more but don't know where to start, the indifferent and apathetic, sceptics, and hostile antagonists. This article was initially inspired by a few geotechnical professionals who probably fall into the last two categories. The apparent reservation among these professionals seems to stem from a number of factors, some of which may be a result of misconception or lack of understanding of how numerical modelling works. This article attempts to address that lack of understanding, discusses some numerical modelling myths and presents some examples where numerical modelling is appropriate and/or inappropriate. This hopefully serves as a quick introduction to the world of "FE" for those who have not had an opportunity to use FE, or view it as a bit of a "black box". It is also hoped that this article provides a refresher for those who are familiar or conversant with numerical modelling.

Basics

The fundamental theories behind numerical modelling have been around for decades. There are numerous examples and references in the public domain on the numerical methods. A simple example of finite difference methods is shown below. Commercial software FLAC is a finite difference package. Finite element (FE) is a slightly different type of numerical method and algorithm, but there is a large degree of similarity. The example below illustrates some key basic concepts on numerical methods in general.

Example: Solving One Dimensional Heat Diffusion Equation using Finite Difference Methods

A 4cm long wire has a temperature of 0 degrees initially. One end of the wire is heated to 100 degrees instantaneously and maintained at the same temperature. What will be the temperature at the other end 2 seconds later?

Figure 1: One dimensional heat diffusion example

Heat diffusion or conduction in a one dimensional problem can be expressed as the following equation:

$$\frac{\partial T}{\partial t} = k\,\frac{\delta^2 T}{\delta x^2} \qquad \textbf{(Eq 1)}$$

Where: t = time
x = one dimensional coordinate
T = temperature
k = material constant

The above partial differential equation can be solved numerically by substituting finite increments t, x and T in place of infinitesimally small increments δt, δx and δT to obtain:

$$\frac{\Delta T}{\Delta t} = k\,\frac{\frac{\Delta T}{\Delta x}}{\Delta x} \qquad \textbf{(Eq 2)}$$

As T = T_{k+1} - T_{k}, , T/x =(T_{i+1} − T_{i},/ x - T_i − T_{i-1},/ x) equation 2 can be re-written as;

$$\frac{T_{k+1} - T_k}{\Delta t} = k\,\frac{\frac{T_{i-1} - T_1}{\Delta x} - \frac{T_i - T_{i+1}}{\Delta x}}{\Delta x} \qquad \textbf{(Eq 3)}$$

Where: T_k = temperature at t = k
T_i = temperature at i^{th} nodes

Rearranging Equation 3 gives

$$T_{k+1} = \left(k\,\frac{T_{i-1} - 2T_i + T_{i+1}}{\Delta x^2}\right)\Delta t + T_i \qquad \textbf{(Eq 4)}$$

To work out the temperature profile along the wire, the wire is divided into, say five discrete nodes, spaced at equal intervals, as shown in the diagram below:

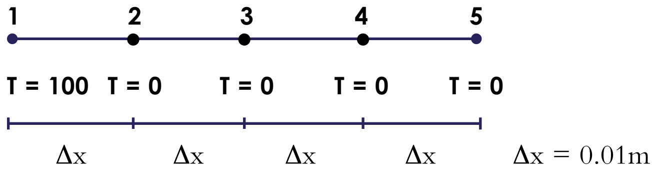


Figure 2: Finite element model of the one dimensional heat diffusion example

Note the temperature at Node 1 will be maintained at a constant temperature of 100 degrees. This is called a boundary condition.

The next step is to work out the temperature profile at t = t where t is a small time increment. For this example, we assume t = 0.2s. We can now work out T at point 2 at T = 0.2s (T_{k+1}) by substituting T_{i-1} = 100 (T_1), T_i = 0 (T_2), T_{i+1} = 0 (T_3), t = 0.2s, t = 0.2s, x = 0.01m and T_i = 0 into Equation 4 and assuming a material constant k = 0.0001 m^2/s gives T =20 at Node 2. We can work out the temperature at Node3 by using T at points 2, 3 and 4 for t =0 in the same way. If we repeat the same process for all five nodes for t = 0.2 s to get the following temperature profile. Note temperature at Node 5 is calculated assuming T_{i+1} = 0 (ambient temperature) in Equation 4 in this example. This assumption may not be strictly valid in real life, but is adopted for the purpose of this example.

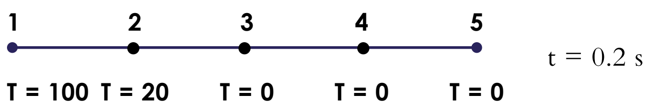


Figure 3: Temperature profile at t = 0.2 seconds

If we repeat the same process for t = 0.4s, 0.6s and so on, to get the temperature profile at t = 2 seconds.

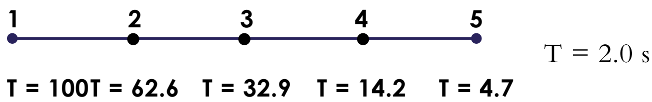


Figure 4: Temperature profile at t = 2 seconds

Commercial numerical modelling packages for geotechnical problems solve a series of complex multi-dimensional equations to calculate changes in stress, strain and a multitude of other varying responses in a similar manner. The simple example above hopefully gives readers an idea of the basic principles of numerical methods.

There are three important concepts which form a fundamental basis of numerical methods:

1. Discretisation

Numerical methods utilise a finite number of smaller points or elements to model real life problems. An example of FE programmes is Plaxis, which utilises multi-node triangular elements (Figure 5). Plaxis calculates the strains and stresses at nodes of the triangular elements and the stress points within the elements, respectively. Simple geotechnical models are typically made up of hundreds of triangular elements. More complex models often utilise thousands of elements.

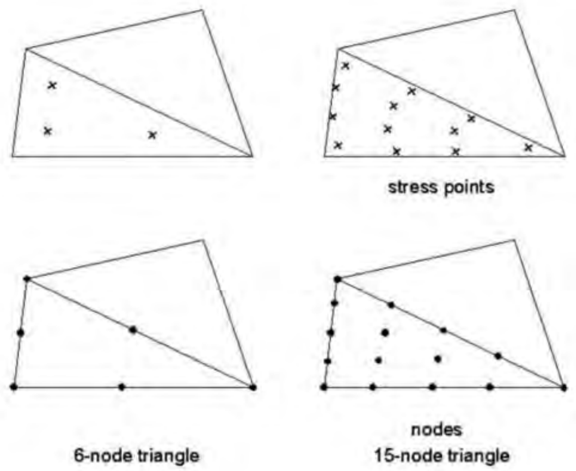


Figure 5: Triangular elements (Plaxis 2008)

2. Approximation

Numerical methods derive numerical solutions by approximation. As discussed in the above example, finite increments such as x are used as an approximation to infinitesimal increments dx. In doing so, a partial differential equation was resolved to an accuracy influenced by the steps assumed in each increment.

3. Iteration

Numerical modelling packages perform a large number of iterations to obtain solutions to complex matrices of equations. The iteration process is repeated over and over again until solutions come to a point where they do not change significantly any more and the solution is said to converge. Most commercial packages allow the user to set an error tolerance so that the calculation stops once the solution converges within a specified error tolerance.

Myths

Some of the common myths about numerical modelling are discussed below.

1. Numerical modelling is an overkill for most bread-and-butter geotechnical problems

This one seems to be a common belief among those who have had limited or no exposure to numerical modelling. It is probably entirely adequate to do simple back-of-the envelop calculations for a lot of day-to-day situations. However, with modern software development and user interface, many numerical modelling packages are incredibly user-friendly and easy to set up. In many cases, it doesn't take much longer to set up a FE model than to set up a conventional limit equilibrium slope stability model (e.g. Slide or Slope/W), to do the same type of analyses. There is, however, one very important "home-gym-equipment-infomercial" type of caveat, that is, *individual results may vary*. Lack of quality input data is another common reason for opting for simpler analyses or calculations. This is often a very valid opinion, but the important point to remember is that the choice of analytical method will not influence the quality of the output or design if there are deficiencies in the quality and quantity of available input data.

2. It takes a long time to run FE models

Hardware development over the last few decades has reduced computation time and made FE far more convenient than what it was in the past. From the author's experience, a 500 to 600-element FE model typically took up to five to six hours to run on a Pentium Max processor PC about 10 years ago. Now it may only take 10-20 minutes to run the same model on a latest quad core processor PC. The computation time quoted here is indicative only, and provided only to give an order of magnitude. The same caveat that was quoted in Item 1 equally applies here. The general rule is that the more elements are used in the model, the more accurate the model output, but the longer the computation time, as shown in Figure 6. Experienced FE users know how to strike the balance between model accuracy and computation time.

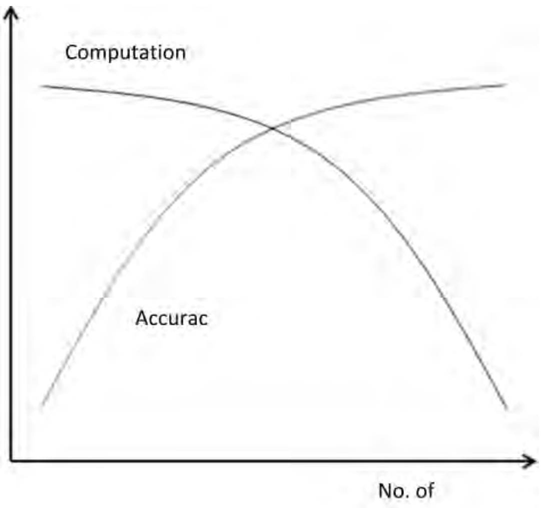


Figure 6: General relationship between the number of elements, computation speed and accuracy

3. Numerical modelling is too difficult to learn

As mentioned above, modern numerical modelling packages have gone through a number of upgrades, and the latest versions are generally quite easy to learn and use. You don't have to know every detail of how FE works to get valuable information out of using the tools, any more than you need to know exactly how a microwave works before you can cook a meal. Nonetheless it helps to know the basics of numerical modelling when you are creating a model and setting up calculation settings. The difficult part is not learning how to use particular software, but it is selecting sensible model input and interpreting model output. Appropriate soil models need to be selected so that the model captures key geotechnical issues at hand. You need an understanding of soil behaviour, geotechnical theories and often common sense to know whether the model output makes geotechnical sense. In fact, this applies to hand calculations as well. A bit of experience also helps.

4. Numerical modelling is an unproven black box

Plaxis Manual (Plaxis 2008) provides a number of example problems where FE model results have been validated against analytical solutions. Excerpts from Plaxis Manual are reproduced here with the permission of Plaxis.

Validation Example 1 – One dimensional consolidation

A finite element model of a one dimensional consolidation problem is shown below. The upper side is allowed to drain. The other sides are kept undrained. External load Po is applied.

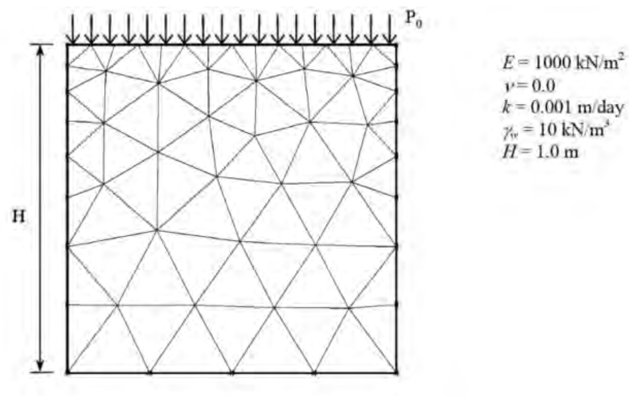


Figure 7: Finite element model of a one dimensional consolidation problem

The calculated excess pore pressure at various heights is compared to analytical solutions in Figure 8. The numerical solution using Plaxis and the actual analytical solution based on the equations of consolidation theory are represented by the smooth and dotted lines respectively.

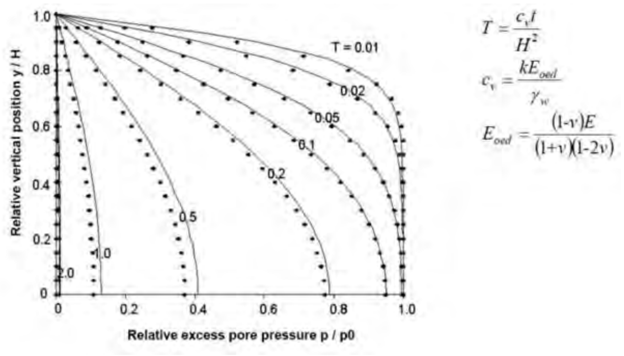


Figure 8: Development of excess pore water pressure as a function of the sample height

Validation Example 2 – Smooth rigid strip footing on elastic soil

Pressure distribution beneath a smooth rigid strip footing on elastic soil is calculated using a finite element model. The FE model is shown below.

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Sleeve friction
Depth (m)

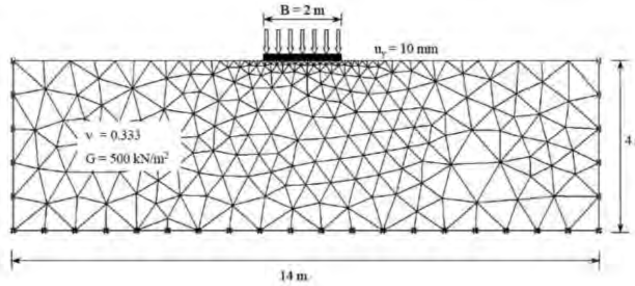

Figure 9: Smooth rigid strip footing model geometry

A 10 mm vertical displacement is prescribed to the footing, and resulting pressure beneath the footing is calculated. The results are compared to Giroud's (1972) analytical solution in Figure 10.

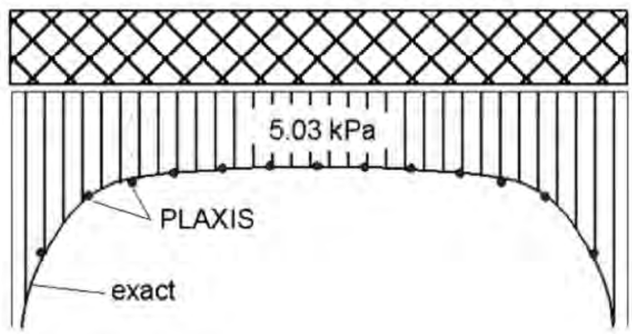

Figure 10: Pressure distribution at footing

In both examples, the model results are in close agreement with the analytical solutions and there are other validation cases.

5. You can solve all geotechnical problems using numerical modelling

FE may sometimes give the user a false sense of accuracy or validity. The user needs to understand the limitations of the particular numerical modelling package, and the nature of the problem at hand. For example, a 2D plane-strain FE model of a soldier pile wall may not necessarily capture the 3D nature of the row of piles.

Numerical Modelling Applications

Settlement / Deformation

Conventional consolidation and deformation theories are often more than adequate for the purpose of simple settlement calculations. The key issue is to understand the limitations associated with the underlying assumptions that were made in the conventional theories, and determining whether these may impact the analysis. For example, Terzaghi assumed a homogeneous material, no change in consolidation and permeability properties due to increasing strain, one-dimensional drainage, and ignored the self weight of the soil. FE packages generally come with more advanced soil models which address some of these issues. Elastic deformation theories may not be appropriate for a problem where the soil has been subject to virgin loading and unload/reload cycles, or where non-linear stiffness behaviour is significant.

Lateral Earth Pressure

Numerical modelling packages often prove to be useful for analysis of complex retaining structures. Consider the example below.

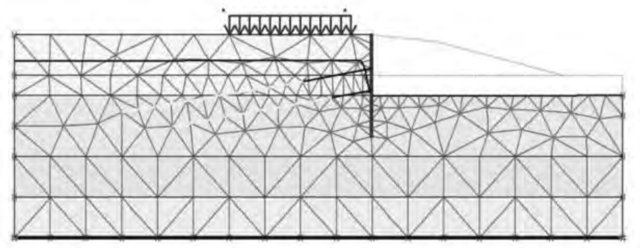

Figure 11: Finite element model of a multi-level tie back retaining wall

While a simple gravity structure can be easily analysed by hand, FE would be a good tool for analyses of complex problems such as the multi-level anchored wall shown in the example. FE also allows deformation to be estimated, which is useful in some situations.

Slope Stability

There are limit equilibrium (LE) programmes such as Slope/W and Slide which are widely used in the industry for slope stability analyses. Equivalent analyses can be carried out using FE. Slope stability is often measured and reported in terms of a factor of safety. It's important to note that LE and FE calculate the factor of safety using different approaches. The fundamental difference is that LE computes the factor of safety as a ratio of disturbing and destabilising forces acting on a free body whereas FE artificially reduces strength parameters incrementally until a failure mechanism develops. The FE software reports the factor of safety as a ratio of the initial set of strength parameters to the artificially reduced parameters. The other important difference is that LE programmes generally require the user to define the extent of possible slip planes and/or a grid of centres of slip rotation.

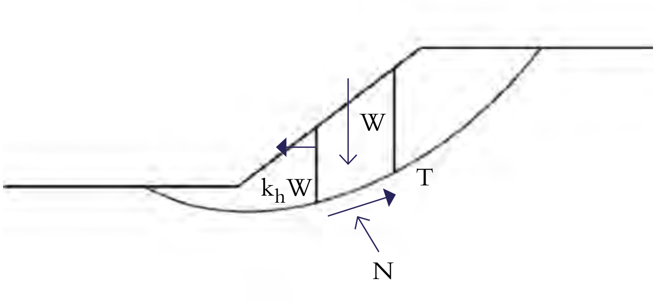

Figure 12: Limit equilibrium slope stability analysis

An example of the traditional method of slices approach to slope stability subjected to seismic loading is Figure 12. The LE works out the factor of safety by considering all the forces acting on a free body, and calculating a ratio of the 'driving' and 'resisting' force components. The shape and size of the free body is pre-determined by an assumed slip plane.

In the equivalent FE analysis, the seismic load is applied as a horizontal gravity to the entire model. The FE calculates stresses and strains in all the elements within the model, and determines a critical slip plane or the 'weakest link'. There is no need to define assumed slip plane extent, (the radii of the failing mechanism) in the FE.

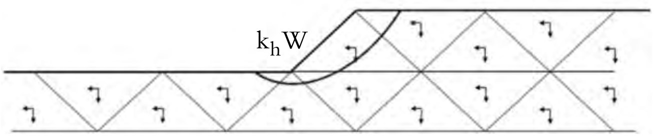

Figure 13: Schematic diagram of a finite element slope stability model

LE and FE analyses can often report similar values for the factor of safety, but there are some cases where the two methods do not necessarily agree. Such cases may occur where there are complex failure mechanisms which cannot be easily defined by simple circular or multi-wedge slip planes, or where stresses and strains have significant influence.

Final Remarks

The intention of this article is not to advocate numerical modelling as an analysis method of choice for all geotechnical problems under the sun. Neither is this written to promote one numerical modelling package over others. It is hoped this article provides readers with a very quick overview of what numerical modelling is all about, and a balanced and unbiased perspective of "FE". It's still up to individual practitioners to exercise judgement as to what form of analysis is appropriate for any particular situation, based on their experience and knowledge. There are many issues and considerations which need to be taken into account in numerical modelling that are beyond the scope of this article.

One final remark could be an old cliché – rubbish in, rubbish out. This is so true in numerical modelling. And no matter how experienced we think we are with numerical modelling, a back of the fag packet calculation is still a valuable check.

Acknowledgements

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This field-based course provides hands-on experience in outcrop mapping, geomorphic mapping and simple testing of rocks and soils for geotechnical purposes. A variety of rock masses and soil masses in the Auckland region will be mapped during an eight-day field session. Two days of office-based work will follow to allow completion of field mapping assignments.

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THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

To RQD or not to RQD: Applicability of RQD in Characterising Rock Masses with Some New Zealand Examples – Dr Simon Nelis

1. Introduction

Joint spacing, or fracture density and by definition block size is the most important parameter governing the behaviour of rock masses (Goodman, 1993; Palmstrom and Nilsen, 2000). The presence of joints divides the rock mass into blocks ranging in size from cm3 in crushed or highly fractured rock to m^3 in massive rock. The scale of an excavation relative to block size will determine whether the rock mass will behave as a continuous, or bulk material, or be influenced by the mechanical properties and geometry of joints and behave as a discontinuous material. Understanding these rock mass properties is vital for efficient engineering design.

The Rock Quality Designation (RQD) is used for characterising the fracture density in rock core recovered from drilling investigations and is an indirect measure of block size. It is routinely used in civil engineering and mining operations, as a measure of rock mass quality and is often the only method used to provide an indication of jointing or fracture density along the drill hole. Its success, is in part, due to the simplicity of the scheme; but this simplicity also introduces inherent limitations for characterising the fracture state of rock masses, in particular its 3-dimensional structure.

The purpose of this article is to present a review of RQD, its general limitations and also its applicability for characterising some New Zealand rock masses. Extensive review of historical and contemporary borehole logs, often show a clear misunderstanding or misapplication of RQD to very weak rock masses, for example. Moreover, the New Zealand Geotechnical Guidelines (2005) do not provide any guidance on the use of RQD. It is hoped to stimulate debate over methods most suitable to New Zealand conditions.

RQD is calculated at the time of logging, usually by a Junior Engineering Geologist or Engineer, who may be unfamiliar with how RQD should be applied. Moreover, at the interpretation stage, there can be a lack of understanding of the limitations of the scheme for classifying the variation in jointing in rock masses. These effects are compounded when one considers that RQD is used as a fundamental input into other rock mass classification schemes, such as Rock Mass Rating (RMR) and the Q-system, which feed into engineering design.

2. Review of RQD

RQD was originally developed by Deere (1963), but was not formally published until 1967 (Deere *et al.,* 1967). It was introduced at a time when the only information on rock quality came from the geologists' descriptions and the percentage of core recovered (Deere and Deere, 1988).

2.1 Measurement Procedure

The RQD is a modified core recovery percentage in which all lengths of *sound or intact core* greater than 100 mm long are summed and then divided by the length of the *core run* (Deere, et al 1967). The calculation of RQD is summarised in Figure 1.

The RQD should be measured down the centre of the core axis and vertical and sub-vertical fractures are treated as intact rock to remove bias introduced by vertical drilling. Where vertical fractures are present, such as columnar jointed basalts, inclined boreholes should be used.

Drilling induced fractures should be fitted together and treated as intact rock and included in the RQD. It is often difficult to distinguish between drilling induced breaks and natural fractures, particularly in schistose rocks, or very weak laminated mudstones and siltstones. Often drilling breaks may occur along existing sedimentary features of the rock, such as laminations, and are often parallel to such bedding structures. Regardless, drilling induced fractures are often rough, planar and lack any mineral deposition on their surfaces. If in any doubt as to the origin of a fracture, it should be treated as natural in order to be conservative about rock mass quality (Deere and Deere, 1988).

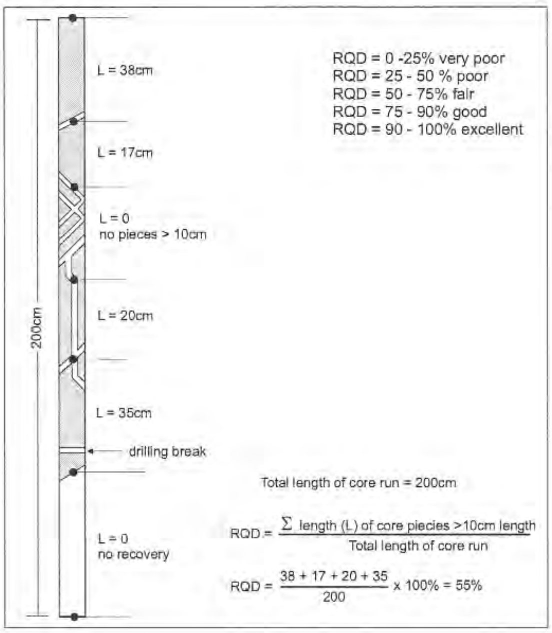


Figure 1: Procedure for the measurement and calculation of RQD (after Deere and Deere, 1988).

2.2 Core dimensions

RQD was originally developed for NX-sized cores (54.7 mm diameter) obtained using double-tube coring techniques, still specified in ISRM guidelines. In reality RQD is applied to a range of core sizes. Modern drilling techniques commonly used in New Zealand employ a triple-tube arrangement, which produces common core diameters of NQ (47.5 mm) and HQ (63.5 mm). There has been much research into the influence that core size diameter has on the computation of RQD. In part, this has arisen because of the increased requirement for characterising rock masses at depth, where it is difficult to use a consistent core-size for the entire hole length. Deere and Deere (1988) and ASTM D6032-08 suggest that RQD is applicable for core sizes ranging from BQ to PQ (36.5 mm to 85 mm, respectively). The application of RQD to a greater range of core sizes than was originally envisaged is based on the assumption that good drilling techniques have been used. A number of correction factors are in use to calculate RQD for non-standard core sizes. The most common approach is to define the threshold value of core length as being equal to twice the core diameter. For PQ (85 mm), this would equate to summing core lengths greater than 170 mm and dividing by drill run length. The rationale for the sliding scale is based on the greater sensitivity of smaller core diameters to drilling- and handling-induced fractures.

2.3 Soundness and weathering

RQD was originally developed for logging hard rock (i.e. intact strengths >20 MPa). Deere and Deere (1988) state RQD should only be undertaken on core which is ***hard and sound***. This should down-grade the rock quality where the rock has been altered and weakened by weathering, hydrothermal or tectonic activity, or has not undergone full consolidation / compaction, for example. This becomes highly problematic when applying RQD to poorly cemented, weak Tertiary sedimentary sequences in NZ, e.g. Waitemata Group rocks.

Only rock which is moderately weathered or better should be included in the RQD. Highly or completely weathered rock should not be included in the calculation of RQD.

2.4 Applications of RQD

RQD is routinely applied to assess 'rock mass quality' and is used as a primary input into a number of other rock mass classification schemes; notably Rock Mass Rating (RMR) and the Q-System. These schemes have their origin in underground mining and tunnelling and are often used to assess temporary stand-up time for unsupported tunnels, or tunnel support requirements. They can also provide information on problematic geological and geotechnical conditions during excavation.

Although RQD was initially proposed as an attempt to describe rock quality, in reality, it only describes fracturing degree, by in fact considering the spacing of joints. Hudson and Priest (1979) related RQD to joint spacing or joint frequency, λ, by:

$$RQD = 100\, e^{-0.1\lambda}\, (0.1\lambda+1)$$

RQD can also be used to calculate the deformation modulus of the rock mass. A full review of the relationships is beyond the scope of this review and better methods now exist, such as the Geologic Strength Index, GSI (Hoek *et al.,* 1995). However, it is important to note that most relationships contain little information for rock masses with RQD's <60 % and therefore should be used with caution.

3. Limitations of RQD

Several authors have identified limitations associated with the use of the RQD (e.g. Bieniawski, 1973, 1984; Edelbro 2003). However, these limitations are poorly understood by people undertaking the core logging or even undertaking interpretation. RQD is often blindly applied as the only rock mass classification undertaken. Understanding its limitations is important, particularly during the proposal stages of projects to ensure the correct information is being collected by the drilling program. These limitations influence the engineering results where RQD is applied in classification systems, numerical modelling and other engineering assessments. As Karl Terzaghi (1961), stated:

"I am more and more amazed about the blind optimism with which the younger generation invades this field, without paying attention to the inevitable uncertainties in the data on which their theoretical reasoning is based and without making serious attempts to evaluate the resulting errors."

3.1 Joint Spacing

RQD is an indirect measure of joint spacing (Section 2.4). In order to illustrate some limitations of RQD, Figure 2 provides two examples at opposite ends of the RQD spectrum.

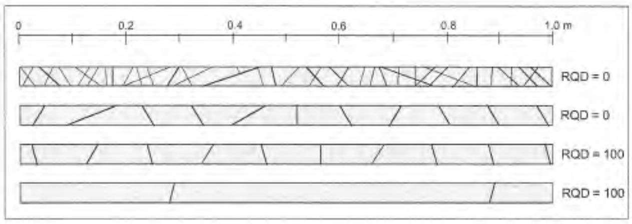


Figure 2: Examples of minimum and maximum RQD for various joint densities along drill cores (from Palmstrom, 2001).

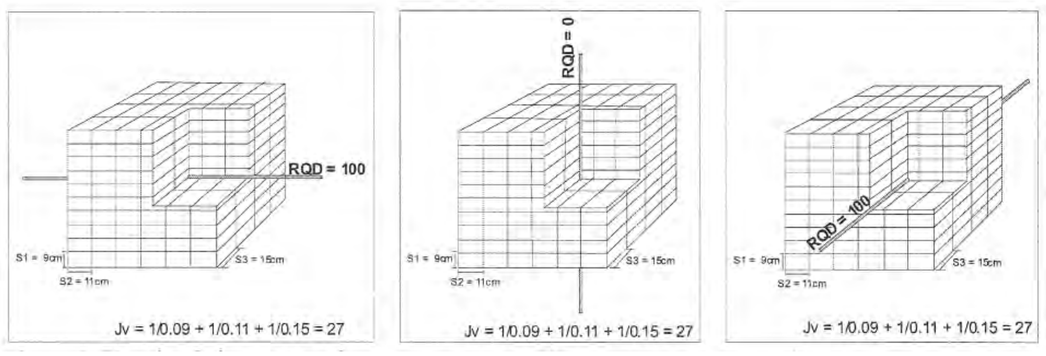


Figure 3: The effect of drilling direction on calculation of RQD, which can be both 0 and 100, depending on the orientation of the borehole (after Palmstrom, 2005).

The same RQD can be produced for different joint / fracture intensities within the rock core. For example, RQD = 0 where recovered core pieces are 99 mm long. An RQD = 0 will also occur where no core pieces are longer than 10 mm. An RQD = 100 may be produced where fracture spacing is >1000 mm, but an RQD = 100 will also be produced where core pieces of 100 mm are recovered. An additional limitation is that the RQD, on its own, gives no information on core pieces <100 mm in length; i.e. it does not matter if the discarded core pieces are un-cemented sands or unweathered, weak rock pieces < 100 mm in length.

The preceding discussion has indicated that RQD is relatively insensitive to small or large joint spacings. Therefore, it is not a very good classification scheme in rock masses with very closely spaced or very widely spaced joints. Some limitations of the RQD in characterising very small or very large block sizes may be overcome by factoring RQD. For example, the Q-System factors RQD according to: RQD/Jn, where Jn is the number of joint sets present (Table 1).

Number of Joint sets	RQD Correction Factor -Joint Number (Jn)
Massive, no or few joints	0.5-1.0
One joint set	2
One joint set, plus random	3
Two joint sets	4
Two joint sets, plus random	6
Three joint sets	9
Three joint sets, plus random	12
Four or more joint sets, heavily jointed, 'sugar cube' etc...	15
Crushed rock	20

Table 1: RQD correction factors according to the number of joint sets, as used in the Q-System.

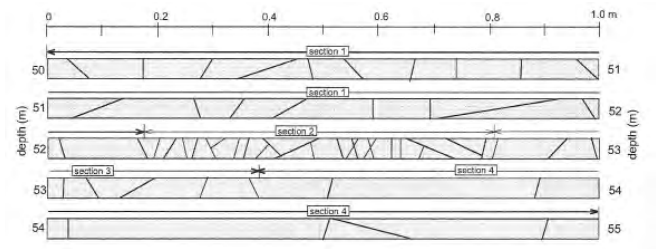
However, the RQD/Jn relationship is not linear, but varies depending upon the block volume. So, although this correction extends the use of RQD to a greater range of block sizes, the correction can introduce errors, if its limitations are not fully understood.

3.2 Drilling Direction Bias

RQD is also dependent on the direction of drilling (Figure 3). This effect must be recognised by designers in particular, but also during the planning stages of projects, with a view to reviewing the requirement for inclined boreholes.

3.3 Run Length Bias

As stated in Section 2.1, RQD is usually measured along a standard length of core, which usually equates to the drill run length. However, logging core as standard length sections can introduce errors where there are areas of higher and lower joint densities. Figure 4 shows a hypothetical core laid out representing a depth range of 50-55 m, obtained in 1 m run lengths.



MEASUREMENT IN SECTIONS			
Section	Length	Core pieces > 10 cm	RQD
1	2.17	1.62	75
2	0.63	0	0
3	0.56	0.23	41
4	1.63	1.55	95

MEASUREMENT EVERY METRE			
Interval	Length	Core pieces > 10 cm	RQD
50 - 51	1.0	0.66	66
51 - 52	1.0	0.82	82
52- 53	1.0	0.26	26
53 - 54	1.0	0.75	75

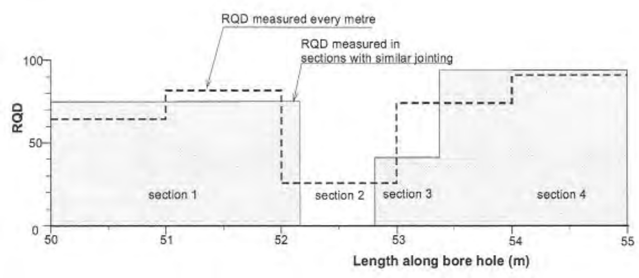


Figure 4: Variation of calculated RQD depending on the standard length of core used (Adapted from Palmstrom, 2005).

The effect of logging RQD by drill run length (1.0 or 1.5 m) is to subdue the natural variation of jointing along the length of core. The greatest variation occurs where the core is highly fractured; logging in sections of similar jointing density gives an RQD of 0, whereas logging per drill-run length, in this case every metre, overestimates rock mass quality, giving an RQD of 26.

In practise, relying on RQD could introduce errors if fracture zones or more heavily jointed sections of core are not specifically pulled out. Also, qualitative descriptions of joint spacing fail to make variations in joint spacing explicit for the designer. Depending upon the project, consideration might be given to changing the lengths over which RQD is calculated to better characterise variations in joint density.

4. RQD in New Zealand Rock Masses

4.1 Waitemata Group Rock

The Waitemata Group rocks comprise flysch-type deposits of interbedded sandstones and siltstones. The sediments were laid down in a broad subsiding basin approximately 20 million years ago flanked by two volcanic arcs; to the west the Waitakere Group and to the east the Coromandel Group. The sandstones were deposited as fast-flowing high-energy turbidity currents and the thicker beds are typically graded with coarse material at the base of the bed and finer material at the top. Intact rock strengths in the siltstones and mudstones range from very weak to weak and contain interbedded extremely weak uncemented sands.

Several distinctive lithologies are interbedded within the sandstone and siltstone beds of the Waitemata Group. The most conspicuous is the Parnell Grit. The Parnell Grit beds represent sub-marine volcanic debris flow events, which predominantly originated from the western volcanic arc. The Parnell Grit is a mixture of coarse sand to boulder sized clasts of volcanic (mainly andesitic) derived sediments; the matrix is variable and can comprise clay, silt and sand and is typically weak to moderately strong.

RQD when applied to Waitemata Group Rock has a number of limitations that Geologists and Engineers should be aware of:

- Waitemata Group rock is not a hard rock;
- The presence of un-cemented sands and extremely weak sandstones.

It is important to understand how these rock mass properties affect the calculation of RQD and its implications.

4.1.1 Uncemented extremely weak sandstone

The author has reviewed many borehole logs, from historical and contemporary investigations, from a range of Consultants and it is clear that RQD in Waitemata Group Rocks is commonly misapplied, or at the very least inconsistently applied. Lengths of uncemented sand, which do not meet the soundness test, are routinely included in the calculation of RQD. Frequently, rock is described as extremely weak, and is included in the RQD. The NZ Geotechnical Society guidelines stipulate that extremely weak rock should also be accompanied with an equivalent soil description. Therefore, extremely weak rock should not be included in the RQD. The fact they are often included is down to a misunderstanding amongst Geologists and Engineers on what the RQD should be applied to. Also, because the extremely weak, uncemented sand is often recovered as intact lengths of core >100 mm interbedded between very weak to weak siltstones, they are often included in the RQD count. Fundamentally, this is incorrect and over estimates rock mass quality, regardless of the origin of uncemented sands.

4.1.2 Weakly cemented interbedded sandstone/siltstone

Weakly cemented sands are often subject to core disking. This occurs during the drilling process and is caused by drilling induced shear stresses. It becomes extremely difficult to determine whether these breaks are drilling induced, or whether they exist in situ. If they are deemed to be caused by drilling, then they are excluded from the RQD. The implications are important since it can produce an RQD of 100% or 0%, dependent on how they are classified. Deere, *et al* (1967) recommended that if in any doubt these should be included, since an RQD of 0% is inherently more conservative than an RQD of 100%.

In reality, core disking most probably occurs parallel to horizontal and sub-horizontal bedding within the rock (Plate 1). The bedding structures, although initially closed, have much less tensile strength than the intact rock and so the core preferentially breaks along bedding. These drilling induced fractures should not be included in the RQD, since the aim is to characterise *in situ* quality, although they could be included as part of the Handled RQD.

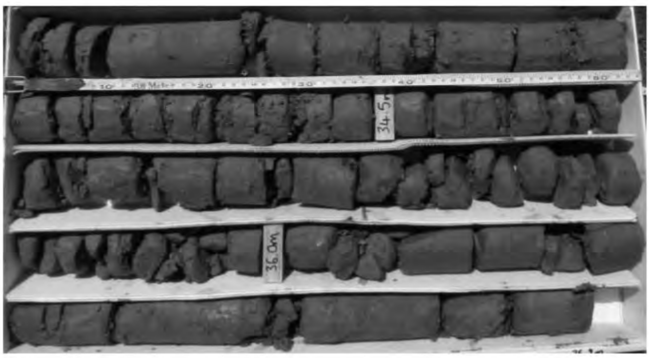


Plate 1: Core disking as a result of the drilling and handling of the core prior to logging. These fractures should not be included in the RQD, but could be counted as part of the Handled RQD

Plate 2: Crushed / sheared greywacke. Although intact length of core >100 mm are recovered and the rock is weak, it should not be included in the RQD.

4.2 Greywacke

New Zealand greywacke comprises interbedded sandstones and siltstones, which have been very weakly metamorphosed. Greywacke rock masses commonly have a complex geological structure; bedding is generally steeply dipping, folded and sometimes overturned (Richards and Read, 2007). Due to tectonic processes the rocks are often crushed and sheared, with the weaker mudstones (argillites) being more susceptible to these processes. Typically the rock masses may contain four or more joint sets, plus random joint sets, with joints being closely to very closely spaced, with low persistence. In addition to open joints, there are many closed or healed joints (incipient joints), which have very low tensile strengths. Recovered core, which contains very closely spaced incipient joints may be recovered as intact sticks >100 mm in length. However, upon disturbance, for example by excavation, these fractures may open and the rock mass disintegrates. Failing to account for these joints can influence the assessed rock quality.

Crushed and sheared zones are typically extremely weak, or may be reduced to a soil-like structure in places. Consequently, crushed and sheared zones should not be included for calculation of RQD. Even where the shear / crush zones are weak, they should not be included in the RQD since they have different geomechanical behaviour compared to the surrounding rock mass (Plate 2). These features should be explicitly picked out as discreet zones, noting their dip during logging.

5. Alternative Measures of Rock Quality

A number of alternative methods could be applied in order to characterise rock mass quality in Waitemata Group Rock and Greywacke. This is not intended to be a definitive guide, more to generate discussion and thought. Nor is it intended to suggest that RQD should be replaced completely by other methods. Each project has different technical goals and required inputs. However, using a range of quality measures can often produce more informative interpretations of rock mass quality, providing they are easily understood and quickly applied.

5.1 Handled RQD

In Waitemata Group rocks, a high RQD does not necessarily translate to a high quality rock mass. It is possible that 1.5 m of extremely weak, uncemented sand(stone) can be logged and given an RQD of 100%, if it is recovered intact. This is very misleading because it gives the impression of competent rock. Moreover, RQD only assesses rock quality in situ; it does not provide an indication of rock quality and behaviour after excavation. In greywacke rock masses, the presence of incipient joints, which are very weakly closed, can cause a large reduction in rock mass quality once disturbed.

To overcome this problem, the 'Handled' RQD (HRQD) can be used (Robertson, 1988). The HRQD is measured in the same way as RQD, but after the core has been firmly handled in an attempt to break the core into smaller pieces. During handling the core is firmly twisted and bent, but without substantial force and without the use of tools. The adoption of HRQD also allows weakly cement, or incipient joints to be taken into account. For Waitemata Group rocks it would also prevent the inclusion on non- or weakly cemented sands in the RQD count, thereby preventing overestimation of RQD.

In reality, if core is not being logged on site, it is the Handled RQD which is being recorded.

5.2 Ratio of cemented to uncemented rock

In order to prevent confusion over application of RQD to uncemented sands, the ratio of uncemented to cemented lithology, expressed as a percentage could be used, calculated like RQD, per drill run length. Although not intended to replace conventional RQD, it use would help identify if RQD had been applied incorrectly. The same boundaries used for conventional RQD could be used to assess quality. This is because if RQD is applied correctly, the two schemes should mirror each other closely. Hopefully this would prevent confusion over the application of RQD in these materials, as has so often been seen.

6. Alternative Measures of Block size

Considering the relatively high cost of obtaining drill cores, it is surprising that very little attention is given to obtaining better estimates of jointing density in New Zealand practise. A number of different measures of jointing density and hence block size / volume. Only those applicable to rock core will be reviewed, since this is where RQD is commonly used.

The Weighted Joint Density, wJD, introduced by Palmstrom (1995), can be used to indirectly calculate block size and volume from recovered drill core and from outcrop mapping. The weighted joint density is based on the measurement of the angle between each joint and the ground surface or borehole (Figure 5).

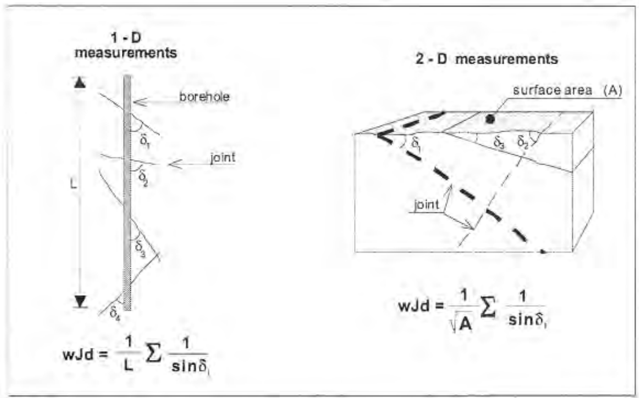


Figure 5: The intersection between joints and drill core (left) and between joints and a surface (right). From Palmstrom (1995).

In order to simply the procedure for logging core on-site, the following relationships may be developed, based on grouping the interval angle:

For 1-d measurements,

$$wJD = \frac{1}{L}\sum\frac{1}{\sin\delta i} = \frac{1}{L}\ s\,f\,i$$

And for 2-D measurements

$$wJD = \frac{1}{\sqrt{A}}\sum\frac{1}{\sin\delta i} = \frac{1}{\sqrt{A}}\ s\,f\,i$$

where *s* = angle between joint and borehole / surface and *f i* is a rating factor (Table 2).

Angle interval (between joint and borehole or surface)	1/sin δ	Chosen rating of the factor f_i
δ >60°	<1.16	1
δ = 30 - 60°	1.16 - 1.99	1.5
δ = 15 - 30°	2 - 3.86	3.5
δ < 15°	>3.86	6

Table 2: Angle intervals and rating factor, *fi*.

Using the Weighted Joint Density, a number of other relationships may be developed, since wJD can be correlated with the volumetric joint count, which can then be related to alternate measures of spacing or block size. Although full discussion of these methods is beyond the scope of this review, Figure 6 shows how these measurements are related and also the fact that RQD only provides information for a limited range of joint spacings.

7. Conclusions

The RQD is often routinely and blindly applied, with little appreciation of its original derivation and its intended use. The incorrect application of RQD in rock engineering investigations and calculations may result in inaccuracies or errors. RQD, should therefore, be applied with great care. Consequently, while RQD is a practical parameter for core logging, it is not sufficient on its own to provide an adequate description of the rock mass. These errors can be compounded because RQD is used as a fundamental input into a number of other rock mass classification schemes.

Junior staff, responsible for the majority of core logging, are often instructed to record the RQD, but very rarely is its application explained; perhaps because many senior staff also fail to recognise its limitations in characterising the intensity of fracturing. RQD was originally developed for application to hard rocks. For Waitemata Group rocks, this poses some problems, particularly because those recording or reviewing are unaware that it should not be applied to uncemented sands, crush/sheared zones, even though they may be recovered as intact sticks of core >100 mm in length. Senior staff need to be aware, during review, of these potential problems. It is suggested that different approaches to recording rock quality can be used to supplement RQD and serve as a check that it is being recorded properly. Research has been conducted in the last 50 years into alternative methods for characterising jointing in rock masses. This work has occurred due to the increasing use of underground spaces and the need to adequately characterise rock mass conditions. This paper suggests simple alternative measures of rock quality and block size that can be used on drill core samples in the field. At the very least, practioners should be aware of alternative methods that exist for characterising jointing density, so that adequate consideration can be given as to the value of RQD for providing information on rock mass quality. Given the high cost and reliance on borehole data, it is surprising such methods are not employed more often.

It is hoped this review will stimulate discussion about which methods provide the most useful information, given the high cost of site investigations. As tunnelling and underground excavation becomes more widespread due to limited surface space, these issues will become more prevalent.

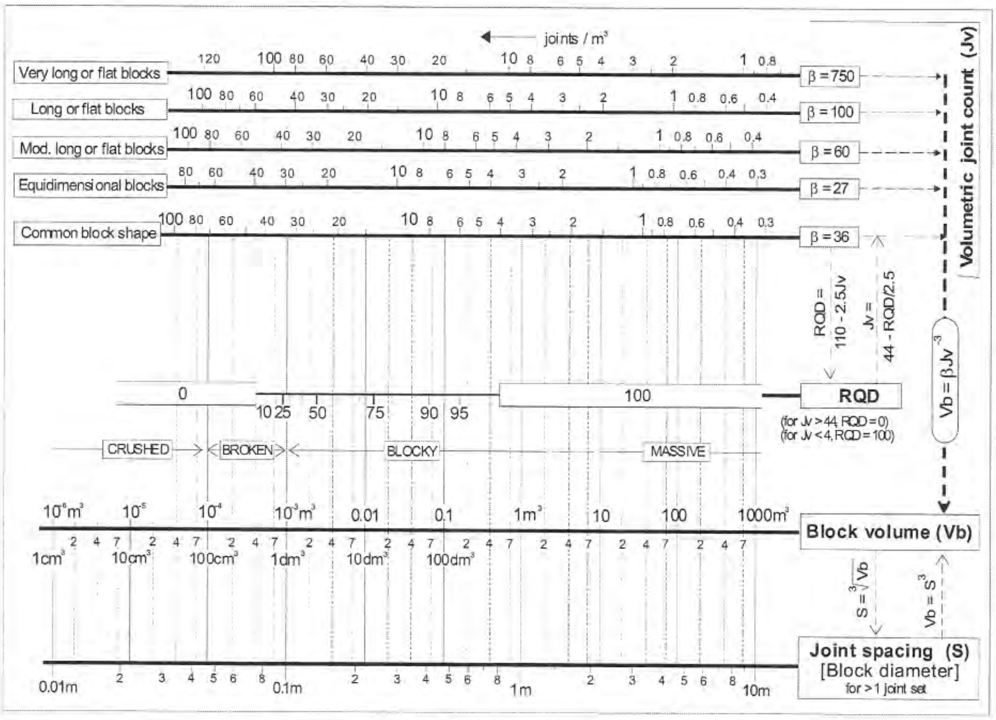


Figure 6: Relationships between RQD and other common measures describing the variation in jointing density in a rock mass From Palmstrom (1995).

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Dr Simon Nelis
Senior Engineering Geologist
Beca Infrastructure Ltd.

PROJECT NEWS

Darfield (Canterbury) Earthquake – On the Ground

On ground support in Canterbury

As one of the few geotechnical and geological engineering firms to provide mobile CPT and SCPT, RDCL mobilised a CPT drill rig to Canterbury to assist in post earthquake assessment. Support was offered immediately to large and smaller geotechnical engineering companies and the machine was on-site, from Hawke's Bay, within two days.

Due to its manoeuvrability the bobcat mounted CPT rig provides access into areas traditionally considered challenging and is therefore ideal in sandy, wet or rough terrain. Mounted on a mobile platform it provides powerful 16 tonne push/20 tonne pull capacity, ideal for assessing liquefaction and ground load bearing capability after a major earthquake.

Above: CPT rig on sand

Testing options

CPT provides ideal in-situ assessment evaluating the potential for soil liquefaction and vertical/lateral ground displacement, due to its repeatability, reliability, continuous data and cost effectiveness.

Piezocone CPT(u) testing measures pore pressures (u) in addition to tip and friction resistance providing a complete suite of data for geotechnical assessment. This testing produces a continuous, detailed log of ground conditions and better repeatability of measurement compared with conventional SPT (Standard Penetration Testing).

Seismic Cone Penetrometer testing (SCPT) utilises a tri-axial geophone array mounted behind the conventional CPT cone to measure P- and S-wave velocities. Measurements are taken at generally 1 m, or intervals specified by the client using a sledgehammer on a steel plate as an energy source. SCPT is the preferred method for site soil classification (NZS1170.5:2004 Section 3.1.3.1).

RDCL operate a Geotech AB piezocone, a high tech device that utilises cordless technology (radio signals) for data transfer providing optimal probing productivity. Inside the probe, the digital coded signal is converted to an acoustic signal, which is transmitted along the drill rods to the surface. Sound signals are received by a microphone at the surface, which transmits the signal to a PC via a computer interface. This testing is fast and reliable, the digital outputs speed processing and provide detailed analysis. Processing occurs in a number of hours not days.

Assessing Canterbury

The RDCL rig was employed throughout Canterbury on numerous subdivisions and commercial sites. Led by Geotechnical Engineer, Richard Dee, these projects provided a rigorous education into the impact of the shallow sited 7.1 Darfield earthquake. "I worked as a Geoechnical Engineer for road and rail infrastructure in Ireland. Other than pictures, and video I had not witnessed recent seismic activity on-site. Being on the ground in Canterbury was an eye-opener and another step forward in the education of what is 'Mother Nature'. I now have accurate firsthand knowledge into the complex geology of the Canterbury region."

The ability to switch between tracks and wheels came into it's own on sand dunes. "It's a fast change with minimal downtime and we completed the testing to a tight timeline. Ease of access on and around difficult terrain means we were able to process a number of sites without transport issues and get onto the next project," says Richard.

Eija Hulkko, RDCL's Geotechnical Engineer provided data reduction support directly from the Hawke's Bay office. The data from the Darfield earthquake provides current information on the impact of liquefaction updating data on phenomena not seen in New Zealand since the 1931 Napier earthquake.

"It was fascinating to process data for Canterbury noting the differences to Hawke's Bay. Both have deep soft sites with layers of sand. The challenge lies in reading the data in its local context and remembering that every site is different. We were working closely with the clients both onsite and during data processing. Their experience was valuable in understanding the local subsoil condition during testing and data processing."

Reported by: Richard Dee and Eija Hulkko
Geotechnical Engineers
RDCL

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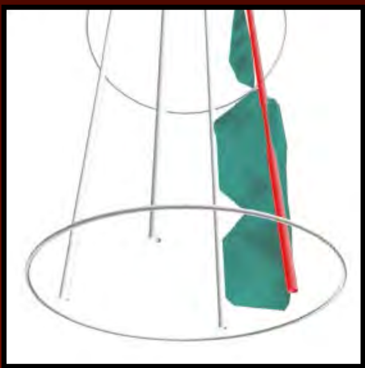

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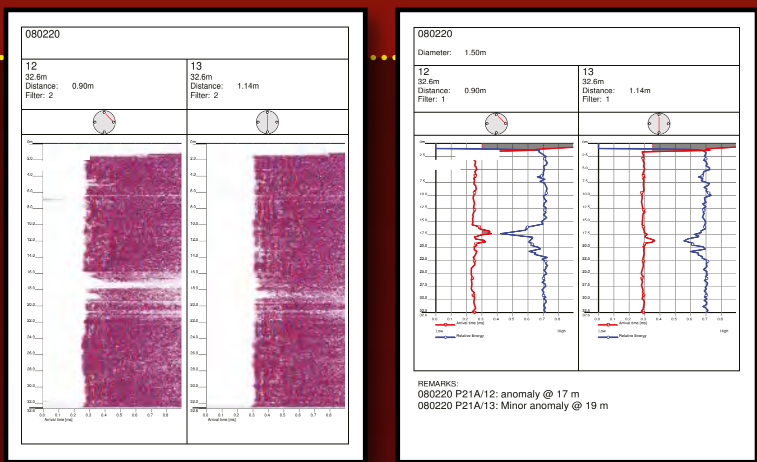

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2011 PACIFIC CONFERENCE ON EARTHQUAKE ENGINEERING

BUILDING AN EARTHQUAKE-RESILIENT SOCIETY

AUCKLAND , NEW ZEALAND 14 - 16 APRIL

NEW ZEALAND SOCIETY FOR EARTHQUAKE ENGINEERING

THE CONFERENCE

The Pacific Conference on Earthquake Engineering (PCEE) has been held four yearly since 1975. The 2011 Conference will take place in Auckland, New Zealand. Over 220 abstracts from 14 countries have been received, indicating that the 2011 Conference will again provide an important forum for Earthquake Engineering researchers and practitioners from throughout the Pacific Rim.

The New Zealand Society for Earthquake Engineering (NZSEE) invites all interested researchers and practitioners to attend the PCEE. The theme of the 2011 conference is:

"Building an Earthquake-Resilient Society"

KEYNOTE SPEAKERS

Each day, keynote presentations on the Conference theme will be presented by internationally eminent researchers and practitioners in the Earthquake Engineering. Keynote speakers will include:

Prof. Nigel Priestley
(Emeritus Professor of Structural Engineering at the University of California at San Diego and co-director of the Rose School, Pavia, Italy)

Prof. Roberto Leon
(Professor of Structural Engineering at the Georgia Institute of Technology, U.S.A.)

Dr. Robin McGuire
(Founder of Risk Engineering of Boulder, Colorado. Past director of Earthquake Engineering Research Institute (EERI) and a past president of the Seismological Society of America (SSA))

Prof. Robin Spence
(Director of the Cambridge University Centre for Risk in the Built Environment, U.K.)

SPECIAL SESSIONS

- Darfield (Canterbury) Earthquake Sequence Forum
- Advances in Seismic Retrofit of Reinforced Concrete Buildings
- New Perspectives in Seismic Hazard: From Observation to Quantification
- State of the Art in the Seismic Assessment and Retrofit of Unreinforced Masonry Structures

KEY DATES

1 Dec 2010	Online Registration Opens
1 Feb 2011	Accepted Papers Due
9-11 Apr 2011	Christchurch Field Trip
11-13 Apr 2011	SW Pacific Earthquake Resilience Workshop
14 Apr 2011	Conference Opening
15 Apr 2011	AGM for NZSEE

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ANZ 2012

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www.anz2012.com.au

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ENGINEERS AUSTRALIA

STANDARDS, LAW AND INDUSTRY NEWS

IAEG Young Professionals Commission

During the Young Professionals day at the IAEG 2010 Congress held in Auckland on the 5th September, Fred Baynes, the IAEG President, called for keen YPs to form a commission to ensure the future of the IAEG. It is worth pointing out that for the IAEG a young professional is up to 40 years of age. By the end of the next day a group of like minded enthusiastic individuals had formed a committee to get the commission going. The inaugural meeting of the committee was held over dinner on 8 September to get to know each other and to agree on the commission's basic aims, which are to;

- promote engineering geology and associated fields.
- facilitate technical development.
- facilitate networking

All this is to ensure the future of the IAEG through the promotion of young professionals & practitioners. There are currently 14 members on the commission from 12 different countries and it became clear during the meeting that the way to achieve these aims would vary immensely across the world, and different methods and approaches will be needed to make sure our objectives are met.

Formation of the IAEG YP Commission

Reported by: Beverley Curley
Chairperson: IAEG Young Professional Commission

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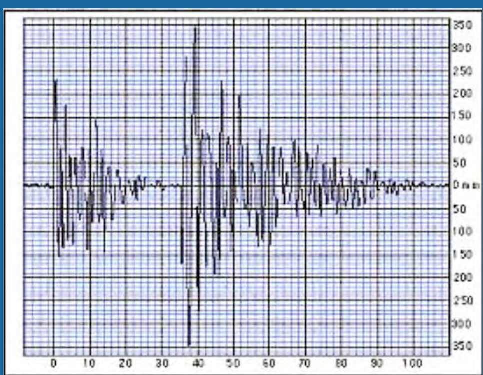

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NZGS Young Geotechnical Professionals

The Young Geotechnical Professionals group has been encouraged to be formed to represent, support and provide a voice for the young professionals. We represent a lively, increasingly influential and rapidly growing section of Geotechnical Engineers and Engineering Geologists nationwide. Through a social culture of innovation, integrity, networking and the pursuit of excellence, we anticipate facilitating in the professional and personal development of the young professionals.

This role encompasses the ongoing developments with working in coordination with other Young Professionals across the international societies NZGS represents. Following on from the Young Professionals day at the IAEG 2010 Congress, a young professional group for IAEG has been established, with members from some 20 countries - they will be working with Giorgio Lollino to establish an interactive forum on the new IAEG website presently under development. Beverley Curley is currently representing New Zealand on the IAEG YP committee. The ISSMGE also has an active international young professional interest group (Student and Young Member Presidential Group – SYMPG) developed out of the conference held in Alexandria last year and Lucy Coe represents New Zealand on that committee. If you would like further information on this group please refer to the ISSMGE Bulletin: Volume 4, Issue 3 or direct enquires to Lucy Coe - email: lucy.coe@beca.com.

Luke Storie (Auckland Branch) and Joyce Seale (Christchurch Branch) are providing assistance / support with the 2010 Student Awards which are to be held in mid November.

Latest activities:

- Student Awards 2010 presentations in Auckland (4 abstracts received) and Christchurch (9 abstracts received). Selected finalists will make their presentations at special branch meetings in November.

Upcoming activities:

- Finding a new YGP representative for the 2011 committee. If you are interested please contact Amanda or Kate.
- Look to promote students to join NZGS from the universities in early 2011.
- Announcement of next ANZ Young Geotechnical Professionals Conference in Australia.

Highlights from the Young Professionals day at IAEG 2010 Congress – "Geologically Active"

The Young Professionals day was well received with a breakfast and networking session in the morning, followed by the Richard Wolters Prize Presentations where nine countries were represented.

The 2010 Richard Wolters Prize held at the IAEG 2010 Congress was awarded to Australian Darren Paul who is an engineering geologist with Golder Associates in Melbourne. Darren presented on 'An Expert System approach to the Identification of Geological Uncertainty in Geotechnical Engineering' which was part of his Dissertation thesis at the Department of Civil and Environmental Engineering Imperial College of Science, Technology and Medicine at the University of London.

The Richard Wolters Prize specifically recognises meritorious scientific achievement by a younger member of the engineering geology profession and is awarded to honour Dr. Wolters' many contributions to international understanding and co-operation. The young professionals of NZGS would like to congratulate Darren on his achievement for the Australasian region.

Following on from the presentations that afternoon the YP's made their way to the viaduct for some Americas Cup match racing. This event was well attended and formed a unique connection between countries and peers which was great for unwinding and relaxing before the Congress proper. The relationships and networks developed between the YP's on that one day will serve them throughout their career.

I would like to thank all those people who helped make the YP day a success and hope that all conferences/ congresses and symposiums that the NZGS hold in the future will promote the ongoing development of the Young Geotechnical Profession.

We welcome support and inspiration from the young geotechnical professional's community. If you have any ideas or activities you would like to see happen please contact me.

Reported by: Kate Williams
YGP Representative
Email: kwilliams@tonkin.co.nz

International Society for Rock Mechanics

ISRM

ROCHA MEDAL 2012

Since 1982 a bronze medal and a cash prize have been awarded annually by the ISRM for an outstanding doctoral thesis in rock mechanics or rock engineering, to honour the memory of Past President Manuel Rocha while stimulating young researchers.

Starting with the Rocha Medal 2010, one or 2 runner-up certificates may also be awarded.

An invitation is now extended to the rock mechanics community, and especially to Faculty members, for nominations for the Rocha Medal 2012.

Full details on the Rocha Medal are provided in ISRM By-law No. 7.

Application

To be considered for an award the candidate must be nominated within two years of the date of the official doctorate degree certification.

Nominations shall be by the nominee, or by the nominee's National Group, or by some other person or organization acquainted with the nominee's work.

Nominations shall be addressed to the Secretary General and shall contain:

- a one page curriculum vitae;
- a written confirmation by the candidate's National Group that he/she is a member of the ISRM;
- a thesis summary in paper and digital formats, written in English, with between 5,000 and 10,000 words, detailed enough to convey the full impact of the thesis and accompanied by selected tables and figures;
- one copy of the complete thesis and one copy of the doctorate degree certificate;
- a letter of copyright release, allowing the ISRM to copy the thesis for purposes of review and selection only;
- an undertaking by the nominee to submit an article describing the work, for publication in the ISRM News Journal.

Application Deadline

The nomination must reach the ISRM Secretary General by 31 December 2010.

Past Recipients

1982	A.P. Cunha	PORTUGAL
1983	S. Bandis	GREECE
1984	B. Amadei	FRANCE
1985	P.M. Dight	AUSTRALIA
1986	W. Purrer	AUSTRIA
1987	D. Elsworth	UK
1988	S. Gentier	FRANCE
1989	B. Fröhlich	GERMANY
1990	R.K. Brummer	SOUTH AFRICA
1991	T.H. Kleine	AUSTRALIA
1992	A. Ghosh	INDIA
1993	O. Reyes W.	PHILIPPINES
1994	S. Akutagawa	JAPAN
1995	C. Derek Martin	CANADA
1996	M.P. Board	USA
1997	M. Brudy	GERMANY
1998	F. Mac Gregor	AUSTRALIA
1999	A. Daehnke	SOUTH AFRICA
2000	P. Cosenza	FRANCE
2001	D.F. Malan	SOUTH AFRICA
2002	M.S. Diederichs	CANADA
2003	L. M. Andersen	SOUTH AFRICA
2004	G. Grasselli	ITALY
2005	M. Hildyard	UK
2006	D. Ask	SWEDEN
2007	H. Yasuhara	JAPAN
2008	Z.Z. Liang	CHINA
2009	G. Li	CHINA
2010	J.C. Andersson	SWEDEN

All relevant information can be obtained from the ISRM website, at http://www.isrm.net.

IAEG 2010 YP's go Sailing

During the 11th International Association for Engineering Geology and the Environment (IAEG) Congress which took place in Auckland, Beca sponsored the Young Professionals (YP) sailing event which took place on the Hauraki Gulf on Sunday 5th September, showing its commitment to development of geotechnical professionals. Over 50 YPs from around the world attended the sailing event following the Richard Wolters prize presentations.

The event was billed America's Cup Match Racing, unfortunately one of the actual America's Cup boats was unable to compete due to technical difficulties and was therefore substituted. However the substitute (the Lion boat 3900) was no underdog, coming with a pedigree of its own and the added advantage of being able to carry more people. The lighter and more maneuverable America's Cup boat NZL 41 was up against Lion 3900 which was heavier but more powerful. The weather was kind with an 8-12 knot breeze generally blowing from the north-east.

Most match racing is between one-design boats, meaning that ideally the boats should perform identically on all points of sail and that any differences in performance are attributable to the crew, however the substitution threw in a whole new set of circumstances. The America's Cup Boat NZL 41 was additionally handicapped by reefing the sail. So whilst the boats were not directly matched the skills of the crews were pitted against one another accurately and tactics of position, wind shifts and tides were used to force each opponent to an unfavoured point of sail.

The boats set sail from Viaduct Harbour at approximately 4 pm following a short race and safety briefing. Following a period of practice, the action suddenly heated up as the boats lined up in the pre-start ready to compete head to head. The YPs were given the opportunity to be fully involved or just sit back and enjoy the action with a dedicated crew on board each yacht.

As this was harbour racing, both boats were concentrating on crossing the line before their opponent just after the starting gun, so tactically looking for tight coverage and drawing fouls. It was the Lion boat over the line first with a slight hint of being just before the gun but no protest was raised, so a good start!

The course was set as a classic windward leeward course, heading out from the bridge towards Waiheke. The wind was moderate blowing about 10 knots with the Beca flags outstretched and coping with an apparent wind nearer 15 knots.

From the onset the action was nonstop. The pre-start tactics and fight lasted until the gun, and while NZL 41 was more aggressive, Lion attacked when they had the opportunity, with great tacking manoeuvres holding off the challenge.

The boats battled up the course towards Rangitoto with lots of opportunity for the crews to shadow one another.

This was the tacking leg of the race with the boats not only battling one another but going up to wind, heeling over with a couple of crew members scrabbling up the decks and sliding about trying to gain their footing.

Once round the top mark it was a run most of the way home, however each boat had to put in a couple of jibes for best course, with a few calls for 'watch out for the boom' as it came swinging across the boat.

At the run to the finish Lion just pipped NZL 41 to take the honours. Congratulations to the Lion crew and commiserations to all those on NZL 41! The event proved to be a success for all and as one of the exhilarated young sailors said:

'It was wonderful to participate in the sailing with likeminded people from all over the world and I'm sure the other sailors would agree that it was a very rewarding experience. This event was beyond my expectations and I am very grateful to the IAEG and Beca for giving me the chance to participate in it.'

Both boats cruised back to dock and the sailors disembarked to share stories over a pint.

Reported by: David Lee
Beca Infrastructure Ltd

2010 Rankine Lecture Review

The Rankine Lecture is a prestigious invited lecture in geotechnics awarded by the British Geotechnical Association. The list of past recipients reads like a Who's Who in the advancement of geotechnical understanding; names like Gasagrande, Hoek, Janbu, Ishihara…etc, etc. On October 26 the 2010 recipient, Professor Chris Clayton, from the University of Southampton, presented this year's Rankine Lecture at the Auckland School of Engineering. The topic was "Stiffness at Small Strain – Research and Practice". The night was well attended, and refreshments served by Maccaferri and Randstad providing an appropriate start to the evening. Chris' lecture covered the background to soil stiffness and elasticity and why an understanding of these properties is critical to effective numerical modelling. The use of non-linear anisotropic stiffness relationships was discussed along with the field and laboratory test methods suitable to obtain useful data on this issue. The lecture abstract is included below, and the full paper can be found in Géotechnique.

Stiffness at Small Srain – Reserach and Practice
Professor Chris Clayton, University of Southampton, U.K.

The rapid development of computing power and of numerical modelling software over the past forty years has made sophisticated analysis of geotechnical problems accessible to most practising engineers. Typically computer packages now offer a wide range of constitutive models, which the design engineer needs to choose between, and then obtain parameters for. For those structures designed to be far from failure, for example supporting urban excavations, strains in the ground are small. A sound knowledge of stiffness parameters at small strain is essential if realistic predictions of the ground movements that may affect adjacent buildings or underlying infrastructure are to be made. This lecture reviews what is now known about the complex stiffness behaviour of soil and weak rocks in the context of elasticity, arguably the simplest of constitutive behaviour. Drawing on experience gained through field observation and numerical modelling, the case is made for the routine use of non-linear anisotropic stiffness. The determination of the parameters required is then explored, and the usefulness of advanced triaxial testing, and dynamic laboratory and field testing examined.

Reported by: Paul Salter
URS NZ Ltd

Brief Update on Retaining wall Guidelines

An NZGS Subcommittee chaired by CY Chin is working on Module 2 of the NZ Geotechnical Earthquake Engineering Practice Guidelines, which will relate to the seismic design of retaining walls. The plan is to cover retaining wall issues in this module and create separate guidelines for embankments and foundations. At this stage, the terms of reference and scope of the guidelines have been completed, along with a literature review of certain topics and drafting of some of the guidelines themselves. In September, Chin was able to take advantage of a 2 week VIP (Visiting Industrial Professional) IPENZ Grant which allowed him to spend time with the Geotechnical Engineering research group at the University of Auckland and advance these guidelines. More work is still to be done by the various members of the subcommittee in

2011 who are P. Brabhaharan, John Wood, Mick Pender and Phil Clayton.

This Module 2 will follow on from the "Geotechnical Earthquake Engineering Practice - Module 1 - Guideline for the identification, assessment and mitigation of liquefaction hazards", shown below, which NZGS published in July 2010 (downloadable from the NZGS Website).

Reported by: Paul Salter
URS NZ Ltd

NZGS Website Update

Our remodeled website has been up and running for a whole year now. Some recent statistics and observations follow:

How many people use NZGS?

During the last 6 months, the NZGS website has had 50% more visitors than the previous six months and 25% more page views. Of note, during the 11th IAEG Congress in Auckland, the visitors to the NZGS website more than doubled! Almost all of these new visitors to the website were from New Zealand. It was great to see that everybody was checking our site to get information on the Congress.

What are the most visited pages on the website?

We can see from statistics that during the last six month period, the most visited pages on www.nzgs.org were the publications, guidelines, conferences and jobs pages. This does not differ significantly from the previous six month period, except for the guidelines page, and can possibly be attributed to the publication of the seismic design guidelines (a 34 page document entitled Geotechnical Engineering Practice, Module 1, Guideline for the identification, assessment and mitigation of liquefaction hazards, 2010) which is free to download. Further guidelines are also being prepared – so watch this space!

Where are our visitors from?

Users visiting the website are mostly from New Zealand, and this hasn't altered during the last 12 months. The second biggest number of visitors to the website are from Australia, but many are also from the United Kingdom and the United States. In addition to this, there has been an increase in the number of website visits from people in Iran.

Email Notifications

You might be missing out! The NZGS Secretary does not send every conference or event, job or news item to members. With the exception of Branch Presentations, and some significant awards and courses, most items are added to the NZGS website without circulation to the wider NZGS community. If you are interested in something and have not signed up for an email notification, you may be missing out.

Have you any feedback?

If you have yet to visit the site, please take a moment to do so. We have included plenty of opportunities for visitors to send us feedback - so if you can't find what you are after or have a brilliant idea – please send it through!

As always, if you see anything that needs updating, or correcting, please contact either **webmanager@nzgs.org** or **secretary@nzgs.org**

IAEG 2010 CONGRESS (4 – 10 September 2010)

New Zealand sits astride the leading edge of the Australian plate where it converges with the Pacific basin in a mobile margin of subduction, shearing, volcanism and uplift. A land of mountains, faults, earthquakes, volcanoes, sensitive soils, weak rock, landslides, rivers and coastlines – these things characterize New Zealand. It follows that the theme selected for IAEG2010 was *Geologically Active*.

Some of you suggested that we arrange a volcanic eruption in the Auckland harbour as part of the Congress – most of you will be aware than an M 7.1 earthquake occurred in Christchurch at 4.36 am on the morning of the first of the pre-Congress meetings, causing extensive damage, but no casualties. I received the following from a colleague in Spain: *"I hope that you were not too much affected by the earthquake in the South Island (what were you thinking when you chose as the Conference theme "geologically active"!)*".

Perhaps ironically amongst our first keynote speakers were Susumu Yasuda on liquefaction and George Hooper on behalf of the EQC, Principal sponsor of the Congress. Earlier this year an M 7 earthquake occurred at a similar shallow depth in Haiti, resulting in widespread damage and enormous loss of life – why this difference? Some luck, the time of the day, low population density, but also the application of New Zealand's building codes (in part the subject of The Great Debate held on September 9). Increasingly as engineering geologists we are operating at the margins of our experience. We are tunneling deeper, cutting taller slopes, occupying more marginal land.

Some 709 people from 46 countries gathered to participate in IAEG2010. Geologically Active… our understanding of what this really means has been broadened, stretched, given new significance. I hope that IAEG2010 will alter in some way, the way in which we approach our next projects – a new perspective, a changed methodology, a new collaborator, with the outcome of improving practice and building more resilient communities.

Congress Events:

The Congress was event-full and encompassed the following:

4 September Meeting of the Executive of the IAEG

5 September Young Professionals' Day including Mentoring Breakfast facilitated by Jamie Fitzgerald, Richard Wolters' Prize presentations and Match racing on Auckland's harbour as well as the meeting of the Council of the IAEG

6 September Congress opening ceremony, keynote presentations, Richard Wolters Prize presentation, Hans Cloos lecture and Icebreaker reception with the Nairobi Trio

6 September to 10 September Congress sessions; commission meetings; poster sessions

8 September mid Congress field trips

9 September The Great Debate and the Congress Dinner, the Great Kiwi BBQ
10 September closing ceremony.

Enormous thanks to the core team that gave so much to make this all happen! Gregory Pinches (programme lead), Debbie Fellows (Treasurer and promotions), Doug Johnson (Field Trips and programme), Kate Williams (Young Professionals), Tim McMorran (co-Convenor and programme), Mandy Mills (Social), Sally Hargraves (Sponsorship and field trips).

What they said:

"Very impressed with the large number of quality papers within the conference proceedings." Kane Inwood, NZ

"Very impressed with the vibrancy and energy of the Society – setting a first class international example – keep up the good work!" David Boon, UK

"A well organised conference – down to the smallest detail. Great to see many old friends and make new contacts. The New Zealand Society made an excellent presentation from years ago in Nottingham and have lived up to their words. And then capped it all with the Christchurch earthquake!!" Owen White, Canada.

"That was one of the most stimulating and finest meetings I have ever been to.Congratulations!!!! It was brilliant. Many thanks to you and your team for such a superb conference. It was outstanding and you are to be congratulated for such a major accomplishment. I enjoyed every minute of it, learnt heaps, met a lot of very interesting people and didn't want it to end!!!" Dr Hamish Campbell, NZ.

"It's a good conference with many highlights like Icebreaker, field trips… the chance to [meet] new people. I'm organising here my next student excursion to NZ or Australia." Frank Otto, Germany.

Top left: Pacific theme at the Great Kiwi BBQ and **Above:** the Kiwi bach. **Opposite:** Opening ceremony, Fred Baynes accepting the wero (challenge) in a traditional Maori Powhiri.

"Kia Ora! Back home after a long trip and still feeling the effects of the 15 hours difference. And delighted to have participated in the excellent Congress you and your team organised. Congratulations to you and all the organising committee. Every detail was well planned: the technical sessions, the conferences, the debate, the YP breakfast, reception and the social programme! The reception desk was always available to help - always in good spirits. We had a room for the South American meeting and they also helped me with an extra night in the hotel and flight reservation from Wellington. Enjoyed very much the ice-breaker reception, Wine Tour, the EG of Auckland fieldtrip and the Kiwi BBQ. The post-congress fieldtrip was also fantastic with a superb tour leader - Dick Beetham." Francisco de Jorge, Brazil

Website:

www.iaeg2010.com will remain live until the end of March! Check out our photo gallery (you may well be there!) and participate in the YP blog or provide other feedback or photos.

If you would like to purchase the Conference keynote and invited papers book (350 pp) + delegate papers CD-ROM (4600 pp) the price is US$539. The book can be ordered via CRC Press or Taylor & Francis.

Reported by: Ann Williams
Beca Infrastructure Ltd

BOOK REVIEWS

Geotechnical Engineering in Residual Soils – by L.D. Wesley

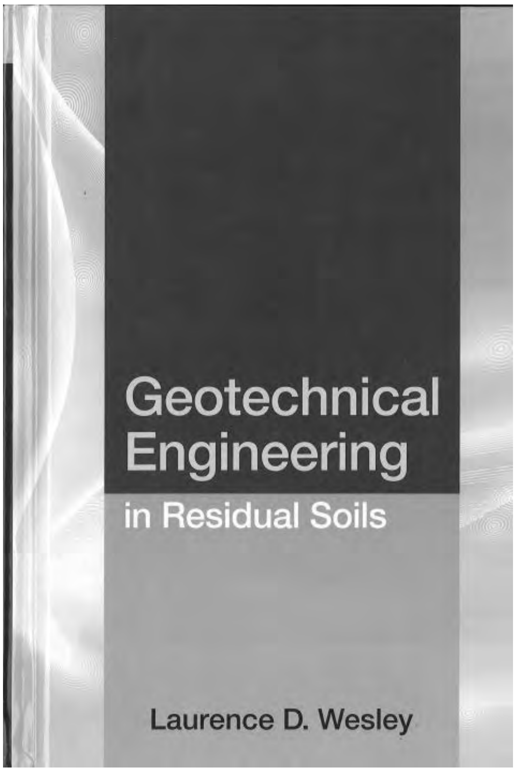
This book, in the author's words, is an addendum to his earlier book Fundamentals of Soil Mechanics for Sedimentary and Residual Soils also published by John Wiley in 2009. He chooses in this book to focus particularly on characteristics of residual soils and takes the opportunity to point out unique characteristics of these soils and the fundamental differences this class of soil have when compared to sedimentary soil.

Mineralogy and structure play important roles in classifying residual soils and the author introduces this in a concise manner in Chapter 2 of the book. Following this, chapters usually found in "traditional" geotechnical text books are covered. These include Consolidation & Settlement, Shear Strength, Bearing capacity and Slope stability. However, there are significant differences from "traditional" textbooks in his approach as he provides examples of how geotechnical engineers need to be aware of different behaviours of residual soils. Of note, the author provides examples of test results on residual soils that do not follow linear relationships in e-log p' plots, instead some better fit linear relationships in e-p' plots instead. Some useful correlations between index test results and shear strength parameters are provided.

The author advocates the use of residual soils as fill in reinforced earth construction, arguing for its consideration compared to granular fill material on the basis of material economy and availibility. The chapter on slope stability discusses interesting characteristics of residual soil slopes - particularly with respect to commonly found steep in-situ slopes and the effects of rainfall on slope stability. A particularly useful chapter on volcanic soils can be found near the end of the book where observations on allophane clays, ash clays derived from rhyolitic parent material and Pumiceous materials are made.

In all, this book would be a useful text for those requiring an introduction to geotechnical engineering relating to residual soils. It serves a useful reminder that these soils can display fundamentally different characteristics to soil of a sedimentary nature.

Reviewed by: C Y Chin
URS New Zealand Ltd



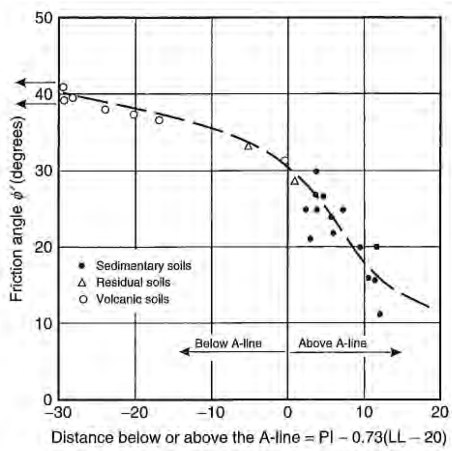


Figure 5.5 The friction angle (ϕ') related to position on the plasticity chart.

Author	By L.D. Wesley
Publisher	John Wiley and Sons
Year Published	August 2010
Hardback	272 pp
ISBN	978-0-470-37627-0
Web shopping	http://au.wiley.com
Price	NZD $205.00

CONFERENCE REPORTS

Observations of the Congress from a roving reporter for NZGS

– Paul Salter

Day 1

Although my office is only a couple of kilometres from the Sky City Convention Centre, I'd decided to get a taxi up there - in Monday morning rush hour traffic. So by the time I got dropped off and settled into the Sky City Theatre the lights were dimming and a hush was spreading over the audience for the opening ceremony. A conch shell was sounded followed by the solemn entry of the Maori welcoming party. Judging by the cameras, the Powhiri was something most of our international guests had never seen - a uniquely New Zealand way to open a conference. In due course, Fred Baynes accepted the traditional challenge set down by the welcoming party, on behalf of "his people" (us), and made the comment in his opening address that although the 11th Congress was a Geologically Active theme, delegates should also be contemplative about the engineering geology they would hear.

With opening ceremonies, introductions, and welcomes out of the way, Hamish Campbell from GNS gave a fine summary of New Zealand's geologic evolution – including tectonic analogies with milk and cream – that set a baseline of understanding about NZ on which many of the subsequent speakers would be elaborating.

As principal sponsor, the EQC's George Hooper spoke next – a particularly relevant presentation, being two days after the costliest natural disaster in New Zealand's history. However, George emphasised that a key function of EQ Cover was not only protection against "the big one", but against the events that occur almost every day somewhere in New Zealand.

A mid-morning break saw the first opportunity to move to the Exhibition Area, and my first opportunity to take in the NZGS booth, which Society secretary Amanda Blakey had been carefully planning for months (this booth turned out to be THE place to meet during breaks, successfully combining white leather couches and free chocolate fish! - well done Amanda). The level of exhibitors was extremely high, reflecting the premier status of the event, and even included a CPT rig which I understand set off the building fire alarms when it was driven in the previous day. The high standard of food and beverages supplied was universally acknowledged.

The heavy-weight nature of the key-note presentations continued with Susumu Yasuda's incredibly topical paper on liquefaction damage and a provocative presentation from Sergio Mora, noting among other things that disasters should not be called natural disasters, and the "psychosis" instigated around climate change by some special interest groups.

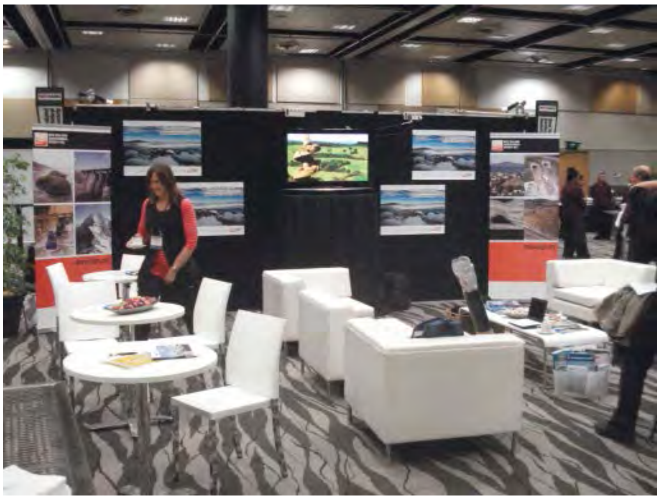
Above: Day one

Tim Sullivan gave an overview of thinking on the Geologic Model, suggesting new ways of considering this topic, and Simon Loew presented the challenges engineering geologists have faced with construction of extremely long tunnels through exceedingly complex geological conditions.

The day was rounded out with presentations by the winners of two prestigious awards, the Hans Cloos Medal won by Martin Culshaw of the UK and the Richard Wolters Award won by Darren Paul of Australia. An icebreaker reception in the Auckland Town Hall was a chance for old colleagues to catch up and new contacts to be made.

Day 2

The real challenge of Day 2 was deciding which of the 4 sessions running simultaneously to attend. Fortunately, the venues and timing were run such that you could hit most of the items on your wish-list even when swapping between venues. Overall, the content and standard of presentations were high. Even long-in-the-tooth Auckland-based geologists like myself were exposed to new ideas and thinking on local geotechnical issues, as well as getting an insight into in far-off exotic locales (…the Qinghai-Tibet Railway, the Tala-Fergana Fault in central Kyrgyzstan, landslide hazards in Cyprus, etc). Papers such as the one by Paul Marinos, on "Errors in Geological Judgement; their Consequences in Engineering Works", are always good to keep you grounded too. To wrap the day, there were interesting presentations on how geology impacts wine production, followed by a wine tasting tour of New Zealand.



Above: NZGS stand

Day 3

After two days of intermittent to solid rain, Wednesday dawned fine and warm for the field trips. A great range of options were available; staying in Auckland to investigate the local engineering geology, heading north to traverse the Northland Allochton, or going south to the coal mines around Huntly or the gold mines of Coromandel.

As leader of the Auckland Field Trip (along with Warwick Prebble and Aaron George) I got to play tour leader to 1 of 3 the buses that visited Mt Eden, Oraki Basin, Kepa Road, and St Heliers before heading to Soljans Estate Winery in Kumeu for a relaxed lunch. Entertainment was provided by the trip sponsor, Boart Longyear, who drilled a borehole in the winery's front lawn during lunch, giving delegates an excellent chance to talk drilling and investigation methods before boarding the buses for a visit to the dramatic (and unstable in places) cliffs overlooking Maori Bay and Muriwai. All delegates were safely accounted for, after briefing returning to collect one straggler from the Maori Bay gannet colony, and a great day was had by all.

Day 4

Quality presentations continued throughout Day 4 of the Congress. One amazing piece of video footage, in particular, was presented in Domenico Calcaterra's case study of weathering-related landslides on Mt Poro (Italy) – a 2 million m^3 landslide of frightening violence captured on film.

At 4:30pm most delegates assembled for The Great Debate: 3 speakers for and 3 against the proposition "Disaster mitigation is a waste of money; it creates a false sense of security and is irresponsible". Hamish Campbell moderated, explaining the debate was sponsored by EQC - "trustees of a $6 billlion EQ Fund who are a small group that work at keeping the Minister of Finance at bay". George Hooper (who works in that small group) opened proceedings noting we should be thinking about managing with Risk Resilience, not thinking about absolute Risk, and the need to avoid shifting personal responsibility to the Public purse.

Above: Day three, fireld trip

Sergio Mora noted disaster mitigation is only one of 4 branches of risk management stool, and we really want risk reduction, which is more feasible and reduces hazards and vulnerability.

In the true spirit of debating, Helen Anderson (ex-Chief Executive of the Ministry of Research, Science and Technology) took a more controversial position for the affirmative, agreeing that disaster mitigation is a waste of money because "people are the problem!" with many falling into categories of "stupidity or bravado" in the face of natural hazards. Although, she did note this was not her personal view, and she was only giving voice to the disaster risk management deniers for the purposes of this debate.

Lavasa Malua (Chief Executive of the Ministry of Natural Resources and Environment for Samoa) took the opposing view that in Samoa's experience disaster risk management had created more resilient communities and was everyone's reasonability.

Jeanette Fitzsimons (ex-Green Party Co-leader) noted that she wasn't expecting anyone to argue in favour of this proposition after the Christchurch Earthquake, but also noted we are happy to invest in building codes to protect against a relatively rare event like this earthquake, but

Above: Day four, Great Debate

unwilling to invest in climate change prevention "which has much more consequence". She advocated that only agreements to stop further coal mining will stop climate change.

John McAneney (Macquarie University) wrapped up the debate by noting that engineering controls have helped for events such as the Christchurch Earthquake and Australian Cyclones, but some hazards cannot be engineered (such as volcanoes).

Based on the number of serious questions at the conclusion of the debate it was obviously thought provoking as well as fun.

Following the debate, delegates decamped to the Americas Cup Village at Vaiduct Harbour for The Great Kiwi BBQ – a themed Congress dinner unlike any before it and unlikely to be experienced again anytime soon (when was the last time you sat on a log around a camp fire, or on the front deck of true Kiwi bach) at a conference dinner. The level of preparation the Committee had put in for this event was obvious, the food was great and the feedback from local and overseas delegates was overwhelming positive.

Day 5

The final day of Congress saw more quality presentations and near the end of the day the chance to hear presentations from GNS staff on the initial observations and findings of their Canterbury earthquake investigations.

The closing ceremony featured thanks to the Convenors, Organising Committee, presenters and volunteers, the passing of the baton (in this case a missing IAEG flag) to representatives of the Turin, Italy 12th Congress Organising Committee, a haka, and everyone singing Pokarekare Ana. A very New Zealand way to finish a very successful Congress.

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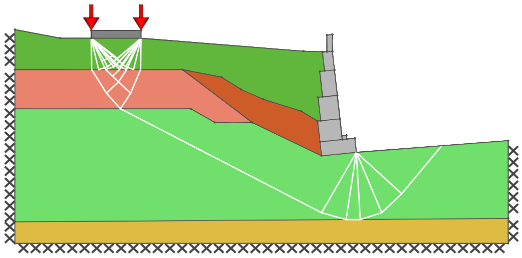

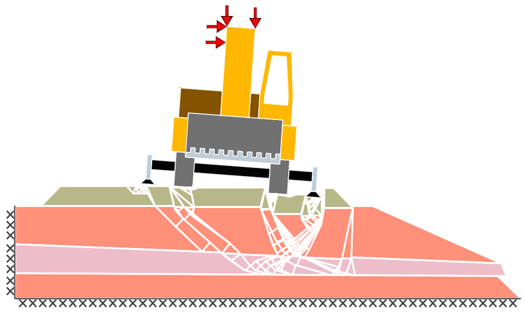

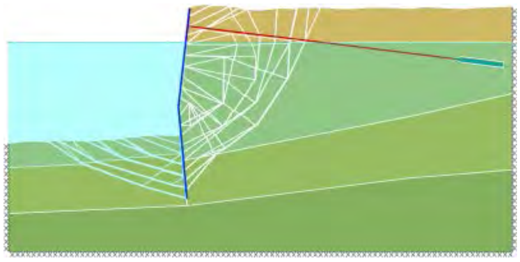

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Conversations with Key-note Speakers

NZ Geomechanics News co-editor Paul Salter sat down with 3 of the keynote speakers for informal conversations about their work and their impressions of NZ.

Editor's Note: *These interviews are based on conversation notes and recollections, and should not be considered verbatim.*

Dr Sergio Mora, Independent Consultant, Costa Rica

Sergio, have you been to NZ before?

Yes, this is my second visit to New Zealand. In 2008 I lead short courses on Disaster Risk Management, in Auckland and Christchurch, which were sponsored by the New Zealand Geotechnical Society.

Where were you born, and what got you interested in geology?

I was born in Costa Rica. Growing up I was interested in maps and books about various far-off places around the world. I developed a strong interest in earth sciences from that.

Where did you train?

I completed degrees in engineering geology at the University of Costa Rica, then an MSc and PhD in engineering geology, focusing on rock mechanics, at the National School of Engineering Geology in Nancy, France.

I know you've worked as a lecturer, and also an advisor to various development banks on Natural Hazard issues – your keynote address included some pretty provocative comments about disaster management.

In my experience science and politics are closely linked. Science can be manipulated by special interests for their own benefit. In my opinion science needs to be high quality, reliable and accountable. There are many "interested parties" that use science to justify their self existence and their finances.

Climate change has been a much debated issue, but you've said this can be a distraction from climate variability which may be more important for disaster risk management, right?

In my opinion there is undeniable evidence that anthropogenic global warming is occurring, and this should be of alarm to us. But we are being defocused by looking totally at Global Warming while devastating Climate Variation effects are occurring. Is information being managed ethically on this issue? Are we prioritizing and setting our goals correctly? In Spanish we have a saying; "First Monday, then Tuesday" which basically means "first things first". We are not doing a good job being communicators of risk in this regard.

In your address you mentioned that the effects of the Haiti earthquake, compared to the similar size Christchurch event, prove that disasters are not natural disasters but a result of poor planning and poor management of risk.

I spent 4 months in Haiti recently and comparing these two events, the value of Building Codes is apparent. Codes provide a minimum standard, they are not perfect but they are a minimum standard. A problem for poor countries is having a Code, but not enforcing them - this is a policing issue.

Your presentation mentioned Port-Au-Prince had been levelled by earthquakes twice before. Are you hopeful that things will be done differently in Haiti in future?

Haiti needs to take advantage of a window now open. I believe positive changes will be made but I am realistic - if any changes are made that will be good. Unfortunately, many of the professionals who can bring about these changes were lost in the earthquake - five close colleagues of mine died.

Where are you going to next?

I'm going to Djabouti next week to look at development and natural hazard risk management there.

Dr Simon Loew, Institute of Geology of the ETH Zurich, Switzerland

Have you enjoyed Congress?

I've learnt a lot from the wide range of topics discussed and, yes, I've thoroughly enjoyed the conference.

Is this your first time in NZ?

Yes.

Your key-note address included a great overview of the how engineering geology for tunnels in the Alps has evolved over the last 150 years. It looks like those early geologists had a very difficult job predicting the likely tunnel conditions?

Yes, it was tough for geologists back then. In the late 1800's deep drilling techniques were not available so they were mainly limited to surface mapping to develop tunnel long sections. Pilot tunnels were also drilled in some cases to collect additional data. New ideas about Alpine tectonics, including the concept of nappes, were also evolving, so there was often conflicting opinions between the geologists which were debated in public over many years.

Even with boreholes, some of the tunnels appeared so long and the geology so complex, it seemed like it would still be a hard task to develop long sections?

Yes, the engineering geologists needed to be good structural geologists as well.

You showed a nice video of violent strain burst in a tunnel. What is the construction safety record like now for these very long tunnels?

The safety record is good now. In several more recent tunnels one 35km long and one 56km long there were no deaths due to unforseen ground conditions, although one worked did die from a dropped rock bolt incident.

Thanks and enjoy the rest of your stay.

Thanks.

Dr Susumu Yasuda, Tokyo Denki University

Have you visited NZ before?

This is my fifth trip to New Zealand. New Zealand has similar engineering challenges to Japan – earthquakes, volcanoes, typhoons, tsunami risk, etc. I also like the scenery and the friendliness of people here. I've been very impressed by the organisation of Ann and the others on the Congress Organising Committee.

Where did you train as an engineer?

I did a degree in civil engineering at the Kyushu Institute of Technology, and my PhD in civil engineering at the University of Tokyo. I also worked in a geotechnical consultancy for 12 years after that, which provided a lot of good practical experience. My work has involved a lot of laboratory testing, including many laboratory liquefaction tests - multi-directional tests involving shake tables and cylindrical triaxial tests.

The video footage you showed during your address of laboratory induced liquefaction of manhole models was very interesting.

Yes, I have the benefit of having students who can help set up these laboratory tests!

Your laboratory tests and observations of actual liquefaction damage have obviously been key to developing your thoughts on the performance-based criteria for seismic design you mentioned in your key-note address?

Yes, in my opinion there is the possibility to revise Japanese Building Codes to include performance-based criteria based on allowable values of liquefaction induced deformation. We can estimate the deformation of structures and the allowable values of deformation, and incorporate these into design criteria. As I mentioned a river dike, for example, might be allowed to settle several metres and still be serviceable, provided it does not allow for overflowing after the earthquake. A road or house will tolerate much less liquefaction induced settlement and remain serviceable.

So, the Christchurch Earthquake and the extensive liquefaction with this event must have been of particular interest to you?

Yes, I visited Christchurch for a day on Wednesday [the mid-conference field trip day] to observe the liquefaction damage. I arrived in New Zealand and heard the news of the earthquake and read the newspapers the next morning, although the papers generally did not use the term "liquefaction" rather "sand and water coming from the ground". We visited 4 suburbs; Kaiapoi, Bexley, New Brighton, and Dallington. Bexley was particularly badly damaged. I have loaded my photographs and account of this 1-day visit onto my web-site because it is important for my colleagues in Japan and New Zealand to be able to see the type of damage that occurred.

[Susumu proceeded to show me the web link (http://yasuda.g.dendai.ac.jp/news100904.html) to his site visit report, which had an extensive range of damage photographs. Although the report itself was all in Japanese, I was able to later use a web translation page and read his detailed account of the damage observed. Despite being only a few days after the quake, the report included references to liquefaction damage from the 1901 Cheviot and 1987 Edgecumbe earthquakes, and showed graphical results of particle size distribution (PSD) analyses of material from 4 sand boils done by Mick Pender at the University of Auckland].

So what are your plans after the Congress?

A contingent from the Japanese Geotechnical Society arrives here on Sunday. Colleagues of mine from 3 universities are arriving. This is a significant event to learn from in terms of research and collecting data.

All the best Susumu, and thank-you for taking the time to talk.

You are welcome.

Reported by: Paul Salter
URS NZ Ltd

11th IAEG Congress - "*Great time, great talks*" – Pierre Malan, Auckland

A huge number of delegates were accosted for comment during the final stages of the11th IAEG Congress as they passed by or sat at the NZGS lounge in the exhibition hall at Sky City. A few emails have also trickled in with thanks and congratulations following the Congress. Thank you for taking the time to share some of your insightful views.

Where were our visitors from?

Australia, USA, Portugal, UK, Germany, Canada, Switzerland, Nepal, Uruguay, Russia, Austria, Hong Kong, South Africa, Costa Rica, Japan, Western Samoa, Turkey, Brazil, Czech Republic, Norway, and NEW ZEALAND! Caio Cavalhieri, of Sao Paulo comments, "it is an amazing experience to be here with all of you (from many parts of the world) and sharing experiences. Thank you, Kiwi family."

Did our visitors love New Zealand?

Of course! However, the week of the Congress dawned with pretty abysmal weather– Auckland had a brisk late winter nip in the air accompanied by bleak grey skies – not exactly 'spring'. But that didn't seem to bother most, having had a lovely time and taking note of the important things: "I've liked NZ. Most importantly the people have been great, the city is great... Auckland is a cosmopolitan city" – Marcus Musso of Uruguay.

Does NZGS Rock?

(as suggested in a couple of slides at the NZGS exhibition stand)

It would appear that NZGS does certainly rock – many people admired the Society's newsletter, NZ Geomechanics News, the beautiful scenery on our posters, the amazing photo show in the exhibition hall, and the varied work being undertaken by our members. In particular, David Boon of the UK commented that he was "very impressed with the vibrancy and energy of the Society – setting a first class international example – keep up the good work!" Could there be higher praise?

Victor Cavaleiro of Portugal wrote that "this newsletter of the New Zealand Geotechnical Society Inc – it is with excellent organisation and the very good illustration and the contents seems a very good articles." Indeed – exactly the 'press release' we have been waiting for!

What aspects of the Congress impressed the delegates?

"I've liked everything. NZ is friendly place! Very interesting technical papers" said Valentina Svalova, from Moscow, Russia. Closer to home, Shane Greene our own Dunedin Branch Coordinator noted that the "Venue was great and range of topics extraordinary." Many others also commented on the variety of topics, such as Rori Green of USA and NZ, "topics especially relevant with Christchurch EQ event. Food is excellent. Enjoyed opening ceremonies and great facilities." From a technical perspective Kelvin Trask said he had "learnt heaps about Geology and the interesting people in the industry. There's a lot more underground than you might think!!"

In summary, a quote from Francisco N de Jorge of Brazil sums it up nicely, "every detail was well planned: the technical sessions, the conferences, the debate, the YP breakfast, reception and the social programme! The reception desk was always available to help - always in good spirits."

Was the food the best part?

Well...there were certainly plenty of comments about the superb catering at SkyCity, the Icebreaker Reception and the Congress Dinner, and many visitors to the NZGS stand were scrambling to take a chocolate fish or pineapple lump as they scurried past. Perhaps that was the only reason they were passing after all...? Surely not. Paul Nathaniel of the UK noted he got "to know a geologically very interesting

country and to meet many friendly people (oh, the chocolate fish and red wines have gone down well too)." Thanks to all for eating the chocolate fish and pineapple lumps so that I didn't have to eat them all myself!

Thanks to the Organising Committee

Praise was heaped on the Organising Committee from many delegates – as far back as when little NZ secured the bid to host the event. Owen L White of Canada reminisces "a well organised conference – down to the smallest detail. Great to see many old friends and make new contacts. The New Zealand Society made an excellent presentation years ago in Nottingham and has lived up to their words. And then capped it all with the Christchurch earthquake!!"

Another lovely quote thanking the Committee was from George Hooper, of NZ, "can you please pass on my appreciation to all on the organising committee – it was obvious that as a team you had all worked very hard to ensure success, and it was done in great style. Congratulations and thanks."

Jim Griffiths, UK, also "wanted to pass on my congratulations for the superb congress you and the team organised. As someone who really knows what is involved I thought the event went extremely well."

Perhaps a final note on this subject - from Paul Marinos, Greece, who kindly said that the Organising Committee can "relax now!" I hope they are.

Final Bouquets

So many delegates commented on the social aspect of meeting and seeing a large number of colleagues, many old friends, and making new connections too. Richard Roth, California, USA noted that he "enjoyed talking with colleagues", and Warwick Prebble, NZ, also mentioned how he had a "fantastic fun and wonderful time meeting old friends and gaining new ones". Someone even felt that they had been "led astray by a terrible South African friend who I hadn't seen for over 30 years" – well Mr Guy Grocott, we trust you weren't too led astray?

A perfectly rounded summary came from Greer Gilmer, NZ: "Enthusiastic conference organisers, easy to move between the talks, yum food and loads of interesting talks". Fantastic. I suspect that was exactly how it was planned.

And the final quote, from Hamish Campbell, NZ, whom many of you will know was also riding the wave of the Earthquake as well as the Congress, declared "that was one of the most stimulating and finest meetings I have ever been to. Congratulations!!!! It was brilliant."

Perhaps that should be 'bloody' brilliant – well done everyone!

Hei Kona – till next time.

Reported by: Amanda Blakey
Management Secretary

Students at IAEG 2010 Congress

Thank you to the Earthquake Commission for sponsoring 3 students to attend the 11th IAEG Congress in Auckland in September. We also congratulate Sam Harris, Renée Schicker and Chris Ritchie on being selected by their institutions! After the event we asked each of them to write a paragraph or two for NZ Geomechanics News to tell us what did (or didn't) work for them at the Congress – what did they get out of the experience? Here are their thoughts.

Sam Harris, University of Auckland

"It was good to get a taste of such a large international conference. Not only did it provide the opportunity to see what research was being undertaken in my specific area from all around the world, but it also gave the opportunity to view many different kinds of research in the entire geology field. I also enjoyed personally meeting some of the authors whose work I have been following because of its applicability to mine, not only was it good to meet them in the presentation rooms but also at a more relaxed setting such as the ice breaker event and the congress dinner. I found the keynote speakers very interesting, and particularly liked the timing of the Christchurch Earthquake to the event, which was a great conversational piece. I'd like to thank the EQC for providing me the opportunity to attend this event."

Renée Schicker, Waikato University

"I am grateful to have had the opportunity to attend the IAEG Congress, and am thankful to EQC for covering the registration. I was admittedly a late entry, only having been informed of this in the week prior to the congress, but my registration ended up being organised within a couple of days and everything seemed to work out superbly. Unfortunately I was unable to attend the young professional's breakfast on Sunday and while I attempted to attend the match racing later in the afternoon I just missed the boat and instead caught the fire alarm at Sky City. I attended every day, and sat through a lot of enjoyable and informative presentations and there were quite a few impressive speakers who really caught and held your attention. I found the great debate was very entertaining. The great kiwi barbeque was brilliant in every aspect, very well thought out, great theme, food and entertainment. The Congress was a great opportunity to meet and chat with some of the people in the industry both here in New Zealand and internationally. It was great to also meet some of those whose work I had read and referenced during the course of my MSc degree. For me it was a great experience, and I hope that other future students will get the same or a similar opportunity. Thanks."

Chris Ritchie in the field at Congress

Chris Ritchie, University of Auckland

As my first conference, I found IAEG Congress 2010 very informative as it provided exposure to the professional world of engineering geology. The mix of academics and professionals at the congress produced a wide variety of content. The high quality of presentations and posters were a great example for my own graduate school work, and demonstrated ways of making ideas available to others in the field.

The series on gravitational hazards was most relevant to my area of research. Investigation techniques and methods used by the presenters were useful in planning my master's project. The presentations came from a wide range of localities around the world, and were particularly interesting when applied to civil works. It was beneficial to see the area of research I'm currently undertaking being applied worldwide.

EQC

CETANZ Careering Ahead in 2010

CETANZ (Civil Engineering Testing Association of New Zealand) held its second biennial conference at the Edge Events centre on the 23rd and 24th of September.

The theme of the event was "Careering Ahead" which reflected the launch of the civil engineering lab technician level 4 and 5 qualification. Infratrain along with the CETANZ committee had been busy, amongst other things, for the two years prior to the event creating a structure and programme providing a career pathway for civil laboratory staff. The theme was created as a play on words from the inaugural conference in 2008, The Road Ahead and for a young society we have certainly come a long way in a short period of time.

The event was a huge success and had many excellent presenters from varying industries including civil laboratory staff, engineers and scientists. Amongst the fantastic range of papers, there were many topical and informative presentations including, A review of volcanic hazard and risk in Auckland presented by Dr Jan lindsay of the University of Auckland, Engineering geology and debris flow hazards at Matata by Annette O'Leary of AECOM and Mix design testing by Thorsten Frobel of Fulton Hogan. Max Cope formerly of Geotek Services and Steven Cooke of Opus International gave presentations on the much debated scala penetrometer and Sean Bearsley of Higgins presented on the design and analysis of proficiency trials to name but a few.

Keynote speakers, Terry Kayes from Kayes Consulting and Jeremy Sole, CEO of the New Zealand Contractors Federation provided excellent insight into learning and leadership which laid the platform for the launch of the qualification.

The conference concluded with a panel session where the delegates could discuss the direction they would like to see the new committee take and also provide feedback on what had been achieved. The membership and delegates congratulated CETANZ on its achievements and suggested that future strategies focus on promotion of the new qualification, creation of a scholarship or award/travel grant for young presenters, making the newsletter available on the website, survey of our industry customer base, continued proficiency program and forming a stronger relationship with our Australian counterparts.

Conference MC, Bruce Hopkins provided great flow to the conference proceedings and he created an inclusive atmosphere which was enjoyed by all.

The conference dinner at the Hilton Hotel on Auckland's Viaduct Harbour and was well attended by the delegates who came from all over New Zealand and as far afield as Australia and Fiji. The current CETANZ chairman, Paul Burton handed over the reins (presented as a scala on a chain in pendant style) to the new chair, Jayden Ellis. Gary Bentley of Opus also took the time to tell a few jokes after the act of Les and Des as the evening's entertainment.

The event was particularly successful thanks to our sponsors InfraTrain New Zealand, Stevenson, IANZ, OPUS, Geotest, Perry Drilling, Drillforce, Civiltrain, New Zealand Geotechnical Society Inc, Geotechnics and The Measurement & Calibration Centre. The professional and organisational skills of John Walker of the Auckland University Centre for Continuing Education for organising the event were first class and played a major part in the success of the conference.

A massive thanks to the outgoing committee members and a big welcome to the new members for the next term and we look forward to providing a bigger and better event in 2012. Please visit www.cetanz.org.nz for information on the society including membership application, upcoming events, technical publications and training/careers news.

Conference Convenor: Michael McGlynn
Editor CETANZ
Geotechnics Ltd

2nd International Symposium on Cone Penetration Testing (CPT'10)

9-11 May 2010, Huntington Beach, California, USA

The 2nd International Symposium on Cone Penetration Testing was held in Huntington Beach, California. The conference was held at the Hyatt Hotel just across the road from the beach. This is a 'Baywatch' style beach with surfers, lifeguard huts, beach volley ball, sunshine, etc. The only thing missing was a bikini clad Pamela Anderson running in slow motion across the sand.

The conference was a 'follow up' on the 1st International Symposium on Cone Penetration Testing, CPT'95 conference held 15 years earlier in Sweden. The theme of the symposium was the 'solution of geotechnical and geoenvironmental problems using the cone penetration test' with particular emphasis on the exchange of practical knowledge and the application of research.

The conference was well attended with 240 participants from 40 countries. The proceedings contain 126 technical papers, 4 Keynote Lectures, 3 Session Reports and 9 Regional Reports. Unlike most conferences where different sessions are held concurrently in different rooms, the format of this symposium was to have invited speakers present session reports summarising all the papers in three categories; CPT Equipment & Procedures; CPT Interpretation and; CPT Application. In this way everyone was keep together in the same room and received very good summaries of the papers. There were also Regional Reports that provided a summary of CPT practice in different areas of the world. The format of the symposium encouraged discussion as topics were raised. Everyone had the opportunity to participate and benefit from these discussions, whereas in concurrent sessions in separate rooms, interesting information or discussions can be missed.

There was a good mix of academics, consultants and contractors amongst the delegates, which provided a good theoretical and practical balance. All the 'big names' in CPT were there (e.g. Peter Robertson, Paul Mayne, Tome Lunne, John Powell, etc) and there was lively discussion on various topics. One of the speakers coined the phrase 'conehead' to describe those who are devotees of the CPT test. This became an unofficial theme of the symposium with many speakers and delegates then declaring themselves to be 'coneheads'.

It was interesting to see how CPT practice varied across the world. I was surprised that older style electric CPT (without pore water measurement) and mechanical cones were far more commonly used in Europe than the more sophisticated CPTu systems. Most of the papers covered standard type 10cm^2 CPT/CPTu testing with correlations to other tests/soil parameters and comparisons with observed behaviour. Surprisingly there were very little covering 'newer' developments such as seismic cones or environmental cones. However, there was talk of a new seismic cone being developed that will be able to continuously record shear waves whilst the cone is pushed at the usual speed into the ground, avoiding the need to stop to undertake discrete seismic tests. There were a few papers and much discussion about dealing with 'intermediate soils' that behaviour in a semi-drained state under the cone push. Research has been undertaken to consider variable push rates so as to better identify and quantify these soils. These variable push rate techniques may have some merit in NZ as we do tend to have many silty soils that probably behave neither in a completed drained state nor in a completely undrained state with the cone pushed at the standard 2 cm/s rate.

The developments in off-shore CPTs were particularly interesting with very high tech remotely controlled submersible rigs and rigs with coiled rods that straighten when being pushed and then are bent back into a coil when pulled out. One of these off-shore submersible rigs was on display in the carpark outside the conference venue, along with an impressive display of other truck and track mounted rigs. There was plenty of interest and rig envy from many of the delegates.

The symposium finished with a banquet dinner and a very entertaining talk by James K. Mitchell on his 'personal reflections on the CPT'. Overall the conference was a success with all looking forward to the next international CPT symposium (CPT'25?).

Note: All the papers in the proceedings are available for free download from the website www.cpt10.com

Reported by: Marco Holtrigter
Ground Investigation Ltd

AWARDS

Student Awards 2010

This year has seen a resurgence in the number of applicants for the NZGS Student Awards. We had 13 students applying from across the country by submitting an abstract to participate in the presentations for the Awards.

Two awards are presented, the Southern Region and the Northern Region.

SOUTHERN REGION

We had nine applicants from the South Island with the following three finalists selected to present their topics:

1. **Malcolm Hicks** – "Surface Waves and Wind Power: Geotechnical investigations of wind turbine foundations using Multichannel Analysis of Surface Waves (MASW)"
2. **Rob Hunter** – "Mechanisms causing internal erosion in filters for embankment farms"
3. **Kim Rait** – "Fragmentation in Rock Avalanches"

The Southern Region presentations were made at the University of Canterbury on 23 November. The group was small and at least half were students supporting their peers. All three presentations were of a professional standard for content, structure, visual presentation and clarity of explanation. Questions originated from the students and the professionals who provided a supportive and encouraging atmosphere and all three presenters fielded the questions with confident knowledge based answers. The three judges, Bruce Riddolls, Richard Young and Joyce Seale found distinguishing one presentation from the other difficult as the only notable difference being that the students were in different stages of their research. Therefore, the judges deemed that each had presented their research to very high standard and it was decided to award the Student Award – Southern Region jointly to all three.

Congratulations to Malcolm, Rob and Kim. We will look forward to hearing about the outcomes of your research.

And thank you to the MC, David Bell and the judges for facilitating the session.

NORTHERN REGION

We had four applicants from the North Island this year from which all four were selected to present their topic at the University of Auckland on 17 November. The topics that were presented are outlined below:

1. **Anas Ibrahim** – "Small strain shear modulus of Auckland residual soils using bender elements"
2. **Christopher Ritchie** – "Large failures in volcanic rock in New Zealand. A case study from the Te Toto Amphitheatre, Raglan"
3. **Xiaoyang Qin** – "Numerical and experimental investigation of foundation material and geometrical non-linearity"
4. **Sam Harris** – "Modelling the response of soil water content to rainfall events"

The Northern Region presentations were made at the University of Auckland Engineering School on 17 November to a small audience. All presentations were of excellent quality and clarity with some curly questions asked of the presenters. The judges had a hard task of deliberation with a final decision to award the Northern Region Student Award to Xiaoyang Qin. The judges felt Xiaoyang had mastered his topic and presented in a clear and concise manner, answering all questions thoroughly. Thanks to the Engineering School for sponsoring the event and providing refreshments, to our Judges Laurie Wesley, Ann Williams and Ross Kendrick, and to our MC Luke Storie.

We congratulate all the students on their achievements and wish them well for their future studies.

Copies of the award winners submitted abstracts are included in this issue of the Geomechanics News.

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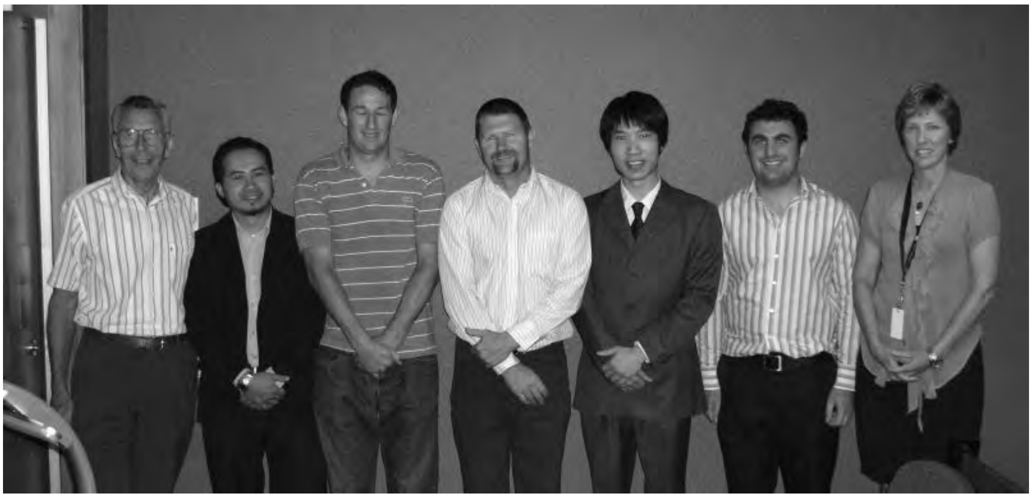

Above: Northern Region; Laurie Wesley (judge), Anas Ibrahim, Sam Harris, Ross Kendrick (judge), Xiaoyang Qin, Chris Ritchie, Ann Williams (judge)

Left: left to right; Malcolm Hicks, Kim Rait and Rob Hunter – joint winners of the Student Awards 2010 – Southern Region.

Southern Region Student Award 2010 – JOINT WINNER

K.L. Rait & E.T. Bowman – Fragmentation in Rock Avalanches

Rock avalanches or sturzstrom events have been observed by witnesses and found in the geological record in steep mountainous areas around the world, including for example, here in New Zealand at Falling Mountain in Arthur's Pass, at Elm in Switzerland and at Nevados Huascarán, Peru; at times causing great devastation and large loss of life. Typically, these events appear to occur in areas of tectonic activity where pre-fractured ground masses exist. The avalanche material has been observed to travel as a dry flow at excessive speed, occasionally surging up the sides of valleys. These phenomena cease as quickly as they begin and deposit highly fragmented material that is inversely graded.

Understanding the behaviour of sturzstrom is important as the scale of an event is such that it is not possible to protect communities and lifelines. If the small scale behaviour of sturzstrom is clearly understood then it may become possible to predict the likely travel path of a sturzstrom which will assist with hazard mapping and planning of future developments in affected areas.

Many theories have been advanced to describe this phenomenon. Albert Heim, after investigating the Elm event, suggested that mechanical fluidization was responsible. Hsu (1978) further suggested the extension of mechanical fluidization to include Bagnoldian (i.e. collisional) grain flow in the behaviour of sturzstrom. Other theories suggested include air cushion (Kent, 1966), air fluidization (Shreve, 1968), frictionite (Erismann, 1979) and acoustic fluidization (Melosh, 1983). Although each theory is relevant to a particular sturzstrom event, no theory suggested so far can adequately explain all of the behaviours seen in a sturzstrom and its resulting deposit.

More recently McSaveney and co-authors (McSaveney 1978; Davies and McSaveney, 2002; Davies et al., 1999) have suggested explosive fragmentation as a possible explanation. This theory suggests that fragmentation of rock under an extremely high overburden pressure produced by a large volume of debris causes an isotropic dispersive pressure that dilates the debris, reduces friction and causes long run out.

We extend and adjust this theory by suggesting that fragmentation of multiple grains under a high overburden pressure produces high velocity fragments that impulsively load surrounding grains. As the fragmentation becomes more violent, the impacts cause an isotropic dispersive pressure that allows the fine rock material to behave like a pressurised fluid reducing effective stress and therefore friction (i.e. following Terzaghi's theory of effective stress and Coulomb type friction) (Terzaghi and Peck, 1967).

Further we suggest that the packing of the material is also extremely important for this behaviour to occur. A tightly packed material under a high overburden pressure will fragment more violently and produce more energy, thus more stress on the surrounding grains. The surrounding grains either then fragment from the additional stress, or move to reduce the stress impulsively loaded upon them. This will then continue throughout the material until all stress is removed, thus assisting with speed of movement and long runout. A fragmenting rock from a loosely packed material would not have such a marked effect on fragments or grains surrounding it as energy transfer from fragmentation reduces quickly the further away a neighbouring grain is placed. Thus the effect on runout would be short lived.

To investigate this new theory of sturzstrom behaviour, we utilise the Discrete Element Method, in particular PFC3D from Itasca (2008). Small rock particles are built as hexagonal close packed agglomerates where the discrete element is a spherical particle. These agglomerates are then cubically arranged and slowly brought into contact. A cubic aggregate is produced from these agglomerates with isotropic pressure of 1MPa. The sturzstrom specimens are then created by using a top wall to pressure the aggregate to two set pressures: 500kPa for the specimen close to the top of the sturzstrom, and 5MPa for the specimen near the base.

Each sturzstrom specimen is then bound in the y and z directions and sheared in the x direction through a periodic boundary. The shearing is controlled by the top and bottom layer of agglomerates travelling in opposite directions to create a rough moving boundary. A central 27 agglomerate cube is set as the breakable group and the stress, kinetic energy and breakage of this cube is monitored through out the testing.

We find that an aggregate simulated under high overburden pressure as expected at the base of sturzstrom and undergoing fast shear produces the highest amount of kinetic energy and stress of all of our tests. The resultant high stress suggests that there is a large amount of pressure being applied to the particles from both the shear effect and surrounding fragmentation of agglomerates. Thus fine material can move around fragments within the sample and potentially act as a pressurised fluid to reduce effective stress and enhance the runout of sturzstrom.

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Southern Region Student Award 2010 – JOINT WINNER

Robert P. Hunter – Mechanisms causing internal erosion in filters for embankment dams

An experimental study to understand the mechanisms of internal erosion through filter materials used in earth dams is presented. Glass particles of various grading size combinations will be tested in a new box permeameter using optically matched oil as the fluid, under variable hydraulic heads to determine the mechanisms in which 'soil' erodes or moves through the filter, known as suffusion.

Early research was carried out by Terzaghi (1922) with his empirical criterion concluding that to prevent particles passing through a filter, they must have $D_{15f}/D_{85s} < 4$ (the stability criterion), and a $D_{15f}/D_{15s} > 5$ to satisfy permeability criterion, which separates safe from potentially unsafe filters. In these criteria, D_{15f} represents the particle size in which 15% of the total filter particles are smaller, similarly D_{15s} is the size that 15% of the base soil particles are smaller. However numerous physical test procedures and mathematical models now provide a deeper insight and understanding, and are vital methodologies during filter design.

Physical testing commonly focuses on, (1) filter behaviour when a concentrated leak or piping has formed in the base soil; (2) the self filtration behaviour, i.e. where by some particles from the soil column erode into the filter becoming trapped, still allowing for the through flow of fluid and restabilising both base and filter materials; (3) cracking in core materials and whether a filter can prevent the continuation of erosion; and (4) the idea of the 'perfect filter' which is designed to stop the smallest particle which can arise during erosion. However, despite many laboratory test procedures (conventional, slot, slurry, no erosion filter test (NEF-test) and continuing erosion filter test (CEF-test) having been developed to assess the suitability of filter materials, there is no 'standard' test procedure. Tests typically focus on measuring the weight of particles eroded, visual inspections of water colour, or the size increase in preformed pinholes or slots.

Mathematical or 'analytical' models can be useful to simulate the behaviour of base soil and filter particles to give suggested approximations for seepage rates, rate of particle erosion and can therefore provide a recommended filter thickness required to decrease the calculated probability of failure, which refers to a maximum tolerated volume of particle erosion. However, mathematical models require assumptions and simplifications which can limit their applicability and reduce accuracy, for example, Indraratna and Vafai (1997) note that for cohesive soils such as plastic clayey fills, their model gives conservative predictions. Furthermore, such models typically do not account for bridges and arches which increase void space and permeability, and can collapse to reduce these factors to change the dynamics of the filter behaviour.

To reduce assumptions and gain a better overall understanding of internal erosion and particle migration or suffusion, the mechanisms causing internal erosion need to be better understood, as to date, little research surrounds this. Consequently, this research aims to uncover these mechanisms using a method that allows us to 'see' particle movement at a clear enough scale to analyse, which can therefore aid in improving empirical and mathematical formula. This will allow for more accurate and sophisticated specifications as to the design of granular filters for embankment dams.

The laboratory technique will use glass particles of grading combinations similar to those used in previous studies, particularly Skempton and Brogan (1994), and from known problematic grading sizes, including gap and broadly graded materials, which will be packed into a glass box and subjected to an upward head flow. Under an initially small head the sample will become saturated until oil flows out the top of the overflow tube where discharge can be measured. Head will be stepped up in increments with 3 standpipe piezometers measuring the response at varying heights in the sample. Throughout the test a planar laser sizer will be shone through the side of the permeameter, allowing photos to be taken at a high frame rate to show a 2-dimensional slice through the sample of filter particles as fluid flows through the glass particle matrix. This will allow us to observe under what conditions particular sized and shaped particles become mobile and re-stabilise, and their migration behaviour, ie. the mechanisms causing internal erosion, such as the collapse of bridges and arches between particles. Previous research at the University of Canterbury has shown that the glass-oil seepage behaviour can mimic that of soil-water closely, so long as attention is paid to scaling rules, allowing us to carry out this research with confidence that the results relate to 'real' filter materials.

Having a greater understanding of the mechanisms that initiate and sustain internal erosion, it is hoped that the design of filters in embankment dams will be of the highest possible quality, preventing erosion, and channelling seepage flow to leave downstream embankment shoulders free from seepage, and hence ensuring the stability and safety of dams in the future.

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Southern Region Student Award 2010 – JOINT WINNER

Malcolm Hicks – Surface Waves and Wind Power: Geotechnical investigations of wind turbine foundations using Multichannel Analysis of Surface Waves (MASW)

Multichannel Analysis of Surface Waves (MASW) is a developing geophysical technique being used in geotechnical investigations of wind turbine foundations on the Te Rere Hau windfarm in Palmerston North, and other investigation sites in the lower North Island.

Geotechnical investigations of windfarms can involve detailed investigations of numerous (in the order of hundreds) wind turbine locations on a single windfarm site. Windfarm sites in the lower North Island are typically located atop mountain ranges which have undergone significant tectonic deformations, including uplift, shearing, folding and faulting, resulting in highly variable geotechnical and geological conditions.

Traditional geotechnical investigation methods provide stiffness information of a localised volume very near a drill or probe site. On the other hand, MASW surveys, offer several significant advantages. They are able to investigate a hemisphere of the subsurface which is representative of the large scale environment, taking into account all influencing factors, including fracturing, joint spacing, infilling and weathering variations with depth.

Recently, surface wave methods have become the seismic techniques most often used to estimate surface wave velocity (Vs) structure of soil and rock, largely due to their non-invasive methods, and their greater efficiency in data acquisition, data processing and reduced costs (Miller et al, 1999; Stokoe et al, 1994).

Multichannel Analysis of Surface Waves is a seismic investigation method which evaluates the velocity profile of the subsurface in a 1D, 2D or 3D format. This velocity profile can then be used to derive elastic conditions, or stiffness, of the subsurface. MASW measures the frequency dependant seismic surface waves, which are known as Rayleigh waves. MASW analyses the propagation velocities of the surface waves, and from this the representative shear-wave velocity variations of the surveyed area, in the form of a layered model, can be derived.

Shear wave velocity values obtained from insitu measurements are used to compute the low strain shear modulus required as an input parameter in wind turbine foundation design. Due to the critical importance of evaluating the stiffness of near surface materials for geotechnical investigations (Park 1995), this method of dynamic analysis of foundation materials is applicable to a wide range of geotechnical engineering projects.

Through a conversion process detailed in Mahoney & Kupec (2010) shear wave velocity profiles can be converted to elastic modulus profiles, involved in a two step computation which relates Vs and shear moduli (G), which can then be used to determine the elastic modulus (E). The relationships between Vs and G, and G and E are detailed below (Kramer 1996).

$G = \rho Vs^2$ (1) and $E = 2G(\nu+1)$ (2)

Therefore, relating Vs to E directly by substituting G into equation (2) (Mahoney & Kupec, 2010):

$E = 2\rho Vs^2(\nu+1)$

MASW is best used in combination with other site investigation methods. More traditional site investigation (boreholes, lab testing etc) data used in combination with MASW improves the repeatability of the surveys over a site, as traditional testing data acts as a 'standard', characterising the site material. There are a number of correlations with both Vs data and low strain shear modulus data which have been identified, including correlations with SPT N-values (Anbazhagan & Sitharam, 2010), borehole measurements (Xia, Miller et al. 2002) and dynamic soil properties (Anbazhagan & Sitharam, 2006).

My study will advance understanding about the relationship between seismic velocities in certain material types, and the associated geotechnical properties they represent. This is important in developing methods of greater control on what the surface wave velocities are reflecting. They are currently being used to represent the elastic modulus of lithologies, but the elastic modulus, encompassed in MASW, is dependent on a wider range of geotechnical and geological properties. These include weathering, fracturing, groundwater and primary lithology, along with intrinsic material properties, such as density and poisson's ratio. Hence the shear wave velocities are being used without knowing the full extent of their controls.

Other problems also exist in the investigation of wind turbine locations as a single sounding is taken at the proposed location of construction, which is an average across the entire array taken at a point. This produces difficulties when data is extrapolated laterally, as there is a high possibility for lateral variability, which is due to a hemisphere of energy being represented as a 1D profile, especially in highly variable geology, ie: weathered greywacke, and due to topographical effects.

Ultimately my study aims refine the current procedure for the conversion between surface wave velocities and elastic modulus calculations, to minimise errors associated with the conversion process, and to determine the geological controls which influence surface wave velocities at the investigation sites. This can be achieved in part by refining each input parameter, and determining the most efficient schedule of site investigation methods to combine with MASW to provide the most accurate results.

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Northern Region Student Award 2010 – WINNER

Xiaoyang Qin – Numerical and experimental investigation of foundation material and geometrical non-linearity

In current practice for earthquake-resistant design, the structural and geotechnical components are designed separately. Often the effect of non-linear foundation behavior on structural response is very difficult to consider, thus linear foundation behavior is assumed. However, by doing so large amounts of unnecessary cost are entailed to prevent any non-linearity of the foundation. For example, bearing failure of the foundation is eliminated by constructing an oversized foundation to ensure that a generous bearing strength is available throughout the design earthquake. Foundation uplift is prevented by utilizing additional tension piles. Consequently, this approach always leads to an over conservative foundation compared to the requirement of a structure under static loading. Large amount of expense does not make any contribution within the service life. On the other hand, Structural design action will also be increased significantly by fixing column on a rigid foundation. From moment and lateral forces distribution, all actions that are distributed to the foundation will be reflected back to the structure and thus the structure would experience stronger effect of the loading. Moreover, greater damage can also appear in the structure if the foundation has much stiffer than the structure. When structure experiences cracking or yielding during earthquake, any further permanent deformation would concentrate at that position and increase the potential for structural collapse.

In this work, the investigation was performed by both conducting a small scaled shaking table testing and numerical modelling. In the experimental testing, the performances of a multi-storey steel structure with three different design approaches for the foundation were examined. They were fixed rigid foundation which referred to the current foundation design approach, foundation with allowable uplift on un-deformable support and with allowable uplift including plastic soil deformation. The considered structure was an office building which was designed by New Zealand Design Standard. In the experimental setup, the overall structural system and the input earthquake excitation were scaled by Buckingham's ϖ theorem so that the testing could replicate the dynamic behaviors of the prototype in earthquake. The permanent damage and plastic response of the prototype during earthquake were simulated by an artificial plastic hinge that constructed on the scaled down model. The bending moment capacity of the artificial hinge was controlled by load cell and the repeatability of the plastic behavior was achieved by using Teflon washers. The overall behaviour of soil-structure interaction (SSI) was obtained by testing the model inside a sand box. The sand box used in this work had 400mm sand fill and the density of sand was controlled by raining the sand from a constant high.

A macro-element model was used for modelling. The structural plasticity, geometrical non-linearity and soil material plasticity were incorporated and assessed as a system of whole. The system was described by four degrees of freedom. They were vertical, horizontal displacement and rotation of foundation and a horizontal displacement at the top of the structure. The elastic and plastic soil behaviour was model by two different bearing strength surfaces. The

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first one was the surface for combined loading of surface strip foundation on sand and the second one was the one specified by EC8 for strip footings on purely cohesive material. Newmark-Beta constant average acceleration and linearly varying acceleration method were applied for the numerical integration. Newton-Rhapson iterations and improved Euler's method were used to minimise the computation error.

From the results of both numerical modelling and experimental testing, there were strong evidences that foundation non-linear and plastic responses could provide beneficial effect on the structural seismic performance. The observation of both results clearly indicated that the activated forces in the structure reduced significantly. This was because occurrences of foundation uplift restricted the bending moment development in the structure by temporarily separating the foundation from its supporting soil. When supporting soil deformation was allowed, further activated force reduction could be achieved, by dissipating energy in the soil rather than in the structural members. In the experiment, when the bending moment capacity of the artificial plastic hinge was reduced, ductile behaviour of model was initiated once a specific threshold was reached. The testing result confirmed that the permanent damage on the model with fixed base was three times larger than that with allowable uplift. These findings confirmed that uplift reduced the damage on structure during earthquake. In addition, even the fixed base model has many times of activated force reduction due the column plastic hinge development, the bending moment was still greater than that with allowable uplift. When supporting soil yielding was allowed, plastic hinge development on the model was completely eliminated.




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NZ Geotechnical Society

2010 PHOTO **COMPETITION**

WINNER

...another day in the office

Winner: "Gates of Haast surveying and borehole drilling for potential new bridge" **Shane Greene**, *Opus International Consultants Ltd*

Clockwise from top: Highly Commended, "South Island Drilling " **Annette OLeary**, *Aecom.;* "Remarkable Excavation" **Emily Hodgkinson,** *Opus International Consultants Ltd.*; "Drilling a water reinjection well at Dunedin International Airport….the power lines are off!" **Shane Greene,** *Opus International Consultants Ltd.;* "Turei Hill Slip Earthworks" **Harry Follas,** *Opus International Consultants Ltd.*

FOREIGN CORRESPONDENT WITH A DIFFERENCE

Kate Williams
Engineering Geologist
Roving Reporter/Co-Editor NZ Geomechanics News

It seems only fitting given that our requested foreign correspondent for the December issue pulled out at the last minute that I was given the task of filling a page (or two) in the newsletter. Generally collating and editing for the NZ Geonews (as I call it) comes up when I am about to head off or I'm off on leave from Tonkin & Taylor Ltd somewhere new around the world. As it turns out I tend to take the NZ Geonews with me to help pull together the final edits in my spare time! So here is a foreign correspondent profile with a difference. Foreign as it seems this year my input to the NZ Geonews has been while I am overseas! I promise there is only a little bit of geology....

The June 2010 issue was edited on a flight back from Reykjavik, Iceland in May/June 2010, the total journey took 44 hours so there was plenty of time for reading! (Not that the NZ Geonews takes that long to edit for those of you wanting to take on the co-editor role next year!!)

Iceland is like going to Disneyland for geologists, a bit like New Zealand, just on the other side of the world 'literally'. Iceland lies on the geologic rift of the Mid-Atlantic Ridge between the Eurasian and North American tectonic plates. New land was being generated right beneath my feet! The island is a wonderland of volcanism, geological landscapes, rift zones and geothermal activity. At the time of my visit the volcano Eyjafjallajökull also happened to be erupting however by the time we had circumnavigated the island in a clockwise direction it had stopped erupting and only the clouds of wind blown ash remained. What unbelievable luck I have.

With extensive geothermal energy being tapped into for heating and electricity production, Iceland had an endless supply of hot pools in nearly every town which were a real treat. Driving through lava fields, over tectonic plates, across remote high mountain passes, to within kilometres of the Arctic Circle, past glacier lakes with floating icebergs and hiking around geothermal areas to hot water streams for a soak were all highlights. Long nights and the midnight sunset was a special favourite.

This December 2010 issue was edited and complied while I was in California, USA, in the Mojave Desert to be exact in 30 degree sunshine on R&R from the Darfield Earthquake, so there wasn't much else to do but laze by the pool reading some of the articles and news items!

Los Angeles has the real Disneyland but the rocks are all fibreglass. California is again an exceedingly complex geologic landscape sitting astride two sliding tectonic plates – with the most famous and visible transform fault in the world splitting the state - the San Andreas Fault. The western half of California lies on the Pacific Plate while the eastern half of California lies on the North American Plate. This time earthquakes and mountain uplift created the landscapes I was seeing.

The Mojave Desert is a bit of a contrast to Iceland and I guess they are at two extremes. One thing that was obvious was the large amount of wind turbines (over 5000)

Above: Another Foss (waterfall) in Iceland

Above: Red Rocks Canyon, Nevada

Above: Big Lava bubble, Iceland

Left: Wind turbines, Mojave

of various generations (30+ years) of technology. I noticed in particular the clean green image that gets portrayed and was interested to see while hiking along a section of the Pacific Crest Trail through the turbine area the amount of oil leaking from the turbines down the blades (probably dripping all over the dry desert below) and also the missing segments of the fibreglass nacelles from the turbines due to the high winds – this may be a glimpse into the future of some NZ wind turbine areas currently being constructed. Just how sustainable is this technology 30 years on when the life of the equipment is nearing its end and who will come back and dismantle it and restore the areas now not in use?

I also was lucky enough to visit a few other spots of natural wonder in the USA, with the Red Rock Canyon in Nevada and Yosemite National Park, California. Due to snow and ice however the trails in Yosemite were mostly closed but one summers day I will return to tackle the cable section of Half Dome however I'm afraid I will leave El Capitan and its spectacular granite faces to the professionals.

I consider myself very fortunate to be able to experience the world through geologists eyes where every rock grabs my attention and I am very lucky to have these opportunities to travel when the offers arise. The only problem with my holidays is I seem to never get away from geology but maybe (secretly) that's why I chose this profession!

Is there a theme to my holidays?, I don't think so, its just the 'world' we live in.

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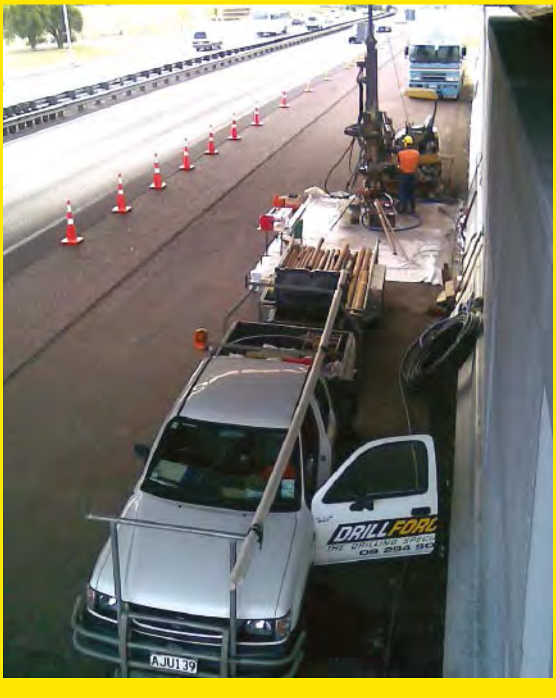

COMPANY PROFILE

Hiway Stabilizers (Hiways)

Hiway Stabilizers (Hiways) group of companies are New Zealand's largest stabilisation and deep soil mixing specialists. The company provides clients with unmatched levels of service, from front end technical input through to industry leading quality control and work practices in the field. Choosing to remain small and specialised has always been the company philosophy since it first commenced trading in 1982.

This continuous drive for improvement and excellence has resulted in Hiways receiving an unprecedented number of accolades over the years. These have included numerous innovation awards, both nationally and internationally, as well as excellence awards in the areas of project delivery and technical merit.

At the core of Hiways' philosophy is a strong drive for innovation and the promotion of recycling, reuse and sustainability practices. This has been achieved through identifying and coupling suitable technologies with sound technical engineering and construction practices.

Achievements have extended to both road stabilisation and more recently Geotechnical and Environmental Engineering. This includes: pioneering work to develop road stabilisation in New Zealand, development of stabilisation best practice, research and development of proprietary binders, design and development of specialist plant, establishment of fill drying technologies, and the introduction of foam bitumen pavement recycling.

Geotechnical achievements include the successful introduction of deep soil mixing (DSM) into New Zealand, introduction of launched soil nailing and development and introduction of mass stabilising techniques. Environmental projects include involvement with remediation of the Mapua chemical treatment site in Nelson (at the time NZ's No1 contaminated site) and the recent completion of a major geotechnical and geochemical trial at the Tui mine tailings site. Hiway Environmental are strong advocates for sustainable contaminated site remediation – particularly focusing on engineering reuse and the benefits of recycling.

Over recent few years, the Hiways group has increased its in-house technical and design capability with the employment of professionally qualified staff in the fields of pavement and geotechnical design. Two professionally qualified Chartered Geotechnical Engineers have a thorough understanding of geotechnical engineering and design requirements including specific seismic design requirements. The majority of completed projects have been design/build/certify contracts where innovative design was achieved using advanced finite element analysis. This wealth of specialist knowledge enables HGL to communicate directly with other consultants and engineering clients.

Above: Clive Wastewater Treatment Plant – Deep soil mixing of liquefiable soils using TurboJet system (treatment up to 20m)

Staff are active members and participants of a number of professional and industry organisations. Hiways are strong supporters of industry conferences and regularly publish and present technical papers specific covering stabilisation, geotechnical and environmental engineering. Through membership of local and international organisations, Hiways benefits from the exchange and sharing of industry best practice, particularly with design and exposure to leading technologies and innovations. This high level of technical competency also extends to providing specialist advice and input into project schemes at an early stage, and collaboration with consulting / design engineers and clients. This approach fits well with recent trends in procurement methods towards design build, alliance and ECI models.

Hiway Stabilizers Environmental (HSE) was created within the Hiways group specifically to extend stabilisation competencies to areas of ground improvement, soil reinforcement and environmental remediation. In mid 2010, HSE was rebranded into two separate companies, one specialising in advanced geotechnical solutions (Hiway Geotechnical) and the other specialising in innovative ground remediation techniques (Hiway Environmental).

Hiway GeoTechnical Ltd (HGL) focuses on two key geotechnical sectors – deep soil mixing and slope reinforcement and stability. Deep soil mixing technology serves to provide a wide range of applications extending from slip repairs and slope reinforcement through to ground improvement, foundations and ground reinforcement. Almost 10 years ago, Hiways pioneered the development DSM for road infrastructure slip repairs, a particular problem associated with various regions in NZ characterized by slip events triggered by high rainfall, unstable geology, increasing traffic volumes and loads. HGL has successfully remediated several large landslide sites affecting state highway infrastructure – two such sites are the Ogles site on SH1 in Northland, and several sites on the notoriously unstable Kilmog hill on SH1, north of Dunedin. Interestingly enough, many of the sites successfully remediated using DSM reinforcement, did not respond to previous attempts at (expensive) traditional repair methods such as deep drainage systems. More recently, HGL has been involved in the design for foundations and ground improvement on several leading roads of national significance projects.

Today HGL is New Zealand's leading provider of soil mixing technologies, having pioneered its implementation into New Zealand some 10 years ago. Over this time, both the technology and the technical understanding of its underlying principles have evolved dramatically.

HGL can provide a complete suite of soil mixing solutions to their clients, on a par with international best practice. This includes: mass stabilizing (MS), shallow soil mixing (SSM), deep soil mixing (DSM), and deep jet mixing (DJM) solutions.

In addition, HGL have a suite of soil and slope reinforcement solutions, which allow the company to provide innovative, cost-effective solutions for an extremely wide range of applications. These solutions include: Shotrods™ – launched (or ballistic) soil nails, Supernails™ – high production horizontal soil reinforcement; Supermicropiles™ and GCS wall construction. In addition, HGL can offer a number of light-weight alternatives to polyblock or pumice backfill.

Commitment to technical excellence, and state-of-the-art design practices have resulted in a large number of successful innovative solutions, which can be benchmarked against world leading best practice from international geotechnical organisations.

HGL can access specific technical support and technologies from its international partners where required and have carried out a number of projects on this basis throughout New Zealand and the Pacific Islands. Performance based focus, often tailored to match specific client requirements, has resulted in the ongoing implementation of leading technologies into New Zealand over the last 10 years.

Above: Rodney District Council - Slip remediation site using DSM

Above: Kawakawa Bay, Slope stabilization using Supernail system

Hiways' are ISO 9001: 2000 accredited and have fully passed several independent audits on the effectiveness of the adopted quality management systems. All the processes have high degree of quality control with on board computers which provide a range of monitoring and data capture to ensure product application rates are achieved the operational parameters are recorded. For DSM Columns, data can be downloaded and processed enabling analysis of individual columns to ensure design parameters are achieved. Along with sampling and post construction testing clients and engineers can be confident design parameters have been met.

Hiway GeoTechnical
GEOTECHNICAL SOLUTION PROVIDERS

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GHD Limited

GHD Limited (GHD) is an international network of professional and technical consultants that employs more than 6000 people across five continents. We are wholly-owned by its staff and serves clients in the global markets of water, energy and resources, environment, property and buildings, and transportation.

GHD was established in Australia in 1928 by Gordon Gutteridge who focused on water and sewerage. In 1939 Gerald Haskin & Geoffrey Davey joined the partnership. GHD arrived in New Zealand in 1999 with the acquisition of Manuaku Consultants Ltd (NZ).

Currently we have 16 offices throughout New Zealand employing approximately 400 full time staff. Our geotechnical staff work on projects within New Zealand and throughout Asia-Pacific.

Mine development in Sumatra

Our network of forward-thinking engineers, architects, planners, scientists, project managers and economists collaborate to solve client and community challenges. They embrace the core values of Teamwork, Respect and Integrity to create enduring relationships that deliver exceptional results. GHD is a company built on partnerships. It continues to be an enduring force to connect, collaborate and communicate with our clients to solve their challenges, to drive our success and to make the world a better place. We care for the wellbeing of our people, communities and the environments in which we operate.

Projects

Hunua No 4 Watermain

The Hunua 4 Watermain project for Watercare Services Limited is a partnership between CH2M Beca and GHD to design a new large diameter watermain from the Redoubt Road Reservoir in Manukau to Khyber Pass in Newmarket. The principal project deliverables were to provide preliminary design considerations for micro-tunnelled crossings of the state highway and northern main trunk rail line, as well as the crossing of a significant tidal creek system were provided with ongoing design assistance. A significant investigation of 200 boreholes was carried out in the complex geotechnical setting of Auckland's major geological units. The resulting geotechnical assessment of the ground conditions provided a geotechnical design focused on the pipe support and constructability, water control, contamination, pavement rehabilitation, trenchless crossings and seismic design.

Working in partnership with key stakeholders is central to our approach and project delivery.

Eureka Bend Investigation and Reporting

The strategically important route of SH60 over Takaka Hill in the Tasman District was affected by a major landslide, and the route was temporarily secured with a single lane bailey bridge. The project outcomes were to i) Reinstate an operable two-lane highway at the Eureka Bend site as quickly as possible, ii) Provide a permanent long-term solution to the landslide with a design life of 100 years, iii) Deliver a cost effective solution consistent with the provisions of the Land Transport Management Act.

Assessment of the geological model gained through existing information, targeted mapping and site investigations lead to the design selection of a temporary soil nail wall with reinforced soil embankment. This design allowed for all of the construction, procurement and timing constraints to be accounted for. The innovative approach to design through collaborative ECI process lead to the project winning Roading NZ Excellence Award, NZTA Best Block Project Award and ACENZ Silver Award. The project was completed within an accelerated timeframe and under budget.

Fox Valley Geotechnical Risk Monitoring and Management

As part of the Southwest New Zealand World Heritage Area Fox Valley is visited by over 200,000 visitors annually and is an incredibly dynamic environment subject to various land instability processes. Given the status of the area and the close proximity of the access road from SH6 to the glacier, it was considered critical to develop a robust system of monitoring, particularly in difficult to access areas, and have systems in place should instability occur, or be considered likely to occur. GHD developed this system for the Department of Conservation.

The system is based around photogrammetric aerial surveys, which have been successfully adopted in combination with more traditional monitoring techniques to allow DOC to manage public access in a

Test pitting in Canterbury

far more scientific manner than was previously possible. Photogrammetric survey has confirmed areas of slope movement and more recently the amount those areas have moved. This information is used in combination with daily (and more frequent if necessary) site observations and rockfall monitoring to provide risk management in Fox Valley. DOC staff are more aware of areas to be concerned with and are able to respond very rapidly to changes in conditions.

GHD CLIENTS | PEOPLE | PERFORMANCE

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… continued from page 5.

although there was no requirement from Council to do so. The reinforce slab was not particularly well detailed, without any control joints cut in a slab 34 m long, nor did it have crack arresting bars at re-entrant corners. This slab did crack at about quarter points, the worst crack being 2 mm wide, but still appeared to be contained by the reinforcing and crack width was considered acceptable. It was also reported that some of the cracking tended to re-close with subsequent after-shocks.

In comparison in reviewing another house with an unreinforced concrete floor, a crack through the middle of the house opened up following the initial earthquake, and then continued to grow with after-shocks to a final width of 5 mm which is not acceptable, causing distortion with cabinetry and walls etc. Without any reinforcing in the floor, there is no way of really knitting the floor back together again. If another large earthquake occurred I would anticipate that this crack would keep growing and this particular house could end up write-off.

I appreciate that there have been cases of reinforced slabs snapping like a carrot when a house has straddled a ground tension crack. However, what does one expect when one anchors one side of the house into the ground with a "grader blade" like footing, and the other side of the house into the ground with a similar footing and then and earthquake tears the ground apart between the two? It is little wonder that a slab will pull in two.

Rib raft designs would be a good practical and cost-effective solution in most instances. As they sit on the ground without footings anchoring it into the ground. The ground could split and move beneath a rib raft with limited adverse effect. I further noted that during the earthquake, movement of rib raft slabs appeared to be limited to about 10 mm in relation to services, which was insignificant. I had seen far worse with conventional foundations. I have reached the conclusion that when atmospheric pressure is considered, a rib raft slab will cling to the surface like a limpet, and does not move about as one would expect.

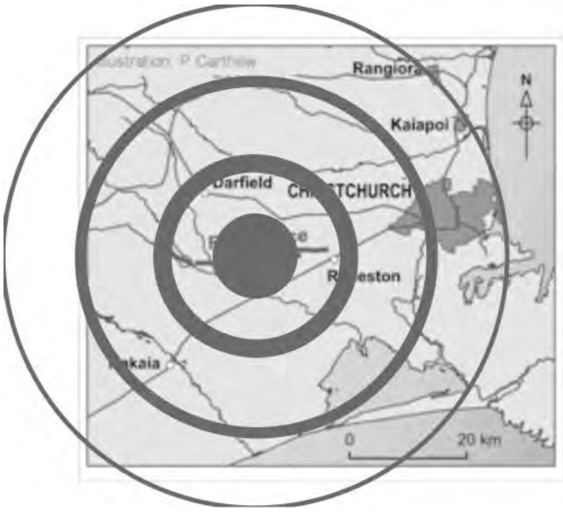
In addition, a rib raft slab has enough rigidity and strength, not only to hold the building above it together reasonably well, but also to facilitate re-levelling if necessary.

With respect to rib raft slabs, I have spent over $30,000 researching design guides from the US and Australia to develop the spreadsheet system for the use and would be happy to assist in developing New Zealand guidelines and standards covering their use.

Colin Ashby
Ashby Consulting Engineering Ltd, Warkworth

GEOTECH TEASER

Seismic Wave Propagation



Body waves generated by an earthquake consist of a faster P wave (or primary wave), transmitted by compression and dilation, and a slower S wave (or secondary wave), which shears the ground at right angles to the direction of travel.

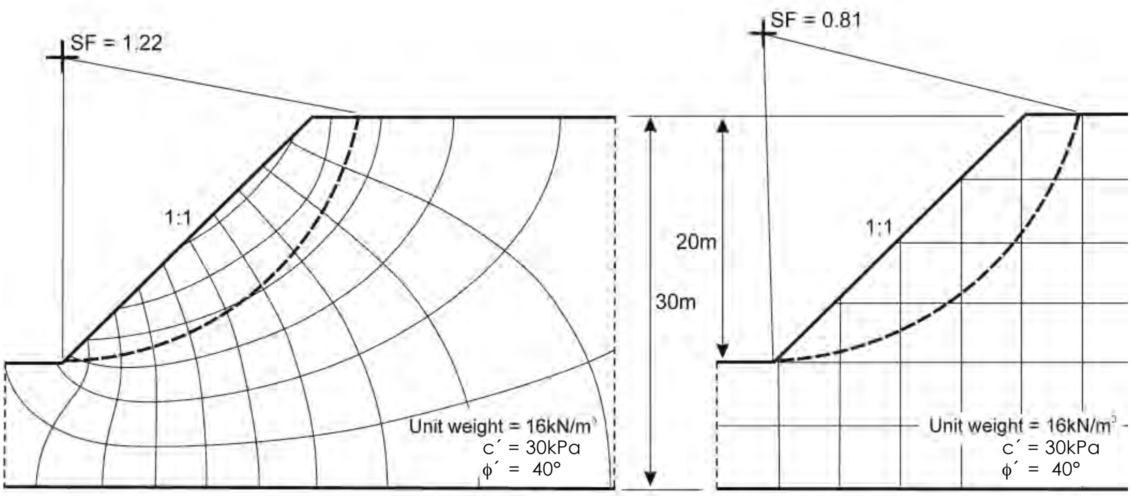
Assuming your house is 10 km from the Darfield Fault, on a site underlain by unconsolidated alluvium, and P waves travel about 1.7 times faster than S waves (according to the relationship $v_p = \sqrt{3}\, v_s$), what will the time lag be between the first P and S wave arrival if the shear wave velocity of the alluvium is 500 m/sec?

Question by: Paul Salter
URS NZ Ltd

Answer: to June's Teaser – Laurie Wesley

The diagram below shows two possible answers. The first is a (more or less) correct answer, based on a realistic flow net. The flow net can be obtained by hand sketching or using a programme such a SEEP/W. The corresponding values of r_u are also shown. The second answer is obtained using the assumption common to almost all computer programmes if the phreatic surface is put in at ground level. The pore pressure is simply calculated from the vertical intercept between the phreatic surface and the slip surface. In effect this implies equipotential lines to be vertical and seepage lines to be horizontal. The resulting "flow net" is physically absurd. The two level surfaces, at the top and toe of the slope, are both lines of constant head and are therefore equipotential lines, NOT flow lines as computer programmes imply.

The point of this question is to highlight the errors likely to be involved in stability analysis of steep slopes using conventional stability programmes, especially when the water table is also steep. In the example here both the ru value and the safety factor are in error by about 50%. The assumption made by computer programmes is only acceptable for gentle slopes, meaning flatter than about 1:2.5. Even at this slope the ru value is overestimated by about 10% for an average slope, with a similar effect on the safety factor. The error will generally be less the lower the slopes and the higher the cohesive component of shear strength in relation to the frictional component.



(a) True seepage state, r_u = 0.39 on circle shown

(b) Seepage state assumed in computer analysis when input is phreatic surface at ground surface, r_u = 0.61

MEMBER PROFILES

Georg Winkler

Occupation
Engineering Geologist
Land Development & Exploration Ltd

Living in Gisborne is tough. Not only are lunch time surfs at one of the many beaches commonplace, the 5 minute walk home after work means that even more time can be spent in the sun rather than in the car on the way home. But geotechnical engineering in Gisborne is also tough as nothing is straightforward. Gisborne is not blessed with great geology from a stability point of view. The geology is young, soft, and often shattered, sheared and crushed with a high proportion of swelling clays and very low friction angles to boot. Add to that an uplift rate of 2 to 5m every 1000 years, and a susceptibility to weather bombs, large earthquakes, and the highest susceptibility to tsunamis in the country and you have a recipe for a disaster! Nothing wants to stay put, nothing meets the design codes, and any development in Gisborne typically pushes the envelope in terms of meeting them. And that's what makes it fun.

Land Development & Exploration Ltd (LDE) thrive on this sort of thing, being a company that specialises in geological and geotechnical engineering particularly in difficult geological terrain. And that is what has allowed its 7 professional staff to get around the country – doing the dirty geological and geotechnical work for others who might find something a little too challenging for their liking. LDE specialise in the Northland Allochthon having researched and worked extensively in that terrain, and also with its identical twin brother – the East Coast Allocthon which LDE's founder Georg Winkler detailed at length in his MSc thesis prior to commencing his professional career in 1994. As such LDE get to do a lot of work throughout Northland helping people to get a handle on this schizophrenic beast.

Other work includes active fault mapping and trenching, which are also almost a prerequisite for doing anything in Hawkes Bay, Wairarapa, and Gisborne. Additional interesting challenges to add to seismic hazards are developing over hillsides that have been affected by ridge-renting / ridge spreading (sakungen). These pulled apart hills are widespread in the Gisborne and Hawkes Bay regions, and are a spectacular eye opener for the uninitiated.

With the growing TA demand for information on earthquake induced ground deformation, liquefaction and lateral spreading assessments which were once thought of as over the top are also a specialty of LDE. Real life experience of the spectacular effects of these hazards resulting from the 2007 Gisborne earthquake and now the Darfield Earthquake has allowed staff to match the theory with reality – a factor that has allowed LDE to have confidence in how particular sites are likely to behave.

Understanding the engineering geology of volcanic terrane, and its often wildly varying lithologies and behaviours is also a speciality of LDE. Having played a lead role in the investigation and stabilisation of the Golden Cross Landslide at the Couer Gold mine in Waihi, as well as a number of large infrastructure projects throughout the Auckland and Bay of Plenty, LDE have in depth experience to provide expertise to larger consultancies.

In addition to lots of sunshine, Gisborne is also blessed with another New Zealand oddity – active and ancient mud volcanoes. These are surprisingly widespread throughout the district, with recent evidence of catastrophic eruptions propelling mud and debris several tens to hundreds of metres into the air and the subsequent development of locally extensive mudflows. Geysering of water, mud and debris also occurred in one area following the 2007 Gisborne earthquake. Not only are these areas of mud volcanism very interesting, they also present yet another hazard for LDE to assess.

Yes, some geology is tough. But yes it is interesting too! Combining that with great people, travel, sunshine and surf makes working at LDE interesting and fun. We love it.

EVENTS DIARY

Links are available from the NZ Geotechnical Society website – www.nzgs.org

2011

10-13 January, 2011
Santiago, Chile
5th International Conference on Earthquake Geotechnical Engineering
www.5icege.cl

8-9 March, 2011
Auckland, New Zealand
14th Australasian Tunnelling Conference
www.atstunnellingconference2011.com

13-15 March, 2011
Dallas, Texas, USA
GeoFrontiers 2011
www.geofrontiers11.com

14-16 April, 2011
Auckland, NZ
Ninth Pacific Conference on Earthquake Engineering – Building an Earthquake Resilient Society
www.pcee.nzsee.org.nz

15-17 May, 2011
British Columbia, Canada
5th Canadian Conference on Geotechnique and Natural Hazards
www.geohazards5.ca/index.php?lang=en

16-18 May, 2011
Rome, Italy
7th International Symposium: Geotechnical Aspects of Underground Construction in Soft Ground
http://www.tc28-roma.org/

18-22 May, 2011
Semarang, Central Java, Indonesia
GEDMAR2011 and the 5th International Conference on Geotechnical and Highway Engineering
3rd International Conference on Geotechnical Engineering for Disaster Mitigation and Rehabilitation 2011 (GEDMAR2011) combined
reliability.geoengineer.org/GEDMAR2011/

19-20 May, 2011
Paris, France
International Symposium – Railway geotechnical engineering
www.georail2011.com

23-27 May, 2011
Hong Kong, China
The 14th Asian Regional Conference on Soil Mechanics and Geotechnical Engineering
http://www.cse.polyu.edu.hk/14arc/

21-26 May, 2011
Helsinki, Finland
The World Tunnel Congress 2011 and 37th ITA General Assembly
www.wtc11.org

2-3 June, 2011
Munich, Germany
3rd International Symposium on Geotechnical Safety and Risk (ISGSR2011)
www.isgsr2011.de

6-8 June, 2011
Norway
4th International Conference on Geofoam Blocks in Construction Applications
www.EPS2011.no

13-16 June, 2011
Maputo, Mozambique
XV African Regional Conference on Soil Mechanics and Geotechnical Engineering

26-29 June, 2011
San Francisco, USA
45th US Rock Mechanics Geomechanics Symposium
www.armasymposium.org

26-28 June, 2011
Atlanta, USA
Georisk 2011 – Risk Assessment and Management in Geoengineering
http://content.asce.org/conferences/GeoRisk2011/

4-6 July 2011
Leuven, Belgium
Eurodyn 2011 – 8th International Conference on Structural Dynamics, and a Minisymposium on Dynamic soil-structure interaction and wave propagation
(MS03)
www.eurodyn2011.org

25-29 July 2011
Toronto, Canada
9th U.S. National and 10th Canadian Conference on Earthquake Engineering
http://2010eqconf.org

31 August-3 September, 2011
Seoul, Korea
The Fifth International Symposium on Deformation Characteristics of Geomaterials
www.isseoul2011.org

6-8 September, 2011
Moscow, Russia
Environmental Geosciences and Engineering Survey for Territory Protection and Population Safety (EngeoPro 2011)
www.engeopro2011.com

13-19 September, 2011
Athens, Greece
XV European Conference on Soil Mechanics and Geotechnical Engineering
www.athens2011ecsmge.org

18-21 September 2011
Vancouver, Canada
Slope Stability 2011
www.slopestability2011.ca

2-6 October, 2011
Toronto, Ontario, Canada
XIV Panamerican Conference on Soil Mechanics and Geotechnical Engineering & V PanAmerican Conference on Learning and Teaching of Geotechnical Engineering, & 64th Canadian Geotechnical Conference
http://www.panam-cgc2011.ca/

16-21 October, 2011
Beijing, China
12th International Congress on Rock Mechanics – Harmonising Rock Engineering and the Environment
www.isrm2011.com

November 7-9, 2011
Perth, Australia
International Conference on Advances in Geotechnical Engineering
www.icage2011.com.au

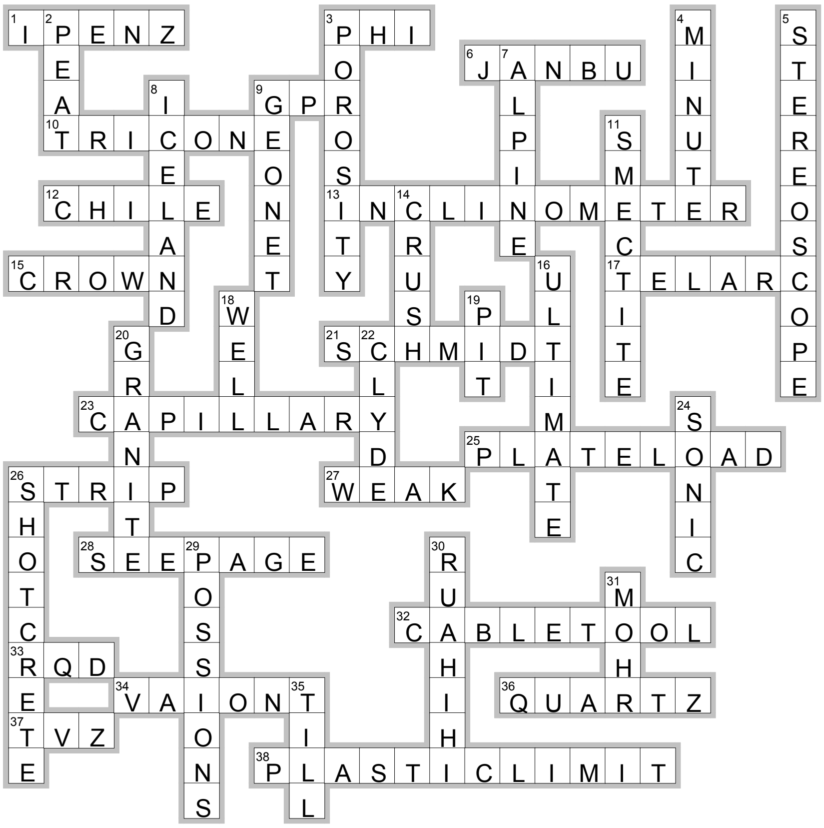
2012

4 - 6 July 2012
Galway, Ireland
International Conference on Geotechnical Engineering Education
Organised under the auspices of the recently reformed TC306 Geo-engineering Education Technical Committee, ISSMGE

July 15-18, 2012
Melbourne, Australia
11th Australia – New Zealand Conference on Geomechanics
www.anz2012.com.au

ANSWER

Answer to June Issue 79 Crossword page112



EclipseCrossword.com

NEW ZEALAND GEOTECHNICAL SOCIETY INC.

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• Co-opted position
+ Appointed position
* Elected members of committee

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ADVERTISERS DIRECTORY

NEW ZEALAND GEOTECHNICAL SOCIETY INC.

Objects

a) To advance the education and application of soil mechanics, rock mechanics and engineering geology among engineers and scientists.
b) To advance the practice and application of these disciplines in engineering.
c) To implement the statutes of the respective international societies in so far as they are applicable in New Zealand.
d) To ensure that the learning achieved through the above objectives is passed on to the public as is appropriate.

Membership

Engineers, scientists, technicians, contractors, students and others who are interested in the practice and application of soil mechanics, rock mechanics and engineering geology.

Members are required to affiliate to at least one of the International Societies.
Students are encouraged to affiliate to at least one of the International Societies.

Annual Subscription

Subscriptions are paid on an annual basis with the start of the Society's financial year being 1st October. A 50% discount is offered to members joining the society for the first time. This offer excludes the IAEG bulletin option and student membership. No reduction of the first year's subscription is made for joining the Society part way through the financial year.

Basic membership subscriptions (inclusive of GST), which include the magazine, NZ Geomechanics News, are:

Members	**$76.67**
Students	**Free**
Annual IPENZ service centre fee applies to all NZGS members who are not members of IPENZ	**$43.70 (incl GST)**

Affiliation fees for International Societies are in addition to the basic membership fee:

International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)	**$24.00**
International Society for Rock Mechanics (ISRM)	**$33.00**
International Association of Engineering Geology & the Environment (IAEG)	**$21.00**
(with bulletin)	**$70.00**

All correspondence should be addressed to the Management Secretary. The postal address is:

NZ Geotechnical Society Inc, P O Box 12 241, WELLINGTON

The Secretary
NZ Geotechnical Society Inc.
The Institution of Professional Engineers New Zealand (Inc)
P.O. Box 12-241, WELLINGTON

NEW ZEALAND GEOTECHNICAL SOCIETY INC

NEW ZEALAND GEOTECHNICAL SOCIETY INC.
APPLICATION FOR MEMBERSHIP

(A Technical Group of the Institution of Professional Engineers New Zealand (Inc))

FULL NAME Dr/Mr/Mrs/Ms/Miss (Underline Family Name): ....

HOME POSTAL ADDRESS: ....

Phone No: ( )........................... **Cell Ph:** ( ) .... **Fax No:** ( ) ....

E-MAIL: Home.. **E-MAIL:** Work..

DATE OF BIRTH ....

ACADEMIC QUALIFICATIONS: ....

PROFESSIONAL MEMBERSHIPS: .... **Year Elected**...

PRESENT EMPLOYER: ....

WORK POSTAL ADDRESS: ....

OCCUPATION: ....

EXPERIENCE IN GEOMECHANICS: ....

STUDENT MEMBERS: ....

TERTIARY INSTITUTION: .... **SUPERVISOR:** ....

SUPERVISORS SIGNATURE: ....

Preferred email (please circle): home/work **Preferred address:** home/work

Note that the Society's Rules require that in the case of student members "the application must also be countersigned by the student's Supervisor of Studies who thereby certifies that the applicant is indeed a bona-fide full time student of that Tertiary Institution". . . ; Applications will not be considered without this information.

Affiliation to International Societies: All full members are required to be affiliated to at least one society, and student members are encouraged to affiliate to at least one Society. Applicants are to indicate below the Society/ies to which they wish to affiliate.

I wish to affiliate to:

International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)	Yes/No
International Society for Rock Mechanics (ISRM)	Yes/No
International Association of Engineering Geology (IAEG)	Yes/No
& the Environment (with Bulletin)	Yes/No

DECLARATION: If admitted to membership, I agree to abide by the rules of the New Zealand Geotechnical Society

Signed .... Date ....../....../.......

ANNUAL SUBSCRIPTION: Due on notification of acceptance for membership, thereafter on 1st of October. Please do not send subscriptions with this application form. You will be notified and invoiced on acceptance into the Society

PRIVACY CONDITIONS: Under the provisions of the Privacy Act 1993, an applicant's authorisation is required for use of their personal information for Society administrative purposes and membership lists. I agree to the above use of this information:

Signed .... Date ....../....../.......

(for office use only)

Received by the Society ....

Recommended by the Management Committee of the Society ....

NEW ZEALAND GEOTECHNICAL SOCIETY INC. PUBLICATIONS 2010

Publication Name	**List Price Members**	**List Price Non-Members**
New Zealand Geomechanics Society Conferences:		
Proceedings of Technical Groups, Vol 22, Issue 1G **(1 left)** *Geotechnical Issues in Land Development* Hamilton 1996	$20	$35
Proceedings of the New Zealand Geotechnical Society Symposium – *Roading Geotechnics 98* Auckland 1998	$40	$70
Proceedings of the New Zealand Geotechnical Society Symposium – *Engineering and Development in Hazardous Terrain* Christchurch 2001	$50	$70
Proceedings of the New Zealand Geotechnical Society Symposium – *Geotechnics on the Volcanic Edge* Tauranga 2003	$50	$70
Proceedings of the New Zealand Geotechnical Society Symposium – *Earthquakes and Urban Development* Nelson 2006	$50	$70
Proceedings of the 18th New Zealand Geotechnical Society Symposium – *Soil-Structure Interaction*, Auckland 2008.	$50	$70
(CD)	$20	$25
Australia – New Zealand Conferences on Geomechanics:		
Proceedings of the 2nd Australia – NZ Young Geotechnical Professionals Conference, Auckland, December 1995	$25	$40
Proceedings of the 5th Australia – NZ Young Geotechnical Professionals Conference, Rotorua, March 2002 (spiral bound reprint)	$75	$85
Proceedings of the 6th Australia – NZ Conference on Geomechanics Christchurch, February 1992	$50	$100
Proceedings of the 9th Australia – NZ Conference February 2004 – 'To the enz of the Earth' **(Vol 2 only)**	$150	$200
Other Publications:		
NZ Geomechanics News Collection 1970–2010 Volumes 1–79 (CDRom)	$25	$40
2005 Soil & Rock Guideline	$25	$50
Shear Vane Guidelines	$15	$20
Back Issues of *NZ Geomechanics News* **(selected issues)**	$20	$20

Prices do not include GST or postage & handling

Orders to: Amanda Blakey, Management Secretary. Email: secretary@nzgs.org

ADVERTISING INFORMATION

NZ Geomechanics News is published twice a year and distributed to the Society's 760 plus members throughout New Zealand and overseas.

The magazine is issued to society members who comprise professional geotechnical and civil engineers and engineering geologists from a wide range of consulting, contracting and university organisations, as well as those involved in laboratory and instrumentation services.

Advertisement Location	Single Issue	Advert. Size (mm)
Black & White		
Full Page Internal	$270	185 wide x 265 high
Half Page Internal	$210	90 wide x 265 high
		185 wide x 130 high
Quarter Page Internal	$180	90 wide x 130 high
Colour		
Back Cover	$720	210 wide x 297 high
Inside Cover (Front or Back)	$720	210 wide x 297 high
Full Page Internal	$480	210 wide x 297 high
Half Page	$240	175 wide x 130 high
A3 Centrefold	$900	420 wide x 297 high

Inserts

Insert to be posted with magazine – $240/flyer
Maximum size single A4 page
Special price given on request for other types and sizes

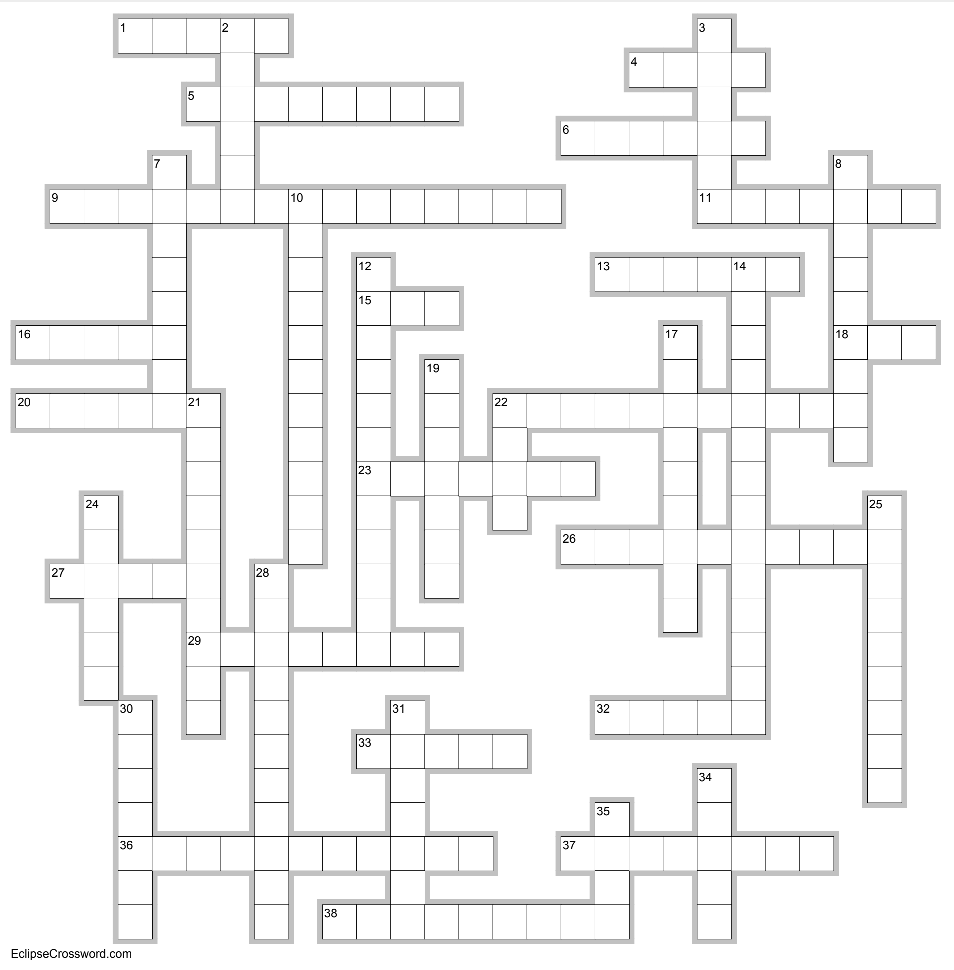
Note

1. All rates exclude GST.
2. Space is subject to availability.
3. A 3mm bleed is required on all ads that bleed off the page. Bleed must be set up on all files that are supplied.
4. Advertiser to provide all flyers.

If you are interested in advertising in the next issue of *NZ Geomechanics News* please contact:

Management Secretary
Amanda Blakey
Email: secretary@nzgs.org

GEOTECH CROSSWORD



Across

1 Flat top of a dam
4 GNS 1:250,000 mapping project
5 Laboratory shear strength test with controlled water conditions
6 Loose broken rock used for slope protection (3,3)
9 Load per unit area ground can support without excessive yield (7,8)
11 NZ tunnel with significant swelling ground during construction
13 Metamorphic rock common in Otago
15 Rock mass classification system by Bieniawski
16 Rock fall from tunnel wall
18 Furthest margin of displaced landslide material
20 Law stating strain is linearly proportional to applied stress
22 Particular class of structures covered under EQC Act 1993
23 Popular brand of geologic hammer
26 Place where earthquake rupture originates
27 Line on plasticity chart marking approximate upper limit for natural soils
29 Congress number of IAEG Auckland Congress
32 Cement slurry used to seal fissures
33 Radioactive gas from certain rock and soils known to accumulate in building basements in some countries
36 The ease with which rock can be excavated mechanically
37 US state where wastewater injection into deep wells in 1960's caused earthquakes to magnitude 4 3
38 1987 NZ earthquake

Down

2 Shape or volume change due to stress
3 Dark volcanic rock forming the Moon's "seas"
7 Current NZ Minister for Earthquake Recovery
8 Largest volcano by volume in the Auckland Volcanic Field
10 Canterbury University author of several papers on liquefaction
12 Picture representing vertical slice of ground (5,7)
14 Water content at which the soil volume is lowest (9,5)
17 Rock type
19 Right lateral movement on fault
21 Downward movement of a structure due to soil compression
22 Most landslide prone continent according to Durham University, International Landslide Centre
24 International consultancy celebrating 50th Anniversary
25 Name of large submerged continent which includes NZ
28 Name of first trained geologist to visit NZ in 1839
30 Geophysical log useful in indicating the presence of fluid
31 Boards joined side-by-side lining an excavation
34 Limestone terrain
35 Japanese earthquake resulting in more than 6000 deaths in 1995

> The answers will be printed in the June 2011 issue of NZ Geomechanics News, and also posted on the website.

Crossword supplied by Paul Salter

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