NEW ZEALAND GEOTECHNICAL SOCIETY INC

DECEMBER 2012 issue 84

NZ GEOMECHANICS NEWS

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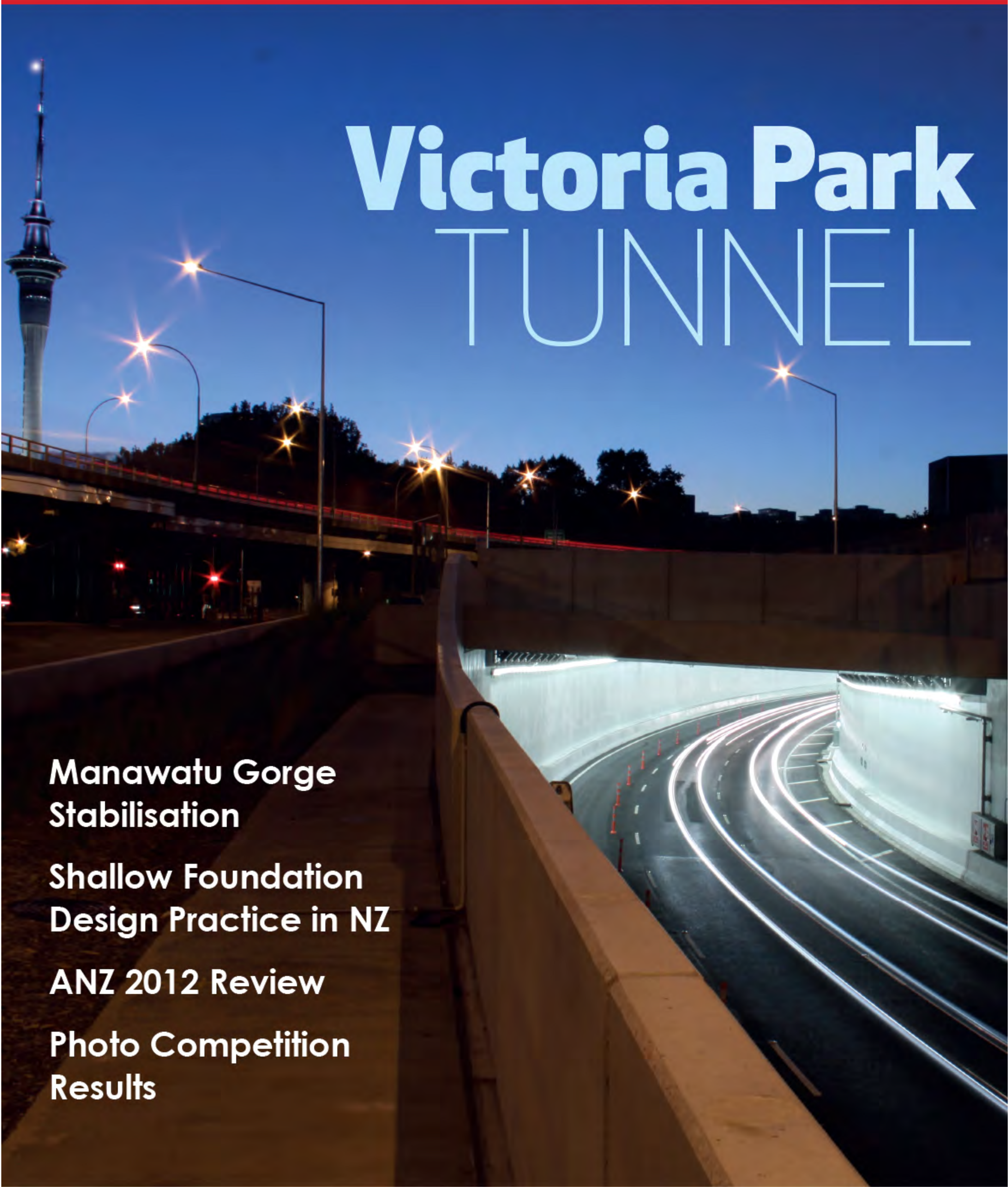

Victoria Park TUNNEL

Manawatu Gorge Stabilisation

Shallow Foundation Design Practice in NZ

ANZ 2012 Review

Photo Competition Results

Rimutakas, Wellington

Rocks Road, Nelson

Lyttelton, Christchurch

Redcliffs, Christchurch

NEW ZEALAND GEOMECHANICS NEWS

CONTENTS

DECEMBER 2012, ISSUE 84

Cover image: Victoria Park tunnel, photo thanks to Victoria Park Alliance

CHAIRMAN'S CORNER

SEASON'S GREETINGS AND welcome to this end-of-year edition of Geomechanics News. I am reliably informed by our able secretary, Amanda that our membership has passed 950 and is fast approaching 1000. New members come from all areas of geotechnical practice, but there is a notable increase in student numbers, which is a very healthy sign for the profession and the Society. To mark the occasion member one thousand will receive some form of special recognition, yet to be decided.

This issue of Geomechanics News is the first for Hamish Maclean as senior editor, assisted by new co-editor Camilla Gibbons. Special thanks to outgoing editor Paul Salter for his commitment while editor and his considerable efforts to continue the development of the magazine.

The management committee would like to acknowledge the contributions of Professor Michael Davies to the Society over the past four years. Professor Davies is the ISSMGE Australasian Vice President and is leaving the University of Auckland at the end of the year to take up an appointment in the UK. Having a strong international presence has been of considerable benefit to the Society and I'm sure Professor Davies will continue to support the region, particularly the Australian Geomechanics Society bid to host the prestigious 2017 ICSMGE conference in Sydney. Michael will continue as regional VP for ISSMGE until his term expires next year.

Conferences

A highlight this year for me was attending the 2012 Young Geotechnical Professionals conference, held in Melbourne prior to ANZ2012. The Society, together with EQC, sponsored ten YGP members to attend the conference and present papers. I attended in the capacity of mentor and was thoroughly impressed with the high standard of presentations; judging was a real privilege as well as a difficult chore. The prize for the best New Zealand paper went to Richard Heritage for his presentation 'Analysis of basement excavation through organic silt'. Given the high standard, a number of presenters could have been awarded the NZGS prize. Congratulations to all those who attended.

The ANZ2012 conference was also a great success and sets the pace for the next ISSMGE regional (ANZ) event, which on rotation is to be held in New Zealand. Planning is in the very early stages, but Wellington in early 2015 is firming as the favourite. Details will be posted on the website as they become available. That year will be busy as the ICEGE conference on earthquake geotechnical engineering will be held later that year in Christchurch.

The 19th NZGS Symposium will be held in late November 2013 in Queenstown. It will have been 5 years since the last symposium in Auckland; other international and regional events having crowded the calendar in 2010 (IAEG2010) and this year (ANZ2012). Follow the link on our website for information.

The next ICSMGE conference is in Paris in September 2013. Congratulations to the authors of the eight papers that were accepted by the conference organisers.

David is an engineering geologist at AECOM NZ (formerly Maunsell and prior to that, Worley Consultants). He has a masters degree in Earth Science from the University of Waikato and has been practicing in the fields of engineering geology and geotechnical and civil engineering for 30 years.

Projects have taken him to many out-of-the-way places in the Asia-Pacific region, as well as the length and breadth of New Zealand. Particular areas of interest are the volcanic geology of the North Island and Indonesia, natural hazard assessment, and civil engineering projects such as hydroelectric and transportation developments, particularly the early stages of site reconnaissance and feasibility assessment.

Awards

The Student prize this year represented a significant and successful innovation. For the first time the prize was based on poster presentations, rather than lectures and twenty six submissions were received, which is well in numbers received in a typical year. The winning poster was to be judged at a live-streamed ceremony in Auckland on 27 November, at which Professor Michael Davies was also to deliver an invited presentation, which effectively doubled as his NZGS farewell. Thanks to CY Chin and Ann Williams for agreeing to adjudicate. Details of the event and winner will be posted on the website and reported in next June's Geomechanics News.

Entries are sought for the Geomechanics Award, which is presented for an outstanding published paper by a member in the past few years. Details are on the website.

NZGS Website

Members I'm sure will have noticed the recent changes to our website. The site was migrated in early November to a new platform hosted by IPENZ. The new platform potentially offers more functionality, including such features as member's only pages. It is early days yet and more design work is required, but comments and suggestions from members about the layout, content and functionality are welcome. Please forward comments to Amanda.

Registration of Engineering Geologists

Professional recognition of engineering geologists in New Zealand has moved a step closer now that the IPENZ board has approved the registration process being within their jurisdiction. The post-nominal will be PEngGeol (Professional Engineering Geologist). The next steps are a small change to the IPENZ rules, preparing assessment forms and documents and training assessors. We are still working towards registering the first batch of engineering geologists early next year. Ann Williams has led this initiative and has received invaluable assistance from Geoffrey Farquhar.

NZGS Short Courses

Successful short courses on in-situ testing were held by Diego Marchetti and Ernst Wassenaar in July and by Prof Peter Robinson in August. The courses, in Christchurch and Auckland, were very well received and supported and clearly indicate a solid demand for such events.

The recent short course and evening lecture series in Christchurch, Wellington and Auckland presented by former Rankine lecturer Dr Brian Simpson was also well received. Charlie Price is to be congratulated for his fine work coordinating and managing the visiting overseas lecturers. Arranging mutually suitable dates and locations has been a challenge, especially as it commonly requires coordination with Australian Geomechanics Society chapters.

Seismic Guidelines

The subcommittee being lead by Kevin McManus is revising Module 1 of the NZGS publication 'Geotechnical earthquake engineering practice' (the Seismic Guidelines). As previously reported the aims are to:

Update the seismic hazard section to reflect changes in the GNS approach to hazard (specifically PGA and magnitude weighting) and provide additional guidance as necessary

Update the liquefaction sections to incorporate lessons from the Christchurch earthquakes

A second document (Module 2) is proposed covering building foundations to give more guidance on earthquake resistant design of foundations. Drafts of both documents are to be available in February next year.

David Burns
Chair, NZGS
David.burns@aecom.com

EDITORIAL POLICY

NZ Geomechanics News is a biannual bulletin 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 bulletin 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.

EDITORIAL

WELL, IT'S MY turn to sign off as co-editor of GeoNews and it's been a lot of fun working on this magazine, or Bulletin, as it has now become.

Thank you to the co-editors I've worked with, and to Karryn and Amanda for all your help putting each issue together. Despite the deadlines, some of the things I've enjoyed most were the Q&A interviews with industry experts, and talking with people impacted by geotechnical issues - like residents affected by the Abbotsford Landslide 30 years ago, or by the recent Christchurch Earthquakes - people directly influenced by geotechnical decisions. It's also been fun putting together the geotech crosswords and teasers, and seeing the magazine expand to a spine-bound Bulletin that sits nicely on the shelf next to other geotechnical journals.

I'm writing this from the desk of my new assignment here in Panama, where I'm the Resident Geologist on a dam being built to expand the canal – which will likely keep me busy for the next couple of years. Who knows, maybe a GeoNews Foreign Correspondent article may follow… All best Hamish and Camilla as you take the Bulletin into new territory. *Paul Salter*

Thanks Paul and welcome Camilla! We hope you all enjoy this issue which is packed with interesting articles. No doubt this reflects another busy and interesting year for members of the NZ Geotechnical Society. Included in this issue are technical articles on the new Victoria Park Tunnel in Auckland, seismic design of slopes and retaining walls and shallow foundation design practice in NZ. We review ANZ 2012 and 9YGP, and also put a few questions to Jean-Louis Briaud (president ISSMGE) who was in NZ earlier in the year. Also worth a look is the NZGS submission to the Royal Commission of Inquiry into building failure caused by the Canterbury Earthquakes which was presented in August 2012.

Finally, and perhaps more importantly, have a great and safe Christmas break and the GeoNews team will see you next year. *Hamish Maclean*

I had a phone call from Hamish a few months ago, asking if I wanted to co-edit this bulletin as Paul was heading away, happily agreeing I did not know quite what to expect but it has been fun putting this issue together and I look forward to working on future issues. I hope you will enjoy reading this, with a great range of articles from all over the country and updates from CERA, and SCIRT on the work rebuilding Christchurch, in addition to a report on the recent emergency works to stabilise the landslip in the Manawatu Gorge. I hope you all have a well-earned break and have a great Christmas and New Year.

Camilla Gibbons

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.

Hamish is a Geotechnical Engineer with Tonkin & Taylor Ltd in Auckland. He completed his Civil Engineering degree at The University of Auckland. Following valuable construction experience working for Fletcher Construction on the later stages of the second Manapouri tailrace tunnel, he has spent the past seven years working as a geotechnical engineer in the Tonkin & Taylor Auckland office. This has included a wide variety of projects with a focus on retaining wall design and landslip assessment and remediation.

Hamish Maclean, NZ Geomechanics News Co-editor
HMaclean@tonkin.co.nz

Camilla is an Engineering Geologist with Aurecon in Christchurch. Originally from the UK, she completed her Geology degree at The University of Bristol and her Masters in Engineering Geology at The University of Leeds, graduating in 2004. She worked for Mott MacDonald in the UK for three years before coming to New Zealand at the start of 2008. She has been involved in many large and small projects all over NZ and Australia and since the earthquakes in 2010/2011 she has been heavily involved in mapping, assessing and mitigating rockfall and landslide hazards in the Port Hills around Christchurch. Camilla was awarded the New Zealand Engineering Excellence Awards, Young Engineer of the Year in 2011 for her work on rockfall following the earthquakes in Christchurch.

Camilla Gibbons, NZ Geomechanics News Co-editor
camilla.gibbons@aurecongroup.com

THE SECRETARY'S NEWS

Shared exhibition space with Australian Geomechanics Society

ANZ 2012 Conference – Ground Engineering in a Changing World

THE ANZ CONFERENCE, Melbourne, July (think coat), indeed seems like a 'changed world' away. I clearly recall the promise of literary recollection, however the after-glow of travel, fun, good food and meeting new, interesting people, dimmed with the pledge. The confines of reality took hold – new deadlines, old 'to do' lists, urgent emails (aren't they all?) – and finely honed procrastination skills prevailed. Perhaps it could write itself, materialise, fully spell-checked, and emailed off to the editors to boot! Alack and alas.

Melbourne is a pleasant distance from Auckland (two movies and a meal), and a good many NZGS members (over 50) attended the spectacle at the Crown Conference Centre. I met a steady stream of seasoned and new NZGS members at our exhibition stand in the main Expo hall, and I would like to thank those that introduced themselves to me. It was a pleasure to fly the NZGS flag, figuratively and literally – an NZGS banner was successfully taken across the Tasman, through border patrol, into the land down under and almost ended up on the telly (yes, they were filming the television show 'Border Security' at Melbourne Airport).

With my extensive non-geotechnical, non-engineering geology, and mainly non-engineering background (jargon does not an expert make), I must admit to not actually attending the technical sessions. However, the expo hall was awash with enthusiasm, reflecting a keen audience held enthral by keen presenters. Those with more letters after their names can analyse the merits of plenary presentations.

However, I did attend the sessions celebrating 75 years of ISSMGE and found those pertinent. Dr Harry Poulos, and our own Professor Michael Davies and Lucy Coe, shone. Their leadership roles and responsibility shown to accurately portray the past, present, and future of the industry, within the auspices of ISSMGE, was more than admirable. It was engaging, relevant and motivating.

Conference banquet Crown Plaza ballroom

An honourable mention must be made of my time spent 'chewing the fat' with my counterpart at the Australian Geomechanics Society – Peter Robinson – at our shared exhibition space. It was enlightening to meet Peter, and at times our conversation felt a little like insider trading. I suspect we both learnt a bit about the other Society and how each operates.

Thank you to the Management Committee for agreeing to fund my attendance at the Conference.

Also, best wishes for holidays full of sunshine, friends, family and a fabulous festive season.

Amanda Blakey
Management Secretary
secretary@nzgs.org

INTERNATIONAL SOCIETY REPORTS

International Society of Soil Mechanics and Geotechnical Engineering

Australasia VP Report: November 2012

THE HIGHLIGHT OF the term of office of the Vice-President for any of the ISSMGE regions has to be the ISSMGE regional conference. This was certainly my experience when the AGS hosted the most successful ANZ 2012 in July. The statistics associated with the conference indicate the achievements of the organising committee, chaired by Stephen Tyson. It attracted 577 delegates (an ANZ record) with 109 coming from outside the region. The programme allowed for 165 papers to be presented along with 96 posters. There were 50 sponsors and exhibitors and all the sponsorship packages were sold. It is clear that the high number of registrations resulted from consistent and strong promotion from the organising committee and the use of social media Facebook and Twitter as a means to attract and communicate with the younger generation of geotechnical engineers (and, perhaps, some of the more senior ones too!). Not only was I delighted by the outcome, but the ISSMGE President, Professor Jean-Louis Briaud, and the ISSMGE Board were all most impressed by the professional way in which the conference had been organised and by the high quality of the programme. I would like to take this opportunity to thank Stephen Tyson and the organising committee for their hard work and congratulate them on the outstanding success of ANZ 2012.

At the conference the AGS announced formally that it would be making a bid for the 19th International Conference on Soil Mechanics and Geotechnical Engineering (ICSMGE). It is proposed that this will be held in Sydney during 2017.

The rules of the ISSMGE allow only one society to make a bid for the ICSMGE 2017. However, because the Australasia region has only two societies and these have traditionally worked closely together, bringing the ICSMGE to Australia in 2017 is seen by the AGS and the NZGS as bringing the ICSMGE to Australasia. Whilst not an official bidder for the conference, the NZGS will be taking a major role as a joint host by organising pre and post conference field trips and facilitating satellite conferences and seminars that are frequently held in association with ICSMGE. These activities - and the conference itself - represent an excellent opportunity for geotechnical engineers in New Zealand to discuss the latest developments with colleagues from around the world; as well as demonstrate to them the depth and breadth of novel geotechnical engineering practice and research that takes place in New Zealand.

As the ISSMGE Vice President for Australasia I will be stressing to members of the ISSMGE Board and representatives of ISSMGE Member Societies – who will be voting for the venue for ICSMGE 2017 at the ISSMGE Council meeting in Paris next year - the additional strength that the active support of the NZGS gives to the AGS bid. The AGS organising committee for ICSMGE 2017, which is being chaired by, Graham Scholey, the immediate past chair of AGS is requesting all members of AGS and NZGS to assist in bringing the conference to our region by publicising the bid to colleagues from who are members of other ISSMGE member societies.

A meeting of the ISSMGE Board was held in association with ANZ 2012 which covered a number of new and continuing issues as follows:

- **Webinars.** These started one year ago and have been offered free of charge. Nevertheless, ISSMGE faces expenses associated with the organisation and delivery of the webinars (about US$20,000/year). When the webinars were first introduced the plan was to start charging US$200 per computer connected for the webinars to cover the expenses. However, at the meeting the Board decided that webinars will continue to be free of charge until September 2013 as a service to our members.
- ISSMGE Foundation. Grants from the Foundation will be reviewed 4 times a year rather than 2 times a year to improve response time and provide more opportunities for applicants. It is expected that there may be strong demand for funding associated with the ICSMGE in Paris next year. Nevertheless, I would encourage ISSMGE members, particularly younger members who have difficulty obtaining funding to present a paper or poster at the conference, to consider applying for a grant from the Foundation.
- **Corporate Associates Presidential Group (CAPG)** Sukumar Pathmanandavel of Coffey Geotechnics gave a report on the tasks their group is working on after a recent meeting hosted by Michael Lisyuk, Chair of CAPG, in St Petersburg, Russia. The number of Corporate Associates is increasing

steadily thanks to the work of many with Vibropile and GHD joining recently. However, although the member societies in Australasia are very well supported by individual members, the number of Corporate Associates is embarrassingly small. I would encourage you to help increase the number of Australasia Corporate Associates by getting your own organisation to join and working on colleague in other companies to do the same! Further details can be found on the ISSMGE web site or by contacting me.

- **Copyright and fairness.** The ISSMGE position which is developing is that authors would give to the publisher the permission to publish papers in ISSMGE organised conferences but would retain the copyrights. The Board intends to establish and publish the policy for this as soon as possible.
- **Member societies.** The applications of Belarus and Bosnia-Herzegovina to become ISSMGE member societies were approved by the Board.
- **International Seminars**. The International Seminar in the South East Asia region was approved.

Readers of my previous reports and members who serve on ISSMGE Technical Committees (TCs) will be aware that, since his election, the President has encouraged each of the TCs to established distinguished lectures to promote the field covered by the TC and to recognise the outstanding contribution to that field by the lecturer. These lectures complement the most prestigious lecture "awarded" by the ISSMGE - The Terzaghi Oration – which is delivered at each ISSMGE International Conference as a tribute to Professor Karl Terzaghi, first President of the International Society. The President is responsible for selecting the Terzaghi Orator after consulting with Member Societies and Board Members. Following his request for nominations for the Terzaghi Orator for the 2013 ICSMGE in Paris, the President received 16 nominees from around the world. From this list he selected Dr Suzanne Lacasse of the Norwegian Geotechnical Institute. In addition to being a highly successful Director of the Norwegian Geotechnical Institute and well known for her contributions to advancing the discipline of geotechnical engineering, Dr Lacasse has practiced in North America and been President of the Canadian Geotechnical Society. As the 8th Terzaghi Orator Dr Lacasse is a very worthy successor to William Lambe (1985), Kaare Hoeg (1989), Victor de Mello (1994), Kenji Ishihara (1997), Michele Jamiolkowski (2001), Frans Barends (2005), and Harry Poulos (2009). The Terzaghi Oration will be held in Paris immediately after the opening ceremony of the 18th ICSMGE. I hope very much that, with the hard work of the AGS supported by the NZGS, the 9th Terzaghi Oration will be held in Sydney immediately after the opening ceremony of the 19th ICSMGE!

Professor Michael C.R. Davies
Vice-President for Australasia and First Vice-President ISSMGE

International Society for Rock Mechanics

Australasia VP Report: September 2012

THIS REPORT DESCRIBES ISRM related activities in Australia and New Zealand for the period to September 2012.

ISRM MEMBERSHIP

Australia	242
Corresponding Members	19
New Zealand	105
Total	366

Council and Board meeting in Stockholm (REPORT FROM LAST MEETING)

The International Society for Rock Mechanics held its Council meeting in Stockholm, Sweden, on 27 May, in conjunction with EUROCK 2012, organised by the Swedish ISRM National Group and the Rock Engineering Research Foundation – BeFo. 41 of the 49 National Groups were either present or represented. The Council was also attended by two Past Presidents, the Chairmen of the ISRM Commissions, and representatives of the IAEG and the ICOLD.

Membership of the ISRM

The ISRM has now 6,783 individual members (an all-time record) and 140 corporate members, belonging to 49 National Groups. This represents an increase of 4% in the number of individual members since the last year. 46% of the members come from Europe, while Asia has been the fastest growing region in the last years.

Modernisation of the ISRM

The President, Prof. Xia-Ting Feng, explained the modernisation initiatives that are underway. In particular, he focused on the Young Members Presidential Group which has recently been formed with members appointed by the NGs up to 35 years of age, on the steps being given towards the creation of the ISRM Foundation for Education and on the creation of an ISRM book series where books produced by the Commissions can be published. He also mentioned the efforts being made to increase the membership.

Rocha Medal

The ISRM Board decided to award the Rocha Medal 2013 to Dr Mathew Pierce from Canada for the thesis "A model for gravity flow of fragmented rock in block caving mines" presented at the University of Queensland, Australia. He will receive the award at the 2013 ISRM International Symposium in Wroclaw, Poland.

Two runner-up certificates were also awarded to Dr He Lei, from China, for the thesis "Three dimensional numerical manifold method and rock engineering applications" presented at the Nanyang Technological University, Singapore, and to Dr Andrea Perino, from Italy, for the thesis "Wave propagation through discontinuous media in rock engineering" presented at the Politecnico di Torino, Italy.

Membership Certificates can now be obtained on the website

ISRM members can obtain their membership for the last year automatically on the website

Cooperation with other Societies

The Secretary General reported on the meeting held on 23 May of the Federation of the Geo-engineering Societies - FedIGS, with the IAEG, the IGS, the ISRM, the ISSMGE.

It was decided to intensify the forms of collaboration already existing by means of joint sessions in conferences, invited speakers from other member societies and the participation in the technical Commissions of the societies.

Newsletter now fully digital

The digital newsletter is sent to all ISRM members and subscribers every 3 months. It includes news about the society and other news of interest to rock mechanics. Contributions are welcome with short news on issues of general interest.

The latest issue of the News Journal, edited by Prof. John Hudson and Prof. Xia-Ting Feng, has 80 pages and contains the annual review of the Society's activity along 2011 and technical articles such as a summary of the 6th Müller Lecture. It was posted on the website where it can now be read online or it can be downloaded.

A Tribute to John Franklin, 1940-2012

Professor John Franklin passed away on 6 July, after a prolonged illness. Geo-engineering at large is poorer today. John served as ISRM President (1987-1991) and Chairman of the ISRM Commissions on Testing Methods (1975-1987) and Education (1991-1995).

ARMS 7, Seoul, 15-19 October 2012: 2nd Circular and Students´ Night

The Korean Society for Rock Mechanics (KSRM) - Korean National Group of ISRM - extends a cordial invitation to the international community to attend the 7th Asian Rock Mechanics Symposium, an ISRM Regional Symposium. The event will be held on October 15-19, 2012 in Seoul, Korea; it is a timely celebration of the 1st

Asian Rock Mechanics Symposium that took place fifteen years ago in the same location.

One of the highlights will be the Students' Night, on 14 October. This event is organized in order to encourage active participation of young members and establish network among young members in the rock mechanics community. The program is sponsored by the ISRM Young Member's Presidential Group and includes a Han River Cruise (Supper provided) and a beer and rice wine party together with the special lecture, 'Your lives as rock mechanician', by the Australasian Vice-President.

Upcoming meetings

15-19 October 2012, Seoul, Korea – ARMS 2012 – 7th Asian Rock Mechanics Symposium: an ISRM Regional Symposium

20-22 May, 2013, Brisbane, Australia – Effective and Sustainable Hydraulic Fracturing – an ISRM Specialized Conference

18-20 June 2013, Shanghai, China – SINOROCK 2013 - Rock Characterization, Modelling and Engineering Design Methods – an ISRM Specialized Conference

20-22 August 2013, Sendai, Japan – The 6th International Symposium on Rock Stress – an ISRM Specialized Conference

21-26 September 2013, Wroclaw, Poland – EUROCK 2013 – Rock Mechanics for Resources, Energy and Environment – the 2013 ISRM International Symposium

26-28 May 2014, Vigo, Spain – EUROCK 2014 – Rock Engineering and Rock Mechanics: Structures in and on Rock Masses – an ISRM Regional Symposium

15-17 October 2014, Sapporo, Japan – ARMS 8 – 8th Asian Rock Mechanics Symposium – The 2014 ISRM International Symposium

10-13 May 2015, Montréal, Canada – ISRM 13th International Congress on Rock Mechanics

7-9 October 2015, Salzburg, Austria – EUROCK 2015 – Geomechanics Colloquy – an ISRM Regional Symposium

Dr David Beck
Vice President Australasia

International Association for Engineering Geology and the Environment

Australasia VP Report: September 2012

Membership

New Zealand and Australia are now the 3rd and 4th largest membership groups respectively of IAEG after Germany and China. In part this is a function of our membership method. In larger countries (USA, India, Brazil, active engineering geological groups are large and are less interested in the international view.

A new Hong Kong (SAR) Regional group has been established, recognising the significant role of engineering geologists in Hong Kong and the particular issues facing HK that are distinct from mainland China.

National Groups are asked their views on the establishment of a student membership category that does not include the Bulletin but has a zero membership fee. Student membership would be available only to bona fide students for a maximum of two years.

50th Anniversary

A sub-committee has been established to prepare a book that celebrates the history and future of Engineering Geology as part of IAEG's 50 year celebrations in 2014 that will be provided at no cost to delegates of IAEG2014 and be available for purchase by others. Contributions are welcome, in particular of an Australasian view of transforming incidents or persons in the development of Engineering Geology in New Zealand and Australia. Please send submission to ann.williams@beca.com.

Hans Cloos Medal

The 2012 recipient of the Hans Cloos medal is Professor Victor Osipov, chairman of the Russian National Group of IAEG and Director of the Sergeev Institute of Environmental Geoscience RAS. In order to further raise the profile of this prestigious award and of IAEG, it is proposed to ask the recipient of the medal to present a Hans Cloos lecture, which could be toured internationally.

Richard Wolters Prize

The IAEG Executive and Council meetings were held at Banff, Canada on the occasion of the joint International Landslide Conference and 2nd North American Landslide Conference in June 2012. Marc-Andre Brideau, lecturer in Engineering Geology at the University of Auckland, contested the Prize representing NZ and was judged runner-up. This was a particularly good result as all six candidates were worthy recipients of the award.

Website

The homepage of www.iaeg.info will highlight a National Group and its significant outputs/ work/ characterisation/ events/etcetera each month; data as supplied by the National Group. It would be good to see the New Zealand and Australian geotechnical societies raising our profile in this way.

Commissions

There are currently 21 active Commissions. A Technical Overview Committee (TOC) has been established to monitor and support the Commissions. Outputs from those commissions that have completed their work will be available on the website along with outputs of current commissions. New Zealand's Beverley Curley leads Commission 30: Young Professionals. Please support her in this role. She is contactable at bacurley@hotmail.com.

Newsletter

The new secretariat has reinstituted a regular (6 monthly) newsletter. Newsletters can be viewed on the IAEG (www.iaeg.info) and NZGS websites.

IAEG Sponsored Conferences

The next IAEG Council meeting will be held in conjunction with the Asia Regional meeting in Beijing "Global View of Engineering Geology and the Environment" September 24 – 25, 2013. See www.iaegasia2013.com.

The website of the IAEG Congress to be held on the 50th Anniversary of IAEG in Torino, Italy, is live. Register on www.iaeg2014.com to receive updates.

New Zealand

As you will be aware, we are working towards professional recognition of engineering geologists through IPENZ (PEngGeol) in New Zealand. Guidelines and competency standards have been established and approved for consultation at the August Board meeting of IPENZ. Once IPENZ has completed consultation, preparations for implementing the Guidelines can be made.

Ann Williams
IAEG Vice President, Australasia

- Subsoil Drainage Filtration
- Reinforced Soil Walls
- Slope Stability Systems
- Earth Anchoring Systems
- Pavements and Embankments
- Landfill and Environmental Barrier Systems
- Stormwater Management Systems
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NZGS BRANCH ACTIVITIES

Auckland Branch Activity Report

THE AUCKLAND BRANCH has continued 2012 with a diverse and interesting range of monthly presentations. At the time of writing this report we have a full list of presentations untill the end of the year. We are eager to hear from anyone interested in speaking at our branch events for next year so if you know of an interesting project or speaker, please feel free to get in touch with a Branch Coordinator.

PRESENTATIONS SINCE THE LAST GEOMECHANICS NEWS:

22 May 2012 – Martin Barrientos from Beca presented an overview on the geotechnical considerations of the Victoria Park Tunnel project. The presentation highlighted the difficulty of the contaminated soil dumped during the reclamation of the park, the fast paced construction period and the use of secant and diaphragm walls to achieve a water tight box to house the tunnel. The talk was interesting and very well received.

12 July 2012 – Professor Jean-Louis Briaud, president of the ISSMGE, was in the country before the ANZ Geotechnical Conference in Melbourne and presented on Unsaturated Soil Behaviour for the Practicing Engineer. Prof. Briaud focused on two topics, firstly on the theory of unsaturated soil mechanics and secondly on its application, particularly for shallow foundations supported on small to medium sized buildings. Professor Briaud finished his presentation with two videos, on 'the Beauty and the Beast', with the first on the surface tension of a droplet of water and the second on a high speed impact of a fully loaded truck on a bridge pier as part of his recent research.

23 July 2012 – Dr Nick O'Riordan, principal of Arup presented on the seismic stability of deep excavations in dense urban areas using the Transbay Transit Center currently under construction in San Francisco as an example. The talk highlighted selecting ground motions for use in dynamic numerical analyses and that conventional code based methods may overestimate or wrongly distribute loads from adjacent buildings. The immense scale of the project was impressive and the presentation was very well received by around 65 attendees.

25 July 2012 – Diego Marchetti and Ernst Wassenaar, gave a half day short course on in-situ testing. The course introduced a number of in-situ soil testing methods such as CPT (Cone Penetration Test), DMT (Flat Dilatometer Test) and Tee Bar Equipment. The course also discussed how the test results can be used in geotechnical applications. Highlights of the course included having the test equipment available for those that attended to inspect.

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Luke is currently undertaking a PhD at the University of Auckland on the earthquake resistant design of foundations. He is investigating the response of a number of buildings in the Christchurch CBD following the 2010/2011 earthquakes and is following on from research that has been undertaken under the supervision of Professor Michael Pender. Previously, following his graduation from the University of Auckland with a BE(hons) and BA conjoint degree in 2009, Luke was a Geotechnical Engineer at Coffey Geotechnics (NZ) Limited where he worked on a range of small to large scale projects in New Zealand and Australia.

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Aidan is a Geotechnical Engineer with Beca Infrastructure Ltd, based in Auckland. He graduated from the University of Auckland in 2009 with a BE (Hons) and has a passion for slope stability and river engineering. Aidan joined Beca in 2010 and has worked in Auckland, Tauranga and Wellington on large infrastructure projects, as well as a variety of other projects throughout the country.

21 August 2012 – Professor Peter Robertson, gave a 1 day short course on the application of the CPT for geotechnical design. The course focused on the different types of CPT, the interpretation of parameters and the application for liquefaction assessments. Professo. Robertson also demonstrated two commercially available software products CPeTIT for the presentation and interpretation of CPT data and CLiq for liquefaction assessment of CPT data. The large turnout to the course indicated the high calibre of the presenter and the interest in the topic.

3 September 2012 – Professor Ikuo Towhata from the University of Tokyo presented on the March 2011 magnitude 9 earthquake. The presentation focused on the geotechnical effects to the built environment including: background information on what happened in Japan during the 2011 gigantic earthquake; lessons learned from that earthquake; on-going reconstruction of river levees; liquefaction problem in private houses; and difficulties in mitigation of liquefaction problems. The presentation was very well received by attendees, in part from the particularly interesting field observations of liquefaction and other seismic effects that Professor Towhata had observed following the earthquake.

2 October 2012 – Mr Jay Veetil, from Maccaferri presented on the award winning Projet Sikkim which involved building an airport runway embankment deep within the Himalayan mountains of Northern India. The presentation covered the design of the runway on the edge of steep and hilly terrain, the design methods used to design the 74m high reinforced soil embankment, the long term structural performance and project management. Mr Veetil also described the performance of the structure in response to a seismic event that occurred near completion of the project. It was a fascinating presentation and the immense scale of the project was made clear by a video traversing the project works from a helicopter.

We are expecting exciting presentations in the new year. More details will follow by email.

Auckland Branch News

As many of you will be aware, we have been continuing to live stream and record our presentations so they are available for those that cannot make it on the night or are in other parts of the country. This has been very kindly supported by the Engineering Department at the University of Auckland. We would greatly appreciate feedback that anyone han. If the live stream has not worked for you for whatever reason please get in touch, the people at the University are more than happy to set up a test stream so that any problems can be worked out. Furthermore, if you want to have a copy of a recorded presentation could you please download it as soon as possible after we send it out because the links become inactive after aeabout a year.

In other news, Luke Storie is now the YGP representative with Erica Cammack's departure to Australia. We wish Erica all the best in Australia and thank her for her support and help during her time as branch coordinator. Luke continues to help coordinate Auckland Branch events. Aidan Thorp has joined Luke and Pierre Malan as an Auckland Branch coordinator.

Lastly, we would like to thank all of our sponsors for continually helping us out every year.

Service and Solutions

CLL CONTRACT LANDSCAPES

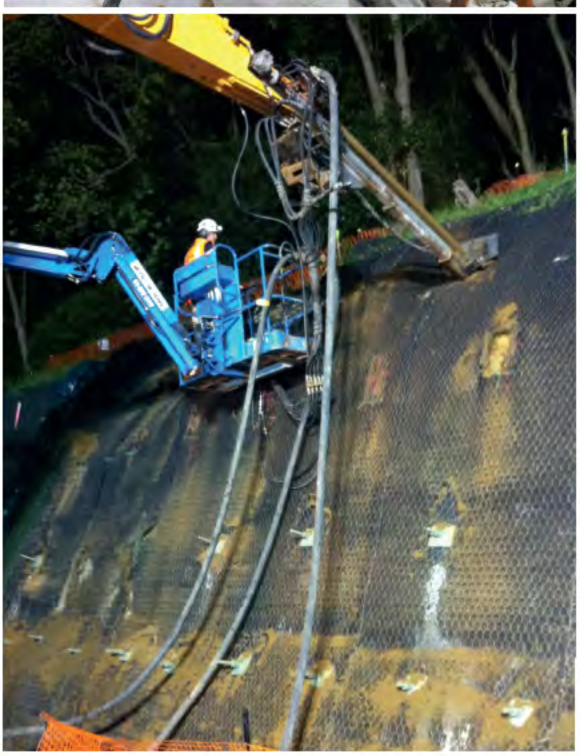
25 YEARS FROM being a one man band Terry Donnelly and his XA falcon ute has grown the company to a staff now exceeding 130 of dedicated and focused individuals supported by a large modern fleet of specialised equipment. With a positive culture built on a "service and solutions" attitude throughout New Zealand, CLL are recognized today as industry leaders with advanced skills in projects such as:

- **Rope access landslip stabilisation using soil nails, anchors and micro piles.**
- **Restricted access, driven and drilled piling and combining various dewatering techniques.**
- **Temporary retention solutions for deep holes and high cuts.**

An example for CLL expertise can be seen with their specialised civil engineering approach to stabilizing a significant 8m high cut within a short Christmas access period, for the new Parnell Rail Station project. Setting up two anchor drilling rigs on 30 tonne excavators, CLL drilled over 200 quantity 9m deep x 150mm diameter bore holes up to heights of 8m to anchor and soil nail the unstable cut zone, which also incorporated the construction of a palisade wall to protect neighbouring properties.

CLL's ever enthusiastic and longtime Special Projects Chief Don Iggulden under took the demands of the project. Working in 18 hour shifts, Don's team completed holes from start to finish in under 20 minutes, with the use of specially modified drag bits and 800cfm compressors to remove the tailings out of the holes. Staff following the drill crews quickly installed the bars and grout completing the demanding project in record time. This may all sound like a rather typical civil engineering stabilising day's work, but throw in continuous rain, rope access teams involvement to roll out rock fall prevention mesh and a couple of unidentified ongoing landslides and you will appreciate the quality and efficiency of these professionals.

Manco's engineers enjoy working with CLL with their demanding equipment design and deliver requirements as unique solutions can always provide improved productivity and profitability.



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Waikato Branch Activity Report

ON 25 SEPTEMBER, a meeting was held to discuss local and national practice in relation to the assessment of liquefaction. Liquefaction has been shot into the public eye by the recent Christchurch earthquakes. Previously it was not widely understood what liquefaction was, where it could occur or what its potential impacts were. There is now an increased general awareness of the risk and, as the focus moves from Christchurch to practice in other regions; national guidance or legislation is on its way. The Waikato and Bay of Plenty region has areas of recognised liquefaction risk. However locally, liquefaction assessment is not always carried out or even recognised as necessary. In light of this, it was felt that a local round table type discussion was due to widen the understanding of local liquefaction risk and assessment. Rolando Orense of the University of Auckland kindly attended and gave a lightening quick tour through liquefaction assessment, lessons from Christchurch and some interesting research from local Waikato soils. Andrew Holland of AECOM then followed with a few examples of assessments of Waikato sites that showed liquefaction risk. A good discussion followed which highlighted the variation in liquefaction practice in the local industry, the differences in requirements from local authorities and gave some good information on sources of information and guidance.

There will likely be follow on events to keep everyone up to date as national practice is modified to take on the lessons from Christchurch and as regulatory bodies begin to roll out requirements and standards of assessment for development.

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Kori took over the role of joint 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.

Andrew Holland
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Andrew is a Principal Geotechnical Engineer at AECOM.He studied engineering at the University of Auckland, graduating in 2002. Since then, Andrew has worked in geotechnical consultancy in New Zealand and England and has worked on projects around the world including in London, Morocco and Saudi Arabia.

Andrew's experience includes geotechnical investigation, assessment and design for infrastructure, buildings and development. Andrew is a Chartered Professional Engineer (CPEng) and is the geotechnical team leader in AECOM's Hamilton office.

Wellington Branch Activity Report

THE WELLINGTON BRANCH activities are organised by a committee of 7 people mainly from local consultancies. Since the last report we have been fortunate to have had presentations from a number of visiting overseas experts. We plan to have more talks from local speakers from early next year.

Meetings held

While not a NZGS event, GNS provided an update on 21 June – on the "It's Our Fault" programme (for better defining the earthquake risk in the Wellington region) –

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this included an update on geotechnical and liquefaction characterisation of soils in the Wellington region, the use of 'period dependent site-effects' for foundation assessments as well as the latest on research on a major subduction zone earthquake in the region.

24th July – Half day Short Course on In Situ Testing- on the selection of penetration test methods, by Diego Marchetti and Ernst Wassenaar. Approximately 12 people attended. The course focused on CPTs and DTMs and was clearly presented and engaged those attending. The content was well pitched in terms of level and most people on the course took valuable information away.

22nd August – Part Two In-Situ (Short) Course, by Professor Peter Robertson. Approximately 35 people attended this entertaining and very informative 2 hour free short course on the interpretation of CPT data and liquefaction assessment methods.

9 October – The 2012 William B. Joyner Memorial Lecture, entitled "Building Near Faults" presented by Jonathan D. Bray, of University of California, Berkeley. The talk was very well attended (the GNS lecture theatre was 'pretty full'), and the talk itself was very interesting and thought-provoking.

18th October 2012 – Geotechnical Conceptual Design for The Planned Redevelopment Of Treasure Island, California: Uri Eliahu, GE, President, ENGEO. The meeting was held at lunchtime at Opus and was a 'sell-out' – indicating the interest in a midday meeting slot. The talk covered a broad spectrum of issues for the project including planning for sea level rise, liquefaction and settlement, and ground improvement.

Upcoming Activities

Christchurch themed talks by GNS staff:

- The geology of Christchurch
- Port Hills slope stability

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Canterbury Branch Activity Report

THE COORDINATORS WISH to thank the Canterbury Branch members for their support at a number of talks, meetings, and short courses over the winter months. Branch membership has increased substantially of late; reflecting a number of international, expat and local practitioners heading to the region to assist, and gain valuable experience, with the earthquake recovery.

Events to which Branch members have been invited since April include:

- Several joint meetings with the Canterbury Technical Clearinghouse, NZSEE and SESOC continue on a regular basis. These are a useful forum for practitioners with a 'soil-structure' interest to share experiences, discuss best practice, and hear updates on the advisory groups such as the EAG.

10 July – Maccaferri arranged a presentation on some rockfall mitigation measures with case studies from the Port Hills. Approximately 60 members attended and enjoyed the refreshments provided by Maccaferri.

28 June – The Late Quaternary geology and groundwater models of Christchurch. A two-part talk presented by John Weeber (Hydrogeologist – Clemence Drilling) and John Begg (Regional Geologist – GNS Science). Approximately 100 people with a wide range of geotechnical experience in Christchurch attended. They were presented with excellent summarises of the historical and recent subsurface investigations and of the groundwater and ground conditions in the city. Thanks to McMillans Drilling for providing refreshments and pizza.

23 July – Part 1 of Short Course on In Situ Testing. Diego Marchetti and Ernst Wassenaar outlined some of the advantages and a drawback of selected in situ testing techniques was well attended by Branch members.

27 July – Mitigation of Liquefaction Using Stone Columns by Ass Prof Russell Green (Virginia Polytechnic Institute and State University). A seminar organised by the Department of Civil and Environmental Engineering to which Branch members were kindly invited to. The talk was well attended by approximately 70 people.

15 August – presentation on the Brisbane Airport Link, northern busway and airport roundabout project by Mike Straughton (Arup Brisbane). Thanks to Arup for their kind sponsorship of this event.

24 August – Part 2 of Short Course on In Situ Testing, Prof Peter Robertson. Approximately 60 members enjoyed anecdotes from our colleague Peter Roberston, along with advice on the acquisition and interpretation of CPT data.

3 September – A useful summary of vibro ground improvement for mitigating liquefaction risks was presented by Wilhelm Degen who is visiting the University of Canterbury. The members who attended appreciated the

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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.

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Edwyn is an engineering geologist with 11 years geotechnical experience in New Zealand, United Kingdom, Caribbean, Algeria and Bulgaria, with skills in the following areas:

Geotechnical investigations for civil engineering works (dams, roads, land development, buildings, landfills etc); Geological hazard assessments for major projects; Engineering geological mapping and aerial photo interpretation; Assessment of risks associated with natural hazards; Groundwater investigations; Peer review and expert witness.

Edwyn's has developed expertise in feasibility studies and geotechnical investigations for infrastructure projects, ranging from dams and reservoirs to roads, wind power developments, buildings, and land stability assessments.

practical insights into the technique provided by Dr Degen from his 30+ years of foundation industry experience.

28 September – "Simplified Procedures for Estimating Earthquake-Induced Deviatoric Slope Displacements" lecture by Johnathan Bray, University of Canterbury. An interesting lecture on advances in seismic slope stability: calculating displacements based on slopes and peak ground accelerations. Approximately 60 people attended the presentation.

23 October – A presentation by Jonathan Bray regarding development near Fault lines. An interesting talk which provided some insight into the problems created when development rules become too prescriptive without appropriate site specific consideration being required. Well attended by a selection of long term and new members. Refreshments and venue provided by MWH were well appreciated.

The Branch Members have also been enjoying web casts of events in other areas of the county, and accessing downloads to recorded presentations through the Societies web site.

Please contact the Coordinators with any suggestions, questions or feedback. We are currently planning the Branches' end of year get together, and there will possibly be a few evening presentations before then.

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Shamus is an Engineering Geologist who works for Tonkin & Taylor in Christchurch. Passionate about maps and landforms from an early age, Shamus graduated from Canterbury with a BSc Honours in Eng Geol in 2002 and has worked on a variety of geotechnical projects throughout New Zealand, as well as working in London, and travelling around the world, before repatriating to Christchurch. Faced with the aftermath of the 2010/11 Canterbury earthquakes, Shamus has been intricately involved with the land damage assessment team, working for EQC, and looks forward to helping Christchurch emerge from the rubble.

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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.

Otago Branch Activity Report

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David is a geologist and geomorphologist at GNS Science in Dunedin. South Island born and bred, David's early professional experience included work as a coal geologist in Buller, and as an engineering geologist on the Clyde Power Project. Since joining GNS Science in 1993, he has specialised in Quaternary geology, landform evolution and landscape processes. David very much enjoys the mix of scientific research and applied geoscience that his work entails. He contributes extensively to regional geological and geomorphological mapping, as well as to a range of other disciplines including earthquake geology, groundwater geology, and engineering geology.

THE GEOTECHNICAL COMMUNITY was greatly saddened by news of the tragic death of Graham Brown (Brownie) in a work-site accident while clearing a rockfall on the Milford Sound Road on 19th October. Brownie spent most of his career on infrastructural projects, focusing on drilling work since the early 1970's for Ministry of Works and Development, and its successors, most recently Downer. Notable projects in which Brownie was involved included foundation strengthening work for Arapuni Dam on the Waikato, almost a decade on the Lower Waitaki hydro investigations from the late 1970s to early 1980s, Clyde Power Project landslide investigations, and innumerable small projects in the greater Dunedin area, where he and his family have been based since the late 1980s. Brownie had two trips to the Antarctic. In 1984 he was a driller on the CIROS-2 scientific drillhole sited on sea ice in Ferrar Fjord over 200 m of water. This drillhole was particularly notable for a freak windstorm that wreaked all the drillsite buildings just a few hours after the hole was completed. Brownie was widely known as a quiet achiever, working at the pace needed to produce top quality results which, to Brownie, meant a good clean hole with good core recovery, well-installed anchors, or well-placed instruments. Considerations such as deadlines and penetration rates were low on his priority list. Although a man of few words on the drillsite, he had a reputation for providing excellent log sheets. Graham Halliday recalls that if he asked Brownie to do something difficult, Brownie's usual reply was "can't be done", then half an hour later would come up with some ingenious way of doing it! Mark Walrond recounts always being impressed by the way that Brownie remained relaxed in the face of the frequent changes of plan by engineers, and just got on with whatever was the new plan. Shane Greene remembers being sent out to assist with a rock slide affecting State Highway 6 near Queenstown. The job of the day was blasting to help free up some loose rock, and he was surprised to see Brownie, the driller, was there helping. Shane asked him "You do blasting too?" Brownie's response was, "I do everything mate". That was Brownie!

Flowers and a card expressing our deep sympathy were sent to the Brown family on behalf of the New Zealand Geotechnical Society.

STANDARDS, LAW AND INDUSTRY NEWS

NZGS Submission to the Canterbury Earthquakes Royal Commission

THE FOLLOWING IS the New Zealand Geotechnical Society's submission to the Royal Commission of Inquiry into building failure caused by the Canterbury Earthquakes. Our submission was presented in August 2012 and addresses issues raised in the Commission's discussion paper 'Roles and Responsibilities', a copy of which can be found on our website together with the NZGS submission. The discussion paper is concerned with the current building regulatory framework; building standards, codes and guidelines; and responsibility for preparing standards, codes and guidelines. As the Royal Commission brief is specific to buildings associated with loss of life, our submission could not be wide ranging. For example, we could not comment on liquefaction in suburban areas.

The authors are David Burns and Gavin Alexander, NZGS Chair and Vice-Chair respectively, with input from the Management Committee. Geoffrey Farquhar in particular provided a valuable contribution.

A supporting article from the June 2012 Geomechanics News, titled 'Geohazard Mitigation in New Zealand – In search of a normative and informative balance, by Merrick Taylor of the University of Canterbury, was appended to the submission.

CANTERBURY EARTHQUAKES ROYAL COMMISSION NZGS SUBMISSION ON DISCUSSION PAPER: Roles and Responsibilities
13 August 2012

INTRODUCTION

The New Zealand Geotechnical Society (NZGS) is a Collaborating Technical Society affiliated to IPENZ and represents geotechnical practitioners and academics (engineers, engineering geologists and other geoscientists). The Society's principal aims are to promote the study and knowledge of geotechnical engineering and geosciences, to disseminate that knowledge and to provide a forum for those interested in the geotechnical field to communicate among themselves and with others outside the field in an effort to promote education and the advancement of both geotechnical engineering and geosciences.

As such NZGS is interested in the technical and scientific 'lessons learned' relating to ground behaviour, the performance and adequacy of existing codes, standards and statutes relating to building development and other land use, and the improvements/changes to codes, standards and statutes that might be warranted.

SUBMISSION

The following paragraphs contain the response of NZGS to the questions raised by the Royal Commission in the document 'Discussion Paper: Roles and Responsibilities'. We have responded only to those questions that the Society considers relevant to the geotechnical profession and where it is felt we can be of assistance to the Commission.

Efficacy of Building Regulatory Framework

Question 3. What are your views on the model proposed by IPENZ?

NZGS concurs with the model proposed by IPENZ, as clarified in its submission on this question, and in particular that a new standards model is needed that differentiates between regulation-driven standards and standards that are voluntary and business-enabling.

Standards Development

Question 1. What, if any, are the weaknesses, (e.g. omissions, failures, impediments) in the current building regulatory framework in relation to the process for developing requirements for design and performance of buildings for or in earthquakes?

The ground on which a building is located is integral to the building's performance in an earthquake.

The ground is an inseparable part of the building, and foundation design needs to be integrated into a building's structural design to ensure adequate performance. In effect, the performance requirements of the ground must be equal to or better than the performance requirements of the building and its foundations. This typically occurs in practice but the quality of the integration of geotechnical foundation design and structural design can vary. A gap in design and construction can occur because foundation performance of a building also depends on the performance of the ground adjacent to a building and possibly extending for some distance beyond. Thus a geotechnical assessment broader than just assessing the foundation requirements of a building may be necessary.

Whilst geotechnical elements of building design can have a fundamental bearing on the performance of a building in an earthquake, there are no minimum standards and little guidance on the approach for geotechnical assessment and performance expectations, e.g. liquefaction effects on building foundations (bearing capacity, settlement), effects of lateral spreading on building foundations and land surrounding buildings, slope stability of ground underlying or adjacent to buildings on which a building may rely for support of its foundations.

At present "industry practice" is used, which can result in designers using differing design performance requirements for building foundations and consequent difficulties for Territorial Local Authorities in assessing compliance of designs with the Building Code.

Current building standards and guidelines are inadequate in terms of identifying and evaluating geotechnical issues and risks to buildings during earthquakes and also other non-earthquake geotechnical hazards. The Building Code lists some issues (earth pressure, earthquake, differential movement) but does not include other common hazards such as ground movement, liquefaction, soft ground and geothermal conditions. Some of these hazards are related to earthquakes and some are not.

Structural design of buildings is reasonably easy to codify and a well-developed set of structural design standards has been developed for New Zealand. Geotechnical design however, is significantly more difficult to codify. Some elements can be codified and both normative and informative standards developed as seen in other countries. The current building regulatory framework is weak because of the current exclusion of geotechnical issues from structural codes and the Building Code and the lack of complementary geotechnical standards or appropriately developed guidelines. Another weakness in the existing regulatory framework is ensuring that adequate geotechnical assessment of land is carried out at earlier stages of land development, e.g. at the zoning and subdivision stages. For example it is difficult or not practicable to mitigate a liquefaction hazard for an individual residential building on a small site when a whole subdivision is at risk from the same the hazard.

The lack of minimum standards will in the future hinder, to a degree, improvement of the design and performance of buildings in earthquakes especially if there are corresponding moves to improve aspects of structural design of buildings.

Appended to this submission is a paper prepared by an NZGS member who is completing research into soil liquefaction for a PhD degree at Canterbury University. The paper discusses many issues around the regulation of geotechnical design for buildings and while not all views necessarily would be supported by the Society, the paper provides a useful summary and background to those issues.

Responsibilities

Question 2. If a work programme is needed for the development of building related Standards to ensure performance in an earthquake, (as discussed above in section 3), who should lead this, what are the priority areas, and how should this be funded?

Priority areas for guidance on geotechnical aspects of building design and performance are:

a. Liquefaction assessment and mitigation
b. Retaining wall design for earthquake loads
c. Slope stability assessment for earthquake conditions, including lateral spreading
d. Foundation design, incorporating liquefaction and seismic slope stability considerations.

NZGS notes the difficulty in development of geotechnical standards because of the variability of ground conditions. However some elements can be codified and both normative and informative standards developed. Funding and direction could usefully follow the United Kingdom Construction Industry Research and Information Association (CIRIA) approach.

Capability

Question 2. What skills are needed in the private building sector to ensure seismically resistant buildings?

The society would like to see that the private sector has ready access to ably skilled geotechnical professionals, in particular Chartered Professional Engineers and 'Professional Engineering Geologists'. The NZGS, in collaboration with IPENZ, currently is preparing a process for the professional recognition of engineering geologists to ensure the full range of ground engineering skills are available.

CPEng status is assessed on the basis of demonstrated competence in a self-declared practice area.

In the past, Members of IPENZ could append a practice field (aligned to one's practice area) to the MIPENZ designation. However, the publication of practice fields in any way by IPENZ has been discontinued in recent years. While we agree in general with the IPENZ view that it is unnecessary to publicise individual practice fields and practice areas, the NZGS strongly believes that geotechnical engineering is a special case. It requires particular training and experience in a field that is not well codified. As such, we believe that either publication of a geotechnical practice field for CPEng should be reconsidered or a special competence register for geotechnical engineering be developed, in order that clients and regulatory officials are aware of a practitioner's expertise in this field.

There is variable quality of geotechnical work performed in relation to buildings and the development of land on which buildings are sited. This variable quality is in part related to the competence of professionals working in geotechnical engineering, which requires specialist geotechnical skills.

Resourcing Standards Development

Question 3. Should primary reliance continue to be made on volunteers?

In the NZGS's experience, effective development of new guidelines and updating of existing ones takes far too long if left to well-intentioned but often over-committed volunteers. Learned societies should have input to the development of relevant documents, as they can present good state of practice and knowledge of the state of the art. Industry funded guideline development following the UK's CIRIA model or similar is likely to achieve equally valuable results but in a more timely manner. A secondary issue hindering voluntary guideline development is concern over liability for such advice.

NZGS is also aware that robust peer review of guidelines produced by volunteers within a learned society is required and that learned societies such as NZGS can have variable approaches to peer and industry review of guidelines. It would be better for guidelines to be prepared on a commercial basis with oversight by the appropriate learned society, regulators and end user groups. Funding and direction could usefully follow the UK CIRIA approach.

Question 5. Should there be more use or less use of mechanisms other than Standards to develop and provide methodologies for compliance; why or why not? Who would or should do this work and how should it be funded?

From a geotechnical perspective, formally recognised guidelines to good practice are more suited than standards to the wide variety of problems that geotechnical practitioners are called upon to solve. The guidelines should be prepared on a commercial basis with oversight by the appropriate learned society, regulators and end user groups. As noted, funding and direction could usefully follow the UK CIRIA approach.

The Standards do however need to be extended to include a clear and complete definition of geotechnical items and hazards to be considered in design. Appropriate and approved guidelines for their evaluation need to be referenced in the Standards. It is of particular relevance that the loading standard (NZS 1170.5: 2004) specifically excludes the use of the code seismic loading for liquefaction analysis, and no alternative is provided.

Reported by:
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NZGS

Appendix
Technical Article in *Geomechanics News*, Issue 83, June 2012.
'*Geohazard Mitigation in New Zealand* – in search of a normative and informative balance'. Merrick Taylor.

Geotechnical work at the Canterbury Earthquake Recovery Authority

CERA OR THE Canterbury Earthquake Recovery Authority was established following the 22 February 2011 earthquake in Christchurch as the NZ government's response to coordinate the greater Christchurch recovery. I have started with CERA in May 2011 after returning home from Japan as part of the Urban Search and Rescue (USAR) response following the Great Tohoku earthquake. I was seconded from my role as a Technical Director at Aurecon in Christchurch. Initially I was meant to stay with CERA for only a couple of weeks to determine what ground engineering issues could be around the rebuild. After now 18 months I am still with CERA as the Chief Geotechnical Advisor. The work includes liaison and providing technical advice to various teams and work streams within CERA, including the Community Well Being; Communications; Strategy, Policy and Planning; Infrastructure; Chief Executive Office and Operations teams.

Since the formation of the Christchurch Central Development Unit or CCDU the key issue that needs to be resolved is should the rebuild occur along a similar footprint as the previous central city. A large amount of information was already available and working closely with Tonkin & Taylor and Christchurch City Council the geotechnical constraints around the Blue Print development were resolved. Amongst the 'fun' part was shooting video footage in within the cordon on geotechnical issues and interacting with national and international investors seeking information.

CERA worked very closely with the Earthquake Commission (EQC) appointed engineers Tonkin & Taylor on the flat land to address the land damage and provide certainly with zoning the land.

My own background was around the Port Hills following the USAR work on the securing lifelines after the February earthquake. This work stream alone includes providing geotechnical advice to policy makers and Government officials, disseminate technical information from various sources and distil the key data for decision makers. For example for the Port Hills land zoning work information were provided by EQC, the Port Hills Geotechnical Group, a group of five large consultants working for the Christchurch City Council, GNS Science, CERA and CCC appointed contractors and multiple independent advisors and international peer reviewers. The work is led by senior policy advisors and the technical input was essentially to resolve the zoning of more than 12,000 properties on the hills.

In the early days there were several groups and teams working for Canterbury Earthquake Recovery Authority. One team coordinated the engineering response from the Art Gallery in town, whilst other groups worked in Wellington and Christchurch with policy makers and key stakeholders. I was in the Papanui office as part of the Horizontal Infrastructure Team. I remember the day Roger Sutton became our new Chief Executive Officer. The 13 June 2011 earthquake happened on the same day and the damage in the Port Hills was to some degrees much higher than from the February earthquake. Numerous cliffs failed and boulders once again rolled down the slopes. Fortunately at that stage s124 notices of the Building Act were already placed on the worst affected properties preventing harm from boulder roll. However, the work only increased once the technical challenges became apparent.

Amongst the challenges of the job is that often technically complex and difficult information has have to be presented to the members of the public. Communication is a key aspect of the job and it can involve attending at least one community briefing or meeting per week, and at key announcement milestones this can be as often as twice daily for several weeks on end.

Reported by:
Dr Jan Kupec
Chief Geotechnical Advisor

NZGS Young Geotechnical Professionals

THE YOUNG GEOTECHNICAL PROFESSIONALS (YGP) group has been formed to represent, support and provide a voice for the young professionals in the NZ Geotechnical Society. 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.

The aims of the group are:

1. To motivate young professionals to actively engage in the engineering geological/geotechnical profession and in NZGS;
2. Generate excitement and inspiration amongst the young members of the profession;
3. Increase the participation in NZGS by the young members of the profession;
4. Empower all young professionals and students to build their careers and promote their profession through networking, educational and social events.

Since the last Geomechanics News I have taken over the YGP representative role from Erica Cammack and would like to thank her for all her hard work. I look forward to carrying on the groundwork laid by her and Kate Williams. If any of the members have comments on the aims above or any suggestions for the YGP group I would be more than happy to hear from them.

Latest Activities

9th ANZ YGP Conference

The 9th ANZ Young Geotechnical Professionals Conference was held in St Kilda, Melbourne from 11 – 14 July 2012. The conference was highly successful and there was some great feedback from all those involved. Further details on the conference as well as the NZGS YGP Fellowship award for the best paper by a New Zealander at the conference are included later in this issue.

I would like to take this opportunity to thank the Earthquake Commission Research Foundation and the NZGS for their financial support of the 10 delegates awarded the YGP Conference Award.

Presentations to University Students

Earlier in the year Erica made a presentation to a few of the geology classes at the University of Auckland to promote the NZGS to students and get them involved in the society. In May I gave a presentation to the fourth year and masters geotechnical engineering courses at the University of Auckland and in September, before the committee meeting, I talked to three geotechnical engineering courses at the University of Canterbury. It is planned to do something similar at Waikato and Victoria Universities but I hope to recruit some local help for this. We have had a few students sign up to the society from these presentations which is positive, but this will be an ongoing initiative.

2012 Student Presentation Awards

This year it was decided to run a poster competition for the 2012 Student Awards. By the time this issue is out the posters will have been presented and the awards given out but at the time of writing this report abstracts were in the process of being submitted. Students were required to submit an abstract on a topic relevant to geotechnical engineering or engineering geology then submit their poster for display at a NZGS event to be held in the city with the most submissions. At this stage there have been 12 submissions, with 8 from Auckland, 3 from Canterbury and 1 from Waikato.

The posters are to be displayed before and after an end of year event towards the end of November. A panel of 3 official judges is to be formed to give the final awards, however, members who attend the event would have the opportunity to select their top 3 posters for consideration by the judging panel. Prizes for the top 3 posters will be given out with monetary awards of $1000 for 1st, $500 for 2nd and $300 for 3rd. It was hoped that the top three posters will be able to be included in this issue of Geomechanics News but the timing may mean they are in the next issue.

Upcoming Activities and Ideas:

- Further promotion of the NZGS at Universities
- Student Award abstract consideration and end of year event
- Formation of a YGP liaison group of interested young professionals throughout the country following conversations with delegates at the 9YGP Conference
- Liaison with other young professional groups such as Engenerate – the IPENZ young professionals group
- Part time work opportunities for students on the NZGS website
- A YGP forum on the NZGS website with involvement from senior members
- Social media groups
- Social events – quiz night, rock climbing

Reported by:
Luke Storie
YGP Representative, Email: luke.storie@gmail.com

Registration of Engineering Geologists – Update

RECENTLY IPENZ NOTIFIED the industry of the NZGS-led initiative to establish a register of current competence for Professional Engineering Geologists. Submissions on the proposal closed on 1 October 2012.

The proposed register name is the register of Professional Engineering Geologists and anyone holding current registration on this register will be entitled to use the post nominal "PEngGeol".

Geotechnical practice encompasses the general fields of both geology and civil engineering. Specialisation within both disciplines has led to the recognition of "engineering geology" and "geotechnical engineering" as distinct fields of professional practice. Essentially, the engineering geologist is responsible for predicting the nature of the ground and the geotechnical engineer for analysing how it will respond to changes brought about by physical engineering works.

The statutes of the International Association for Engineering Geology and the Environment (IAEG, 1992) define Engineering Geology as "the science devoted to the investigation, study and solution of engineering and environmental problems which may arise as a result of the interaction between geology and the works and activities of man as well as to the prediction and development of measures for prevention or remediation of geological hazards."

The designations "engineering geologist" and "geotechnical engineer" were defined by the late Professor P.W. Taylor in a submission to the Commission of Inquiry into the Abbotsford Landslip Disaster, as follows:

"The engineering geologist has a thorough knowledge of geology, and also some knowledge, acquired by academic training or through experience or both, of the methods of engineering analysis as applied to geotechnical problems. Instead of the "purely scientific" approach of the traditional geologist, he is trained to apply his knowledge in assisting in the design and construction of civil engineering works. He is capable of understanding the problems faced by engineers and of communicating with them in a way which is of value in making engineering decisions."

"Amongst civil engineers, some specialise in geotechnical engineering. Either by post-graduate university studies, or by practical experience and private study, such engineers have specialist knowledge of soil mechanics, foundation engineering and possibly rock mechanics."

Put simply: good engineering geologists must be geologists who understand engineering needs, and good geotechnical engineers must be engineers who understand the help that geology can bring, and the risks of ignoring it. They are not interchangeable, and nor should they be; each has separate skills, functions and responsibilities.

Only with close collaboration between the two can site conditions be adequately assessed so as to arrive at an economical and stable design. This collaboration is, unfortunately, not as widespread or uniform as might be expected, due in large part to the fact that geotechnical engineers currently enjoy professional recognition, whereas engineering geologists do not.

The Draft Guidelines presented by NZGS to IPENZ are shown on the next page.

Professional Engineering Geologist Competence Standard (Including Elements and Performance Indicators)

The following competence standard sets the entry standard for engineering geologists seeking formal peer recognition as a competent professional engineering geologist by undertaking a competence assessment administered by IPENZ as the Registration Authority. The competence standard below sets the standard for Initial Registration as a Professional Engineering Geologist (PEngGeol) and Continued Registration.

What is a Competence standard?

A competence standard is an indication of an expected level of performance. The competence assessments conducted by the Registration Authority require applicants to provide sufficient evidence to demonstrate they are able to consistently apply knowledge, understanding and skills to the standard expected of a reasonable professional engineering geologist.

This standard is outlined in this document.

Format of IPENZ Competence Standard for Professional Engineering Geologists

The PEngGeol Competence Standard for Professional Engineering Geologists consists of the following:

12 Elements: these represent broad areas of professional engineering geological performance. Taken holistically these elements make up the minimum standard for registration.

Performance Indicators (bullet points): these provide further detail as to the meaning of each element thereby enabling the applicant and assessors to have a clearer understanding of the performance required to demonstrate competency in each element. They are important indicators of competence but are not criteria that need to be met nor are they an exhaustive list.

Definitions: these provide a critical component of the standard and need to be considered carefully by applicants when they are preparing their portfolio of evidence to demonstrate they meet the competence standard.

Performance assessed against each Element

Those undertaking an initial or continued registration assessment are expected to provide to their Assessment Panel evidence of their current competence which demonstrates that they are able to meet all the elements of the standard. The Panel, however, considers the totality of the evidence supplied and makes a holistic assessment as to whether each applicant meets the PEngGeol Competence Standard for Professional Engineering Geologists.

PEngGeol Competence Standard for Professional Engineering Geologists (Including Elements and Performance Indicators)

To meet the minimum standard a person must demonstrate that he/she is able to practice competently in his/her practice area to the standard expected of a reasonable professional engineering geologist.

The extent to which the person is able to perform each of the following numbered elements in his/her practice area must be taken into account in assessing whether or not he/she meets the overall standard.

1 Comprehend, and apply knowledge of, accepted principles underpinning widely applied good practice for professional engineering geology

- Has a recognised Geological degree at Honours level, Master's level or Doctorate level awarded by a university or institution of higher education or has demonstrated equivalent knowledge and is able to:
  - Identify, comprehend and apply appropriate engineering geological knowledge
  - Work from first principles to make reliable predictions of outcomes
  - Seek advice, where necessary, to supplement own knowledge and experience
  - Read literature, comprehend, evaluate and apply new knowledge

2 Comprehend and apply knowledge of accepted principles underpinning good practice for professional engineering geology that is specific to the jurisdiction in which he/she practices (for PEngGeol assessment this relates to the jurisdiction of NZ)

- Understands and operates within the legal and regulatory frameworkin the jurisdictions in which he/she practices
- Understands and applies appropriately the special engineering geological requirements operating within the jurisdictions in which he/she practices
- Understands and applies codified knowledge such as standards, IPENZ practice notes, codes of practice etc.

3 Recognise, define and investigate complex engineering geological problems in accordance with good practice for professional engineering geology

- Identifies and defines the scope of the problem
- Investigates and assesses relevant information using qualitative and semi-quantitative techniques
- Tests interpretations and analyses for

reasonableness of results
- Conducts any necessary research or further assessments and reaches substantiated conclusions

4 Analyse and communicate complex engineering geological problems in order to inform development of engineering solutions and design in accordance with good professional practice
- Analyses geological and geotechnical information to inform engineering design
- Considers the engineering design requirements and identifies constraints and alternatives, including as appropriate the need to design for safety, constructability, maintainability etc
- Uses maps, sections and models to communicate investigation data and interpretation of ground conditions
- Develops concepts and recommendations to inform design and construction that consider project needs, requirements and criteria
- Interacts with the design and/or construction engineer

5 Be responsible for making decisions on part or all of one or more complex engineering geological activities
- Takes responsibility for his/her outputs and for those for whom he/she is responsible
- Accepts accountability for his/her engineering geological activities

6 Manages part or all of one or more complex engineering geological activities in accordance with good engineering management practice
- Plans, schedules, organises and monitors progress of projects or activities to deliver specified outcomes within time constraints
- Applies appropriate quality assurance techniques
- Manages resources, including personnel, finance and physical resources
- Manages conflicting demands and expectations

7 Identify, assess and manage engineering geological uncertainty and geotechnical risk
- Identifies risks which impact on people, property and the environment (professional, technical, Health & Safety, financial, legal, client etc)
- Develops risk management policies, procedures and protocols to manage safety and hazards
- Manages risks through 'elimination, minimisation and avoidance' techniques

8 Conduct engineering geological activities to an ethical standard at least equivalent to the relevant code of ethical conduct
- Understands IPENZ codes of ethics
- Behaves in accordance with the relevant code of ethics even in difficult circumstances (includes demonstrating an awareness of limits of capability; acting with integrity and honesty and demonstrating self-management)
- Informs decision makers of significant consequences from not following advice (e.g. related to risks, safety etc)

9 Recognise the reasonably foreseeable social, cultural and environmental effects of professional engineering activities generally
- Considers issues and impact(s) of own contribution to engineering activities such as use of materials, waste during fabrication/ construction, energy efficiency during use, obsolescence and end-of-life issues
- Considers and takes into account possible social, cultural and environmental impacts and consults where appropriate
- Considers Treaty of Waitangi implications and consults accordingly
- Recognises impact and long-term effects of engineering activities on the environment
- Recognises foreseeable effects and where practicable seeks to reduce adverse effects

10 Communicate clearly with other engineering geologists, engineers and those that he or she is likely to deal with in the course of his or her professional engineering geological activities
- Uses oral and written communication to meet the needs and expectations of his/her audience
- Communicates using a range of media suitable to the audience and context
- Treats people with respect
- Develops empathy and uses active listening skills when communicating with others
- Operates effectively as a team member

11 Maintain the currency of his or her professional engineering geological/ geotechnical knowledge and skills
- Demonstrates a commitment to extending and developing knowledge and skills
- Participates in education, training, mentoring or other programmes contributing to his/her professional development
- Adapts and updates knowledge base in the

course of professional practice
- Demonstrates collaborative involvement with New Zealand professional engineers and engineering geologists
- Awareness and application of recent developments within his or her own practice area

12 Exercise sound professional engineering geological judgement
- Demonstrates the ability to identify alternative options
- Demonstrates the ability to choose between options and justify decisions
- Peers recognise his/her ability to exercise sound professional engineering geological judgement.

Definitions

(i) Practice Area

means an engineering geologist's area of practice, as determined by –

(a) the area within which he or she has engineering geological knowledge and skills; and

(b) the nature of his or her professional engineering geological activities.

The practice area is a combination of both the area in which the engineering geologist holds specialised engineering geological knowledge and the nature of the activities performed, and one or both of these may change over the course of professional life. The competence of the applicant will be assessed in his/her current area of practice.

(ii) Complex engineering geological activities

Complex engineering geological activities means activities or projects that have some or all of the following characteristics:
- Involve the use of diverse resources (and for this purpose resources includes people, money, equipment, materials and technologies)
- Require recognition, understanding and resolution of significant problems arising from interactions between wide-ranging or conflicting engineering, engineering geological and/or other issues,
- Involve the use of new techniques or processes, or the use of existing techniques or processes in innovative ways.

(iii) Complex engineering geological problems

Complex engineering geological problems means problems that cannot be recognised understood or resolved without in-depth engineering geological knowledge and having some or all of the following characteristics:
- Involve wide-ranging or conflicting engineering and engineering geological and other issues
- Are not readily recognised, understood or solved and require originality in analysis
- Involve a wide range of issues, that might be in an unfamiliar setting
- Are outside those problems whose resolution are encompassed by guidelines, standards and codes of practice for professional engineering geology
- Involve diverse groups of stakeholders with widely varying needs
- Have significant consequences in a range of contexts

(iv) Knowledge Specific to Local Jurisdictions

Applicants will need to provide evidence that, within the jurisdictions in which they work, they:

(a) Understand the general principles behind applicable codes of practice;

(b) Have demonstrated a capacity to ensure such principles are applied safely and efficiently; and

(c) Are aware of the special requirements operating within the host jurisdiction.

(v) Methods of Analysis

The techniques used in qualitative, semi-quantitative and quantitative analysis will vary depending on nature of the problem however they include review of literature and published geological maps, field mapping, stereonet analysis, computer, mathematical or reliability modelling, statistics, and the use of planning tools.

(vi) Responsibility for Making Decisions for Complex Engineering Geological Activities

Applicants may be taken to have been responsible for making decisions for complex engineering geological activities when they have:
- Planned, scoped, co-ordinated and executed a (small) project; or
- Undertaken part of a larger project based on an understanding of the whole project;
- Or undertaken novel, complex or multi-disciplinary work.

Reported by:
NZGS PEngGeol working group (Bruce Riddolls, David Burns, Geoff Farqhuar, Warwick Prebble and Ann Williams).

Geotechnical Engineers at "SCIRT" – helping to rebuild Christchurch

Figure 1 Cunningham terrace – post collapse

The origins and set up of SCIRT

You must have been living on the moon if by now you are not aware that Christchurch has been severely affected by four strong earthquakes in the last two years. During the aftershock sequence there have also been over 10,000 earthquakes with a magnitude over 2.0 in the Canterbury area (source : http://www.christchurchquakemap.co.nz/). The earthquakes damaged a significant amount of the publicly owned infrastructure in Christchurch which specifically means the roads, the wastewater, water supply and stormwater supply pipes, the bridges, and the retaining walls.

In order to carry out the rebuild and repair of this damaged infrastructure the Client grouping of Christchurch City Council, NZTA and CERA have set up a contractual structure known as an "Alliance" with the contracting organisations of Fulton Hogan, Downer, McConnell Dowell, Fletcher and City Care. Collectively this Alliance grouping is known as "SCIRT", which stands for "Stronger Christchurch Infrastructure Rebuild Team".

In order to carry out and manage the design and build work for SCIRT, purpose built offices have been set up on Magdala Place in Middleton in Christchurch. Council staff, representatives from the main contracting organisations and Consultant Engineers are all based there. The bulk of the staff in this "design arm" of SCIRT are from the consulting organisations of Aurecon, Beca, GHD, Opus, SKM, URS and MWH, with other companies also represented. All in all, there are approximately 180 consultant engineering staff based at SCIRT and the vast majority are concentrated 100% on the rebuilding of the public infrastructure. The life of SCIRT is currently planned to be approximately 5 years with a total estimated spend of $2.2billion, a figure which, of course, may rise.

Overview of Geotechnical Engineering and Geological Work at SCIRT:

There is obviously a heavy geotechnical and geological emphasis to the work being carried out by SCIRT which includes work on the elevated loess and basalt areas in the Port Hills and the flatter, gravelly, sandy and silty areas on the plains below.

It was realised at an early stage that SCIRT would have a significant requirement for intrusive site investigation works. To manage this, a specific site investigation procurement team was set up by SCIRT which includes 4 staff whose job it is to procure boreholes, test pits and other intrusive items for the design staff as they request it. This is a significant difference between the way a "conventional" consultancy might operate where the engineering staff would procure and manage their own site investigations.

- Some of the day to day challenges which the SCIRT geotechnical staff face include:
- Assessing the risks and magnitude of future

Figure 2: – London Street Soil Nail and Shotcrete Wall;

Figure 3: Cunningham terrace – during construction;

Figure 4: McCormacks Bay Reservoirs Retaining Wall During Construction

liquefaction damage to the proposed road repairs.

- Assessing and advising on future "catchment wide" liquefaction damage in areas where water infrastructure repairs are required.
- Designing mitigation measures for liquefaction damage to new pump stations, lift stations and manholes.
- Designing repairs for retaining structures in accordance with recommendations for raised seismic levels of disturbance issued by "SESOC" (the Structural Engineering Society of New Zealand).
- Assisting structural engineers with design work for new and existing bridge foundations.

Examples of a few retaining wall projects currently designed and being built by engineers in SCIRT

1. London Street in Lyttelton (see Figure 1)

At London Street in Lyttelton, a 5-metre high soil nail wall is being constructed. This will replace an ash block wall that failed during the February 2011 earthquake. The wall will be refaced with ash blocks to maintain an historic appearance and to match adjacent walls.

2. Cunningham Terrace in Lyttelton (see Figures 2 and 3)

At Cunningham Terrace in Lyttelton, an 80m long section of failed wall is being reconstructed using an anchored steel king post and concrete panel wall. The photos below show "before" and "during construction" (October 2012) images of the site.

3. McCormacks Bay Reservoirs Retaining Wall (see Figure 4)

A "stacked rock block" non–engineered gravity structure retaining a filled platform at the McCormacks Bay Reservoirs site experienced significant deformation during the 22nd February 2011, and 13 June 2011 earthquakes. The solution employed was a new anchored post and panel retaining wall of up to 4m retained height as shown in the photograph.

Reported by:
Ian Frogatt
Aurecon

GEOLOGY 701
Engineering Geological Mapping
Summer School
29 January - 8 February 2013

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. One day of office-based work will follow to allow completion of field mapping assignments.

Learning Outcomes:
You will be able to

- develop the art of field observation and description
- draw engineering geological models
- recognise and map geotechnical hazards.

What is it: A 15-point, 700 level course within the School of Environment Geology programme.

When: Summer Semester, 29 January - 8 February 2013

Where: City campus, plus fieldtrips to localities in the Auckland region.

Pre-requisites: GEOLOGY 372 or equivalent course/ experience.

Assessment: Entirely based on the field mapping assignments.

Course details: see ***http://www.env.auckland.ac.nz/home_page/geol701/index.html***

For further information, contact:
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THE UNIVERSITY OF AUCKLAND
NEW ZEALAND
Te Whare Wānanga o Tāmaki Makaurau

AWARDS

NZGS YGP Fellowship

THE YGP FELLOWSHIP is awarded to the author of the best paper by a New Zealand representative at each YGP Conference. The award is judged at the conference by the organising committee and senior geotechnical professionals in attendance (mentors) and announced at the closing ceremony. At the 9YGPC the mentors were David Burns (NZGS Chair - AECOM) from New Zealand along with Alan Moon (Coffey Geotechnics), Allan McConnell (Insitu Geotech Services) and Max Ervin (Golder Associates) from Australia.

This year we are pleased to announce that the winner of the NZGS YGP Fellowship is Richard Heritage from Aurecon. His paper was entitled "Analysis of basement excavation through organic silt" and is included in this issue of Geomechanics News. The judges noted that they had a very tough decision this year as the calibre of the presentations was outstanding. The fellowship provides funding of up to $4000 for Richard to go the next International YGP Conference, which will be held in Paris, France from August 30 to 1 September 2013. A big congratulation goes out to Richard and we look forward to hearing about the conference next year.

Above: Richard Heritage: Winner of the NZGS YPG Fellowship

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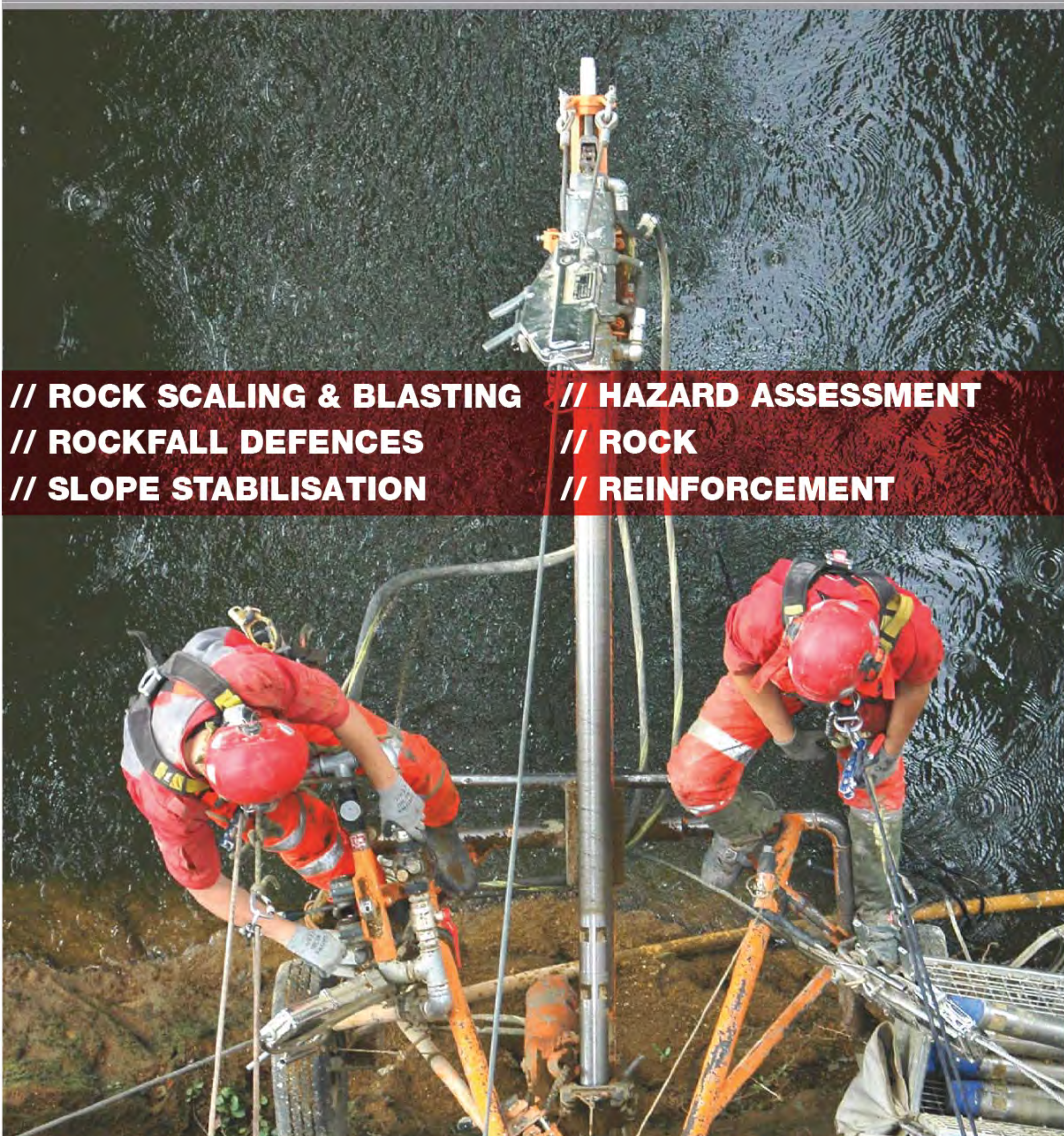

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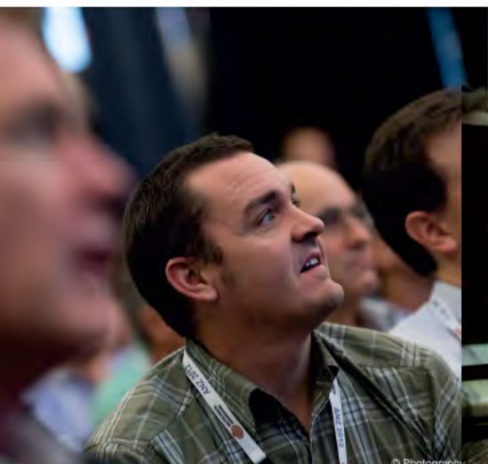
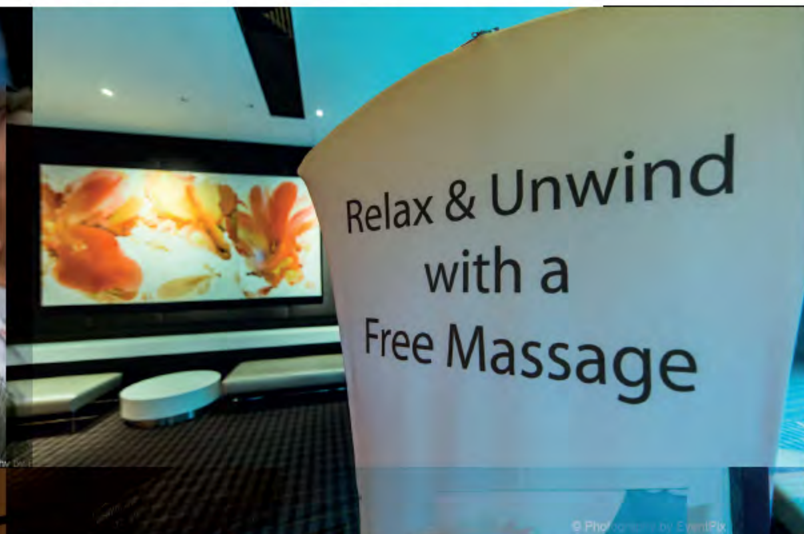
ANZ 2012
GROUND ENGINEERING IN A CHANGING WORLD
CROWN CONFERENCE CENTRE, MELBOURNE





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CONFERENCE REPORTS

Conference Review: ANZ 2012

THE 11TH AUSTRALIA New Zealand Conference on Geomechanics "Ground Engineering in a Changing World" was held in Melbourne on the 15 to 18 July 2012. The conference marked 41 years since the inaugural ANZ conference also held in Melbourne, in 1971.

The conference was attended by over 550 delegates mainly from New Zealand and Australia, but including a respectable number of international attendees from as far afield as America, Europe, Africa, Middle East and Asia.

Eight concurrent sessions were held over a three day period with four main lecture theatres presenting themes on Geohazards and Risk; Evolving Geotechnics & Site Characterisation, Supporting Our Structures, and Sustainable Geotechnics & Geoenvironmental Engineering. Day two saw the introduction of Mining and Underground Geotechnics theme and on day three the introduction of Near Shore and Offshore Geotechnics.

Key note presentations were opened by Jean – Louis Briaud, president of ISSMGE, on the topic of Design Guidelines and Full Scale Verification for MSE Walls with Traffic Barriers Impacted by Vehicles. Subsequent keynote presentations were given by Francis Badelow on Forensic Foundation Engineering and Rectification Design; Nick O'Riordan on Sustainable and Resilient ground engineering and by David Bell on the topic of Geo-Logic and the Art of Geotechnical Practice. The Mercer Lecture was presented by Dr Michael Heibaum on the topic of Geosynthetics for waterways and flood protection structures – controlling the interaction of water and soil.

Harry Poulus, Mark Davies and Lucy Coe informed us of ISSMGE activities and information as part of their celebrations of the 75th anniversary of ISSMGE. An interesting fact from both Harry and Marks presentations was New Zealand's disproportionate over representation of technical members internationally, a sure sign of New Zealand's thriving geotechnical community.

The conference social calendar kicked off with the Welcome Reception in the Crown Hotel's River Room overlooking Melbourne's Yarra River with a fireball display care of the Crown casino's very own flame tower. This was followed by happy hour drinks and poster presentations on the Monday evening and the formal conference dinner at the Crown Palladium ballroom on Tuesday evening.

Breaks between technical concurrent sessions were filled by free flowing food, coffee and refreshments provided in the Exhibition Hall whilst delegates mingled with friends, clients and colleagues, viewed the trade stands and picked up loads of free gadgets and information.

All in all the conference was well run and a great success, reflected in the large numbers of delegates and the high quality of papers presented. Well worth the trip across the ditch.

Reported by:
Benjamin O'Loughlin
Aurecon

Conference Review: ANZ 2012

IN MID JULY 500+ geotechnical practitioners and researchers descended on the Crown Conference Centre, Southbank Melbourne for four days of stimulating and varied presentations on many things geotechnical. The conference began with a bang (or at least several car crashes) care of Prof. Jean-Louis Briaud's talk on the design of traffic barrier MSE walls for vehicle impacts. I certainly gained a greater appreciation of road safety! Over the following three days 175 talks and 107 posters were presented on a wide range of topics - something for everyone. The main theme of the conference centred around the need for sustainable and evolving geotechnics in light of a more uncertain and challenging economic and environmental future. There was an emphasis on structure support, underground and mining environments and geo-hazards. The keynote speakers presented interesting talks along these themes which ranged from the many applications of geosynthetics to forensic engineering, low carbon engineering, and the importance of putting geo before technic. I enjoyed the keynote speaker's talks not only because of their content but also because of their diverse career backgrounds and experiences. The conference was also a chance to celebrate the 75th anniversary of the ISSMGE, with a reflective look back over the society's past, present and future.

The social side of the conference kicked off at the welcome reception on the Sunday night, with the poster session and conference dinner being the other main events. The conference dinner was held in the Grand Palladium ballroom, which had been personalised with some polystyrene rocks and miniature toy drilling rigs on every table. These drilling rigs were certainly the show stopper of the dinner with one lucky person able to take them home from each table, while the rest looked on in envy.

Personally, it was fantastic to have the opportunity straight after finishing my Masters to go to an international conference of this standard, and be able to present a paper at it. One of the major highlights, alongside hearing all the other presentations and presenting my own research, was meeting others in the field of geotechnical engineering and engineering geology.

And, of course the other major highlight of the conference was its setting! The conference was held in the sophisticated surroundings of the Crown Entertainment Centre, a short distance from the Yarra River and city centre. Having a very nice hotel room 21 floors up overlooking the Melbourne CBD certainly added to the trip! Especially since in the not so distance past I had attended a conference in Nelson as a student, where my accommodation had been a mattress on the floor!

All in all, it was wonderful experience and privilege to be able to attend the 2012 ANZ Geomechanics conference. It was great to meet more people within the geotechnical field, as well as being able to hear and learn from some of the best!

Reported by:
Saskia de Vilder
NZGS Member
Geologist, Tonkin & Taylor Ltd

9th ANZ Young Geotechnical Professionals Conference – St Kilda, Victoria, Australia 11-14 July 2012

THE 9TH ANZ Young Geotechnical Professionals Conference (9YGPC) was held in St Kilda in Melbourne from 11 – 14 July 2012. The YGP conference has been held over the past 18 years for geotechnical professionals from Australia and New Zealand who are 35 years and younger with a maximum of 10 years' experience. The aims of the conference are to:

- Promote the professional development of delegates through sharing experience and ideas, and by presenting a paper to senior professionals and peers.
- Expand and strengthen the lines of communications between young professionals within the field of geomechanics.
- Promote an enhanced perspective of the varied roles, responsibilities and opportunities encompassed by the geotechnical profession.

Over the years the conference has been designed to promote informal interaction between participants. This year was no exception, with a great range of opportunities for delegates to network and discuss their professional careers. The atmosphere was informal but the calibre and quality of the presentations was outstanding, with the senior professionals who attended supporting this sentiment. The feedback from the delegates was that it was a very interesting and engaging conference and a brilliant way to meet fellow young geotechnical engineers and engineering geologists. Much gratitude is given to the organising committee who did a fantastic job creating a hugely successful event.

The EQC and NZGS have consistently supported our YGP members with financial sponsorship to attend this conference. A total sum of $10,000 was distributed amongst delegates who were awarded the YGP Conference Award based on their submitted abstracts and circumstances. The support of the EQC and NZGS was greatly appreciated by all recipients of the award and the chance to attend an international conference such is this was invaluable. Below are comments sent through from a few of the award winners about the conference and a photo of all of the delegates that attended:

Attending the 9YGPC was a great experience with many interesting papers and friendly fellow geotechnical professionals. There were several papers relating to the Christchurch earthquakes which were very relevant to my area of work but what I found most interesting was learning a bit more about the geotechnical challenges in the big mines in Australia – something that I previously knew very little about. One of the other delegates (Frances Neeson) commented that it had really reinvigorated her enthusiasm for geotechnical engineering and I entirely agree. – **Richard Heritage**

I greatly appreciated the grant provided by NZGS to attend the 9YGPC- it was an excellent experience! The presentations were of very high calibre. Of particular interest were several interesting projects presented on geotechnical investigations in Christchurch. The keynote speaker presentation on the uncertainty associated with soil parameters acquired from different in situ testing methods was very insightful. The conference provided an excellent opportunity to meet other young geotechnical professionals and learn about what sort of geotechnical issues they are facing and how they are dealing with them. – **Catherine Tatarnuik**

I thoroughly enjoyed the 9th YGP conference in Melbourne. The conference stood out from all others that I have attended, as all delegates were of the same age group and level of experience. The social side of the conference was very well organised, and provided a great opportunity to mix with peers and discuss each other's work. The layout of the conference venue and the informal approach of the organisers in generating interaction between the delegates and mentors resulted in free-flowing and lively discussion. The time slot for each delegate was kept deliberately brief (9 minutes) and resulted in succinct presentations with limited technical content which were pitched at the perfect level for the huge range of expertise in the room.

The conference highlights for me were the presentations on the Australian opencast mines, which are at a much larger scale than anything we have in NZ. The Australian delegates also really appreciated the presentations on the Christchurch earthquakes, although they appeared slightly dumbstruck when informed of the peak ground accelerations experienced during the February 22 earthquake!

I would certainly recommend the YGP conference to any young geotechnical professionals who are considering presenting an aspect of their work and are maybe a bit apprehensive about doing so at a larger and more formal forum. The YGP conference also provides an invaluable opportunity to meet industry peers from both NZ and Australia. As for me, I'll be too old to qualify as

19th Symposium

NEW ZEALAND GEOTECHNICAL SOCIETY INC
www.nzgs.org

Wednesday 20 November – Pre-Symposium Workshops

- Half Day presentations in the morning and afternoon
- Two concurrent streams; Geotechnical Engineering & Engineering Geology
- Welcome Reception

Thursday 21 November – Symposium

- Welcome
- KEYNOTE Speaker: Prof Harry Poulos
- Invited Speakers: Kelvin Berryman and Jarg Pettinga
- Two Concurrent Sessions
- Gala Dinner

Friday 22 November – Symposium

- Welcome
- Keynote Speaker: Dr. Leillio Meija
- INVITED Speakers: Don McFarlane and Mark Yetton
- Concurrent Sessions
- Cocktail function and Poster Session

Saturday 23 November – Post-Symposium Field Trips

- Field Trips to various sites including Clyde Dam and Associated Landslides, SH1 Network, Local Developments
- The opportunity for leisure trips

KEYNOTE SPEAKERS

DR. LEILIO MEJIA

Dr. Mejia is a Vice President and Earthquake Engineering leader at URS in Oakland, California where he has been involved in geotechnical, dam and foundation engineering projects for over 30 years. His experience in the design of large earth dams, including assessing seismic stability and liquefaction issues for these structures, is particularly relevant as he has worked on a number of dam projects in New Zealand.

PROF. HARRY POULOS

Prof. Poulos is a Senior Principal at Coffey Geotechnics in Australia and Emeritus Professor at the University of Sydney. Harry is a recognized international authority in geotechnics, particularly in pile foundation design and research into soil-structure interaction. In his close to 50 years' in the geotechnical industry he has worked on major projects throughout the world, including tall buildings, bridges, tunnels, and offshore structures.

INVITED SPEAKERS

Kelvin Berryman, Don Macfarlane, Mark Yetton, Jarg Pettinga

HANGING BY A THREAD?

Lifelines, infrastructure and natural disasters

For detailed information regarding this symposium and the associated workshops, and abstract submission. www.nzgs13.co.nz

20-23 November 2013

QUEENSTOWN

a "young" geotechnical professional by the time the next one rolls around! – **Jason Kelly**

I had a ball at the 9YGPC in Melbourne. It was great to attend a conference which was small enough to meet and talk with everyone in attendance. I found all of the presentations informative and interesting, many of the papers had some aspect which was new to me which kept my attention throughout. One of the highlights of the conference for me were the presentations given by the mentors, Allan McConnell and Alan Moon. Both were great reminders of important things I should always be thinking about as an engineering geologist. Thanks so much to the organisers, especially Joel Gniel and David Gallagher for putting on such a fun conference, and many thanks also to the NZ Geotechnical Society and the Earthquake Commission for their financial assistance to allow me to attend. – **Erica Cammack**

I thoroughly enjoyed the 9YGP conference and it really reinvigorated me in our discipline. It definitely made all the hard work of preparing, in my case 2 papers worth it! And I thoroughly appreciated the sponsorship provided by NZGS and EQC and would like to thank them for their contribution in supporting my attendance at the conference in addition to the support of Opus. It was a great opportunity to see examples of the innovative work being undertaken within the Geotechnical community in NZ, Australia and the Pacific and the passion our young professionals have for geotechnics. It was fantastic having senior mentors at the conference and listening to their 'take home messages' using examples that have spanned their careers. I was impressed with the standard of presentations, everyone went to a great effort to present their papers in a professional, clear and interesting manner. The conference organisers greatly contributed to the success of the conference and I really appreciated all their dedication to deliver such a successful event. The fieldtrip was a good note to finish on and really illustrated that while the geology of different regions or countries may be different, we face similar geotechnical challenges and therefore, sharing of ideas is crucial to advancing our profession. – **Frances Neeson**

Luke Storie
YGP Representative. NZGS
Email: luke.storie@gmail.com

NZGS Short Courses on In-Situ Testing – July and August 2012

Part One: Introduction to In-situ Testing: Diego Marchetti and Ernst Wassenaar (July 2012)

Part Two: Use and Application of the CPT for Geotechnical Engineering Practice: Prof. Peter Robertson (August 2012)

THESE COURSES WERE initiated by the recent ANZ Geotechnical conference in Melbourne, where a master class on in-situ testing was held. I thought that a similar course in NZ would be useful. Consequently, I managed to convince two of the speakers (Diego Marchetti and Ernst Wassenaar) to come to NZ immediately after the Melbourne conference to hold a short course here.

Prof. Peter Robertson had given a brief talk on CPT testing in Auckland in early January this year whilst on holiday. He promised to return at some later date to do a short course. We hoped that he may have been able to come at the same time as Diego and Ernst, but he was unable to make it at that time. Consequently, it was decided to make the courses in two parts; the first being a general introduction to in-situ testing, with the second to be a more detailed course on the interpretation of the CPT.

Above: CPT Seminar in Auckland

The courses for both parts were held in Auckland, Wellington and Christchurch. The part one courses on the introduction to in-situ testing were half day courses and covered the basics of CPT and DMT. Ernst Wassenaar is the Technical Director of Geomil, which is a Dutch company that has been manufacturing CPT equipment for over 75 years. He explained the principles behind the CPT equipment and its operation. Diego Marchetti described the operation of the flat dilatometer (DMT), which is an instrument developed by his father, Prof. Silvano Marchetti in 1980. Diego's major contribution to the equipment was the addition of a seismic module, which is perhaps the best downhole seismic system in the world today. As well as describing the basic operation of the equipment, Diego also went into more detail about the interpretation of the results of the test.

Above: Marco Holtrigter, Prof. Peter Robertson and Charlie Price

Prof. Peter Robertson's course was a full day course, although the Wellington course was reduced to a shorter presentation due to time constraints. Peter has a speaking style that makes it very easy to follow the topic he is presenting. He has the special ability to reduce highly complex topics into simple concepts that are easy for the listener to understand. Prof. Robertson is a huge proponent of the CPT and his enthusiasm of the topic shows in his presentations. He is widely regarded as a CPT guru, having done decades of research on the equipment, much of which forms the basis for current practice in CPT interpretation. Peter's course covered all aspects of CPT interpretation with an emphasis on liquefaction assessment and the use of the computer programs, CPeT-IT and CLiq for interpretation and design purposes.

All-in-all the courses were well received and well attended. In Auckland alone there were over 50 people for the Part one course and over 80 people for the Part two course. The very high attendance is considered to be a

reflection of the reputation of the speakers and the current interest in the topic of in-situ testing.

I was fortunate to attend all of the courses, as I was hosting the speakers. At each course, I picked up more information and other concepts were reinforced by hearing them repeated. I was already a proponent of in-situ testing, but these courses convinced me further of the power of CPT and DMT testing. The tests are cheap, provide a large amount of data and provide reliable interpretations to soil parameters. After attending these courses, you would have to seriously question ever doing SPTs again!

It was my pleasure to help organise these courses along with the NZGS. Special thanks to Amanda Blakey and Charlie Price, We were fortunate to have such prominent speakers and we thank them for their time. Thanks also to Beca in Auckland and Aurecon in Wellington for the use of their premises. Ground Investigation Ltd was grateful to be the sponsor for these courses.

Reported by:
Marco Holtrigter
Ground Investigation Ltd

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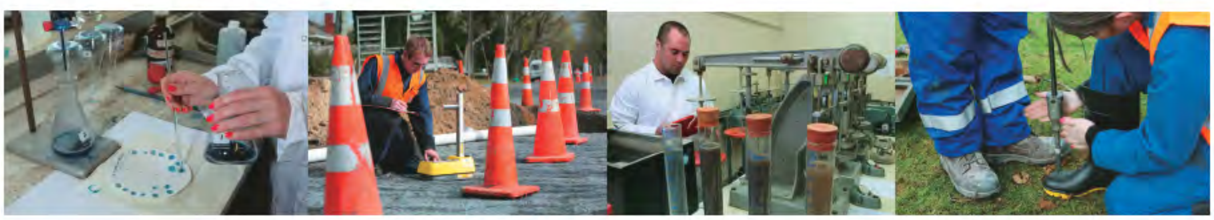

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19th NZGS Symposium 2013

THE 19TH NZGS Symposium in Late November 2013 is looking like a great time for those in the geotechnical industry to book in some professional development, in fact, this will be a great event for anyone interested in participating in a Symposium on the current state of geotechnical practice in New Zealand.

NZGS and the 19th Symposium organizing committee have assembled a varied and interesting programme for this edition of the Society's Symposium, which is focused on Lifelines, Infrastructure and Natural Disasters. The programme is headlined by keynote speakers Dr Lelio Mejia and Professor Harry Poulos, who bring relevant international design experience that will be particularly relevant for this Symposium. Respected local speakers and workshop presenters, such as Kelvin Berryman, Don Macfarlane, Mark Yetton, Misko Cubrinovski, Mick Pender and Jarg Pettinga will ensure a high standard of presentation.

Recent natural disasters in the Australasian region, with tremendous collateral damage and loss of life, in particular earthquakes and floods, are of direct relevance to geotechnical and engineering geology communities. Since 2000 these types of natural disaster have caused over $NZD 100 billion worth of collateral damage, resulted in the tragic loss over 389 lives, caused thousands of injuries and an unquantifiable amount of emotional and psychological damage.

A key objective of the 19th NZGS symposium is to reduce human suffering due to future natural disasters, increase post-disaster infrastructure functionality, and minimise the adverse effects of major disasters on society in terms of both the short-term emergency response and long-term recovery process.

The 19th Symposium organizing committee extends you a warm welcome to this event, which is expected to be one of the highest-attended NZGS symposiums to date.

Reported by:
Paul Salter

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Q&A with Jean-Louis Briaud, President ISSMGE

Professor Jean-Louis Briaud is Professor and Holder of the Spencer J. Buchanan Chair in the Zachry Department of Civil Engineering at Texas A&M University and the President of Briaud Engineers. His expertise is in foundation engineering and more generally geotechnical engineering. He has served as President of the Association of Geotechnical Engineering Professors in the USA, President of the Geo-Institute of the American Society of Civil Engineers, and is the current President of the International Society for Soil Mechanics and Geotechnical Engineering.

What made you decide to become a Geotechnical Engineer?

Actually I did not decide, I was a student in France and I wanted to see the world. Somebody told me that if I went to a certain university they would offer me an assistantship. I thought 'wow, this is fantastic,' so I went to Canada and signed up for the assistantship. When I got there I asked "what am I studying?" and they said Geotechnical Engineering. At the time I wondered what this was?.... but I have enjoyed every moment of it since then. I think that there is a tremendous balance between theory and practice, between mathematics, common sense and engineering judgement. It is a very diverse field and I have never become bored of it.

What is the most memorable project that you have been involved with?

Actually, I have to say it was a project that was very personal to me. It was the repair of the cliffs in Normandy that were being damaged by erosion where the Americans came to defend France. I was in charge of this project and found myself at the bottom of those cliffs thinking about those young Americans ready to climb the cliffs to defend my parents and others. This was tremendously emotional for me and I remember telling the congressman that was funding the project in the United States, "you know my debt towards you is very significant and I certainly don't need to be paid for this work." He replied that they didn't operate that way! It was a tremendous project on a huge scale and was charged with all kinds of emotions for me.

> **"to always have the courage to change the things that you can change, to have the discipline to accept those that you cannot change and to have the wisdom to know the difference."**

If you had one piece of advice that you had to give to a new graduate what would it be in a nutshell?

One piece of advice... I am hard pressed to only give one piece of advice, but I have always told my children that happiness is a choice. If you have the choice between being happy or being unhappy, it's pretty obvious what choice you should make. That's not to say it's easy to make this choice as you are sometimes hit with some very difficult situations but to me the choice is clear.

Travel, see the world, but only after you have finished a bachelor degree or your masters degree. You will learn so much by seeing different cultures, different levels of poverty and 'rich versus poor.' Travel really is a tremendous education. I feel very lucky that I went from France to Canada to the US. I think it helped me to understand people much better.

Could you explain one of the most important lessons that you have learnt in your career?

Well, I am not sure if you mean geotechnical or philosophical but I'll answer with something that really has helped me in my life from a philosophical point of view and that is "to always have the courage to change the things that you can change, to have the discipline to accept those that you cannot change and to have the wisdom to know the difference." I think that when you have to make a difficult decision, when you have something that really bothers you, if you think about those three things you will usually make a good choice.

What do you consider to be the current topic of most importance to the ISSMGE and the Geotechnical Engineering fraternity?

I think that geotechnical engineering is becoming a mature field of engineering and that we have made some tremendous progress over the last 100 years. The one thing that we have not progressed significantly is the image of the profession. If you go out in the street today and you say to somebody "my daughter is a heart surgeon," they will be impressed. If you then said to the same person "my son is a Geotechnical Engineer," they will often say "what is that"? I think that this needs to change. The image of our profession is extremely important. People don't realise how important our work is to them. Our work is often buried and we ourselves often don't see the work that we do as extremely important. We need to ensure that this changes.

Reported by: Pierre Malan
Auckland Branch Co-ordinator, NZGS

PROJECT NEWS

Understanding the Ground Movements Observed in Christchurch
– A Practical Approach

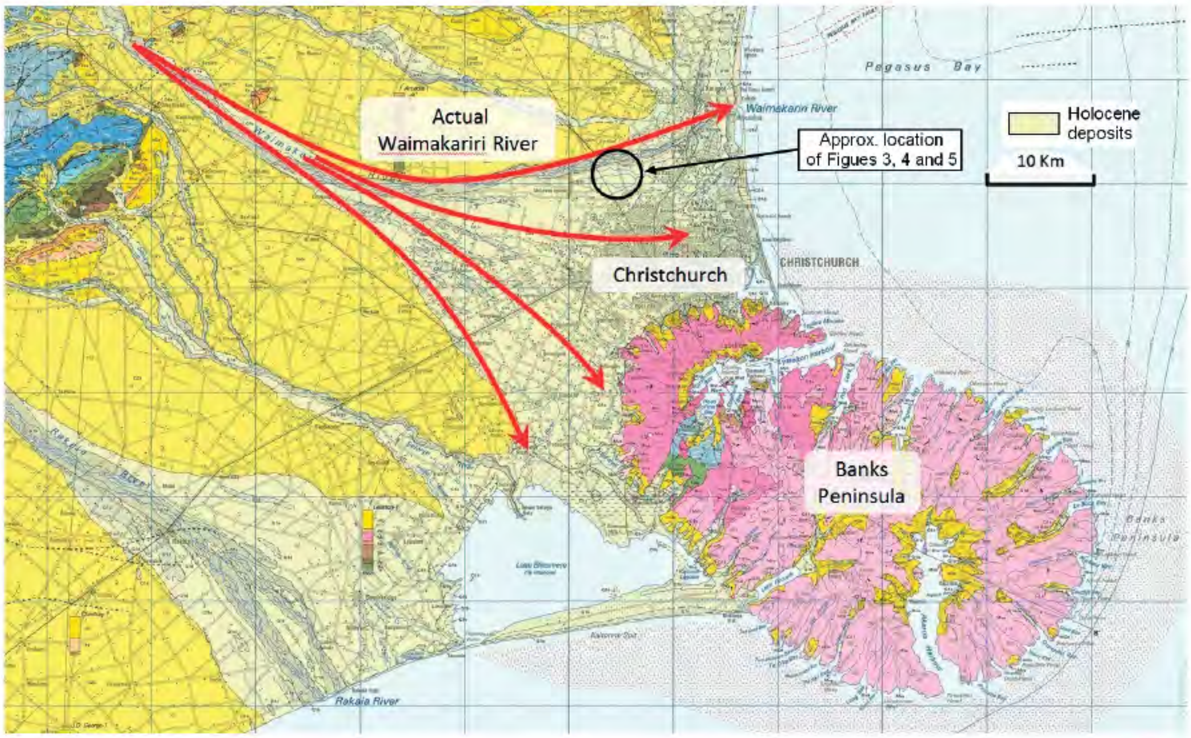

Figure 1: from Geological Map 16, 1:250 000, Christchurch, IGNS 2008

Introduction

Over the last year and a half I have been part of the large group of engineers working on the recovery of Christchurch. My work has focused on the remediation of damaged commercial and residential buildings in the city 'on the flat' (excluding the Port Hills).

During this period, I realised that the clients and people from the broader industry lacked clarity when it came to interpreting the effects of ground movements. I also realised that the ground movements that damaged the properties were often only considered inside the property boundaries rather than part of a wider picture.

Many of the issues encountered could be summarized in one question:

Why do the ground conditions sometimes change significantly over a short distance, which could be between adjacent properties or across a building footprint?

This article attempts to assist in answering this question with several tips that are based on personal observations and interpretations.

TIP 1: General Overview of the Local Geology

Observations

Much of Christchurch City is located on a large alluvial fan deposited from the Waimakariri River. The near surface geology comprises a mixture of recent river, swamp, lake and coastal deposits aged Holocene (less than 12,000 years), as shown in Figure 1.

Interpretation

- Considering the geological map, the Waimakariri River has likely migrated within this fan, throughout recent history (less than 12,000 years), from the south to the north of the Banks Peninsula,
- Similar deposition configurations are likely to be encountered across the fan with an alternation of higher energy (~gravels) and lower energy deposits (~silts),
- The young age of the sediments means that the materials encountered at shallow depths (less than 20m) are likely to be in a soft / loose state,
- The city surface is generally low lying, which results in a relatively shallow ground water table.

Figure 2: Braided Waimakariri River and its remnants under the city (screen shots from Google Earth)

TIP 2: Journey in the Past Beneath Christchurch City

Observations

Photo 1: Modern look of the city; several rivers and streams presently cross it,

Photo 2: Likely view beneath the city. These features can be seen to the west of the airport.

Photo 3: View of the creation of the features shown in Photo 2. View of the braided Waimakariri River.

Interpretation

- Former channels are very likely to cross the entire city,
- In 3-Dimensions, the city is underlain by a random crisscross of historical features like former channels, isolated meanders or ponds.
- The surficial historical features are often either naturally filled with materials ranging from gravel, sand to silt to peat, or artificially backfilled with compressible material like construction debris or general landfill.

TIP 3: Unpredictable Nature of Channels

Observations

The bed of the Waimakariri River significantly changes from year to year as a result of flood events as shown in Figure 3.

Interpretation

The alluvial deposition will vary with the energy of the water flow generally resulting in:

- High energy flow corresponding to strong currents generally found in the main river channels and/or during flood events and/or on the outside of the river meanders. In these conditions, only the larger particles will be deposited (boulders, cobbles, coarse gravels),
- Low energy flow corresponding to still waters generally found in the secondary channels and/or during drought events and/or on the inside of the river meanders. In that case, finer particles will be deposited (fine gravels, sands and silts),

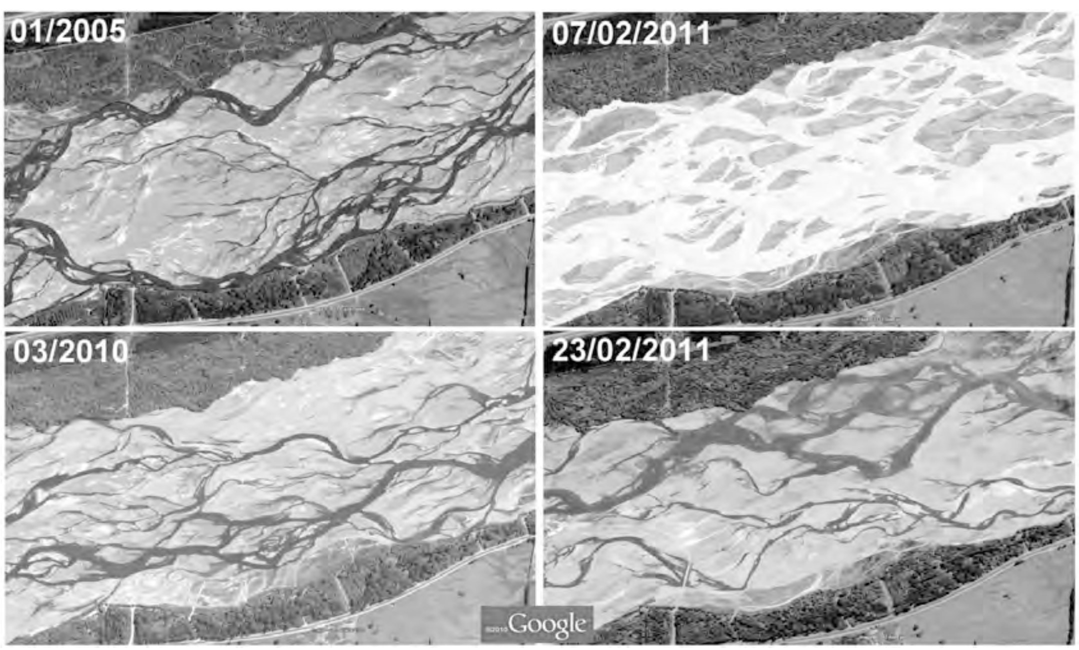

Figure 3: Highly variable flow paths in the Waimakariri River bed over the years (screen shots from Google Earth)

- Clays will mainly be deposited in stagnant water found in isolated meanders or ponds. The dead vegetation accumulating in this water would eventually become peat.

TIP 4: Underground Streams

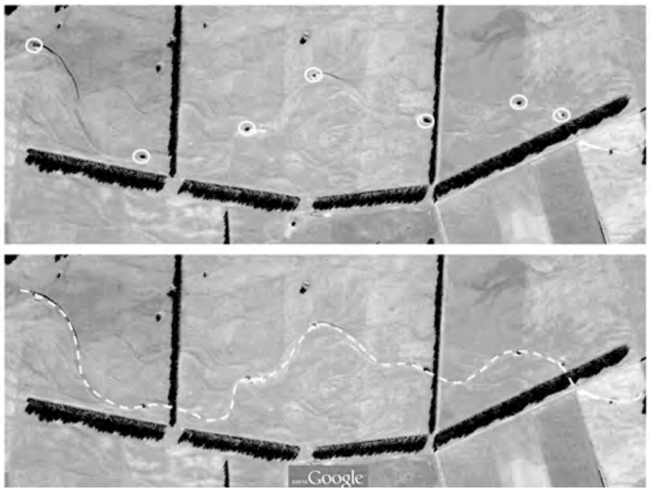

Figure 4: Evidence of underground stream. View to the north of the airport (from Google Earth).

Observations

Several ponds are dispersed along a former channel feature, as shown on Figure 4.

Interpretation

- These ponds likely indicate that water is still running through more permeable material that backfilled the former channel,
- Building over such features may add to the settlement potential,
- The 3-Dimensional superimposition of former channels is likely to create semi-confined or confined aquifers,
- These confined aquifers may give artesian springs after strong earthquakes by building up of excess pore water pressure,
- The dissipation of the excess pore water pressure from the confined aquifers through the soil profile may unpack dense layers and add to the liquefaction potential.

TIP 5: Non-Engineered Fill and Backfill of Channels

Figure 5: Channel backfill in progress on right and spreading layer of fill across surface on left (from Google Earth – North of Christchurch Airport).

Observations

Figure 5 shows a fill being laid along an existing channel alignment, on the right, and fill being spread across a flat field, on the left.

Interpretation

Building over such non-engineered fill may lead to excessive settlements by compression of the non-engineered fill material. These settlements may or may not be earthquake related.

TIP 6: Younger / Softer Material Inside the River Meanders

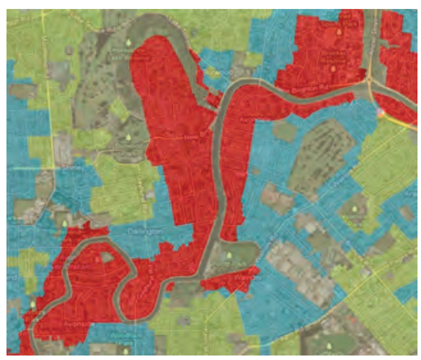

Figure 6: Extensive ground damage (Red Zone) concentrated in the inside of the Avon River meanders (From CERA website - http://cera.govt.nz/maps/technical-categories)

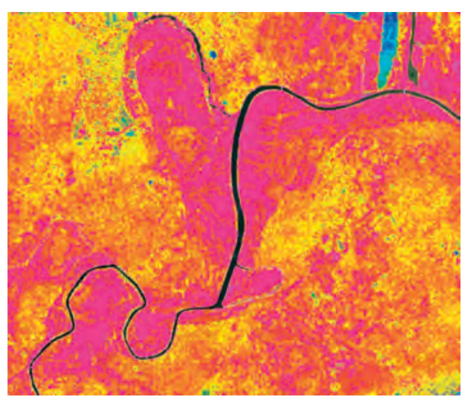

Figure 7: Extensive vertical settlements (pink) concentrated in the inside of the Avon River meanders. (From Canterbury Geotechnical Database – LiDAR surveys - https://canterburygeotechnicaldatabase.projectorbit.com)

Observations

- The Red Zone, defined by the Canterbury Earthquake Recovery Authority (CERA) as shown in Figure 6, and the greatest vertical settlements recorded in the CERA Canterbury Geotechnical Database, as shown in Figure 7, are largely concentrated in the inside of the Avon River meanders
- Note that the vertical settlements shown in Figure 7 include tectonic movements for more contrast.

Interpretation

- Considering the creation process of the meanders, the material inside the curve is younger than on the outside and as a result it is generally looser. This generally applies to both existing and historical meanders such as the Horseshoe Lake area in Christchurch.
- The materials encountered inside the meanders generally comprise sands and fine gravels.
- The combination of sands in a loose state with a high water table often results in liquefaction during strong earthquakes.

Tip 7: Identification of an Old Channel Case history – St Martins, Christchurch

Observations

- On one of the sites which I worked on I encountered evidence of lateral movement which only impacted the front of the building. The Heathcote River is located approximately 150m to the west of the site and this site is perched on top of a river terrace approximately 8m above the river water level,
- However, the lateral movement was clearly directed to the east, in the opposite direction to the river,
- The road, along the eastern side of the property, reportedly settled by up to 800mm,
- Severe liquefied soil ejection was also recorded in the area,
- Figure 8 shows some aligned highlighted obvious areas of liquefaction ejecta observed on post February 2011 aerial imagery, drawing a wide feature crossing the St Martins meander,
- There was no indication of a historical channel on a historical waterways map 'Black Map 1856' or recorded prior the Canterbury earthquake sequence,
- Site observations identified ground cracks parallel to the trend of the wide feature shown in Figure 8, and well delimited ground damage cutting properties in half.

Figure 8: Personal observations - Highlighted obvious areas of liquefaction ejecta on post February 2011 aerial imagery (From Google Earth)

Figure 9: Technical Category TC3 zone crossing the St Martins meander
(From LiDAR surveys – http://apps.geocirrus.co.nz/cera/public/?Viewer=CERA__Public)

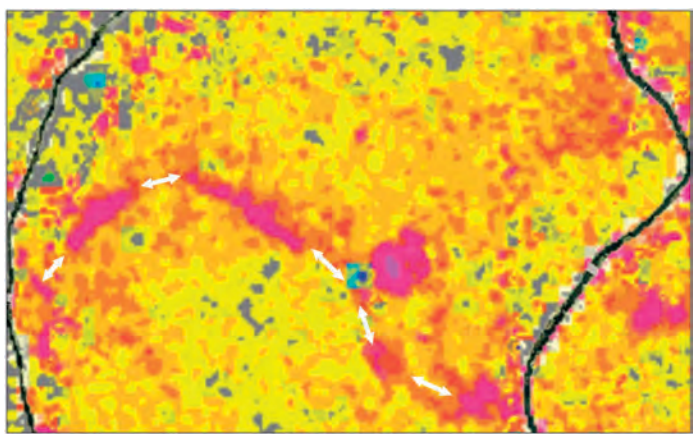

Figure 10: Line of extensive vertical settlements (pink) across the St Martins meander showing historical channel (marked with arrows). (From Canterbury Geotechnical Database - https://canterburygeotechnicaldatabase.projectorbit.com)

Interpretation

- A wide geological feature crosses the St Martins meander and potentially impact a significant number of properties,
- This feature is thought to be a historical channel naturally filled with saturated loose material prone to liquefaction; lateral spreading occurred toward this historical channel,
- Theory later supported by a TC3 band shown in Figure 9 and with a line of extensive vertical settlements shown in Figure 10 that coincide with the wide feature previously identified,
- Similar observations were made in Kaiapoi, after the 2010 Darfield earthquake, by L.M. Wotherspoon, M.J. Pender and R.P. Orense where they established a relationship between observed liquefaction and former channels of the Waimakariri River.

Conclusions

- The Christchurch specific subsurface conditions outline the importance of considering the wide scale picture first when dealing with the remediation of individual properties; isolated land movement features are likely to be part of a larger scale movement,
- The assessment of liquefaction and lateral spreading potential should consider the impact of the interaction between soil layers, mainly the 3-dimensional arrangement of old river features and their associated semi-confined or confined aquifers,
- Lateral spreading not only occurred around existing free edges but also around historical river features filled with highly liquefiable material,
- A preliminary desk study phase is essential in a site geotechnical assessment to identify any wide scale features potentially impacting the subject site, e.g. historical channels, gravel pits, ponds. These features are often naturally or artificially filled with liquefiable soils or compressible material.
- Issues related to historical channels, as described in Kaiapoi by L.M. Wotherspoon et al or in St Martins (refer to Tip 7), are not isolated cases. Study of the large data set from the Canterbury Geotechnical Database highlights other potential buried historical features across Christchurch City area.

Important notice – Canterbury Geotechnical Database

Figure 7 and Figure 10 were created from maps and/or data extracted from the Canterbury Geotechnical Database (https://canterburygeotechnicaldatabase.projectorbit.com), which were prepared and/or compiled for the Earthquake Commission (EQC) to assist in assessing insurance claims made under the Earthquake Commission Act 1993. The source maps and data were not intended for any other purpose. EQC and its engineers, Tonkin & Taylor, have no liability for any use of the maps and data or for the consequences of any person relying on them in any way. This "Important notice" must be reproduced wherever those two figures or any derivatives are reproduced.

Acknowledgements

Rolando Orense, Paul Wopereis and Andrew Jordan are acknowledged for their revision of the draft manuscript and for their valuable comments.

Rob Kerr and CERA are acknowledged for permission to reproduce the maps from the Canterbury Geotechnical Database.

References

1:250 000 Geological Map 16, Christchurch, IGNS 2008

L.M. Wotherspoon, M.J. Pender, R.P. Orense - Relationship between observed liquefaction at Kaiapoi following the 2010 Darfield earthquake and former channels of the Waimakariri River, 2012

Canterbury Geotechnical Database – https://canterburygeotechnicaldatabase.projectorbit.com

CERA website – http://cera.govt.nz/maps/technical-categories

CERA public viewer – http://apps.geocirrus.co.nz/cera/public/?Viewer=CERA_Public

Christchurch Area showing waterways swamps & vegetation cover in 1856, Compiled from 'Black Maps' approved by J. Thomas & Thomas Cass Chief Surveyors 1856 - Christchurch City Council website – http://resources.ccc.govt.nz/files/blackmap-environmentecology.pdf

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Slope Stabilisation of the 2011 Manawatu Gorge Landslide – The Numbers

Photo 2: The site in May 2012 post excavation.

Photo 1: Shortly after the initial failure (photo taken in September 2011).

Introduction

As has been widely publicised over the past 14 months a very large landslide has been affecting the Manawatu Gorge with the first failure and subsequent road closures occurring in August 2011. The initial failure measured approximately 50m high by 100m wide. An estimated 20,000m^3 of weathered greywacke and colluvium ended up on State Highway 3 and in the river. Numerous contractors including Geovert Ltd, HEBs, Higgins Contractors, and McIntosh Bros to name a few have been working tirelessly since August under the expert guidance of MWH Ltd to reinstate the highway and make the route safe.

Several further failures occurred in the months following the initial collapse and now, taking into account the finished excavated slope, the final volume of material removed was in the order of 370,000m^3. The highway is now open to (controlled) two way traffic but remedial work is still being carried out. This article outlines briefly the history of the event and the remedial work carried out by Geovert Ltd.

Background

The initial failure occurred in August 2011 causing the complete closure of State Highway 3 through the Manawatu Gorge, fortunately with no casualties.

Photo 3: Drilling of the perimeter anchors for the mesh drape (photo complements of TTV).

An initial assessment was made by engineers from MWH Ltd (area network consultants for NZTA) and it was decided that immediate temporary remedial stabilisation works were required to improve stability of the exposed slope to provide a safer working environment at road level.

The work was carried out by Geovert rope access technicians and consisted of limited clearing of the head scarp and limited rock removal from the main face. During this time Higgins Contractors were also working on clearing the slip material. This procedure was for the best part a round-the-clock operation for the first few weeks until after the second failure in mid-September people's perspectives changed and a strategic rethink on the clearing and stabilisation was undertaken.

During the excavation and clearing of the highway MWH undertook further investigations, with the aid of Geovert rope access engineering geologists Mat Avery and Simon Bourke, to better understand the processes at hand. At each new collapse event numerous rope traverses were undertaken for the purpose of geological and geomorphological mapping. GNS were commissioned in October 2011 to carry out the first of many laser scans from a helicopter drop off point on the opposite side of the gorge. These scans were invaluable and picked up minute detail of the slip surface and the surrounding area.

Over the following 3 months the slip failed twice again each time regressing further upslope. It was during these subsequent failures that MWH engaged the expertise of GNS scientist Graham Hancox who over the following several months contributed at various levels to the understanding of both the immediate and regional environment. This included a number of reports on the main feature and also on the wider gorge area.

Design

A design workshop was held in November whereby MWH, GNS and Geovert scientists and engineers convened to discuss options for the long term remediation of the slip. By this stage it was clearly evident that the full potential extent of the feature, based on historical evidence, was far larger than what was currently exposed and the site was capable of further large scale potentially rapid failures. The basic design concept was discussed at this meeting with consensus over the following weeks that laying the slope angle back to a more stable angle by means of benching was the most suitable and cost effective option. The cost benefit analysis included consideration by NZTA of rerouting the highway permanently elsewhere.

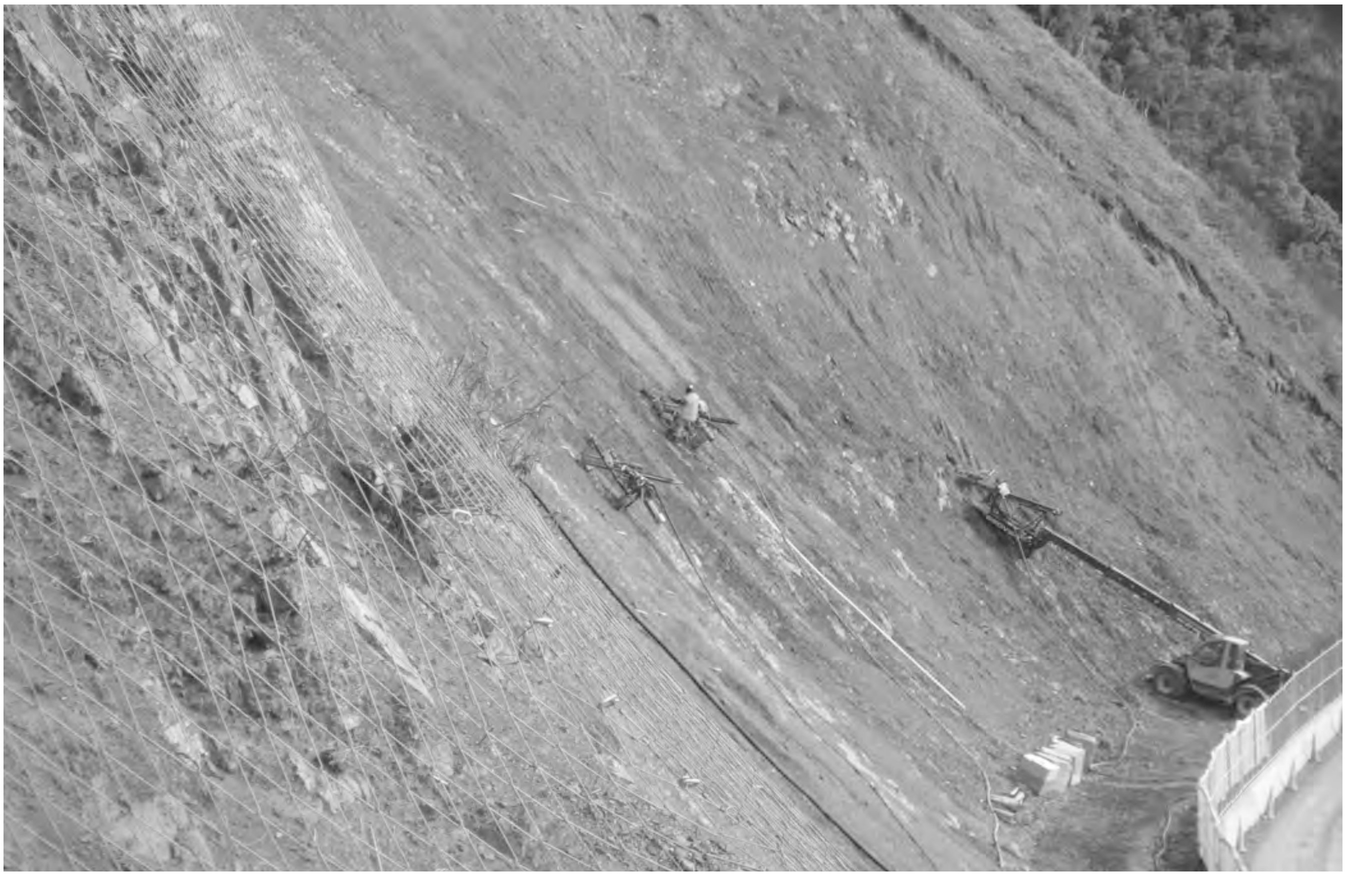
The extents of the earthworks were determined using the DTM developed earlier in the project, based on a combination of GNS produced 3D laser scans and recently flown LiDAR. The slip area was rescanned on a regular basis to help calculate the extensive volumes of material removed from the slip. The earthworks began in December 2011 and finished (down to road level) in May 2012. Approximately 370,000 m^3 of material was removed from the slip. The excavation began at the top via a freshly cut track pushed in from farmland to the south and progressed down slope to road level. All excavated and cut material was pushed over the edge of the benches and removed from the base of the slope.

Once excavation was completed the highway required an almost complete rebuild as there were a number of half and full bridge structures that were extensively damaged during the event, likely both from the sudden impact energy of material during failures and also the long term effects from thousands of tons of material sitting on the structures over an extended 12 month period.

Further specialist consultants including BBO and Earthtech Consulting were commissioned to investigate and design replacement structures. In addition to the earthworks a number of long term management issues were identified with the finished slope including excessive ground water egress, localised areas susceptible to surficial erosion, over steepened colluvium (not part of the earthworks program) and exposed jointed greywacke (the slope comprises interbedded, indurated greywacke sandstone and argillite, typically closely to very closely jointed) likely to release rockfall.

Remediation and Construction

Geovert were commissioned directly by NZTA under the management of MWH for all slope stabilisation and drilling work completed on site to date. The work included installation of a Geobrugg Deltax mesh drape, installation of horizontal inclined drainage holes, stabilisation of the western colluvium slope and installation of a 500kJ Geobrugg attenuator. Geovert's contribution to the reconstruction of the highway included nearly 1000 lm of



drilling including installation of anchors on the abutment of Bridge 8 (complete new build), stabilisation of the Bridge 8 Abutment D potential/slow moving wedge failure, and installation of seismic strengthening anchors for Half Bridge 7 and Half Bridge 9.

Slope Work

1. Geobrugg Deltax Mesh Drape

Carried out in May 2012, the installation of the mesh drape at the eastern margin of the slip was critical to the progress of the project. This was an MWH design utilising Geobrugg Deltax high tensile steel wire mesh.

Significant delays were encountered but eventually a 6 day window was provided so a 24hr operation was implemented to complete the full installation (including drilling).

2. Slope Drainage Holes

The installation of horizontal drains was intermittent during the project with more drains being drilled as the nature of the slope revealed itself during different weather patterns. The drains were typically positioned to target clay seams where water egress was greatest. In one area twelve drains were installed mid-way up the slope and when piped (to avoid surface erosion) the measured flow rate was 18,000 litres per day. This rate has not diminished since the installation.

3. Colluvium Stabilisation

The western edge of the slip consists of ancient slip material (colluvium). A series of investigation holes were drilled by Geovert to determine the depth to rock. Holes were drilled at various levels including mid slope work requiring helicopter delivery of plant. A design to stabilise this portion of the slope was developed based on the information gathered from these holes. The design was to retain the toe of the mass so three rows of anchors were drilled at the base of the slope to a minimum of 4.0m into rock which meant varying anchor lengths between 9 m and 12m long. The final surface was then shotcreted prior to installation of steel waling beams secured by the anchors. Drainage holes were also installed at varying depths.

4. Attenuator Installation

Very early on it was identified that there would be a residual risk of rockfall at the site once the earthworks were completed. Geovert in conjunction with Geobrugg NZ provided a solution through a competitive tender process to reduce this risk. A bespoke rockfall attenuator was designed with assistance from Geobrugg engineers at their head office in Switzerland.

The system is designed to withstand and manage impacts up to 500kJ from boulders with bounce heights up to 4.0m high. The total system length is 140 lm. Due to time and cost constraints the unique Geobrugg A-R posts were specified, these require no upslope support cables

Photo 5: Installing the attenuator posts by helicopter. All fifteen posts were installed in 1hr:20mins.

Photo 6: Delivery of essential supplies complements of the Tui Brewery Girls (photo complements of Tui Breweries).

Opposite, Photo 4: Completed installation of the mesh drape with inclined drainage hole drilling in the background.

which reduces the amount of drilling required therefore reducing construction time.

The system is located 30m above road level and has a 25m long Tecco G80/4 high tensile steel wire mesh tale. A purpose built catchment ditch is to be constructed at the base of the slope to retain material exiting the tale (attenuators typically reduce energies by 30-50%).

Installation of the posts and cables, and tensioning of the system was completed in two days and at the time of writing the mesh installation is programmed to be completed in a further three days. This means the complete system installation (excluding drilling) will be completed in less than one week total construction time.

Geobrugg engineering quality and controls along with their finite element modelling gives the Client full confidence that they are protecting their asset and the road users.

Highway Work

1. Bridge 8 Drilling

The reconstruction of Bridge 8 (eastern end of the site) required the supporting of both abutments by means of ground anchors. These were primarily for seismic strengthening and designed to stop excessive movement of the abutments during an earthquake. The anchors were installed using the Beretta T46 rig with a total of forty two anchors installed. This work was on critical path due to the very tight deadlines to open the road. Until this bridge was completed there was very limited access (even for the Contractors) through the gorge.

Photo 7: Installing the wedge failure anchors on Bridge 8 with the telehandler rig hanging from the crane.

2. Bridge 8 Abutment D

During the excavation of the final abutment on Bridge 8 a major open wedge shaped defect was identified in the rockmass behind the abutment. There was concern that this was an active slow moving failure plane and remedial measures were designed to ensure no future movement could occur. A total of 45m^3 of concrete and grout was pumped into the void, including an initial 20m^{3}of concrete pumped from the surface, a further 10m^3 of concrete pumped through injection holes and a final 15,000 ltrs of grout pumped into 35 ground anchors.

During the installation a flood washed away a portion of the working platform which meant to prevent any delays to the programme a number of the Row 3 anchors were drilled using the telehandler rig hanging from a 50t crane.

Half Bridge 7 and Half Bridge 9

Two half bridges were reconstructed through the middle and western section of the site. Anchors were required on both structures and at both the anchors, drilled through soldier piles, were designed to combat any seismic induced movement.

Originally the plan was to drill the holes with the Beretta T46 from a working bench however another flood event resulted in the rig being hung beneath the structure using a 50t crane. A total of 600 lm of drilling was completed at these two sites.

Conclusion

In summary the stabilisation of the Manawatu Gorge Landslide has been a giant undertaking by all parties involved. While the initial slip was considered large the on-going regression and final remedial design option was far bigger than anyone initially comprehended. Much to the relief of many the project is nearing completion and the Gorge road is open once again.

LOCATION	EQUIPMENT	DESCRIPTION	NUMBER (ea)	DRILLING (1m)
Deltax Mesh Drape	2x Marini	Drilling Mesh	62 2500 m^2	310
Inclined drainage holes	3x Marini	Drilling	60	600
Bridge 7 anchoring	1x Beretta 1x telehandler	Drilling	79	525
Bridge 8 anchoring	1x Beretta 1x Telehandler	Drilling	42	220
Bridge 9 anchoring	1x Beretta	Drilling	6	75
Investigation drilling	1x Marini, 1x Beretta 1x Telehandler	Drilling	13	240
Wedge Failure Stabilisation	1x Beretta 1x telehandler	Drilling	35	420
Colluvium stabilisation	1x Beretta 1x Telehandler	Drilling	123	1120
Attenuator Installation	1x Marini, 1x 50t crane, 1x helicopter	Drilling Attenuator	36 140 1m	250
			Total (1m)	3760

Table 1: Summary of Manawatu Gorge works completed to date by Geovert Ltd

Photo 8: The installation of the upper row of Half Bridge 9 seismic tieback anchors using the Beretta T46 rig.

Acknowledgements

The Client NZTA. The Consultants MWH Ltd Wellington, Palmerston North and Wanganui offices including Chris Robson, Mike Skelton and Murray Salter. BBO and Earthtech Consulting. Local Contractors Richardsons Drilling, Morris & Bailey, HEBs Structures, Goodmans and Higgins.

Repoted by:
Mat Avery and Simon Bourke
Geovert Ltd

TECHNICAL ARTICLES

Geotechnical Engineering and Hydrogeology – Driving the Victoria Park Tunnel Project

– Victoria Park Alliance: Martin Barrientos (Geotechnical Engineer, Beca), Sian France (Associate – Hydrogeology, Beca) and Grant Newby (Technical Director – Geotechnical Engineering, Beca)

Introduction

The disciplines of geotechnical engineering and hydrogeology were cornerstones to the successful completion of the Victoria Park Tunnel project. From the consenting phase of the project to design and ultimately construction, the effects of the tunnel structure were of paramount importance; with responsibility for identification of issues, provision of solutions and monitoring and management of effects relying heavily on these two disciplines. As such, it is presented herein as a theme that the significant role of geotechnical engineering and hydrogeology resulted in the successful delivery of a major infrastructure asset with minimal impact to the dense urban area surrounding the project.

The $340 million SH1 Victoria Park Tunnel project is the first completed of seven Roads of National Significance identified by the New Zealand Government as being essential to our nation's economic growth. Delivered by the Victoria Park Alliance, a consortium comprising the New Zealand Transport Agency, Fletcher Construction, Beca, Parsons Brinkerhoff and Higgins Contractors, the works were completed three months ahead of schedule in March 2012. The project addressed the last major bottleneck on Auckland's central motorway interchange and has unlocked over a decade of investment in the Central Motorway Junction and related projects (Figure 1).

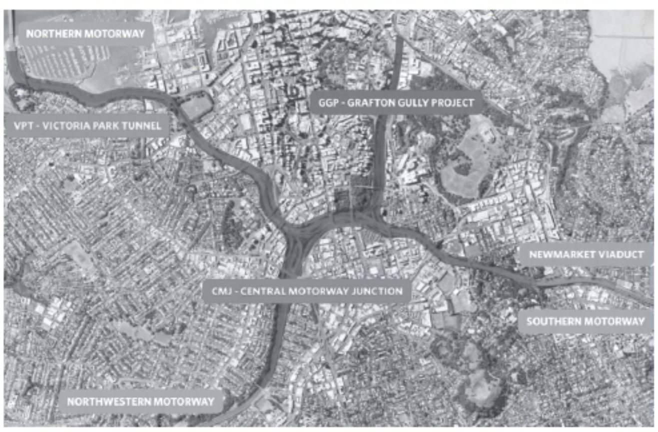


Figure 1: Central motorway upgrades in Auckland

The project encompasses 2.5 km of motorway improvements between the Wellington Street over bridge in the south and the Auckland Harbour Bridge to the north. The main construction works within the corridor were road widening through St Marys Bay for five lanes of northbound and southbound traffic, reconfiguration of the SH1 Victoria Park Viaduct for four lanes of southbound traffic and, adjacent to the viaduct, the construction of a 450 m long cut and cover tunnel beneath Victoria Park for three lanes of northbound traffic.

At the heart of the project, the tunnel presented significant challenges to both its designers and constructors: the mitigation of effects in the long term (design) and in the short term (construction) and working in a tight environment (Figure 2) adjacent to significant existing infrastructure, not least of which, the New Zealand Transport Agency's own viaduct through Victoria Park.

Through a sound understanding of the geology along the alignment (arising from the number and quality of geotechnical investigations), an effectively managed monitoring programme and clear understanding of expected tunnel performance from an effects point of view, the hydrogeology and geotechnical engineering team was able to assist in innovations and early delivery of the project.

Figure 2: High density of construction traffic resulting from work in a tight environment

Geological Setting

An initial geotechnical appraisal for this project was undertaken by Beca in early 2001 when both a second viaduct option and tunnelling solution were being considered.

Additional geotechnical investigations and value engineering were undertaken by both Beca (in 2005) and SKM (between 2006 and 2009) for resource consent and specimen design development of the tunnel option.

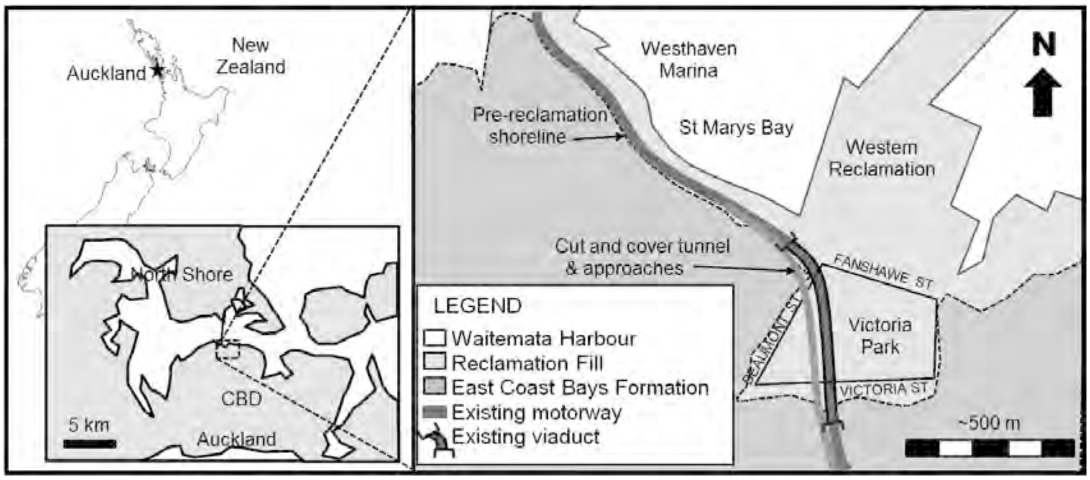


Figure 3: Location of Victoria Park Tunnel (after France et al., 2012)

With the award of the design and construction of this project to the Victoria Park Alliance, further geotechnical and hydrogeological investigations for detailed design and construction proof drilling were commenced in December 2009. The geological model developed from investigation data for this project is presented in Figures 3 and 4.

The tunnel structure transects Victoria Park, a low-lying area of land reclaimed from the original Freemans Bay embayment (Figure 3).

The underlying bedrock unit in this area is the interbedded sandstones and siltstones of the East Coast Bays Formation (ECBF), the outcrops of which are visible along the old cliff line and foreshore. Within the ECBF, rock units can be divided into extremely weak (EW) and very weak (VW) or better. EW ECBF is generally dense to very dense silty sand interbedded with stiff to hard silt, with an unconfined compressive strength (UCS) generally less than 1 MPa and SPT N values ranging between 30 to 50 blows/300 mm. The VW ECBF comprises sandstone interbedded with siltstone, having a UCS in the range of 1 to 5 MPa and SPT N values greater than 50 blows/300 mm and is considered rock. Structural elements of the Victoria Park Tunnel derive their design capacity through embedment into VW ECBF material.

Overlying the ECBF are variable thicknesses of strongly anisotropic alluvium of the Tauranga Group, comprised of soft or loose, unconsolidated, compressible silty and sandy sediments.

The upmost unit, general fill, is largely variable in strength and soil constituents and within the tunnel footprint is almost entirely reclamation fill. Foreshore reclamation works took place at Freemans Bay over a 16 year period to 1901 (Beca, 2006) and utilised as fill quarried material from the nearby headlands and wastes from industries in the vicinity, the most significant producer of which was the Auckland Gasworks Company. Environmental testing undertaken on the fill encountered within the footprint of the Victoria Park Tunnel project found contaminants such as polycyclic aromatic hydrocarbons, semi-volatile organic hydrocarbons, cyanide and heavy metals (SKM, 2008). In addition to waste material, pockets of hydraulic fill are also encountered within the park.

Potential Environmental Effects

It was identified early in the consenting process that the presence of compressible soils could result in consolidation settlement should the tunnel excavation be dewatered for a significant period.

The potential for settlement is particularly important given the proximity of the tunnel alignment to several historic buildings (the old Auckland Gasworks Company administration block, Victoria Park Markets, Campbell Free

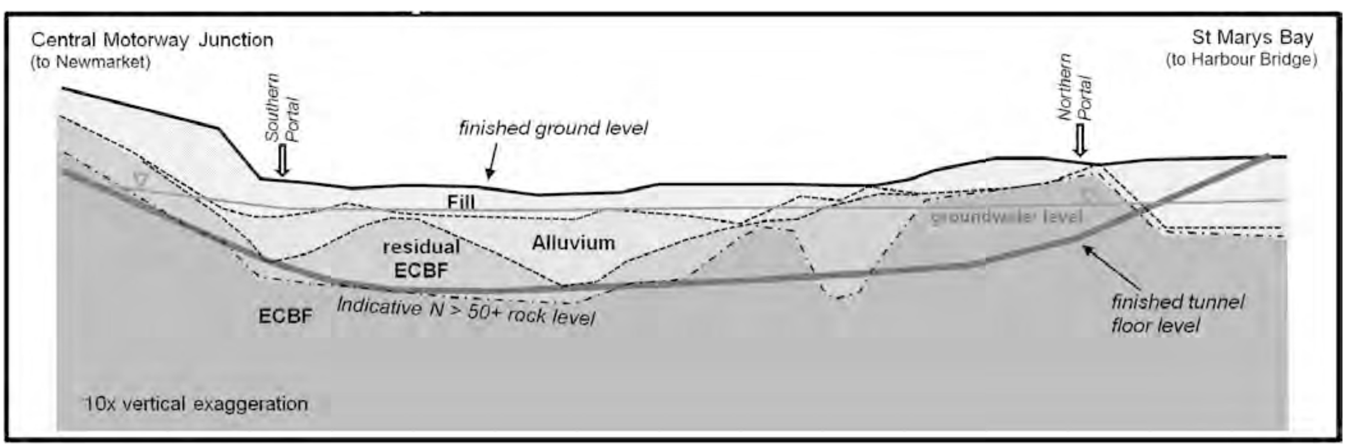


Figure 4: Schematic geological long section along main tunnel alignment (after France et al., 2012)

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Kindergarten and the Rob Roy Hotel), all of which are founded on shallow foundations, as well as the proximity to more recent residential and commercial buildings.

The presence of contaminated material in the fill and proximity of the tunnel to the harbour meant that dewatering could result in changes to groundwater quality (i.e. contaminant migration and / or saline intrusion).

The potential for these adverse environmental effects drove the final form of the tunnel with a sealed, 'dry box' structure identified as the most appropriate long term solution, with resource consent granted on this basis.

It was identified that short term dewatering would still be required to facilitate construction and numerical modelling was used to assess the potential drawdown and associated effects that might result (France, 2008).

A comprehensive groundwater level and settlement monitoring programme was developed in order to monitor actual construction effects. The construction methodology incorporated typical mitigation measures such as groundwater cut-offs and limiting the extent of open excavations, and contingency measures, such as groundwater recharge, were developed.

Structural Form

With a maximum excavation depth of 13 m below ground level (bgl) it was identified that cut and cover construction techniques would be most cost effective compared to a bored tunnel solution.

The structural form of the tunnel is shown in Figure 5 and is comprised of four elements: tunnel retaining walls, roof, base slab and tension piles.

The retaining walls act in combination with the roof and base stab; with the walls provided with frame action by moment continuity (integral) with the roof slab and pinned at the wall-base slab interface, transferring vertical shear demands only.

The base slab is also connected to reinforced concrete piles to resist uplift water pressures.

Design

The design of the Victoria Park Tunnel was guided by the need to limit, as much as possible, the effects the structure would have on groundwater and on the surrounding ground in terms of settlement and lateral movement.

In addition to satisfying the requirements of a 'dry box', the design considered load requirements and constraints set out as follows.

Tunnel Retaining Walls

The retaining walls were sized to meet flexural demands and carry vertical load resulting from wall self-weight, the tunnel roof and soil overburden above and traffic surcharges, including those resulting from construction plant.

The retaining wall system consists of a series of interlocking panels or secant piles (Figure 6). Diaphragm walls are used for the southern half of the tunnel, where greater depths of softer ground allowed rapid installation of diaphragm wall panels. With the higher rock levels in the northern half of the tunnel, secant piles were adopted to address the issue of expected slower production rates with diaphragm wall construction in rock.

As a fast-tracked project and with both secant pile and diaphragm wall rigs available, the opportunity to achieve significant programme gains substantially offset any additional costs associated with mobilising both types of plant to the site.

Design of tunnel walls utilised both WALLAP (version 5 of the retaining wall analysis program) and PLAXIS (version 9 of the 2D finite element modelling program) to provide both structural demands for the excavation phases and lateral loadings for structural analysis with the locked-in roof structure. The PLAXIS analyses were also able to

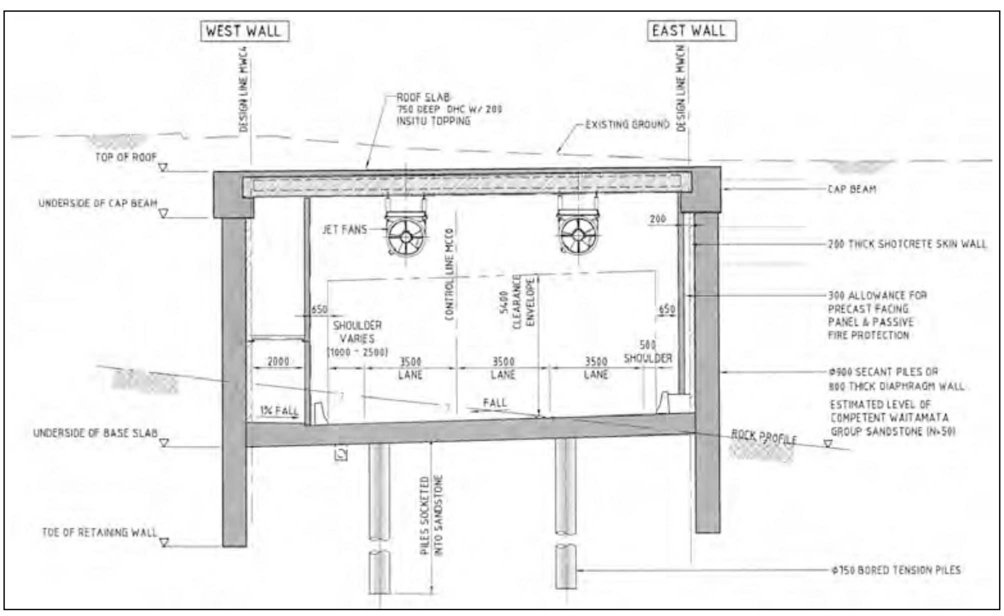

Figure 5: General arrangement of Victoria Park Tunnel

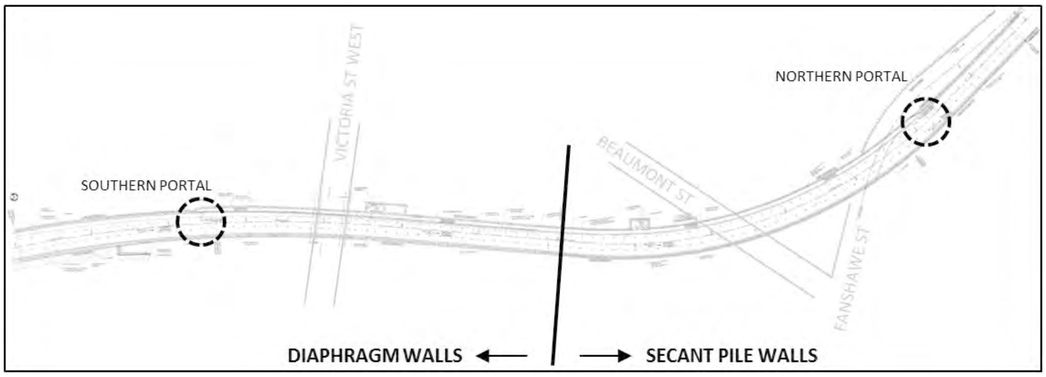

Figure 6: Tunnel retaining walls general arrangement

provide a cross check of the simplified methods of analysis for intermediate sections of the tunnel as verification.

For stability, retaining wall design required 2m embedment into rock; however, the resource consent stipulated that walls should have a minimum embedment of 6 m below the base slab to provide a cut-off to groundwater flow and reduce potential drawdown. Analyses undertaken during value engineering demonstrated that beyond a cut-off depth of 4 m the reduction in drawdown was negligible (i.e. no significant increase in effects by reducing the cut off from 6m to 4m). A revision to the consent was sought and approved, representing a 15 % reduction in reinforcing steel and concrete volumes and significant time savings on programme, both of which contributed to major cost savings.

Tension Piles

As a permanent hold down mechanism, required for the base slab to resist uplift water pressures, 750 mm diameter reinforced concrete tension piles were provided across the base of the tunnel at approximately 7 m centres.

Design capacity was based on the results of pile load tests undertaken for similar conditions on the New Lynn Rail Trench and SH20 Manukau Harbour Crossing projects, with a strength reduction factor of 0.5 adopted as no load tests were undertaken on this project.

Base Slab

The design of the base slab was governed by long term hydrostatic uplift. The retaining walls were socketed into rock which avoids the failure mechanisms of basal heave and toe-kick and both construction and permanent traffic loading without hydrostatic uplift were not critical in base slab design.

Post construction, water pressures were expected to return to a hydrostatic condition in the long term. The water pressure uplift loads acting on the underside of the base slab are based on design phreatic level being situated 0.5 m below the existing ground level, approximately 1 m higher than monitored groundwater levels to allow for short term flood events. At the maximum depth of 13 m bgl, the base slab is designed to withstand an uplift pressure of approximately 120 kPa.

At discrete locations, the material at formation level was either relatively stiff Pleistocene alluvium of the Tauranga Group or residual ECBF overlying bedrock. With the limited depth to rock level, soil rebound pressures were not considered significant when compared to uplift water pressures.

Construction

The cut and cover Victoria Park Tunnel was constructed using 'top-down' construction methods. Works commenced initially in Victoria Park in November 2009 and subsequently extended to several locations along the tunnel alignment to accelerate progress.

The tunnel diaphragm wall and secant pile wall retaining systems were constructed first, followed by the in situ capping beam on top of the walls. Secant piles comprise a series of 900 mm diameter bored piles partially overlapping one another along the tunnel alignment (Figure 7). Every other pile is an unreinforced (or soft) 2 MPa concrete pile. Soft piles are allowed to partially cure prior to installation of the reinforced (or hard) concrete piles between them. The diaphragm walls comprised of a series of interlocking 800 mm thick retaining panels installed progressively in a 'hit and miss' pattern along the tunnel (Figure 8).

Tension pile construction predominantly occurred

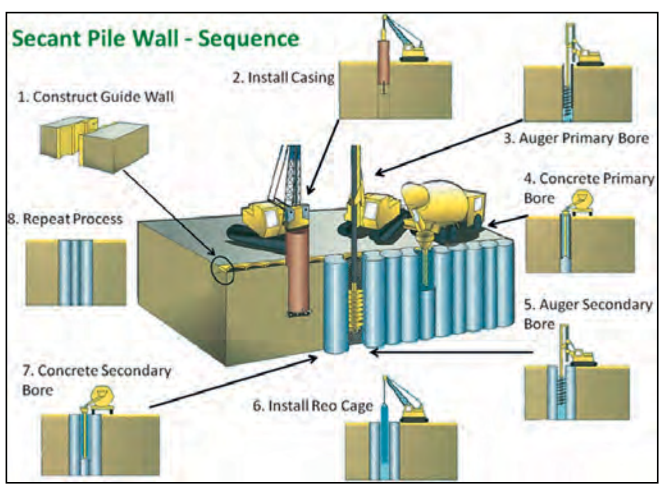

Figure 7: Construction sequence for the secant pile walls

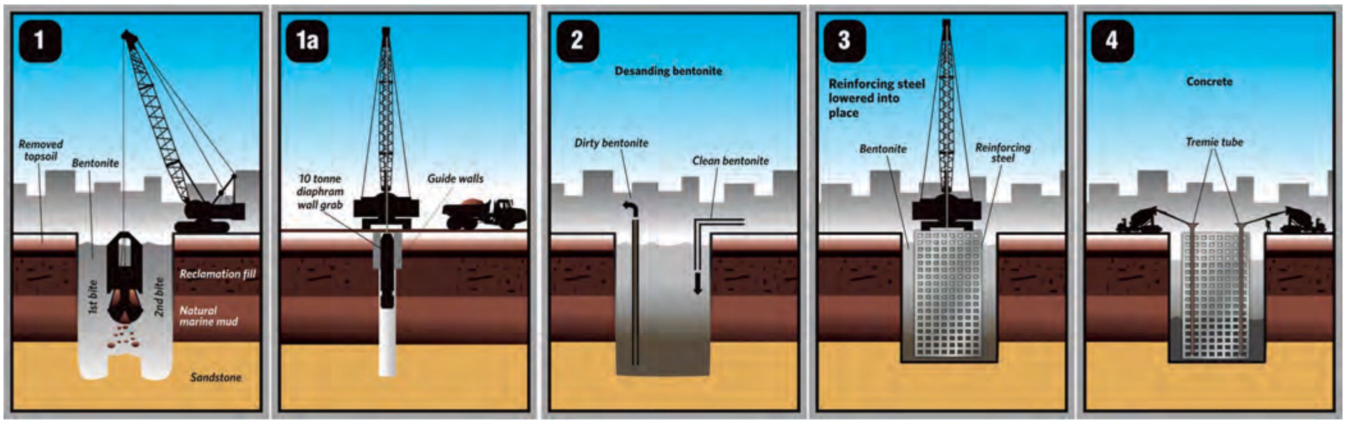

Figure 8: Construction methodology for the diaphragm walls

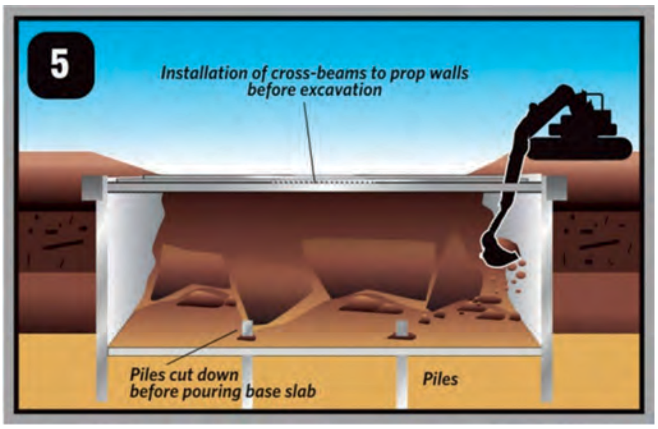

Figure 9: Tunnel bulk excavation between the walls; commenced September 2010

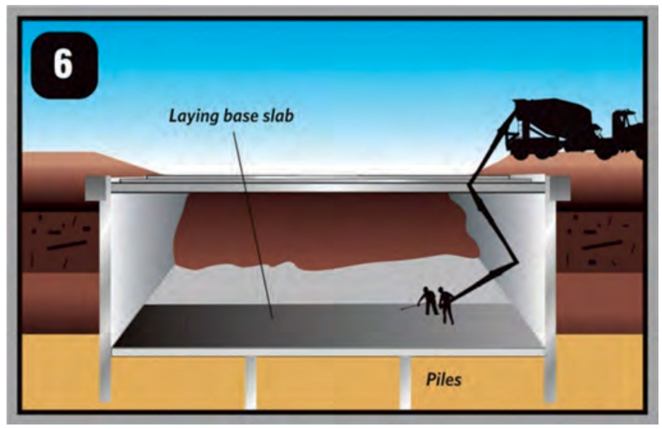

Figure 10: Laying the base slab in 40 m sections

simultaneously with tunnel retaining system construction.

Surficial excavation between completed wall sections enabled installation of groups of three precast concrete double hollow core (DHC) roof beams at approximately 10 m intervals between the walls. The spacing of the beam group was arranged to allow excavation of the tunnel to progress from ground level, reaching between the beams (Figure 9). At this stage, the beams are pin-connected to the tunnel walls; i.e. no moment continuity with the walls.

At the two road crossings (Beaumont Street and Victoria Street West), all DHC beams and in situ topping were placed and backfilled to reinstate the road prior to excavation. The roof at these locations was therefore fully integral with the walls prior to excavation.

Material excavated from between the tunnel walls was generally as expected (indicated in Figure 4). It was only during bulk excavation however, that the extent of contaminated fill material within the footprint of tunnel through Victoria Park would be known.

A sorting station for excavated material was set up to separate reusable clean fill with tainted fill for disposal. In total, some 100,000 m^3 of contaminated material was removed from the site (almost 40 % of the total excavated volume of material from the tunnel).

On completing excavation to formation level, the base slab is poured, connecting to the previously installed tension piles (Figure 10). The construction of the base slab was typically undertaken in 40 m sections and followed excavation works closely, minimising the physical extent and time for groundwater to drain into the excavation.

Groundwater seepage into the excavation was observed at several discrete locations where fractures day-lighted in the excavation face. However, overall groundwater seepage was relatively minor in comparison to surface water runoff and water introduced from construction activities. Groundwater seepage was typically between 5 m^3/d and 10 m^3/d, though occasional peaks of up to 20 m^3/d were recorded. These small inflows are typical of the ECBF; however, because of the very low storativity of fractures, large drawdowns can result from only small water losses, making monitoring of groundwater levels an important component of construction monitoring. This is discussed in the following section.

Negligible seepage was observed through the tunnel walls, although some damp patches were visible as can be seen in Figure 11. This was more frequent at the contacts between secant piles and less common in diaphragm wall sections.

On completion of the base slab, the structural form of the tunnel is achieved with the casting of the roof slab. The remaining precast concrete DHC beams were placed as infill and a 200mm in situ topping cast. The roof then becomes moment continuous with the walls.

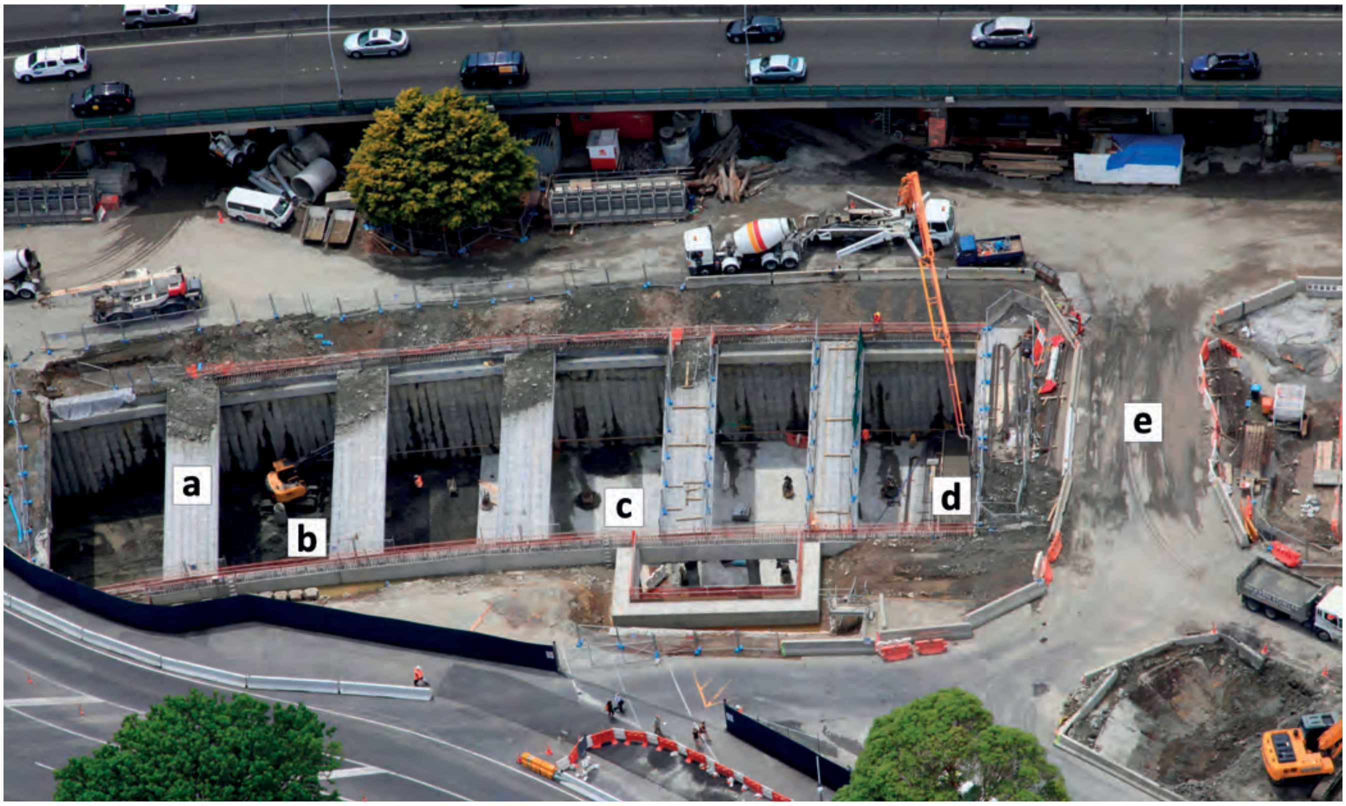

Figure 11: Tunnel construction – a) three DHC beams (pin connected to wall), b) excavation to formation level, c) blinding concrete and cut-down tension piles, d) base slab concrete pour and e) completed roof section (moment continuous with wall)

The image in Figure 11 presents the sequence of works from excavation to completion of the tunnel structural form.

Excavation and Construction Observation

A geotechnical site engineer was engaged in construction monitoring throughout the works to ensure that the geotechnical aspects of the founding and retaining structures of the tunnel were built in accordance with design intent and to assess the encountered ground conditions.

Records from construction monitoring indicate that rock (VW ECBF) was generally encountered at the anticipated depth. Importantly, this demonstrates the quality of geotechnical investigations undertaken for this project and value of construction proof bores.

Consent Compliance Monitoring – Groundwater

The groundwater and settlement monitoring programme comprised ten nested piezometer pairs, 42 No ground settlement markers and 96 No building settlement markers.

Baseline monitoring, undertaken for 12 months prior to excavation commencing, identified seasonal fluctuations in groundwater level of up to 1 m and typical seasonal fluctuations in ground level of 2 mm to 6 mm, but in places > 20 mm. Critically, this baseline monitoring also captured a very dry summer (January to April 2010) when less than 35 % of mean rainfall fell, which identified that groundwater levels could naturally drop a further 0.3 m to 0.5 m on average, but up to 0.8 m in some locations during periods of low rainfall. Given

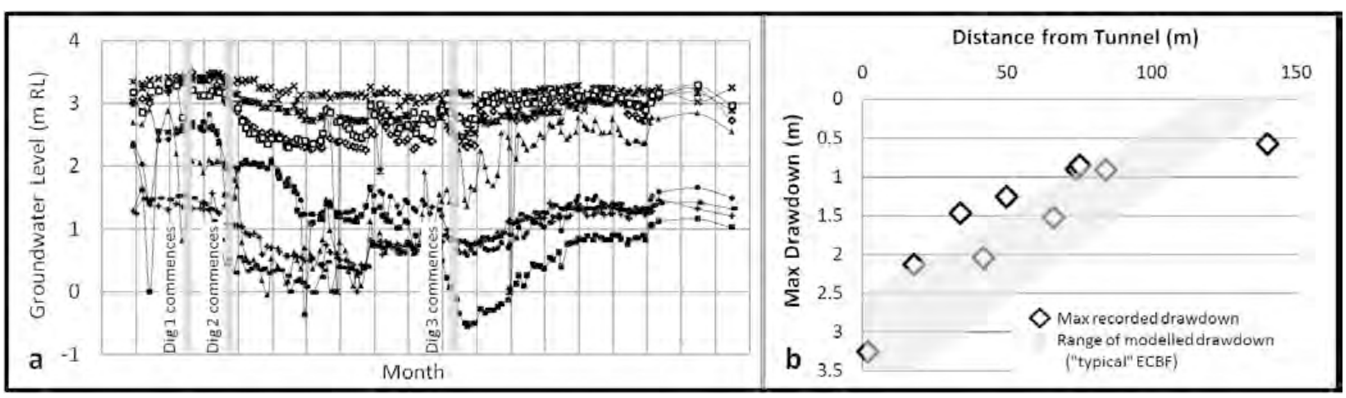

Figure 12: Drawdown in ECBF piezometers – a) maximum drawdown over time and b) maximum drawdown related to distance from excavation (after France et al., 2012)

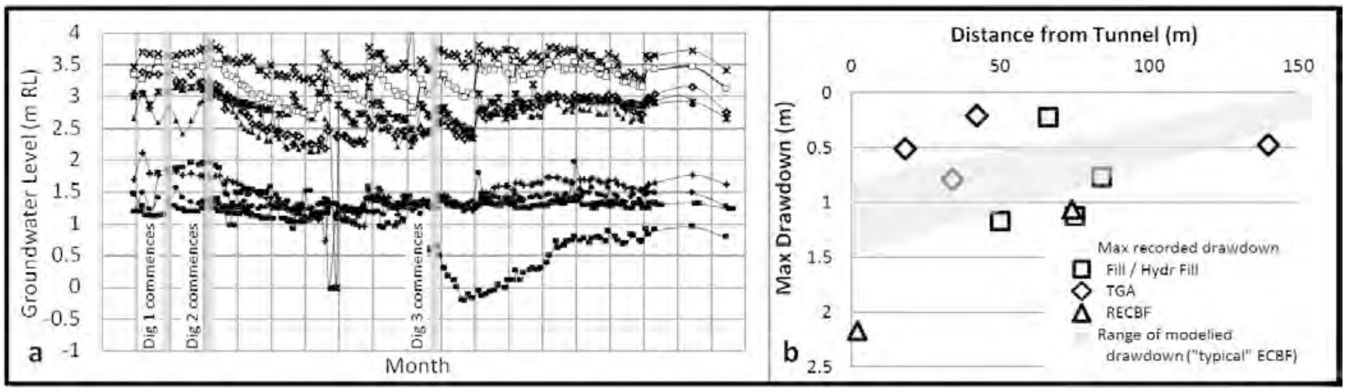

Figure 13: Drawdown in shallow piezometers – a) maximum drawdown over time and b) maximum drawdown related to distance from excavation (after France et al., 2012)

that tunnel bulk excavation commenced in the following dry summer (2011), monitoring data proved essential for setting appropriate trigger levels.

All piezometers screened within the ECBF showed a lowering of groundwater level in response to excavation dewatering. Time-drawdown plots for the sites closest to the excavation (a in Figure 12) show a more pronounced drawdown and recovery curve in response to site activities with a clear drawdown-distance relationship evident (b in Figure 12).

Screened within the fill, Tauranga Group or residual ECBF, eight of the ten shallow piezometers recorded a lowering of groundwater level that could be attributed to excavation dewatering (a in Figure 13); though it is noted that levels typically remained within recorded seasonal ranges. A less distinct drawdown-distance relationship is seen in the shallow piezometers; instead, the greatest drawdown occurs where the residual soils or hydraulic fill are more directly connected to the underlying ECBF rock (b in Figure 13).

Two groundwater drawdown trigger exceedances occurred during construction. However, both were attributed to specific construction activities and managed accordingly (France et al., 2012).

Ground and building settlement markers surveyed throughout the duration of the project have indicated only limited settlement that could be attributable to drawdown or other construction activities. Less than 10 % of all pins showed a measurable drop (more than 3 mm) below their naturally occurring pre-construction lowest level. All other markers monitored as part of the project, including those where the groundwater level was lowered for up to eight months, indicate that vertical movements and angular distortions were within the seasonal range of the preceding year and in many cases within the accuracy of the survey.

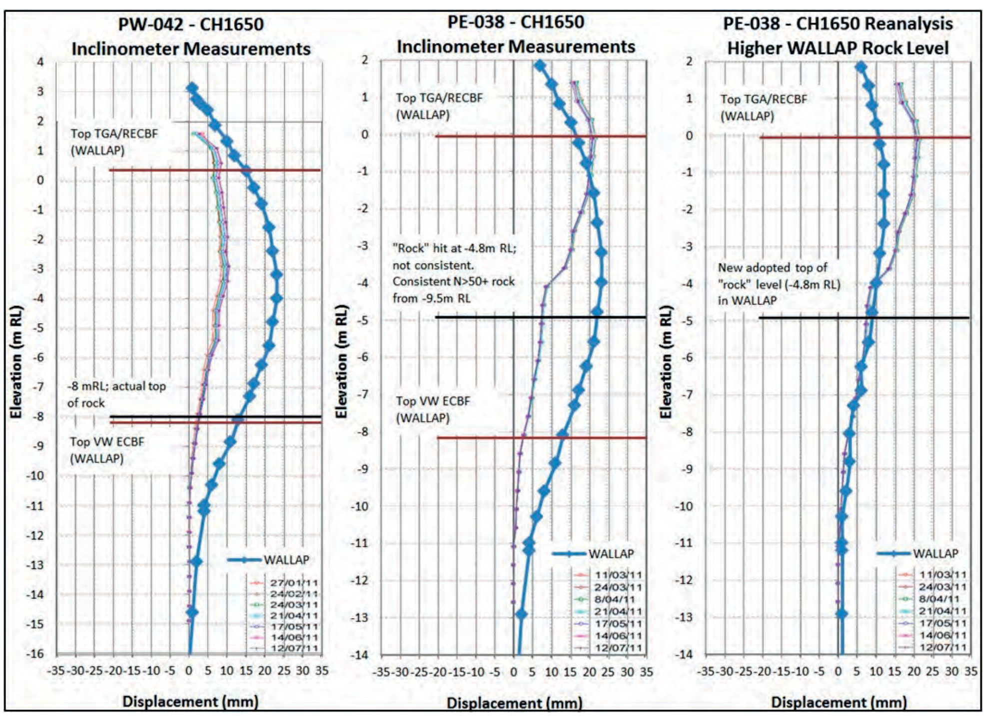

Figure 14: Tunnel wall displacements – comparison between WALLAP calculated and inclinometer (measured) values

Consent Compliance Monitoring – Lateral Wall Deflections

A series of 18 No inclinometers were used to monitor ground performance and confirm conformance with expected deflected behaviour of the tunnel walls. In addition, four earth pressure cells were installed during construction of selected diaphragm wall panels to evaluate soil pressures behind the walls.

The inclinometers were located behind the walls, between 0.5 m and 1.0 m from the outside face, so that any wall movement resulting from excavation for the tunnel could be captured. This may have under-measured actual panel deflection but provides a more accurate assessment of total ground movement, which was felt to be more critical.

While the earth pressure cells were able to identify trends in pressure, increasing with depth, we were unable to successfully correlate measured values with empirical values indicated by analysis. However, the deflections measured with inclinometers were generally consistent in magnitude, although typically less than those indicated by the analyses based on conservative lower quartile soil stiffness parameters.

As an example, the results for CH1650 have been reproduced below (Figure 14) and are directly compared to the results of modelling using WALLAP. The inclinometer values from PW-042 (west wall) indicate typical wall deflection results, with measured deflections of the order of 10 mm and calculated deflections of the order of 25 mm.

The results for PE-038 (east wall) showed deflections of up to 20 mm, thought to be due to increased construction traffic on the eastern side of the tunnel. However, the rock level was encountered at a higher level than expected during the design phase and when this elevated rock level is included in the modelling, the measured deflections are between 5 mm and 10 mm greater than expected. This is consistent with the observed increase in crane traffic on the eastern side of the tunnel.

Closing Remarks

In order to assess and mitigate potential effects on the surrounding dense urban environment from excavation for the Victoria Park Tunnel structure, heavy reliance was placed on the disciplines of geotechnical engineering and hydrogeology.

Selecting the appropriate structural form of the tunnel (a 'dry box', Figure 15) during consenting, reducing the embedment depth of the tunnel retaining walls in design and successful monitoring and management of effects throughout construction are three significant contributions made by these two disciplines.

The design solutions brought to the project satisfied the tunnel performance requirements from a stakeholder perspective and enabled programme savings (time and material cost) from a construction perspective. The latter was a major contributor to the early delivery of this fast-tracked project.

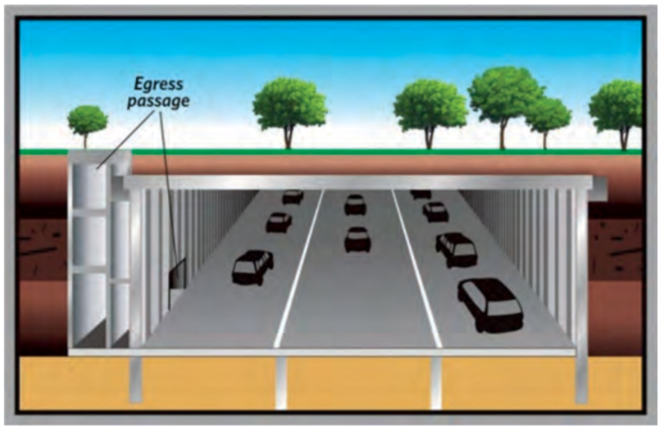

Figure 15: Completed structural form of the tunnel

Within the 'best for project' and high-performance culture of Victoria Park Alliance, the disciplines of geotechnical engineering and hydrogeology were key in driving the Victoria Park Tunnel project.

Acknowledgements

The authors would like to acknowledge the New Zealand Transport Agency, for permission to showcase this project, and Victoria Park Alliance, for the numerous visual accompaniments within the text, including the cover page image.

The contributions of Tim Tang (Senior Engineer, Beca), in the form of memoranda and reports written while he was a member of the Victoria Park Alliance team, have provided much assistance in the composition of this article. The authors here record their appreciation for his support.

References

Beca (2006). Addendum 2 February 2006 of the Vic Park Tunnel Project Documentation.

France, S. (2008). "Victoria Park Tunnel: Drawdown, damming and contaminant migration." Proceedings, 8th Young Geotechnical Professionals Conference, Wellington, NZ, 5-8 November 2008.

France, S. J., Newby, G. & Williams, A. L. (2012). Victoria Park Tunnel – Drawdown and Settlement in the Auckland Central Business District.

SKM (2008). Vic Park Tunnel (VPT) Geotechnical Interpretive Report.

Victoria Park Alliance (2010). Geotechnical Design Report for Victoria Park Tunnel.

Seismic Design of Slopes and Retaining Walls – Some Issues – Bishal Subedi, Senior Geotechnical Engineer, Aurecon New Zealand Ltd

Overview

Retaining walls and earth slopes are common civil engineering structures. Earth dams, levees, rail/road embankments and cuts are some examples of earth slopes. Both these structures are extensively used when the development is on hilly or mountainous terrain. Their proper function during strong earthquakes is vital for the country's infrastructure and people's safety.

In this article I will discuss the seismic design of earth slopes and retaining walls. My objective here is not to go into the details of seismic design, but rather to share my experience on the difficulties I have faced as a practicing engineer. My discussion is limited to the pseudostatic method, which geotechnical engineers routinely use.

Finite element based dynamic analysis, Newmark sliding block and pseudostatic analysis are the methods generally adopted to assess the seismic response of retaining walls and slopes. The finite element method requires sophisticated tools and skills and may not be justifiable for routine type projects. Newmark's sliding block analysis is relatively simple and useful in assessing earthquake induced deformation. Still, the pseudostatic method is popular among practicing engineers and the method is generally acceptable as long as no significant strength degradation of soil is expected during earthquakes.

The pseudostatic method is basically a limit equilibrium method in which the force/moment equilibrium of a soil mass above a potential slip plane (including earthquake induced force) is considered and the dynamic factor of safety of the potential sliding mass is calculated. Despite its limitations, such as the assumption of the rigid perfectly plastic behaviour of soil and the application of a seismic load as a permanent load, this method is widely used. This method has been adopted to evaluate the seismic stability of hundreds of dams (Baldovin and Paoliani, 1994). Lew et al (2010) comment that although other methods may be used in practice, the pseudostatic method (known as Mononabe Okabe or the M-O method for retaining walls) is the most common method of analysis for dynamic analysis of retaining walls.

Despite such widespread use and popularity, there are some difficulties in carrying out pseudostatic analysis for retaining walls and slopes. Peak ground acceleration (PGA) and the pseudostatic coefficient are the two basic parameters required for the analysis, but there are no clear guidelines as to how these parameters are estimated. This is further discussed in the following.

Estimation of Peak Ground Acceleration

Site specific earthquake hazard or site-response analyses are accurate methods to estimate the peak ground acceleration. However, for routine or relatively small-scale projects, time and cost are often barriers for using such methods, and published literature or codes of practice are used instead. Some publications commonly referred to are:

- NZS1170.5: 2004 Structural Design Actions Part – 5 Earthquake Actions – New Zealand (Standards New Zealand, 2004)
- New Zealand Society Geotechnical Earthquake Engineering Practice Module 1 (NZGS, 2010)
- New Zealand Transport Agency Bridge Manual (New Zealand Transport Agency, 2003 with Provisional December 2004 amendment)

NZS1170.5 gives elastic site spectra for New Zealand which can be used to estimate PGA. As far as I am aware, NZS 1170.5 is the most widely used document by the New Zealand geotechnical community. However, the use of this Standard for slopes and retaining structures may not be appropriate. Firstly, the Standard clearly states *"..soil retaining structures and slope instability…resulting from earthquake shaking are outside the scope of this Standard*". The elastic site spectra given in the Standard are mainly intended for structural engineers to use in building design. Secondly, when this is used in geotechnical design, PGA is calculated as the product of the Spectral Shape Factor C_h (when time period T=0), the Hazard Factor Z, the Return Period Factor R and the Near-Fault Factor N (T, D). The return period factor (or the probability of occurrence of earthquakes for the given limit state) is linked with the design life and the Importance Level of the structure, as described by *NZS1170.0: 2002 Structural Design Actions Part – 0 General Principles*. NZS 1170.0 defines the Importance Level only for buildings, not for earth slopes and retaining walls. Notwithstanding this, the use of NZS1170.5 for slope stability or other geotechnical applications, in my opinion, is due to the unavailability of other appropriate references.

NZGS Practice Module 1 is a useful reference for seismic analysis and design in a wide range of geotechnical earthquake engineering applications. The PGA calculation method given in this publication is clear and easy to understand. But it again refers to NZS1170.0 for working out the Importance Level as above.

Bridge Manual gives procedures to estimate ground acceleration for retaining wall design. This manual also has some issues:

- No details are provided to estimate PGA for earth slopes. It only discuses retaining walls.
- The manual has clearly defined Importance Levels for retaining walls and given Return Period Factors to calculate PGA. There is an additional multiplier called "structural performance factor (Sp)" in the PGA calculation. The value of Sp has been specified based on the site's subsoil category. However its use is confusing. For example, the Sp for flexible or deep soil class is 0.67. As there is no Sp factor for PGA in NZS1170.5 or the NZGS guidelines, a PGA calculated from the Bridge Manual could be 33% less than that obtained from the other two documents.

Selection of Appropriate Earthquake Coefficient

In pseudostatic method, the earthquake induced force is calculated by multiplying the weight of the failure body or wedge and the pseudostatic or seismic coefficient. This coefficient is defined as a/g. Here, "a" is the peak ground acceleration commonly expressed in terms of "g" ("g" being the acceleration due to gravity). The issue related to the estimation of the pseudostatic coefficient is whether this coefficient should be equal to the design peak ground acceleration or it should only be a fraction of the peak ground acceleration. Also, if it is to be a fraction of the PGA, then what fraction is to be taken for the design is another issue.

Whiteman (1991) had recommended that except where structures were founded at a sharp interface between soil and rock, the M-O method should be used with the actual expected peak ground acceleration (Whitman, 1991 cited in Lew et al., 2010). On the other hand, it is well recognised in literature that using a seismic coefficient equal to the peak ground acceleration could produce excessive and overly conservative seismic loads, especially in high seismic areas (Kramer 1996, Kavazanjian, et al., 1997, Day, 2002). The pseudostatic method applies the seismic load to the failure wedge as if it is a permanent load (like gravity), which in reality is not true as the peak ground acceleration occurs only for a very short period of time (See Figure 1a and 1b). If the pseudostatic coefficient is to be considered as a fraction of the PGA, there are no guidelines clearly outlining what fraction is suitable for pseudostatic analysis. Published literature gives varying ranges:

Kramer (1996):

Hynes-Griffin and Franklin (1984) .....concluded that earth dams with pseudostatic coefficient factors of safety greater than 1.0 using k = 0.5 a/g would not develop "dangerously large" deformations......There are no hard and fast rules for selection of a pseudostatic coefficient for design....Although engineering judgement is required for all cases, the criteria of Hynes-Griffin

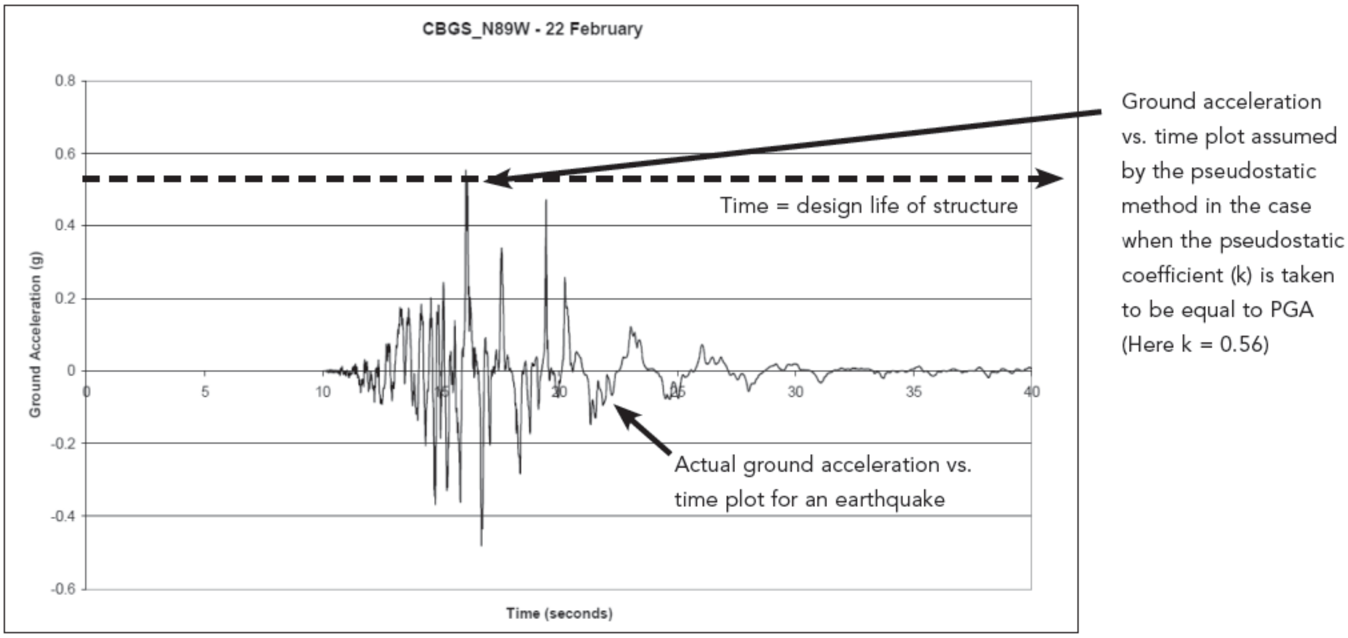

Figure 1a: The PGA of approximately 0.56g in this plot occurs only for a fraction of a second in the 40 second shake period. If this value (i.e. 0.56) is used as a seismic coefficient to calculate the earthquake induced load, then the structure will effectively be subjected to such load throughout its design life (Source of ground acceleration versus time plot: Carr, 2011).

and Franklin (1984) should be appropriate for most cases.

Kavazanjian, et al (1997):

.....However, for retaining walls wherein limited amounts of seismic deformation are acceptable.....use of a seismic coefficient from between one-half to two-thirds of the peak horizontal ground acceleration divided by gravity would appear to provide a wall design that will limit deformations in the design earthquake to small values.

Based on the above, the pseudostatic coefficient could vary between one third to two thirds of the peak ground acceleration. This is a big range, and the calculated earthquake induced forces on slopes or retaining walls could vary significantly depending on what fraction the designer chooses.

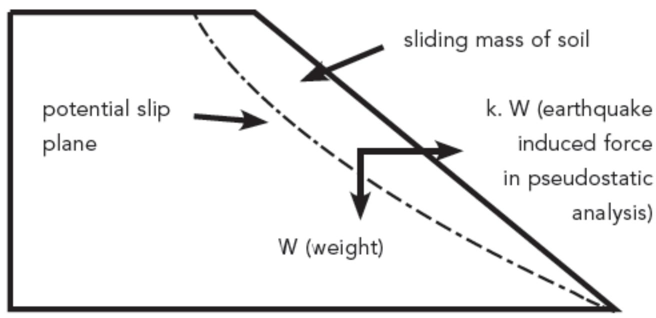

Figure 1b: Simple illustration of calculation of earthquake induced force in the pseudostatic method for a slope.

Conclusion

The Pseudostatic method is an extended limit equilibrium method for seismic analysis. This is simple and easy to understand and widely used for slopes and retaining walls. Two basic parameters required for this method are the peak ground acceleration and the seismic coefficient. But the absence of a clear guideline to estimate these parameters for slopes and retaining walls causes confusion to practicing engineers. This leads to not only inconsistent practice among geotechnical engineers but also to potentially unsafe or overly conservative designs. A guideline addressing these issues would be useful to the geotechnical community.

References

Baldovin, E. and Paoliani, P., 1994, *Dynamic Analysis of Embankment Dams.* The Numerical Analysis and Modelling of Soil Structure Interaction (Editor: J.W. Bull), E & FN Spon, London.

Carr, A.J. (2011), *Report to the Canterbury Earthquakes Royal Commission on Inelastic Response Spectra for the Christchurch Earthquake Records,* Figure A16, www.canterbury.royalcommission.govt.nz.

Day, R.W., 2002, *Geotechnical Earthquake Engineering Handbook.* Mc-Graw Hill.

Kavazanjian, E., Matasovic, N., Hadj-Hamou, T. and Sabatini, P.J., 1997, *Geotechnical Engineering Circular #3, Design Guidance: Geotechnical Earthquake Engineering for Highways, Volume I: Design Principles.* Report Nos. FHWA-SA-97-076, U.S.

Department of Transportation, Federal Highway Administration, Washington, D.C.

Kramer, S.L., 1996. *Geotechnical Earthquake Engineering*. Prentice-Hall, Inc., Upper Saddle River, NJ.

Lew, M., Sitar, N., Atik, L.A., 2010, *Seismic Earth Pressures: Fact or Fiction*. Earth Retention Conference 3 (Editors: Finno, R.J., Hashash, Y.M.A., Arduino, P.), American Society of Civil Engineers, Virginia, USA.

New Zealand Transport Agency, 2003 and 2004, *Bridge Manual*. New Zealand Transport Agency, Wellington, New Zealand

NZGS, 2010, *Guidelines for Geotechnical Earthquake Engineering Practice, Module 1- Guideline for identification, Assessment and Mitigation of Liquefaction Hazards.* Geotechnical Earthquake Engineering Practice (Editors: C.Y., Chin, Williams, A.L.). New Zealand Geotechnical Society.

Standards New Zealand, 2004, *Structural Design Actions, Part 5, Earthquake Actions: New Zealand*. Standards New Zealand, Wellington, New Zealand.

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Theme "...that's not exactly what we had in mind"

'Digger on a leash' – Not exactly what we had in mind for an excavation methodology at this site in Auckland; ***Shiraz Soysa***, Tonkin & Taylor.

Right: Banana Pile; ***Jon Sickling***, Jacobs Associates. **Far right:** We recommended a borehole investigation and the client interpreted that to mean a hand auger investigation... not exactly what we had in mind; ***Alistair Stuart***, GHD Geotechnics.

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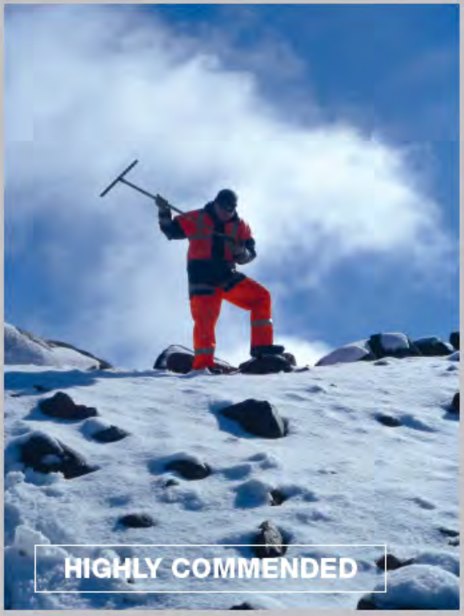

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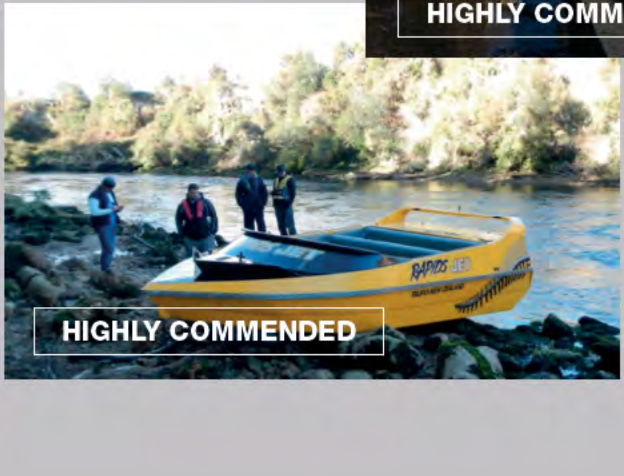

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Left: We had hired a jet boat and skipper for a day as we needed to survey the banks of the Waikato River north of the Aratiatia Dam. We had nosed the boat into the bank to survey an erosion site. During this time (no more than 15mins), the water level dropped significantly, and kept dropping till the boat was well and truly beached about 1m above the water. It took two hours for the water level to rise to where we could push the boat off the bank! ***Jeremy Eade***, Beca.

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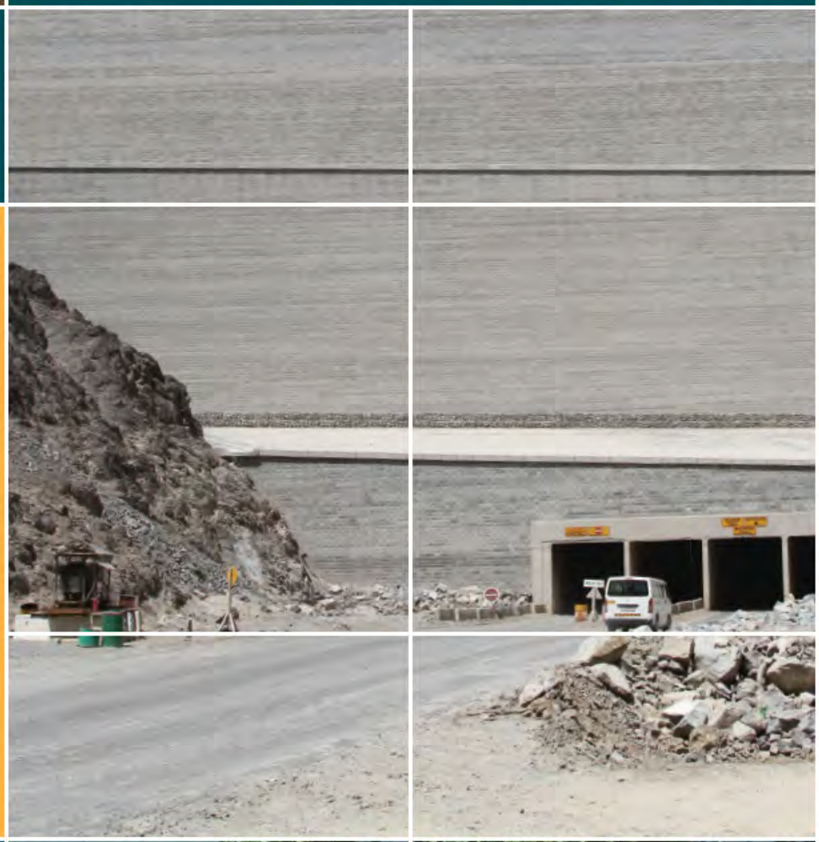

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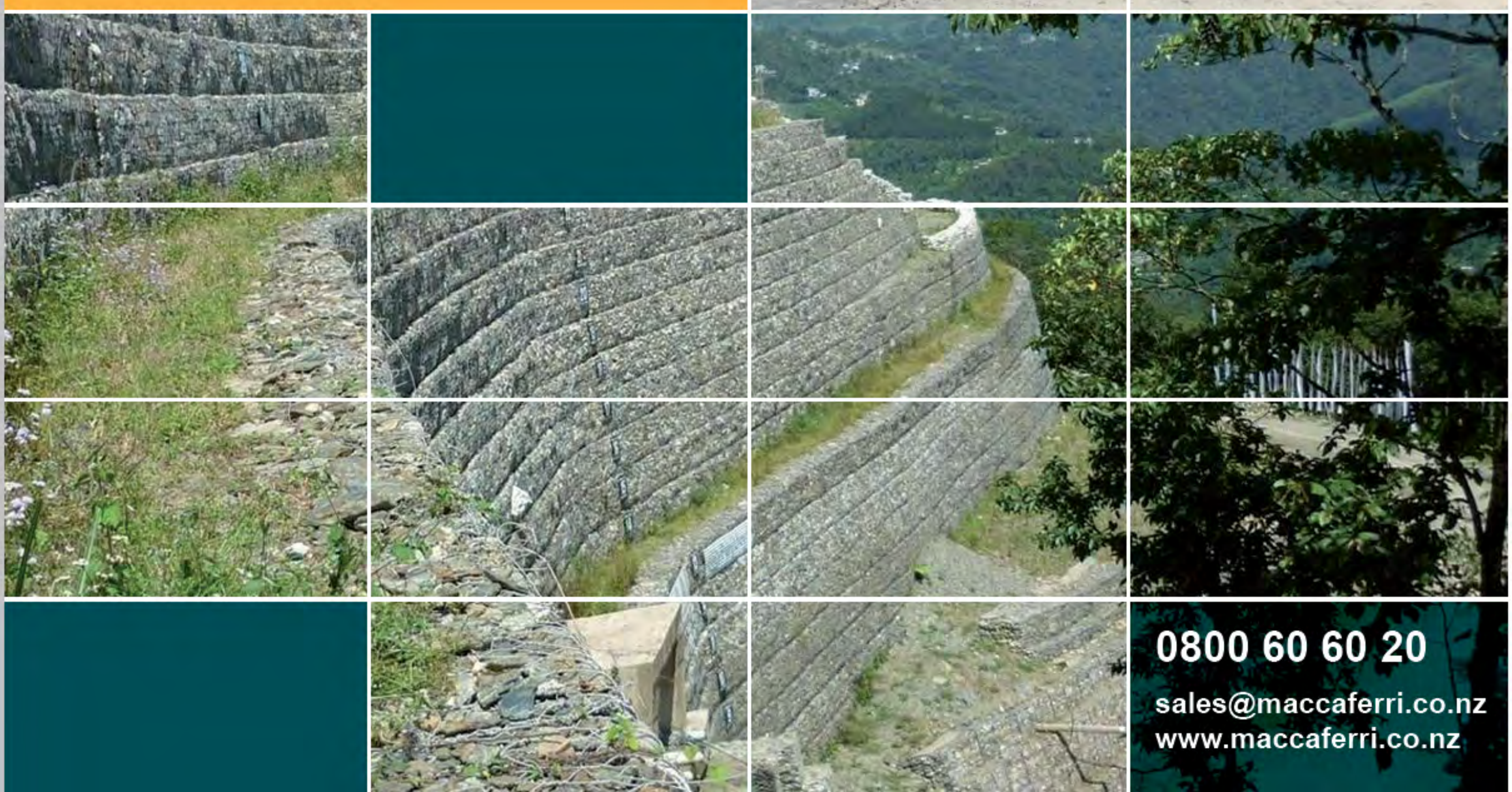

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Analysis of Basement Excavation through Organic Silt – Richard Heritage, Geotechnical Engineer, Aurecon Ltd

Abstract

A 25 storey tower block in Quy Nhon City, Vietnam included a two level basement which required excavation up to 10.5m deep. A diaphragm wall with temporary props was proposed to support the basement excavation. This project was made particularly complex due to the low strength of the ground, particularly the presence of a layer of soft, compressible, organic silt located between 11m and 16m below ground level.

These ground conditions meant that the initial analysis (an 800mm thick wall – a solution used successfully elsewhere for similar sized excavations) resulted in the diaphragm wall's predicted deflections being well beyond the acceptable limits. To reduce the deflections the wall's stiffness was increased. This was achieved by increasing the thickness of the wall. However, the resulting maximum bending moment in the wall was so great that the cost of strengthening the wall sufficiently would make the solution impracticable.

Several alternative options were considered and the final preferred solution involved placing the temporary props at very specific depths and pre-stressing the bottom layer of props. The result was higher prop forces, reduced maximum bending moment in the wall, and the deflections reduced to acceptable levels.

1. Introduction

There are many different solutions available to manage the problem of supporting a basement excavation depending on various factors such as depth of excavation, site constraints, the properties of the subsurface soils and the available materials and technology. This paper presents the challenges faced in designing a retaining wall solution for a two level basement in Quy Nhon City, Vietnam.

2. Site Conditions

The site is approximately 3500m^2 with a proposed building footprint of 43m by 59m. The building is to be 25 storeys tall with a two level basement.

The ground conditions have been investigated by drilling four boreholes to 70m depth with Standard Penetration Tests (SPTs) at 1m intervals and an extensive suite of laboratory tests including Particle Size Distributions (PSDs), Atterberg tests, Oedometer tests, Consolidation tests, Shear Box tests, and various types of Triaxial tests. In total over 450 laboratory tests were carried out.

The site is typically underlain by 68m of cohesive and cohesionless soils overlying basalt rock. The ground water table is approximately 1m below ground level. For the purposes of basement retention design the properties of the upper 30m of soil were analysed and their properties are summarised in Table 1.

Of particular note is the presence of an organic silt layer between 11.0m and 15.5m below ground level. Test results indicate that the layer is very soft having an undrained shear strength (Su) of 15kPa and modulus of elasticity (Es) of 3,000kPa.

3. Methodology

To assess the forces and deflections of the basement retention system the computer programme WALLAP by Geosolve was used. WALLAP is designed specifically for the analysis of retaining walls, piles and retained excavations (e.g. basements). The programme allows analysis of forces and deflections at various stages during construction. All results presented in this paper refer to the stage where the deflections and internal forces in the wall are at their greatest - when the excavation is at its greatest depth (10.5m) and before the reinforced concrete floors have been constructed.

The soil properties used for the analysis (see Table 1) were determined by reviewing the results of the in-situ SPT tests and laboratory test results and a representative value for each layer has been selected. Layers with a fines content of >35% were assumed to behave in a cohesive fashion. The borehole logs show small variations in the depth and thickness of each layer.

4. Preliminary analysis

The preliminary analysis was to determine the most appropriate form of basement retention. The options considered were:

LAYER	MATERIAL	DEPTH TO TOP OF LAYER	$\varnothing$	c	S_u	E_s
1	Sand with some clay	0.0m	29.0°	4.0kPa	-	14,000kPa
2	Organic Silt	11.0m	-	-	15kPa	3,000kPa
3	Sand with some clay	15.5m	30.5°	3.5kPa	-	14,900kPa
4	Clayey Sand	20.0m	-	-	100kPa	21,600kPa
5	Clay/Silt with some sand	27.0m	-	-	150kPa	17,500kPa

Table 1: Soil Properties for Basement Retention Design (obtained from laboratory test data)

- Sheet piles
- Diaphragm wall
- Secant pile wall
- Contiguous pile wall

By assuming a maximum acceptable deflection of 100mm the required stiffness (the product of modulus of elasticity (E) and second moment of inertia (I)) of the wall was determined as $1320MNm^2$ per metre length of wall. This assumed two layers of temporary props installed to support the excavation. The required wall parameters to achieve this stiffness were assessed for each wall option.

Sheet piles were quickly dismissed as very large pile sections with welded UC columns would be required. In addition, the sheet piles would only be temporary (basement walls would be constructed within the excavation and the sheet piles subsequently removed) so this option was unlikely to prove economic.

A contiguous pile wall would require very large diameter piles. This would be technically achievable, however with a high water table constructability issues due to groundwater seepage, and possible 'squeezing' or 'running' of the ground, means that it is a high risk option.

A secant pile wall would eliminate the groundwater issues and should provide a water tight wall. However, the time to construct the required number of piles was unacceptable to the client and this option was dismissed.

The remaining option was a diaphragm wall. This has been used many times before in Vietnam for basement construction. By founding the wall 28m below ground level in a clay layer an effectively watertight excavation could be achieved and the wall could be designed to operate as the final basement walls once excavation was complete.

Note: The excavation depth at this stage of analysis was 8.95m. As architectural design proceeded, this was increased to 10.5m.

5. Design challenges

The major design challenge in assessing a suitable basement retention system is keeping the deflections within acceptable limits (in this case 100mm maximum allowable deflection to limit damage to nearby buildings) while reducing the forces in the wall to manageable levels. The main reason why this problem was particularly challenging was due to the presence of the organic silt. This layer applied a large active force to the back of the wall and provided very little passive resistance at the front of the wall. The organic silt was located just 0.5m below the maximum excavation depth and extended for 4.5m. The effect of very weak ground immediately below the maximum excavated depth was similar to having the maximum excavation depth extended a further 5m, but without the option of providing temporary props.

This combination of high active force and low passive resistance meant that, in order to reduce deflections to an acceptable level, the wall itself is subjected to very large forces both in shear and bending.

6. Force vs. displacement

In order to reduce the forces within the wall, the effect of reducing the stiffness in the wall was assessed. Reducing the stiffness of the wall reduces the amount of load within the wall by shedding more of the load into the struts, and into soil below the wall which provides passive resistance. However, the result is that the wall deflects further. Excessive deflections can result in settlement at the surface behind the wall which may damage adjacent buildings and infrastructure, or severe disturbance to the soil on the passive side (aka base heave) which may eventually lead to loss of strength and passive failure of the retention system.

Shown in Figure 1 is a plot demonstrating how varying the stiffness of the diaphragm wall influences deflections and the level of bending moment in the wall. This plot was produced by conducting three WALLAP analyses varying only the thickness of the wall (i.e. varying the stiffness of the wall).

As shown in Figure 1, there is a balance that needs to be found between the level of deflection in the wall and

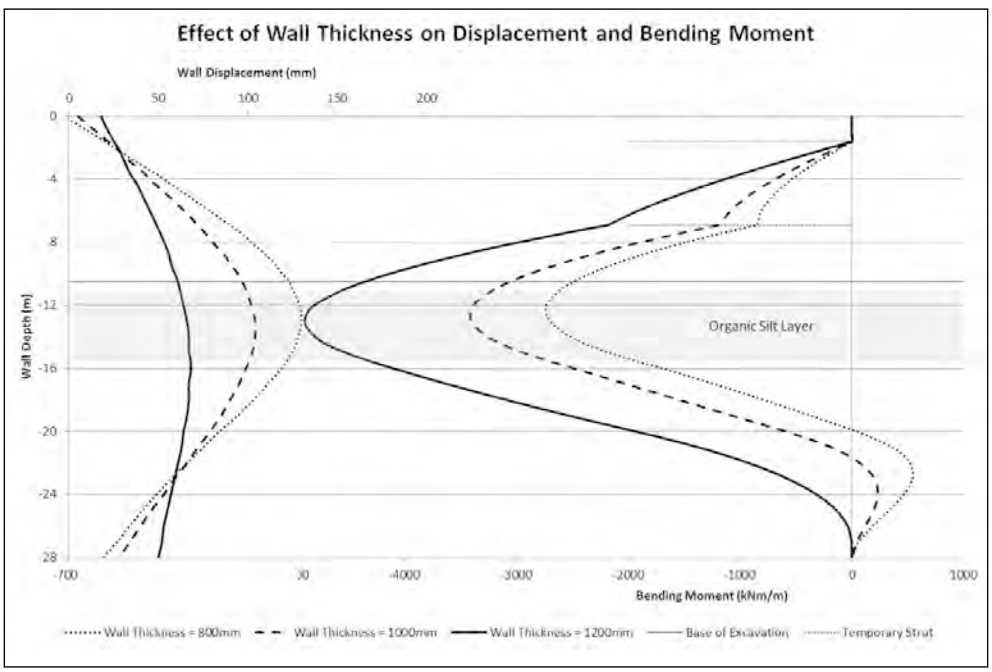

Figure 1: Effect of Diaphragm Wall Thickness on Displacement and Bending Moment

the amount of bending moment induced in the wall. The problem faced was that the level of bending moment in the wall was unacceptably high for the 1000mm and 1200mm thick walls. However, the level of deflection of the 800mm thick wall was also unacceptable. The challenge was to find a way of reducing the bending moment to acceptable levels without increasing the level of deflection.

7. Solution

In order to ensure that the basement excavation remained a practical option several possible solutions were assessed. These were:

- Additional props
- Prestressed props
- Base grouting

By adding additional props a larger proportion of the forces would be resisted by the props and a lesser amount by the wall. Hence the internal forces would be reduced and, by rearranging the props for maximum efficiency, the maximum deflections in the wall could be reduced. Additional props were the cheapest option as the equipment would already be on site and cost of installing additional props would be relatively small. Prestressing or 'jacking' the props would reduce wall deflections and bending moment but with higher prop forces.

However, the greatest forces and deflections occur within the problematic organic silt layer. The most beneficial location to add an additional layer of props would be near the centre of this layer. The idea behind basement grouting was to effectively create a strut within the organic silt by injecting grout from the surface in a horizontal sequence of 'bulbs'. From a technical perspective this was the most effective solution to the problem. However, the technology had not been used before in Vietnam and getting specialist contractors in would likely prove very expensive.

Shown below in Figure 2 is a plot demonstrating the effect of these proposed solutions on the deflections and the magnitude of bending moment in the wall.

The solution adopted was to add a third layer of props including prestressing the bottom layer. This decision was based on cost and time efficiency as well as risk as base grouting was a method unproven in Vietnam. Other solutions such as ground freezing were also considered and quickly dismissed due to the cost implications and the desire to use technology already proven in Vietnam.

8. CONCLUSIONS

When designing a deep excavation, finding a balance between an acceptable level of deflection in the basement retention system and the level of load that the retention system much resist is a complex balancing act. Many factors must be considered to ensure that the level of deflection in the wall does not exceed safe limits or result

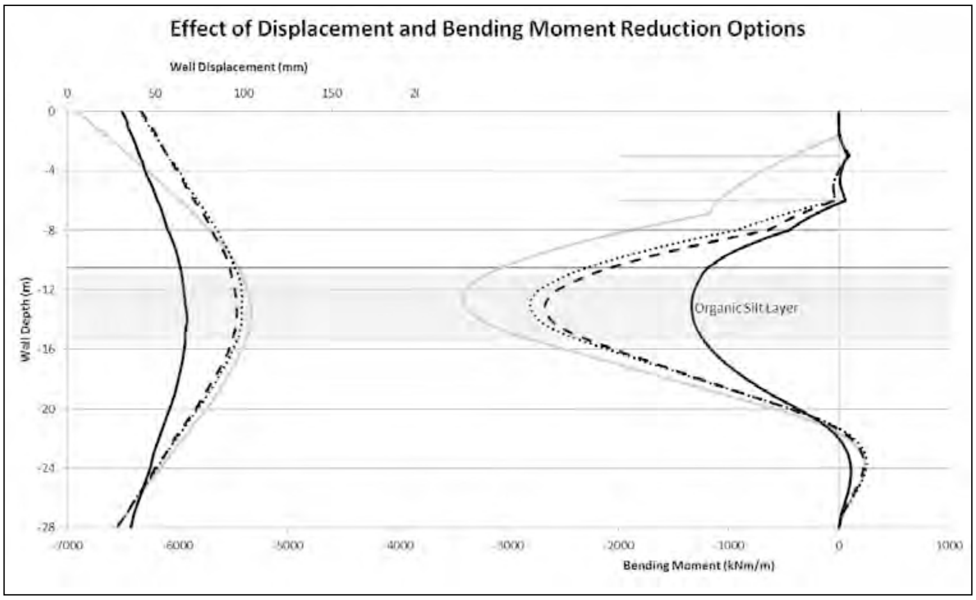

Figure 2: Effect of Displacement and Bending Moment Reduction Options

in unacceptable levels of settlement behind the wall which may damage adjacent buildings and/or infrastructure. While increasing the stiffness of the wall is the simplest way to reduce deflections, this results in the level of load in the wall significantly increasing.

The placement of temporary props to help the wall resist the imposed loads is often utilized. This is a relatively cheap and effective solution which is commonly used during basement excavation. However, in weak soils temporary props alone are not always sufficient. Other methods such as grouting below the walls and/or strengthening the retained soils (e.g. by freezing) can be very effective but also very costly – sometimes to such an extent that it is more economic to reduce the depth of excavation. However, additional time spent during the design stage can often save a lot of unnecessary additional cost and build time. By analysing the problem to more efficiently distribute the load into the temporary props, and prestressing the temporary props to further reduce deflections and the level of load in the wall, a practical solution can often be obtained without significantly increasing the cost of the project.

9. References

Borin, D. (2007) "*WALLAP Propped, Anchored and Cantilever Retaining Wall Analysis Program User's Guide*", Geosolve, Version 5

Bowles, J.E. (1982) "*Foundation Analysis and Design*", 3rd Edition, McGraw Hill.

British Steel Corporation (1984) "*BSC Piling Handbook*", 4th edition.

Broms, B. (1964[1]) "*Lateral Resistance of Piles in Cohesive Soils*", ASCE Journal, Vol.90 SM2 March 1964 pp.27-63

Broms, B. (1964[2]) "*Lateral Resistance of Piles in Cohesionless Soils*", ASCE Journal, Vol90 SM2 May 1964 pp.123-156

BS8002 (1994) "*British Standard Code of Practice for Earth Retaining Structures*", British Standards Institute.

Burland, J.B., Simpson, B. and StJohn, H.D. (1979) "*Movements around excavations in London Clay*", Proc. 7th European Conf. SMFE. Vol.1.

Burland, J.B., Potts, D.M. and Walsh, N.M. (1981) "*The overall stability of free and propped embedded cantilever retaining walls*", Ground Engineering, July 1981

Butler, F.G. (1975) "*Review paper: Heavily overconsolidated soils*", Conference on Settlement of Structures (April 1974). British Geotechnical Society.

CIRIA Report No.104. (1984) "*Design of retaining walls in stiff clay*".

Civil Engineering Code of Practice No.2 (1951) "*Earth Retaining Structures*", Institution of Structural Engineers.

Clayton, C.R.I., Milititsky, J. and Woods, R.I. (1993) "*Earth Pressure and Earth Retaining Structures*", 2nd Edition, Blackie

Henkel, D.J. (1972) "*The relevance of laboratory measured parameters in field studies*", Proc. Roscoe Memorial Symposium.

Khanh, N.Q. (2008) "*Soil Investigation Report, Project: SCB Binh Dinh*", Research Center for Technology and Industrial Equipment (RECTIE) Ho Chi Minh City University of Technology.

Lambe, T.W. and R.V.Whitman (1969)

Pappin, J.W., Simpson, B., .Felton, P.J. and Raison, C. (1986) "*Numerical analysis of flexible retaining walls*", Midland Geotechnical Society. Symposium on Computer Applications in Geotechnical Engineering.

Terzaghi, K. (1954) "*Evaluation of coefficients of subgrade reaction*", Geotechnique, Vol.5, pp.297-326.

Tomlinson, M.J. (1994) "*Pile Design and Construction Practice*", 4th Edition, Spon.

A Review of Shallow Foundation Design Practice in New Zealand –

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ABSTRACT

Bearing capacity assessment for shallow foundation design in New Zealand is an interesting field of engineering. Engineers variously rely on unverified correlations, incomplete codified methods, and/or judgement to arrive at a solution. The author has encountered many instances of bearing capacity assessment having been carried out in a manner indicating the analyst has not grasped the fundamental principles and/or limitations of their method of choice. The variable nature of reporting in the industry can, in part, be traced to the legacy of various over-simplified, 'acceptable' methods of bearing capacity assessment. This paper reviews commonly employed methods for bearing capacity assessment including those given in NZBC Clause B1 Structure, NZS3604 and Stockwell (1977). It is found that a disproportionate amount of reliance is placed on methods that have questionable applicability. None of the methods adequately address seismic design. Suggestions are made for improving engineering practice, some of which should be given immediate effect. The paper should be of interest to civil, geotechnical and structural engineers in their quest to transition from theory to practice.

KEYWORDS: Bearing capacity assessment, shallow (spread) foundation design, seismic design, soil mechanics, complexity of ground behaviour, dynamic cone penetrometer (DCP).

1. INTRODUCTION

The author has reflected on the land performance triaging system that has seen low-lying earthquake-affected residential areas in Canterbury zoned into three Green Zone Technical Categories (TC1, TC2 and TC3) [DBH[2] & CERA]. The categorisation is primarily based on observed earthquake performance of land and buildings and, taking other factors into account, provides an indexing system of how land is expected to perform in a future design earthquake scenario (i.e. a Serviceability Limit State event or an Ultimate Limit State event), and provides guidance on suitable foundation measures for repair/rebuild in those areas. Another intention of the TC zoning is to help direct the limited engineering personnel resources where they can be most effective in the recovery effort.

In essence, this means that land with the most geotechnical complexity (TC3) is the reserve of "CPEng geotechnical specialists", whilst the remaining land (TC1 and TC2) is tended to by a wider population of the engineering community with the majority being non-geotechnical specialists, all of whom are playing an important role in geotechnical investigation and reporting for tens of thousands of properties.

Great effort is being put into the review and implementation of international best-practice methods of ground investigation and geotechnical analysis in TC3 areas. However, while the geotechnical specialists for the TC3 areas pour over the minutiae of borehole drilling methods, drill bit flush apertures, field test tools and procedures, cone penetrometer test calibrations, corrections and the like, ground investigation practices in the TC1 and TC2 areas largely remain unchanged from those employed over the past four decades – the tools of choice being the dynamic cone penetrometer (DCP) test[3], the hand auger and the shear vane.

An unintended side-effect of the TC triaging system is that it gives the impression that TC1 and TC2 land is free of geotechnical challenges. Engineers working outside of their field of competence often do not appreciate the complexities the ground can present, or the limitations of the DCP as a ground investigation tool.

With the investigation practices in TC3 land undergoing so much scrutiny this led the author to question what we actually know about the investigation and bearing capacity assessment practices routinely applied in TC1 and TC2 land and for that matter across much of the country where the DCP is widely used.

The author observes that it is common practice across New Zealand for engineers to derive values of bearing capacity for shallow (spread) foundations using rudimentary ground investigation tools in often complex ground conditions. Calculations are based on questionable concepts and crude, dated correlations from overseas (i.e. not calibrated for NZ soils and its climatic conditions) to arrive at bearing capacity values for design that are reported with apparent (and somewhat unsettling) accuracy and certainty.

This paper reviews commonly employed methods for bearing capacity assessment including those given in NZBC Clause B1 Structure, NZS3604 and Stockwell (1977). It is found that a disproportionate amount of reliance is placed on methods that have questionable applicability. None of the methods adequately address seismic design.

The primary aims of the paper are to:

1. Provide practitioners with knowledge of the background and uncertainty inherent in routine foundation assessment practices, so they are better

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[2] Although the DBH has recently been rebranded into the new Ministry of Business, Innovation & Employment, the acronym DBH is still widely used and the references cited in the paper are still branded as DBH documents.

[3] The terms Scala Penetrometer and Dynamic Cone Penetrometer (DCP) as used in New Zealand are synonymous. The test procedure is covered NZS4402 Test 6.5.2.

informed to make appropriate design decisions;
2. Introduce seismic design issues that influence foundation design and the means by which some of these can be evaluated;
3. Inspire discussion in the engineering community with the intention that this leads to improvements to guidance documents and foundation engineering practice.

The paper includes comments based on the author's observations, experiences and lessons learned working in Canterbury. It is hoped that civil, geotechnical and structural engineers across New Zealand will find something of benefit to their practice.

2. FOUNDATION DESIGN

A paramount objective of foundation design is to keep *settlement* of load-bearing elements within tolerable limits throughout the structure's design life, i.e. to prevent *excessive total and differential settlement*. What is tolerable for a particular structure depends on the particulars for that structure including, for example, its materials, scale, complexity and function.

Yet, routine foundation design practices in New Zealand:

1. Do not address settlement, but instead rely on procedures based on shear strength parameters (s_u, c',ϕ') and the concept of 'bearing capacity';
2. Are for static design only, i.e. they do not accommodate the effects of seismicity; and
3. Have an overwhelming preponderance to rely on the DCP as the primary means of deriving soil strength (and, indirectly, settlement) characteristics.

To address Item 1 a "global factor of safety" (FoS) is applied to the assessed *ultimate bearing capacity* (q_u) to arrive at the *allowable bearing capacity* (*qa*), for example:

$$q_a = q_u/\text{FoS}$$

where FoS = 3 is commonly adopted.

The FoS is referred to by some as the "factor of ignorance" [Fellenius, 1999]. Fellenius comments that the concept of bearing capacity is a "delusion", and states "tests on full-size footings have shown that bearing capacity in terms of an ultimate resistance at which failure occurs, does not exist". He adds that it has been shown conclusively that the bearing capacity principles, as outlined below, provide an incorrect model of actual response of footings to load [Fellenius, 2011].

A resounding message from earthquake damage evaluations of structures in Canterbury is that it is the *settlement performance* that dominates discussions between building owners, engineers, tenants, insurers and their technical reviewers, <u>not bearing capacity</u>. Furthermore, the design of foundations resilient to seismic effects is focused on mitigating excessive settlement [DBH, 2011 & 2012]. Clearly, there is a disconnect between the traditional approach to how we evaluate a foundation's suitability and how we should be undertaking foundation assessments in a seismically active country.

To address Item 2:

(i) the commentary for the procedure either grossly simplifies how earthquake effects should be taken into account ignoring profound effects of seismicity (e.g. Stockwell (1977) does not cover the risk of liquefaction although NZS4205P:1973 explicitly mentions its effects must be considered), or

(ii) the procedure has stated limitations including, for example, that the method should not be applied to problems where earthquake effects can prevail (e.g. B1/VM4 and NZS3604)[4].

Clearly, such methods have limited application in New Zealand.

Regarding Item 3 the author speculates that because the DCP is a cheap, quick and simple test to conduct that over-simplified foundation engineering procedures based on it have endured unchecked for so long.

That the aforementioned procedures and tools are so commonly employed, one infers that it is by hope that the "factor of ignorance" applied to q_u will protect the structure from all of the loads (dead, live, wind, snow & earthquake) imposed on it, rather than by sound engineering design.

3. BEARING CAPACITY

3.1 GENERAL EXPRESSION FOR *STATIC DESIGN*

It is not the intention to go into details of bearing capacity assessment here as the topic is covered extensively elsewhere in many textbooks. However, some basic theory is presented to illustrate the concept still widely relied upon today, and provide important background to topics covered later in the paper.

The general expression for static bearing capacity for an isolated strip footing founded at ground surface was presented by Terzaghi (1943). For drained (or effective stress) analysis the expression is as follows:

$$q_u = c' N_c + q' N_q + 0.5 B\gamma' N_\gamma \quad (1)$$

where

q_u = ultimate bearing capacity
c' = effective cohesion intercept
B = footing width (or breadth)

[4] Where NZS3604 is referred to this also includes NZS4229.

q' = overburden effective stress at the underside of the foundation

γ' = average effective unit weight of the soil below the foundation

N_c, N_q, N_γ = non-dimensional bearing capacity factors

The bearing capacity factors are a function of the effective friction angle of the soil (ϕ').

If $c' = 0$ (e.g. for sand/gravel soil) the expression (1) reduces to:

$$q_u = q' N_q + 0.5 B \gamma' N_\gamma \quad (2)$$

From this expression we see that the bearing capacity of footings in sand/gravel is a function of footing width and depth, and the relative depth of the water table.

For undrained analysis (e.g. for saturated clay/cohesive soil, $\phi = 0$) the expression (1) reduces to:

$$q_u = s_u N_c \quad (3)$$

where

s_u = undrained shear strength

N_c = 5.14

From this expression we see that the bearing capacity of footings in purely cohesive soil is independent of footing size and depth. However, the value of s_u can be significantly influenced by the moisture condition of the soil so the appropriate value must be carefully selected.

Where appropriate, factors are applied to the general expressions to take account for the effects of, for example:

- Footing embedment depth
- Footing shape
- Load inclination
- Ground surface geometry (i.e. slope of ground surface)

3.2 DRAINED OR UNDRAINED RESPONSE?

A critically important aspect of the bearing capacity assessment is for the engineer to decide whether excess porewater pressure may be generated during application of the foundation's load, i.e. does the soil behave with an *undrained response* to loading, or a *drained response* to loading? Determination of this requires a clear understanding of a number of properties of the soil mass including:

1. Soil mass structure and grading (e.g. fine-graded soil, coarse-graded soil, interbedding / layering etc);
2. Relative permeability of the different soil types present;
3. Soil moisture condition (i.e. whether the soil is saturated or not);
4. Groundwater environment (e.g. seasonal water level fluctuation; perched water table); and
5. The rate of load application (e.g. consider that there is a profound difference between the rate of load application during construction compared to that which occurs during an earthquake).

3.3 SOIL COMPLEXITY

The general expressions given above apply only to a homogenous soil mass, i.e. limited to soil profiles that for a depth beneath the underside of the foundation of at least two times the foundation width can be represented with single values for the density, angle of shearing resistance, cohesion, and if appropriate, undrained shear strength. However, in reality this typically is not the case, particularly in alluvial soil environments (Figure 1) which underlie many populated areas of New Zealand.

Alluvial soils are those that are laid down due to water action and may be terrestrial (i.e. in watercourses, overbank flood deposits) or in marine/coastal environments (e.g. estuarine, lagoon, dune). In such environments ground conditions can *vary markedly over short distances both vertically and laterally*, so careful investigation by desk study, site inspection, fieldwork (and sometimes laboratory testing) including accurate logging of soil conditions are essential. Observations of soil moisture and groundwater characteristics are also of paramount importance, as is understanding how groundwater level may change seasonally, and throughout the structure's design life.

The New Zealand Geotechnical Society (NZGS) has published a useful field guide to assist in the logging of essential soil and rock characteristics for engineering purposes [NZGS, 2005]. An A4 summary chart is also available that can be laminated providing a very handy aide-memoire in the field. The distinction between fine sand, silt and clay soils (and mixtures thereof) in the field can be tricky but practical guidance on this is available [NZGS, 2005 and DSIR, 1950].

The NZGS has also produced guidelines on the use of the hand shear vane that can be a useful tool for providing an indication of the undrained shear strength of saturated cohesive soil [NZGS, 2001]. However interpretation of the results for a foundation engineering problem requires experience.

4. SEISMIC DESIGN

4.1 INTRODUCTION

Design issues that should be addressed when designing shallow foundations in a seismic environment include[5]:

1. The ultimate bearing capacity of the foundation

[5] Modified from Poulos (2012)

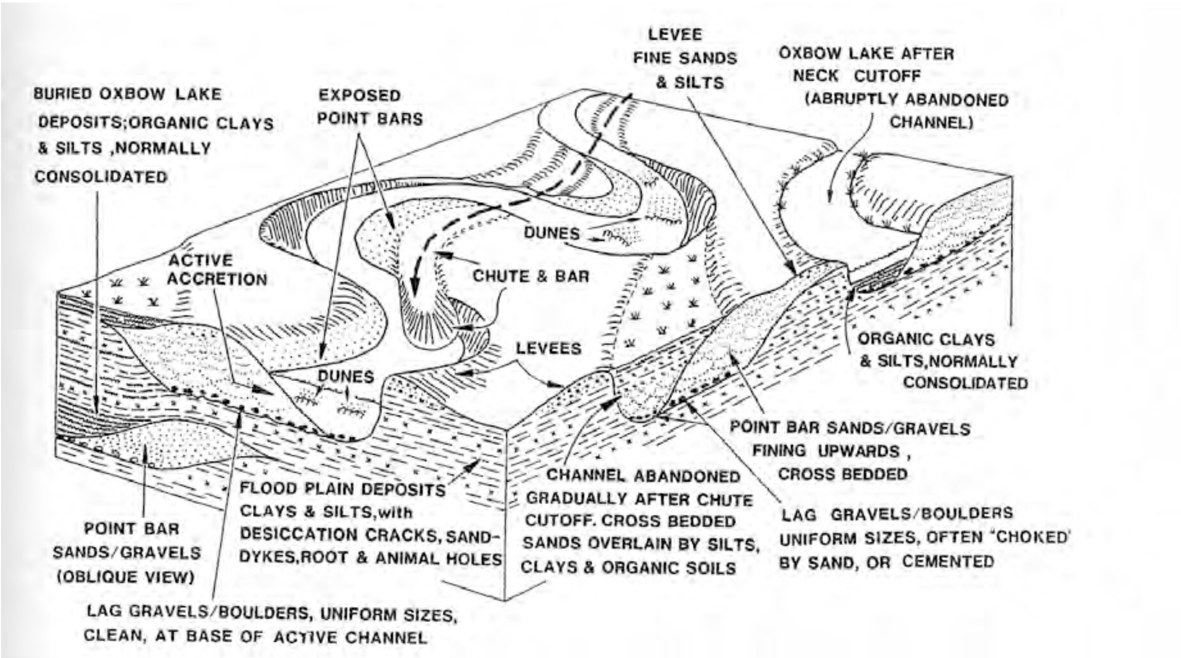

Figure 1: Schematic view of soils deposited by a meandering river (Figure extracted from Fell et al., 2005) This figure is a good model to illustrate the variable ground conditions across Christchurch.

when seismic (inertial) forces are acting;

2. Foundation stiffness and damping, and the movements (vertical, horizontal and rotational) of the foundation;
3. The possible reduction in soil strength and bearing capacity due to the build-up[6] of pore pressures during seismic action;
4. The effects of liquefaction on foundation capacity;
5. The settlements that may be developed if liquefaction occurs;
6. On sloping ground or ground in proximity of a "free face), the compounding adverse effects of lateral spread if liquefaction occurs;
7. Loss of ground under and/or around foundations due to sand/silt ejection; and
8. Sliding of the foundation.

This list provides a checklist for the designer. Unless it is ascertained for the particular structure that a seismic issue is a secondary effect that can be safely ignored, the engineer should assume that the influences are required to be specifically evaluated and accounted for in design.

It is beyond the scope of this paper to address the topic in detail. However, the following sections introduce how some of the influences may be assessed.

Eurocode 8: Part 5 provides a useful set of design principles and advice on seismic design of foundations, including[7]:

1. The susceptibility of foundation soils to densification and to excessive settlements caused by earthquake-induced cyclic stresses shall be taken into account when extended layers or thick lenses of loose, unsaturated cohesionless materials exist at a shallow depth;
2. Attention is drawn to the fact that some sensitive clays might suffer a shear strength degradation, and that cohesionless materials are susceptible to dynamic pore pressure build-up under cyclic loading as well as to the upwards dissipation of the pore pressure from underlying layers after an earthquake;
3. The evaluation of the bearing capacity of soil under seismic loading should take into account possible strength and stiffness degradation mechanisms which might start even at relatively low strain levels;
4. The rise of pore water pressure under cyclic loading should be taken into account, either by considering its effect on undrained strength (in total stress analysis) or on pore pressure (in effective stress analysis);
5. If the settlements caused by densification or cyclic degradation appear capable of affecting the stability of the foundations, consideration should be given to ground improvement methods;
6. Depending on the structure's importance, non-linear soil behaviour should be taken into account in determining possible permanent deformation during earthquakes.

The Eurocodes generally provide a stringent framework for geotechnical seismic design taking into account the

[6] i.e. pore-pressure at levels lower than those at which liquefaction is triggered.
[7] Clauses 4.1.5 & 5.4.1

structure, the foundation and the ground as a holistic "engineering system".

Although these Codes were developed for the European Community there are many useful and highly relevant design principles applicable to New Zealand.

A good feature of the Eurocodes is they give "check lists" of design principles that should be considered.

For geotechnical design *Eurocode 7: Geotechnical design and Eurocode 8: Design of structures for earthquake resistance – Part 5: Foundations, retaining structures and geotechnical aspects* are particularly relevant.

4.2 SEISMIC BEARING CAPACITY

When seismic forces act on a foundation, there will generally be a tendency for the bearing capacity to be reduced because of the presence of a component of horizontal force, resulting in an inclination of the applied load.

Analyses to estimate the effects of seismic action on bearing capacity have been presented by Kumar and Rao (2002) in a convenient graphical form in which the bearing capacity factors N_c, N_q and N_γ are plotted as functions of the horizontal earthquake acceleration coefficient a_h and the angle of internal friction of the soil, ϕ'.

Budhu and Al-Karni (1993) have considered the effect of both horizontal and vertical ground accelerations and have expressed the bearing capacity factors for earthquake loading, N_{cE}, $N_{\gamma E}$ and N_{qE}, in terms of the corresponding values for static loading, N_{cS}, $N_{\gamma S}$ and N_{qS}.

Annex F (Informative) of Eurocode 8: Part 5 presents a general expression for seismic bearing capacity of shallow foundations. The stability against seismic bearing capacity failure of a shallow strip footing resting on the surface of homogeneous soil may be checked with the expression relating the soil strength, the design action effects at the foundation level, and the inertia forces in the soil.

4.3 SOIL STRENGTH REDUCTION DUE TO PORE PRESSURE BUILD-UP

Seismic shaking will generate excess pore pressures within saturated soil, and these pore pressures will tend to reduce the shear strength of the soil. The amount of positive pore pressure will depend on many factors relating to the soil and the cyclic loading.

The propensity for soils to be subject to pore pressure build up was evident in some earthquake-affected areas of Canterbury subject to multiple aftershocks in relatively quick succession. The author considers that the porewater pressure regime had become "charged" with increments of excess pressure from preceding aftershocks so the ground was primed to be more vulnerable to liquefaction.

In deep deposits of liquefiable soil there are long "one-diminsional" drainage paths to the surface only that could potentially take weeks or even months for pore pressures to equilibrate.

4.4 REDUCTION IN BEARING CAPACITY DUE TO REDUCED STRENGTH LAYER

There may be a soil 'crust' above the water table that is not affected significantly by seismic shaking, with a liquefaction-susceptible layer below the water table in which strength reduction may occur.

The greater the reduction in shear strength of the lower layer, and/or the thinner the upper "crust" layer, the greater the reduction in bearing capacity will be.

For *static bearing capacity* in sand (drained) soil, embedding a footing deeper into the ground will generally increase its load-carrying capacity, and widening a footing will result in a lower bearing pressure. However, consider the implications in an environment where the footing is seated within the crust with an underlying liquefiable layer. Under *seismic conditions* a deeper footing (i.e. one founded closer to the liquefiable layer) has a reduced capacity. Similarly, a wider footing gains its capacity from a deeper soil zone so this too will have compromised capacity under seismic conditions.

These points illustrate that relying on principles of static bearing capacity in a seismic environment is not wise.

If there is no crust and the saturated liquefiable soil extends to the ground surface or to the base of the foundation, then the seismic bearing capacity will be very low.

Idriss & Boulanger (2008) state the consequences of settlement may be largely mitigated by the presence of a thick non-liquefied layer above the liquefied soils. A thick non-liquefied layer between the building's footings and the liquefied stratum may act as a bridging layer that arches or redistributes stresses and therefore results in more uniform ground surface settlement. In this manner, a well-constructed building on shallow foundations may settle slightly but not suffer any damage, because the differential settlement is small. This scenario is also recognised in design guidance for Canterbury [MBIE, 2012] that includes a means of surface crust assessment [Ishihara, 1985].

Upward dissipating excess pore pressure from preceding aftershocks and liquefaction-induced land surface settlement (bringing the surface closer to the water table) are compounding effects resulting in the thinning of the crust. Post-earthquake we also observe in Canterbury many instances of new springs which saturate the ground leading to the dual adverse effects of softened soil and reduction of non-saturated crust thickness.

It is evident that in liquefaction-prone areas of New Zealand we should design foundations with resilience in mind to accommodate the potential adverse cumulative effects of multiple aftershocks, as well as possible adverse earthquake-induced changes to the steady-state groundwater regime and soil properties where shallow foundations are seated.

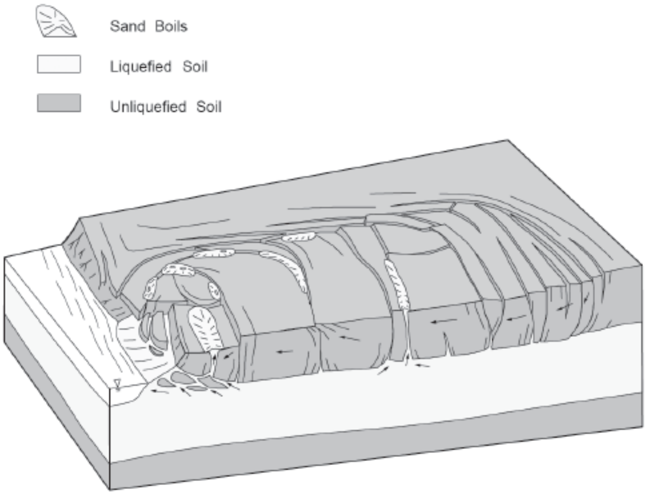

Figure 2: Schematic depiction of a lateral spread resulting from soil liquefaction in an earthquake (Figure extracted from Rauch (1997).

4.5 FOUNDATION STIFFNESS AND DAMPING

Estimation of the foundation stiffness and damping is required for estimating foundation movements due to seismically-induced forces, and also for considering the effects of structure-foundation interaction on the natural period and damping of a structure.

EC8 Part 5[8] notes that due to its influence on the design seismic actions, the main stiffness parameter of the ground under earthquake loading is the shear modulus G, given by

$$G = \rho v_s^2$$

where ρ is the unit mass and v_s is the shear wave propagation velocity of the ground. v_s profiles can be readily acquired using common geophysical ground investigation methods.

4.6 LIQUEFACTION

Earthquake-induced ground deformation can take a number of forms and can lead to excessive total and differential settlement, and rupture of structures, pavements and buried services. Under certain conditions in liquefiable soils, total and differential settlement, sand boils and lateral spreading can occur. In the non-liquefiable 'dry' crust zone above the groundwater level, densification, ground rupture (tension cracking) and differential settlement can occur.

The assessment of liquefaction susceptibility and associated ground deformations is an inexact process. Our best-practise routine analytical methods only provide crude estimates of deformation. Difficulty predicting earthquake-induced deformation is compounded where a site is vulnerable to the complexities of lateral spread (Figure 2).

Assessment and mitigation of liquefaction hazard is the biggest geohazard issue being tackled in Canterbury, but many other populated centres in New Zealand are also susceptible.

The reader is referred to NZGS (2010), Idriss & Boulanger (2008), Robertson (2009), DBH (2011 & 2012) for essential reading on this complex topic.

4.7 LIQUEFACTION-INDUCED BUILDING MOVEMENTS

Currently, there are no routine methods for assessing liquefaction-induced building movements. It is a very complex issue and one that is subject to on-going research.

Routine methods of estimating liquefaction-induced "free-field" ground settlement[9] cannot be used to determine settlement under buildings where the influence of foundation loads significantly alter the stress field in the ground and the deformation behaviour of soil.

However, if a suitably thick crust exists (say, over 1 metre thick below the underside of the foundation) and foundation loads are essentially distributed within the crust, then it may be possible to approximate the liquefaction-induced building settlement for a *light-weight residential structure* from the "free-field" settlement calculations.

Additionally, it may be possible to get a feel for the susceptibility of a foundation to adverse liquefaction-induced settlement by using appropriately degraded shear strength values (e.g. $s_{u(LIQ)}$, Olson & Stark (2002)) in a bearing capacity calculation, but this will not provide values of foundation settlement. If a crust is present then the bearing capacity assessment should be for a *layered soil profile*. For this scenario, punching shear failure may control design.

5. BEARING CAPACITY ASSESSMENT METHODS

5.1 INTRODUCTION

The commonly employed bearing capacity assessment methods in New Zealand practice are for *static design only,* or only give a cursory acknowledgement of the effects of seismicity (see Section 4.1).

The methods include those presented in NZBC B1 Structure, NZS3604, and Stockwell (1977). With the exception of B1/VM4 the dynamic cone penetrometer (DCP) is central to the methods presented for the determination of bearing capacity.

5.2 NZBC B1 STRUCTURE

Of the methods discussed here the *Compliance Document for New Zealand Building Code Clause B1 Structure* [DBH,

[8] Clause 3.2 (1)
[9] Such as those included in DBH (2011) and MBIE (2012).

2011] occupies the highest level in terms of New Zealand's building regulation framework.

It is in this document that the term "Good Ground" is defined[10] and also where Verification Method B1/VM4 Foundations is presented. The SESOC Soils software is provided as an educational tool in the application of B1/VM4 and should be used only in conjunction with the limitations stated in that document.

Also included in the Compliance Document is a section entitled Acceptable Solution B1/AS4 Foundations (revised by Amendment 4 in 2000). The title page states: "No specific acceptable solution for foundations has been adopted for complying with the Performances of NZBC B1". This is an omission that has an immediate need to be addressed.

"Good Ground" means any soil or rock capable of *permanently* withstanding an ultimate bearing pressure of 300 kPa (i.e. an allowable bearing pressure of 100 kPa using a factor of safety of 3.0), but excludes compressible ground, expansive soil and any ground that "could foreseeably experience movement of 25mm or greater". These exceptions are elaborated upon in the Compliance Document.

In May 2011 the definition of "Good Ground" was amended to include *liquefaction* and *lateral spread* as hazards that can lead to excessive ground deformation. It is curious that the identification of *liquefaction* and *lateral spread* is stated as applying to the Canterbury earthquake region only, despite land in many areas across New Zealand being potentially prone to these hazards.[11]

For practical purposes these earthquake-induced hazards should, of course, be evaluated for projects outside of Canterbury earthquake region.

The Compliance Document provides a means of determining the presence of "Good Ground" as follows:

This DCP correlation is directly based on Stockwell (1977).

COMMENT:
Soils (excepting those described in a), b) and c) above) tested with a dynamic cone penetrometer in accordance with NZS 4402 Test 6.5.2, shall be acceptable as good ground for *building* foundations if penetration resistance is no less than:

a) 3 blows per 75 mm at depths no greater than the footing width.

b) 2 blows per 75 mm at depths greater than the footing width.

Depths shall be measured from the underside of the proposed footing.

Amend 4
Dec 2000

5.3 B1/VM4

The B1/VM4 procedure for evaluating the bearing capacity of shallow foundations is based on the general expression (1) for *static design* presented earlier. Clause 1.0 Scope and Limitations of B1/VM4 includes the following pertinent comments:

1. The derivation of s_u, c' and ϕ' must be based on the most adverse moisture and groundwater conditions likely to occur during the design life of the structure;
2. This document must not be used to design foundations on loose sands, saturated dense sands or on cohesive soils having a sensitivity greater than 4;
3. Saturated sands may be subject to liquefaction during earthquake loading and sensitive clays exhibit a rapid decrease in undrained shear strength once the peak strength has been mobilised. The design of foundations on these materials needs special considerations which are not covered in this verification method.

The comment after Clause 1.0.6 states the document covers foundations subject to vibration from earthquake loading but there is no further information on this in the method.

Following submissions to, and reporting by, the Canterbury Earthquake Royal Commission, SESOC is developing structural design guidance including advice and recommendations on foundation design, such as:

1. Designers to no longer use the higher strength reduction factors for load combinations involving earthquake overstrength (Table 1 & Table 4 B1/VM4); and
2. "Structural engineers are not experts with respect to geotechnical issues, and advice should be sought from appropriately qualified geotechnical engineers on all projects involving foundation works".

5.4 NZS3604

NZS3604 is a Standard that provides methods and details for the design and construction of timber-framed structures not requiring specific engineering design. Section 3 of the Standard presents the site requirements and a means of determining "Good Ground" that has the same bearing capacity requirements as those stated in the NZBC Compliance Document.

As for the Compliance Document, the means of determining the bearing capacity is the DCP carried out in accordance with NZS4402 Test 6.5.2. The DCP penetration resistance profile required to prove "Good Ground" was upgraded when the Standard was revised in 2011:

- 5 blows per 100mm to a depth equal to twice the

[10] Subsequently used in NZS3604 & 4229.
[11] See also DBH Aug 2011.

width of the widest footing below the underside of the proposed footing;

- 3 blows per 100mm at greater depths.

These criteria have higher blow counts than those cited in the current Compliance Document. Not only are the blow counts higher but also the proving depth immediately below the footing is doubled to twice the width of the footing. *Consequently, there is a conflict between NZS3604:2011, the NZBC Compliance Document and other DBH*[12] *and BRANZ*[13] *guidance* with respect to the determination of "Good Ground"[14].

It is understood from members of the NZS3604 Standards Committee that the reason for uprated blow count in the 2011 Standard was to accommodate a long-standing discrepancy in an important dimension of the DCP tip. In essence, DCP tips manufactured in New Zealand have a longer barrel length than the tips used by Scala (1956) in his DCP-CBR correlation and used in Australian practice [CETANZ 2010 & 2011]. The longer barrel length meant that for the same blow counts per unit depth the soil could present an apparently greater penetration resistance and hence greater bearing capacity than was actually the case.

Scala's study is central to Stockwell's derivation of the correlation between DCP blow counts and bearing capacity so it is very important that the equipment used in New Zealand practice is the same as the equipment Scala used. Both types of tips are used in NZ practice.

5.5 STOCKWELL (1977)

5.5.1 Introduction

In 1977 Stockwell presented a procedure for the determination of allowable bearing pressure under small structures using the DCP. It is clear from his paper and discussions with Stockwell that the paper was written at a time when soil mechanics was not widely practised. Stockwell wrote: "For many building sites no foundation investigation is carried out other than the builder or local body inspector examining the bottom of the foundation trench".

Stockwell determined that engineering principles could be applied to estimate bearing capacity rather than relying on the heel of a gumboot or prodding the ground with a length of rebar. However, he was discouraged by the state of soil mechanics testing at the time with triaxial soil tests considered too complex and expensive for day-to-day foundation assessment.

Stockwell drew an arbitrary distinction between what he termed "small structures" (including one- or two-storey buildings) and "heavier, more important structures". For the former, he proposed that his procedure would be suitable, but for the latter, "laboratory compression testing of undisturbed soil samples may be carried out to establish density, angle of internal friction and cohesion values for the soil. Formula (sic) and graphs from the literature (e.g. Terzaghi) can be used to calculate allowable bearing pressures".

Stockwell's paper filled a vacuum in foundation engineering practice. It can be considered to have revolutionised field verification of bearing capacity – before it there was an absence of engineering evaluation, but with it an inexperienced person could estimate an engineering property, albeit with a very simplified method based on crude correlations, and for static design only. It relied on using the Scala Penetrometer[15] to derive bearing capacity.

5.5.2 The DCP-Bearing Capacity correlation

At the heart of Stockwell's simplified DCP-Bearing Capacity correlation are the following attributes:

1. The key correlations are based purely on pavement engineering research for runways and highways. There is no direct relationship with foundation engineering for buildings but rather a wholesale adoption of crude correlations from a different engineering discipline.
2. NZS4205P:1973 *Code of Practice for Design of Foundation for Buildings* was a pivotal reference for the topic at the time, but important advice for New Zealand practice was not translated into the procedure.
3. No account is taken of the effects on shear strength of changes in moisture content for fine-grained soils.
4. Caveats, limitations and cautions regarding the use of the correlations included in reference documents on which the procedure is based have fallen by the wayside so that now the DCP is used without question and values of bearing capacity reported with certainty.

The relationships of the key correlations are presented in Figure 3. The California Bearing Ratio (CBR) is the pivot providing a route for the correlation between values of allowable bearing pressure (q_a) from plate load tests to DCP penetration resistance.

A critical relationship is the correlation between CBR and *qa* for plate load test data [Middlebrooks & Bertram, 1942]. Interestingly, despite the profundity of the correlation in Stockwell's procedure the relationship is introduced only as a closing comment to a discussion topic at the end of the 1942 paper. Little is actually known about the origin of the

12 DBH 2010.
13 BRANZ Bulletin 438; 2003.
14 This finding has been raised with MBIE.
15 The terms Scala Penetrometer and Dynamic Cone Penetrometer (DCP) as used in New Zealand are synonymous. The test procedure is cover in NZS4402 Test 6.5.2.

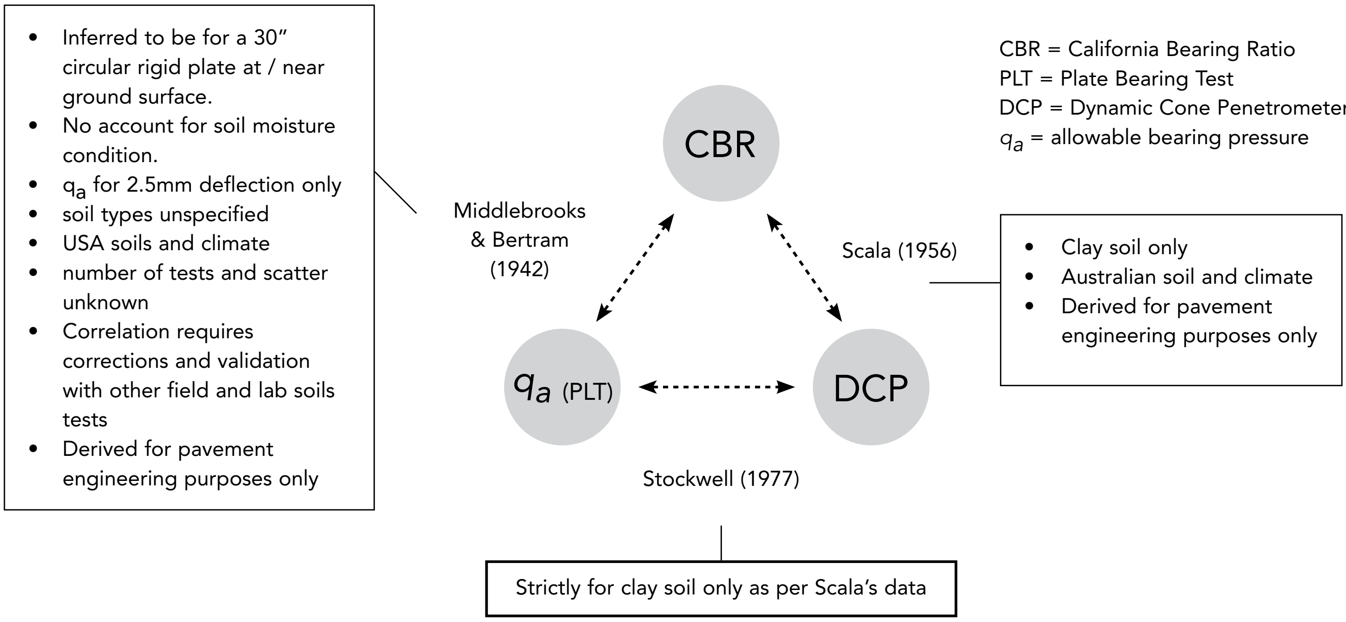

Figure 3: Correlations on which Stockwell's DCP-Bearing Capacity procedure is based.

correlation or its applicability to foundation engineering as noted in Figure 3.

One infers from Middlebrooks & Bertram (1942) that the correlation was not well developed. Pavement research at the time preferred the CBR for flexible pavements and the PLT for rigid pavements. At the time there wasn't a need to research a reliable correlation between CBR and q_a. *The correlation was a crude approximation only and was certainly not intended to be used in isolation.* Middlebrooks & Bertram advocated careful field investigation and laboratory testing to ascertain a suite of soil properties to be considered for pavement design. For example, they state the need for field bearing test results to be "modified for increase in moisture using the consolidation test".

They also stated: "evaluation of subgrade strength requires a great deal of judgement in addition to the tests. Not only the conditions of the materials as they exist at the time of examination must be considered, but, also, the probability of additional water getting into them and thereby lowering their strength. Therefore, if it is anticipated that the soils will become saturated, they should be tested in this condition. If however, it is known that no additional water will reach them, they should be tested at whatever moisture condition exists at the time of construction".

NZS4205P Clause 10.2.2 states: "In assessing the strength of a soil the allowable unit pressure shall be based on the maximum moisture conditions likely to occur".

B1/VM4 Clause 1.0.2 states: "The derivation of <shear strength parameters> must be based on the most adverse moisture and groundwater conditions likely to occur".

This important message is commonly overlooked in DCP-based assessments of the ground profile.

In fact, it is a source of ridicule of the DCP: "Scala penetrometers work best in summer, especially if the soil is allowed to dry out – warning: do not perform retests in these areas in winter, because for some reason it seems to soften" and "Scalas are great at finding competent ground, every time another rod and adaptor is screwed on, the penetration rate slows and the ground seems to get stronger" [CETANZ, 2009].

NZS4402 Test 6.5.2 states the maximum rod length of 1500mm as an 'essential dimension' implying that results obtained with longer rods (and extensions/couplers) cannot be reported to have been obtained in accordance with the Standard.

Crundwell & Smits (1989) reported that the literature surveyed for their research on the DCP-q_a relationship found "a noticeable lack of information published in this area may suggest that, though tried, such correlations have proved not to be successful".

They concluded that "generally the settlement, as a criteria (sic) for design of shallow foundations, may be more critical and therefore more relevant than design on the basis of strength". They recommended that the main thrust of further research into the use of the DCP would be towards settlement studies.

5.5.3 NZS4205P:1973

NZS4205P was in circulation at the time Stockwell's paper was published. Advice and requirements provided in it are very pertinent to modern seismic design practice. Particularly relevant clauses include comments on liquefaction and assessment of potentially difficult soil conditions.

Under the sub-heading entitled *Settlement*, Clause 10.4.2 states: "Attention is drawn to the possibility of liquefaction and settlement due to vibration from earthquakes, machines, etc, in sandy soils. The founding of buildings on these materials in a loose state is not recommended unless they are compacted."

The geotechnical advice in NZS4205P was withdrawn instead of remaining as a provisional code, or upgraded to a working code or developed over the intervening 40 years through research and practice. This was a missed opportunity.

Despite NZS3604 originating in the 1970s the word "liquefaction" only appeared when that Standard was amended in 2011 following a disaster. Many buildings would have been designed with liquefaction in mind over the last 40 years if the advice in NZS4205P Clause 10.4.2 had remained in the designers' set of requirements. Even now, liquefaction and lateral spread are formally recognised in the NZBC Compliance Document and NZS3604/4229 *for the Canterbury earthquake region only*.

Table 4 of NZS4205P provides a table of suggested allowable bearing pressures[16], but specifically identifies peat, silts, volcanic soils and made ground as requiring specific investigation. Stockwell included silt in his graphical DCP-q_a correlation and correction factors.

It is common in soil mechanics research and practice that sand soil and clay soil are distinguished due to their different engineering behaviours. However, silt (falling between the two in terms of particle grading) is not well represented in texts and practical guidance. It is recognised that silt occupies its own place in the assessment of shear strength, earthworks properties and liquefaction behaviour and cannot simply be clubbed into the clay or sand envelopes.

5.5.4 Limitations

Review of the background to Stockwell's paper and the paper itself yields the following:

- The procedure was specifically intended for the "inexperienced person" i.e. someone who was not an engineer (who should understand the limitations of the method and complexities of foundation design in a seismic environment – certainly, at least, in modern engineering practice).
- The procedure filled a need at the time to bring soil mechanics and engineering to the process of assessing foundation properties. However, it is now very dated.
- The procedure should strictly only be applied to clay soil as this is where the data set for the CBR-DCP correlation originates (Scala, 1956). Furthermore, any soil property correlation from overseas should be calibrated for local soils and climatological conditions.
- Stockwell states the procedure is not applicable in gravelly soil, but it is common to see reporting for qa in this material.
- It is not correct to report that qa has been determined in accordance with Stockwell (1977) when the bearing pressure has been incorrectly derived by misuse of the procedure (see below) and/or for soil types for which it was not intended, including peat, volcanic soils and made ground (and, possibly, silt).
- The DCP can be useful to indicate the depths to interfaces of materials with different properties, and thus give layer thicknesses. In this regard it can be used to *'feel' the ground as an indexing tool*. It does not tell us shear strength or settlement parameters.
- The procedure is *for static design only*. This attribute alone should curtail its use in New Zealand's seismic environment (unless seismic design issues (Section 4) have been specifically evaluated and found to be secondary, and can be safely ignored).

5.5.5 Sources of error

It is very common to encounter reporting that references Stockwell's paper as the means by which q_a was derived from DCP test results, but with the reported q_a value for design **having been read directly from Figure 2 of the paper without the required corrections applied.** Stockwell's Figure 2 is presented below (Figure 4).

Section 4 of Stockwell's paper presents the correction factors that must be applied to convert q_a (*Stockwell, Figure 2*) to q_m, the latter being the *modified allowable bearing pressure*. q_m is, in fact, the 'allowable bearing pressure' that designers are seeking when evaluating the bearing capacity of a specific foundation.

The corrections (or modifications) are required to principally take account of the fact that q_a in Stockwell's Figure 2 is derived from bearing tests for a circular footing founded at the ground surface (Middlebrooks & Bertram, 1942).

Stockwell's factors take account of the principles and variables discussed in Section 3 for the general expression (1):

1. Recognition that undrained (saturated clay soil) and drained (sand soil) response to loading needs to be differentiated;
2. Corrections for depth of embedment, which increase bearing capacity;

[16] Do not use these in practice. The reference is only mentioned here as part of the paper's commentary.

3. Corrections for footing width and saturated conditions, which for sand (drained) soil **dramatically reduce the bearing capacity.**
4. Corrections for "vibrational effects (including earthquakes)". This wording is ambiguous, but review of the reference to NZS4205P, finds that the correction is for inertial loading effects only (that impart an eccentricity to the contact pressure distribution), not earthquake-induced settlement or liquefaction effects.

The correction factors are applied in turn i.e. q_a (*Stockwell, Figure 2*) has to be modified by each applicable factor, not just one or another.

Clearly, engineering reports that state the bearing capacity assessment is based on Stockwell (1977) but ignore the correction factors to derive q_m (the allowable bearing pressure that is sought) are deficient, but are common to come across in practice.

Most of the low-lying areas of the Canterbury earthquake region are underlain by sand or silt/sand mixtures and also with high groundwater levels that can be perched and seasonally fluctuate. Under these conditions the 'correct' allowable bearing pressure for a 0.3m wide footing could be less than 50% of the q_a read from Stockwell's Figure 2.

5.5.6 Reporting q_a

Another common attribute of reporting q_a based on the DCP correlation is that the caveats, limitations and cautions inherent in the derivation of the correlations expressed by Middlebrooks & Bertram and Scala have fallen away to the point that bearing capacity values are reported without recognition of any uncertainty.

The *qa* determined in this manner can only ever be reported as a crude approximation[17], and one that is based on the questionable concept of "bearing capacity", and for static design only.

5.5.7 DCP-CBR correlation

The author recognises that a body of work exists in the literature covering DCP-CBR correlations for other soil types. However, this research doesn't address significant limitations or improve the reliability in deriving q_a for building foundations from DCP data.

If anything, it illustrates that research and design practice in pavement engineering using the DCP is far more rigorous than that in the field of foundation engineering.

5.5.8 Local soil conditions

The correlations relied upon in Stockwell's procedure are based only on tests on North American and Australian soils and in their climates.

Much of New Zealand's design practice for highway pavement engineering is based on Australian guidance. The New Zealand Supplement to Austroads Pavement Design Guide (TNZ, 2000) specifically comments on the requirement to establish a DCP-CBR correlation with local soils[18] rather than relying on the correlations derived

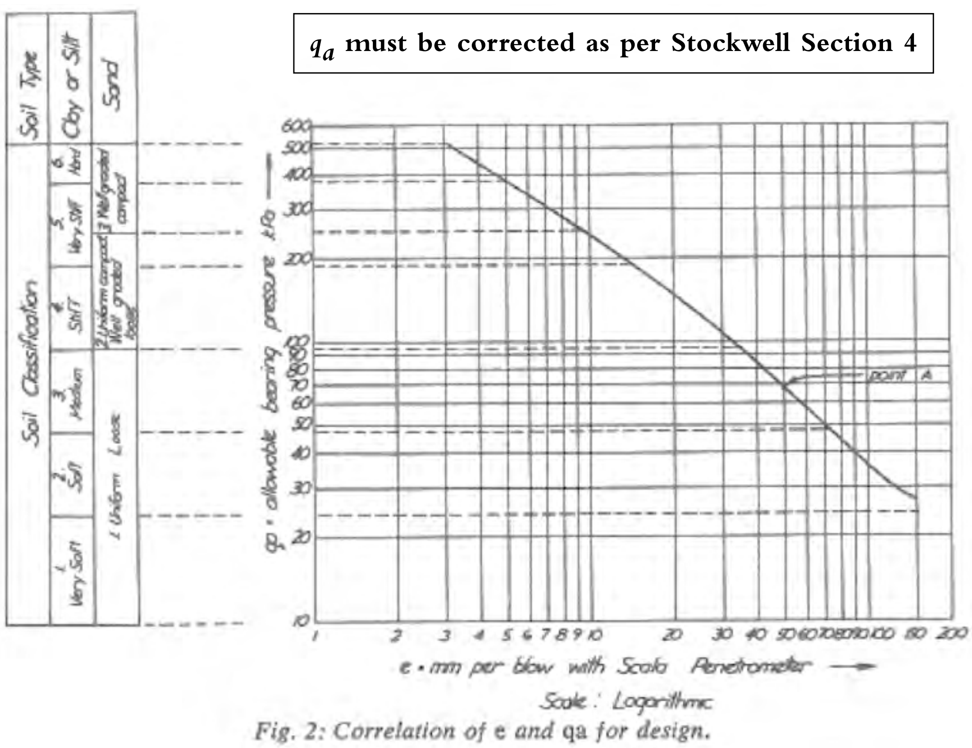

Figure 4: Stockwell's uncorrected DCP-q_a correlation chart

[17] See also Crundwell & Smits (1989).

for Australian soils and climatological conditions.

It follows that DCP-CBR correlations for NZ soils and climatological conditions should be derived for foundation assessment purposes. These correlations will likely vary from location to location across the country.

5.5.9 Influences

Stockwell's procedure underlies the means by which q_a and "Good Ground" are determined with the DCP as per the penetration resistance criteria presented in the NZBC Compliance Document, NZS3604/4229, the BRANZ Bulletin and DBH guidance.

6. DESIGN FOR RESILIENCE

Methods employed to predict seismically-induced land deformations provide crude estimates only. It is prudent, therefore, to make cautious design decisions for foundations.

It is implicit in the Building Code performance requirements that structures be designed so they satisfy performance requirements for a one-off earthquake event. Important points to recognise from this are:

1. The Code requirements should be considered as **minimum design requirements**.
2. The design earthquake scenarios are significant earthquake events. We have seen in the Canterbury earthquake sequence that a significant earthquake can be followed by multiple aftershocks, with multiple seismic events able to cause incremental earthquake-induced land deformation and building damage.

Although a building may satisfy the performance requirements under a single Serviceability Limit State event with ensuing land deformations within the tolerable limits, the cumulative effects of multiple aftershocks can cause land and foundation deformation to become excessive. Using a stiffer, more robust foundation system than the minimum permissible for Code compliance will provide resilience against excessive deformation.

When one considers the cost of buying a section and the cost of building a house, we have found in Canterbury that in some situations relatively little additional expenditure is required to provide a markedly stiffer foundation (e.g. a waffle slab instead of a NZS3604-like slab). This is particularly the case where "Good Ground" is not present and undercut and backfill with structural fill is required.

Some waffle slab manufacturers and designers state that their products can be used on poor soil sites which have allowable bearing capacity as low as 40kPa to 50kPa (compared to the 100kPa for NZS3604 residential foundations). In such cases, this would reduce the amount of undercut and backfill required to provide a suitable platform for their construction.

7. CONCLUSIONS

The paper reviews commonly employed methods for bearing capacity assessment in New Zealand. It is found that a disproportionate amount of reliance is placed on methods that have questionable applicability. None of the methods adequately address seismic design. Such methods have limited application in New Zealand.

When a DCP is advanced into the ground and a blow count profile drawn up we have little idea how that translates to bearing capacity or settlement characteristics of a foundation.

The DCP can be useful to indicate the depths to interfaces of materials with different properties, and thus give layer thicknesses. In this regard it can be used *to 'feel' the ground as an indexing tool.*

It is common practice for engineers to derive values of bearing capacity for shallow (spread) foundations using rudimentary ground investigation tools in often complex ground conditions. Calculations are based on questionable concepts and crude, dated correlations from overseas (i.e. not calibrated for NZ soils and its climatic conditions) to arrive at bearing capacity values for design that are reported with apparent (and somewhat unsettling) accuracy and certainty.

q_a determined using the DCP can only ever be reported as a crude approximation.

The issues raised in this paper should be carefully considered and the commonly employed procedures and industry design guidance based on the DCP to determine bearing capacity reviewed, with particular attention paid to:

1. Much greater emphasis being placed on determining the *settlement characteristics of the foundations and the ground*, rather than relying on the concept of bearing capacity and dated correlations derived for pavement design;
2. Field studies and trials to develop appropriate correlations for NZ soils and climatic conditions;
3. Developing NZ guidance for seismic design of foundations.

The structure, foundations and ground should be treated as a holistic engineering system, with much greater collaboration between the structural and geotechnical disciplines.

Engineers should recognise and only work within their field of competence. Guidelines being developed by SESOC state: "Structural engineers are not experts with respect to geotechnical issues, and advice should be sought

[18] Clause 5.5.2

from appropriately qualified geotechnical engineers on all projects involving foundation works."

The paper includes a checklist of design issues that should be addressed when designing shallow foundations in a seismic environment (see Section 4). Unless it is ascertained for the particular structure that a seismic issue is a secondary effect that can be safely ignored, the engineer should assume that the influences are required to be specifically evaluated and accounted for in design. Advice is given on how some of these issues may be addressed.

This paper includes comments based on the author's observations, experiences and lessons learned working in Canterbury. It is intended that the paper inspires discussion in the engineering community with the intention that this leads to improvements to guidance documents and foundation engineering practice.

ACKNOWLEDGEMENT

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REFERENCES

Budhu, M. and Al-Karni, A. Seismic bearing capacity of soils. Geotechnique, 43(1): 181-187, 1993.

BRANZ Using a Scala Penetrometer; Bulletin No. 438, August 2003.

Crundwell M. L. & Smits A. P.: Interpretation techniques for the Scala Penetrometer Test, Interim Report 1 : Survey of New Zealand Usage and International Literature; Central Laboratories Report 89-B2210, 1989.

CERA Technical Category maps: http://cera.govt.nz/land-information/land-zones

CETANZ CETANewZ Issue 007, August 2009.

CETANZ Technical report on Scala Dynamic Cone Penetrometer Irregularity; Rev. 3, 2010.

CETANZ Technical Guidance (TG1) Scala Dynamic Cone Penetrometer – Cone Calibration; Rev. 0, 2011.

DBH technical guidance on land zones: http://www.dbh.govt.nz/canterbury-earthquake-residential-building

DBH Simple house: Acceptable solution, 2010.

DBH: Compliance Document for New Zealand Building Code Clause B1 Structure; 2010 incl. Amendment 11, 2011 http://www.dbh.govt.nz/compliance-documents

DBH Guidance on using NZS3604 construction on ground with potential for liquefaction; August 2011. http://www.dbh.govt.nz/UserFiles/File/Publications/Building/Guidance-information/pdf/liquefaction-construction-guidance.pdf

DBH Revised guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence, Nov 2011. http://www.dbh.govt.nz/guidance-on-repairs-after-earthquake

DBH Appendix C: Interim guidance for repairing and rebuilding foundations in TC3, April 2012. http://www.dbh.govt.nz/guidance-on-repairs-after-earthquake

DSIR: Soil Mechanics for Road Engineers, pages 70 - 71. 1950.

Eurocode 8: Design of structures for earthquake resistance; Part 5: Foundations, retaining strcutures and geotechnical aspects. British Standard BS EN 1998-5:2004.

Fell R., MacGregor P., Stapleton D., & Bell G.: Geotechnical Engineering of Dams. CRC Press, Taylor & Francis Group, London, 2005.

Fellenius B. H.: Bearing Capacity of Footings and Piles—A Delusion? DFI Annual Meeting, October 14 – 16, 1999, Dearborn, Michigan. http://www.fellenius.net/papers.html

Fellenius B. H.: The Red Book, Basics of Foundation Design, 2011. http://www.fellenius.net/papers.html

Idriss & Boulanger (2008) Soil Liquefaction During Earthquakes, Earthquake Engineering Research Institute; Monogragph MNO-12.

Ishihara, 1985 Stability of Natural Deposits During Earthquakes, Proc. Of the 11th International Conference in Soil Mechanics and Foundation Engineering, pages 321-376 – Figure 88 page 362. (Reproduced as Figure 107 on page 157 of Idriss & Boulanger (2008).

Kumar, J. and Mohan Rao, V.B.K. Seismic bearing capacity factors for spread foundations. Geotechnique, 52(2): 79-88, 2002.

MBIE Guidelines for the investigation and assessment of subdivisions on the flat in Canterbury; 2012. http://www.dbh.govt.nz/subdivisions-assessment-guide

Middlebrooks, T.A. & Bertram, G. E. Soil Tests for Design of Runway Pavements. Proceedings of the Annual Meeting – Highway Research Board, Vol.22, pp 144-184; 1942.

NZGS Guideline for Handheld Shear Vane Test, August 2001. http://www.nzgs.org/publications

NZGS Field Description of Soil and Rock – Guidelines for the field classification and description of soil and rock for engineering purposes, Dec 2010. http://www.nzgs.org/publications

NZGS Geotechnical earthquake engineering practice; Module 1 - Guideline for the identification, assessment and mitigation of liquefaction hazards; July 2010. http://www.nzgs.org/publications

NZS3604:2011 Timber-framed buildings.

NZS4229:1999 Concrete masonry buildings not requiring specific engineering design.

NZS4205P:1973 Code of Practice for Design of Foundation for Buildings.

NZS4402: 1986 Test 6.5.2 Determination of the penetration resistance of a soil – Hand method using a dynamic cone penetrometers, Standards Association of New Zealand, Supplementary Tests (November 1988).

Olson, S.M. and Stark, T.D. (2002). "Liquefied strength ratio from liquefaction flow failure case histories," Canadian Geotechnical Journal, 39 (3), 629–647pp

Poulos H.: Practical Approaches to Seismic Foundation Design. Unpublished, 2012.

Rauch A. F.: An empirical method for predicting surface displacement due to liquefaction-induced lateral spreading in earthquakes. PhD dissertation, Virginia Tech, 1997.

Robertson (2009a) Performance Based Earthquake Design using the CPT, Tokyo June 2009

Robertson (2009b) Interpretation of cone penetration tests – a unified approach; Can. Geotech. J. 46 1337-1335.

Scala, A.J. Simple Methods of Flexible Pavement Design Using Cone Penetrometers. Proceedings of the Second Australia-New Zealand Soil Mechanics Conference, Christchurch, New Zealand. pp.73-84, 1956.

SESOC Interim Design Guidance: Design of Conventional Structural Systems following the Canterbury Earthquakes; Version 8, 18 Sept 2012.

Stockwell, M. Determination of allowable bearing pressure under small structures. NZ Engineering (32,6) 15 June 1977. http://www.ipenz.org.nz/ipenz/publications/engineering-nz/volume32-1977/NZ-Engineering-1977-06.pdf

Terzaghi K.: Theoretical Soil Mechanics. John Wiley and Sons Ltd, 1943.

TNZ New Zealand Supplement to Austroads Pavement Design Guide, 2000.

BOOK REVIEW

Piles and Pile Foundation – Carlo Viggiani, Alessandro Mandolini and Gianpiero Russo.

THE AUTHORS OF this book have made notable contributions to the understanding of pile foundation behaviour and to the analysis of pile foundations. Their book provides a concise and eminently readable summary of their work and that of others involved in modern pile foundation design.

The book is divided into four parts:

1. An introductory general section.
2. Present practice for vertical loads.
3. Present practice for horizontal loads.
4. Analysis and design of piled rafts.

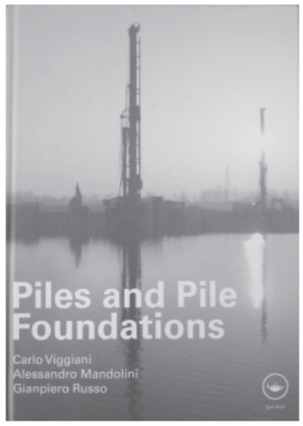
The first part describes, economically but effectively, the principles of soil mechanics, pile types and installation methods, and design issues, and then introduces limit state design concepts and design criteria.

The second part deals with the estimation of axial load capacity from first principles and also from various empirical methods employing in-situ test data. It discusses driving formulae in some detail and then touches on the wave equation analysis. Group effects are dealt with, followed by a very useful summary of methods for the design of rock sockets. The issue of settlement is then addressed, first for single piles and then for pile groups. Simple methods such as the equivalent raft and equivalent pier are considered and then a comparison is made of various software packages for group settlement. A chapter is devoted to soil-structure interaction and the proper design of pile caps, a subject that has received scant treatment in the geotechnical literature.

The authors describe their program NAPRA in some detail and foreshadow its use for piled raft foundation analysis. There are some very useful results for load sharing as a function of pile cap stiffness, results which are unique to this book. Finally, the issue of load testing via various methods is dealt with in a separate chapter, and some of the issues involved in proper interpretation of the pile load test data are discussed.

The third part deals with lateral loading. Estimation of ultimate lateral load capacity is dealt with in a very user-friendly manner, with a series of design charts presented. Another chapter in this part is devoted to the estimation of lateral deflections and bending moments in piles, via a variety of different techniques. The issue of group behaviour is addressed also, but in a relatively brief manner.

The fourth part, in the final chapter, deals with a subject to which the authors have contributed significantly, piled raft analysis and design. They give an excellent and detailed treatment of vertical load capacity and settlement estimation. They emphasize the potential savings in piling



that can be gained by taking account of raft contact, and give examples which indicate that in some cases, halving the number of piles would have very little detrimental effect on foundation performance, while having a major economic benefit. Finally, the effect of disconnected piles below a raft is discussed and the authors point out that in such a case, the piles can be treated primarily as ground improvement, for which less stringent design criteria may apply.

Inevitably, in a relatively compact book of less than 300 pages, some topics will not have received full treatment (for example, combined vertical and lateral loading on pile groups), while others, such as negative skin friction and dynamic response, are not considered. Nevertheless, this is a book that contains a wealth of information that is well-organized and well-presented, by authors who have contributed much to contemporary knowledge and who have a deep understanding of their subject. The book is in a form that will appeal to the practical foundation designer (both from a geotechnical and a structural background) and also to pile foundation researchers. It is recommended highly to both these categories of engineering professionals

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TECHNICAL NOTES

Rebuild Boosted by Sharing of Geotech Data

AN ONLINE DATABASE has been established by the Canterbury Earthquake Recovery Authority (CERA) to provide free access to geotechnical information that is not otherwise easily available.

The Canterbury Geotechnical Database is an online Geographic Information Services (GIS) based system that shares a range of data to those in the geotechnical and structural engineering fields, council building consent officers and other professionals. It is also available to insurers, the Earthquake Commission (EQC), and other hazard analysts and scientific and academic institutions.

With up to 20,000 individual deep investigations to be undertaken during the post-earthquake rebuild of Canterbury, the database not only creates efficiencies in the rebuild by sharing information, but also reduces the number of investigations required.

All of the data is publicly available after a building consent is lodged for a site, however it would not otherwise be readily accessible.

Services available on the database, at https://canterburygeotechnicaldatabase.projectorbit.com, are:

- A searchable and downloadable repository of geotechnical investigation data procured during the Canterbury rebuild.
- Observational mapping of data of land performance, including LiDAR (absolute and differencing), field observations, post event groundwater levels and aerials.
- Published geotechnical mapping information.
- The collection of geotechnical assessments (summary data and PDF reports) for each project.
- The collection of key data on buildings and foundations for each consented repair or rebuild.

The collection of this data will inform a wide range of activities, including hazard analysis and flood management, as well as geotechnical investigations. It will also allow hazard analysts to more accurately understand the risk to Canterbury and exposure to future damage.

The easy access to reports on neighbouring properties will also lead to a more consistent approach by professionals to assessments, and retaining data in one location will help streamline the consenting process.

Development of the database is in line with recommendations made by the Canterbury Earthquakes Royal Commission to territorial authorities for storing and providing geotechnical information.

The database requires the upload of AGS4 compliant investigation data, and a Practice Note is included on the site to assist practitioners. Implemented correctly, the AGS4 format will reduce the time spent on many basic tasks – to the benefit of clients and consultants.

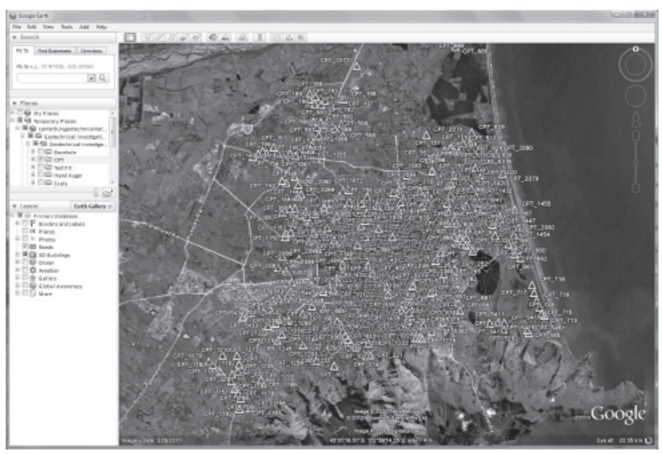
The database terms of use require that, if a user wishes to use data for a project, then the user must also contribute to the database by uploading any investigations undertaken for that project. Failure to do this breaches the terms of use, and hence the data cannot be used to support or inform assessments for a project.

Work is underway to further develop the database, including consideration of how the system can be better integrated with the building consent application process to streamline the process for both applicants and building control officers.

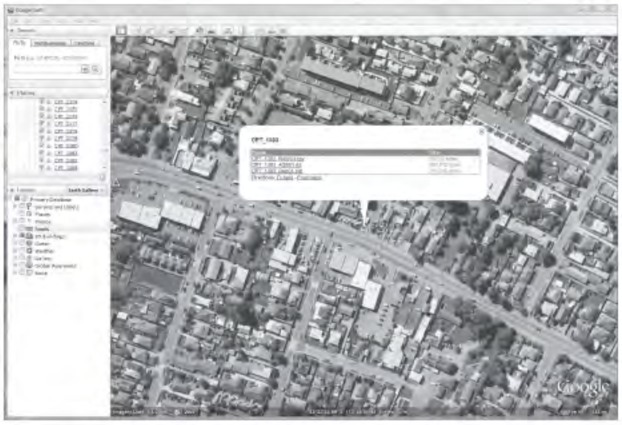
CERA is constantly on the lookout for additional geotechnical information that can be added to the facility to assist engineers in designing more resilient structures, in a more efficient way, in order to rebuild a stronger Canterbury.

Reported by:
Rob Kerr
Canterbury Earthquake Recovery Authority (CERA)

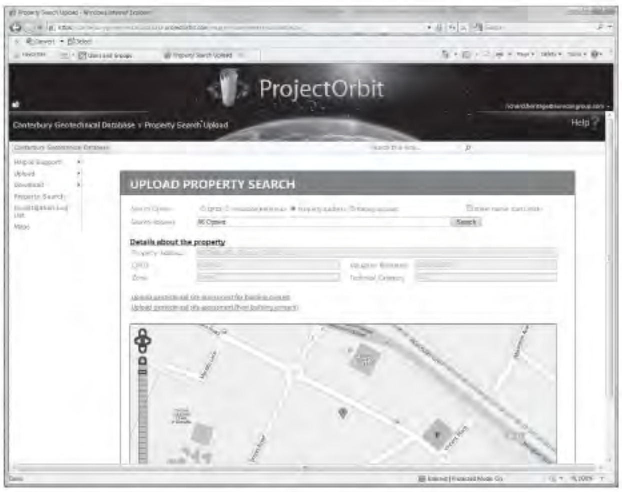
SCREEN SHOTS BELOW



Above: Users access the spatial view through Google Earth. This view shows the general extent of CPT data at the time of the launch on the site.



Above: Users must enter the basic attributes of each test to inform the TC3/TC2 reclassification and the building consent process.



Above: Searching and uploading data for properties can be undertaken by a variety of methods.

Above: Data can be downloaded from individual points directly from the Google Earth view.

COMPANY PROFILES

Southern Geophysical Ltd

Above: A ground penetrating radar survey to delineate the bedrock profile at a wind turbine site

Humble beginnings

Michael Finnemore (PhD), Director of Southern Geophysical Ltd, finds it hard to believe that the company began almost ten years ago literally from his garage. "As a company, Southern Geophysical started out small but had big plans", says Mike. The initial idea was to deliver cost effective seismic reflection surveys for ground water exploration. In the process, we received so many requests for other types of geophysical surveys that we branched out into the full range of geophysical techniques for a range of applications.

Significant growth

Today, our client-base and our mandate has grown significantly, but, Southern Geophysical's philosophy is still the same: deliver to our clients, high quality, knowledge-backed, geophysical data which is suitable for their purpose and proposed outcomes, in a timely, friendly and cost-effective manner. Most of our customers today are engineering or geotechnical consulting firms, that require geophysical data but that do not have their own in-house resources to collect and analyse such data. We work closely with these customers to determine which geophysical method will provide them with the data and information that they require for their project and purpose. Because of the recent level of seismic activity in Christchurch, our focus for the past 2 years, in particular, has been on providing geophysical solutions to Christchurch for application in the rebuild of the city that Southern Geophysical calls home. By coupling our surface geophysical data with mapping and borehole measurements, we can often reduce the costs and risks associated with a project by providing increased understanding of subsurface conditions and parameters.

Geophysical operations

Southern Geophysical is a leader in the application of surface wave geophysics and analysis, especially Multi-channel Analysis of Surface Waves (MASW) and Ground Penetrating Radar (GPR). We are recognized for our strong capabilities to deploy shallow seismic systems utilizing our towed-array and accelerated weight drop (AWD) systems with full differential GPS capabilities. We have the in-house equipment and expertise for acquiring and processing shallow seismic data for the geotech and groundwater industries. But, we also carry out a full range of geophysical surveys too, including full range of GPR (from very deep to detailed concrete surveying), borehole shearwave testing, ground conductivity, pile and integrity testing, and deep seismic surveys for coal seam gas, petroleum and lignite exploration.

Left: A seismic reflection survey in Antarctica

Above: A high frequency radar survey to determine construction details of a historic monument

Southern Geophysical quickly outgrew the garage in the back garden and its subsequent office space (damaged in the September quake) and now has permanent warehouse and office space in Bromley, Christchurch. We are wholly family-owned but are proud to provide employment for 3 full time staff and up to 15 contract staff this year, many of whom are graduates from the University of Canterbury's geology, civil engineering and engineering geology programs. We also have strong partnerships with several other geophysical companies in both the South and North Island.

Mike and his team have undertaken geophysics surveys in the USA, UK, Antarctica, New Zealand, Australia, and parts of the Asia Pacific region. There is no job too small or too large for us.

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FOREIGN CORRESPONDENT

Jan Noering

Occupation
Geotechnical Engineer
Enercon, Germany

Above: In Nambia on route to Germany

A LITTLE OVER a year ago I left New Zealand's fair shores to embark on an adventurous OE through Indonesia and Southern Africa, and unlike many other Kiwis I chose Germany as my final destination.

After three years of working as an Engineer at Tonkin & Taylor in both the Water Resources and Geotechnical Engineering departments, I decided to pack up and look for some new experiences. Because I was born in Germany and have a lot of family there, I decided to see what life was like there and what it had to offer.

A group of five of us started our travels in Bali, with surfing as much as possible being number one on the agenda for this short stop. After experiencing a shark attack and a few too close for comfort encounters with the local reefs, our group split and two of us carried on to Southern Africa. We landed in Durban and road tripped down to Cape Town in search of waves and adventure, then headed inland and travelled up through Namibia. After having significant possessions stolen out of our car while testing some of Namibia's finer waves, we dropped the rental car off and carried on via public transport though Zambia, Malawi and into Tanzania. From South Africa's shark infested waters, to Namibia's deserts, Zambia's Victoria Falls, Lake Malawi's amazing aquatic life and finally into the massively diverse Tanzania, we experienced some pretty unreal adventures and saw some very different ways of life.

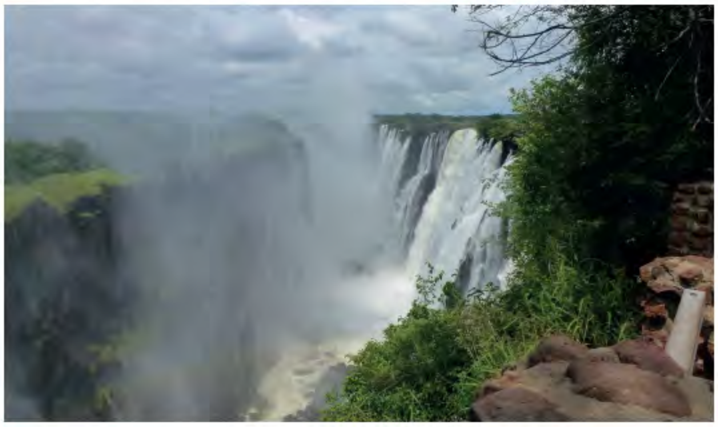
It was a massive contrast leaving a +35 degree Tanzania and landing in a -20 degree Berlin, where it was relieving to find that Germany's job market hadn't yet fallen the way of its European neighbours and jobs proved aplenty.

After inspecting some of Europe's surf spots, as well as many road trips in and around Germany, I landed a job at Enercon GmbH in Bremen (northwest Germany). Enercon is Germany's largest wind turbine constructor and one of the largest in world. The company is only approximately 25 years old, already has over 12,500 employees and is run strictly as a typical German mid-sized company where high growth and profit driving is frowned upon.

At Enercon, I work as part of the Project Management Team, and am responsible for the foundations for wind turbines in the English speaking world (UK, Ireland, Canada, Australia, and New Zealand (approx. 15 turbines on our shores to date)). This means that I assess Geotechnical Reports for each proposed turbine location and work out an appropriate foundation for that location as well as any ground improvement measures required (soil exchange, vibro compaction stone columns, piles etc). I also have to manage projects where Enercon's standard foundations are not applicable. At the moment our biggest wind turbine has a 126m diameter blade and produces in the order of 7.5 MW of energy, so we deal with some pretty impressive loads. Interestingly, we generally find that the rocking spring stiffness of the soil becomes the critical factor for whether the founding conditions are sufficient to take the turbine.

Due to the international nature of our market, it is also extremely challenging trying to deal with all the different regulations, standards and norms that every country uses. I have also found that a standard geotechnical investigation varies hugely from country to country, and making sure that these meet our strict German standards is a constant battle. As many companies do in Germany, Enercon puts a huge emphasis on the quality of its product, meaning that everything must be designed to meet the relevant German standard, as well as that of the local country. This results in Enercon generally not being one of the cheaper options on the market, however the business is still growing faster than one can imagine.

Working in Germany is a hugely different experience to that which I was used to in New Zealand. I have found that people work extremely hard, but as with everything in this country, there are a lot of rules and regulations, which Germans seem to love but it drives me up the wall! Germany is one of the few countries I have seen where no one will cross a red pedestrian light, even if there is no car in sight. That same mentality seems to apply in the work place, where most people are only comfortable doing what's in their job description, not at all like New Zealand where we are encouraged to give everything a nudge.



Left: Victoria Falls

Above: Rock climbing in East Germany

Currently I have several very interesting projects on the go. One project in the Netherlands is just beginning construction and requires an 82m diameter turbine to be placed on a 10m diameter foundation. This was solved with the implementation of a large circular diaphragm wall system to be used as the piling system. I am also starting with a project, where 70m diameter turbine foundations need to be constructed in the very north of Canada. This means that we will have to cart in everything, and because concreting in these conditions quickly becomes very difficult, we are trying to develop a foundation which only needs to be 'fitted' together on site. In the past we have concreted in these conditions by building tents over the foundations and installing an underground heating system in order to enable the concrete to set properly, but as you can imagine this quickly becomes very expensive and the end result is not always up to scratch.

At the moment my job seems to be evolving and I am given relatively free range to create my own niche. I am therefore looking forward to many more new experiences and hope to develop myself into a position where I only run projects that require interesting and out of the norm foundation solutions. A return to New Zealand is also on the cards for me, as I miss the New Zealand life style and climate, however, I first plan to see a bit more of the northern hemisphere.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NOTICE BOARDS

Around the Office

'Around the Office' is a collection of humorous snapshots spotted around the offices of NZGS members. Please send any suitable material to the Editor: Hamish Maclean at HMaclean@tonkin.co.nz

5.6.13 Dutch cheese

During the closing dinner of the Second European Symposium of Penetration Testing (ESOPT II) in Amsterdam in 1982, a competition was held. The aim was to predict the CPT cone resistance of a large Dutch Gouda cheese measured with a miniature cone (base area = 0.75 cm^2), see LGM Mededelingen (1982).

Figure 5.92 shows the result of this test. Below the crust, the cone resistance was steady at about 192 kPa.

To the authors' knowledge, information on CPTs in other cheese types are not available.

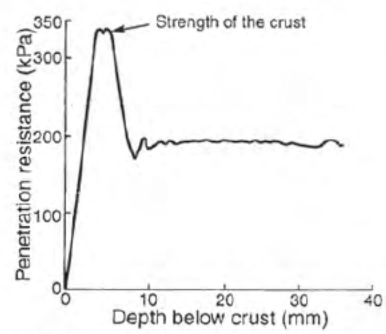


Figure 5.92 Result of CPT in Dutch cheese.

MEMBER PROFILE

John Scott

Occupation
Technical Advisor to CERA

I GREW UP on a dairy farm on the edge of Hamilton and drifted through school without really having any idea what I wanted to do. In my last year I recall my school careers advisor asking me what I was good at. I said I liked physics, maths and being outdoors. She said "have you thought of engineering as a career". My response to that was "no, what is it"! After her debrief I thought that sounded just like me. I subsequently completed my Civil Engineering degree at the University of Canterbury and then drifted into geotechnical engineering via my first job for a small civil engineering consultancy in Auckland – this firm dabbled in geotechnical matters together with other small structural and civil jobs. I left this firm and began my OE on the day they had a rather large geotechnical problem occur. While I wasn't involved in this particular project I reflected a lot afterwards on conversations I had heard about this project around the office and it was one of my bigger learning experiences albeit in hindsight and remote from the issue.

In 1985 I bought a one way ticket to the UK via Australia with the intention Australia would be just for a few months over summer then I would move on to catch the UK summer. However, surprise surprise I ended up staying somewhat longer working on a contract basis for 18 months firstly for Dames and Moore (now URS) then later on for Ove Arup and Partners (who were the structural engineer on the Opera House for those who don't know this firm). The Australian experience was great fun both socially and workwise. I started out, as all geotech's seem to do, supervising miles and miles of drilling – in this case of a major highway project founded on sandstone although some of this time was spent dodging funnel web spiders when logging test pits! Later on I inspected the base of numerous 15m – 20m long drilled pile foundations for the Darling Harbour developments (this bit was not fun especially for somebody with claustrophobic leanings!). The fun bit was being the site engineer on the Opera House Forecourt extension – with the scenery (of course not including the ballerinas wander around in their tutu's) being something special.

The downturn in the Australian economy in 1986 coincided nicely with an upturn in the UK economy and the need to use up the last leg of my UK flight ticket. Also, rather fortuitously (this became a habit as you will see later), my boss from Sydney happened to be in London soon after I arrived and he teed up a job at the London branch of Ove Arups. While I did not appreciate at it at the time I started, I soon realised that this firm and in particular this branch of Ove Arups had some of the best and most highly regarded geotechnical engineers in the world. During this time I learned a lot, and probably even more importantly learned what I didn't know. I was fortunate enough during this time to work on a number of piling projects both on site and in the office including a project that required large hand dug caissons. The caissons formed the foundations for the Embankment Place development - which was an interesting structure built over through and under the Embankment Place tube station while it was operating. This project including going down the tube lines at night to install settlement and movement monitoring devices as the caissons went very close to the tunnels. Fortunately this work was after the trains stopped but it was still got the heart going and wasn't helped by our British Underground guide talking beforehand about all the suicides and accidents that went on in these tunnels AND the station being so close to the ground that it was easy to mistake the gusts of wind above ground for approaching trains!

After getting a bit sick of the long dark winters in the UK I moved back to NZ in 1988 with the view of doing a Masters in geotechnical engineering. During this period I, and probably all the engineering geologist in New Zealand, did time working on land slips that would be affected by the Lake Dunstan/Clyde dam filling. After also sorting out a few domestic issues like getting married and starting a family etc I moved to Sydney in 1990 to do the geotechnical masters course at the University of NSW. I was able to do a large part of this Masters while working mostly fulltime. This work included looking at the large number of slips affecting the rail line between Wollongong and Sydney. This was really interesting stuff in part because there were so many slips (50+) – so many that it wasn't possible to fix them all at once. Because of the need to keep the line open and because many of these slips were actively creeping (albeit slowly eg. mm/day or less) it was agreed with the client to install early warning devices that bridged the headscarp of the slips – which for various geomorphic reasons generally was close to or traversed the rail lines. Land/rail movement over a certain magnitude triggered traffic lights remote for the slips that stopped the trains before they had a chance to derail on the slips. The rail way was inspected daily and on many occasions the lines were realigned over a weekend so as to keep the track operating. This system worked really well and my employer (Longmac - now GHD) got a lot of kodus from the client for this pragmatic risk management approach. The slips were then progressively investigated and stabilised while monitoring continued.

After completing my Masters I moved to Hong Kong to work at the Geotechnical Engineering Office (commonly known in the industry as the GEO). Getting the Hong Kong job was helped in part because there was strong connection in the GEO with Ove Arups in London and former boss of mine in London happened to be in Hong Kong on the days I was being interviewed. It shows our industry is very small and it does not pay to upset anyone as it may come back to haunt you! I started out in a peer review role and moved for a while into managing a quarry rehabilitation project then into managing a consultant programme remediating landslip features. Hong Kong had had a history of landslips occurring in very heavy rain and killing people (mostly illegal immigrants from China squatting on the hills) in the 60s and 70s hence the need for a special department to look after these matters. After a dry period in the 80s some more heavy rainfall events triggered a large retaining wall failure that killed 5 people. The tolerance for fatalities had decreased markedly over the 80s in part because there had been no fatalities for a long period and in part the squatter problem was largely solved. Therefore this fatal event triggered a huge public outcry and as a result there was a big acceleration in landslip and retaining wall remedial works that had to this point being going at a steady trickle under the GEOs supervision. About 15 expats mostly from the UK and myself were recruited in 1992 to manage the acceleration of works.

After 5 years in Hong Kong I moved back to New Zealand and I moved more and more into a project management role - firstly with the

Tauranga City Council then more recently with Beca in Tauranga. However, I could never seem to escape the geotechnical background with many of the projects that I worked on having a strong geotechnical component. More recently I have been working for CERA in an advisory role to the policy team on the Port Hills problem. As I am sure you are aware and which has been discussed in this journal before, the CHCH earthquakes triggered cliff collapses, landslides and boulder roll incidents in the Port Hills. The CERA policy team has had a very challenging time working out how Government should get involved in the Port Hills to help facilitate the recovery of the Christchurch region. It has been a really intense and interesting last 12 months.

In finishing off I believe it is worth noting that the CHCH earthquakes have substantially raised the profile of the geotechnical and engineering geological community in the eyes of the general public. In the past, from the community's perspective and to a large extent also many professions, geotechnical professionals have tended to more backroom working as sub-consultants to other engineering and building professionals. Words and phrases like "liquefaction", "Richter magnitude" and "cone penetration test" are now in relatively common everyday usage in Christchurch. While no-one wants to benefit from a disaster, the Christchurch earthquakes appear to have provided a unique opportunity to more firmly cement the skill set we offer in the minds of the community at large and we should not let this pass us by lightly.

DRILL FORC
AJU139

Shamus Wallace

Occupation
Engineering Geologist.
Tonkin & Taylor Ltd, Christchurch
ACENZ Future Leader 2012

I DON'T RECALL the time that I first became interested in landforms and rocks. Looking through photos of me as a 1 year old recently (as we celebrated our first son's 1 year birthday) photos of me playing at beaches around Dunedin surrounded by interesting landforms suggest this may have had something to do with it. Maybe it was the road trip holidays around New Zealand with the family...this certainly is being passed down, as I seem to have what surely is a problem for most geotech professionals – momentary lapses in concentration 'on the road' when passing through a cutting in some particularly interesting rock formation....a cause for concern for the family, particularly when driving on the 'wrong side' when overseas.

At school I loved geography, maybe it was the enthusiastic teachers, and flying. Although I think the flying part was all about the ability to look down on the landscape. I thought I might want to be a pilot, but that was 'out the window' (ha) as, while having some flying lessons, I was scolded for not concentrating, as I mapped drainage channels and overland flow paths of the Waimakariri when I was being taught how to communicate with the control tower.

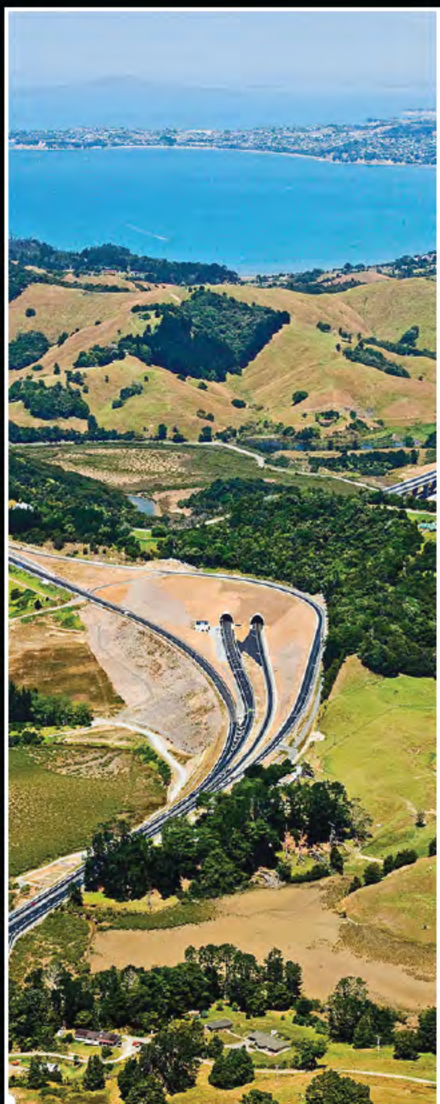
After school (in Rangiora, north of Christchurch) I decided Natural Resources Engineering was a good option, hopefully combining my interest in Geography with a professional degree. About half way through my first pro (2nd) year I had decided that it wasn't quite what I thought it was going to be. I subsequently enrolled in a BSc majoring in Geography and as I had a few extra points to do, picked up some Geology papers. It could have been Dave Bell and other dynamic lecturers in the UC Geol department, but geology and its application to the 'real world' were my favourite subjects.

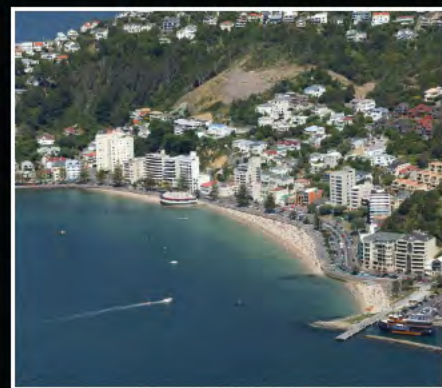
I finished my BSc (after 5 years at uni, counting 2 in Eng School) and decided I hadn't had enough and enrolled in the Honours scheme, another one year of intensity. This proved to be a good decision as my supervisor casually threw into the conversation one day, "Do you want to go to Antarctica to learn how to use the equipment you will use for your Honours project". There could be only one answer, so a few weeks later I found myself spending Christmas and New Years in Antarctica. A visit to the white continent is on many people bucket list and I feel privileged to have been there. I even have a wee piece of rock from Ross Island in my collection.

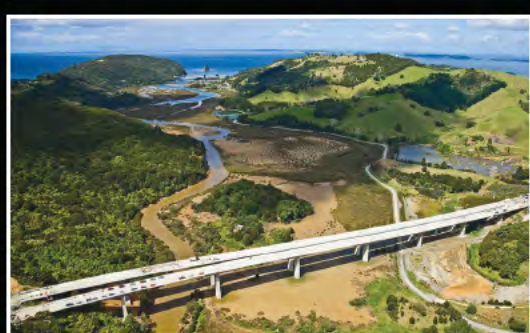
On completion of my Honours Project I went through a small panic that no one wanted to employ me. My first job was working for an independent Geological Consultant, who was at that time working for Solid Energy. I was based in Reefton, undertaking a resource proving drilling investigation in an existing mine. We were using a large HQ rig that was flown onto each drill site and assembled using a Hughes 500 Helicopter. We had to clear each drill site, sometimes levelling it with explosives. Now this was a pretty exciting first 'real' job, in a very interesting and scenic environment. I became a pseudo drill-hand as well, which has provided a solid ground for all drilling jobs I have worked on since.

I moved from this position to one with T&T in Nelson. A little stressful initially, as we hadn't really spent much time on the geology of that region at uni, so I felt a bit out of my depth. Nelson was in boom time, with property the only real currency (after cash) and people were spending significant quantities of the latter on the former. This meant more difficult land could be developed as the cost of the work required could be reflected in the asking price. Working with a great team in a small regional office, I got lots of experience in different aspects of consulting engineering, and I loved living and working in the awesome Nelson area. After a year in Nelson, my wife and I got

Photo 1: The Chicken and the Egg – Interesting rock formations in the White Desert, Egypt







married, and my wife, who had until then been living in Christchurch, shifted to Nelson. It was great to live in the same city, as although we had been together for a while (we met in third form and got married after 10 years together) we hadn't really lived and worked in the same city until this time.

Lisa (my wife) was keen to explore the world. Given my love for my job, my workplace and Nelson I was dubious. It was with significant reluctance that after 2 years in the Nelson T&T office we headed overseas (to London of course!). The purpose of this wee trip was to make some money to see the world. Luckily the pound was at a high 1= 3NZ$ most of the time we were there. We worked for 11 months and were overseas for 28 months. Needless to say we saw quite a bit of the world, spending months travelling Western Europe, Eastern Europe, Africa and USA. Looking back I can't believe I was reluctant to leave Nelson (sorry team!).

In the UK I worked for Atkins, Mouchel Parkman and a small family firm in Reading (I commuted 1.5 hours each way along the M4). This gave me an understanding of real traffic jams, big consultancies and, how can one say it, 'slightly repetitive Highways Agency work'. I did get to do some interesting preliminary pile design work for the London Olympic Site with Atkins. I still recall the day I asked what 'UXO' meant on a drill log – obviously we don't have too many instances of unexploded bombs being encountered in investigations in NZ (thankfully).

On our return to NZ we settled in Christchurch and I returned to work for T&T, and principally worked on geotechnical jobs in Christchurch and around the South Island. The 2010 earthquake changed the environment completely, and for me personally it has been an opportunity. Our house is only slightly damaged, the Pharmacy Lisa and I own is still operating, and you'd have to be under a rock not to realise the impact of it on the workload for geotechnical specialists. Since soon after the first earthquake, I have been involved with the EQC's Land Damage Assessment Team (LDAT). This has been an awesome position, managing a huge workload and staff resource from many different companies from all over New Zealand to respond to EQC's requirements and aid in the recovery of Christchurch. I have loved (almost) every minute of it, and have met a large number of the Geotechnical community who will be reading this article. It has certainly been challenging at times, particularly with multiple earthquake events, however the support from T&T staff and management has been awesome.

The arrival of our son Jackson, in October last year (another earthquake baby) has been another 'post earthquake' highlight, and while work sometimes dominates the day, going home to see Jackson, and get his brilliant smiles, or make him giggle, or laugh at his actions is always the highlight of the day.

In May this year I was nominated for and became a finalist in the Telecom/ACENZ Future Leader Award. We attended the ACENZ conference and I am sure it is with a smile that those around our table recall Lisa, on hearing the CV's of the other finalists being read out, leaned over, patted me on the knee and said "Don't worry you did well just to get here". Imagine her surprise when I won against some stiff competition. This award provides new opportunities, and I am looking forward to involvement with ACENZ in the coming year.

Of course the recovery has only just started and there is heaps more work to do, so I see lots of potential in Christchurch and look forward to it all!

GEOTECH TEASER

The time for 50% consolidation of a 25mm thick clay specimen (drained at top and bottom) in the laboratory is 150 sec. How long (in days) will it take for a 3m thick layer of the same clay in the field under the same pressure increment to reach 75% consolidation? There is an impermeable layer at the bottom of the clay layer in the field.

GEOTECH TEASER ANSWER

ANSWER: to June's Teaser

At failure

$$\sigma_1 = 1.6\ \text{MPa}$$

$$\sigma_2 = -0.4\ \text{MPa}$$

These values give the plot shown in Figure 1.8.

Zero normal stress acts in the directions $\pm\theta$ to the direction of σ_1, where 2θ is given by equation 1.23. Thus

$$\cos 2\theta = -\frac{1.6+(-0.4)}{1.6-(-0.4)}$$

$$\therefore \quad \cos 2\theta = -0.6$$

$$\therefore \quad 2\theta = 126.9^\circ$$

$$\therefore \quad \theta = 63.5^\circ$$

The angle 2θ can also be found by direct measurement from Figure 1.8.

As the planar weakness acts at 30° to the direction of σ_1, the normal stress $\sigma_{n\theta}$

14 *Stresses, strains and Mohr circles*

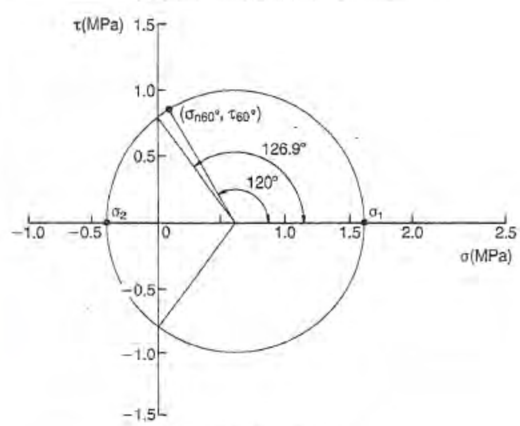


Figure 1.8 Example 1.3.

on this plane acts in a direction of 60° to the direction of σ_1. Thus, the stresses σ_{n60°, τ_{60° acting on this plane are found by rotating $2\theta = 120^\circ$ from the stress point σ_1, as shown in Figure 1.8. The shear stress on this plane can be found from Figure 1.8 by direct measurement, or by observing that

$$\tau_{60^\circ} = \tfrac{1}{2}(\sigma_1 - \sigma_2)\sin 120^\circ$$
$$= 0.866\ \text{MPa}$$

EVENTS DIARY

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

2012

10-14 December 2012
Bangkok, Thailand
Geosynthetics Asia 2012 – 5th Asian Regional Conference on Geosynthetics
www.set.ait.ac.th/acsig/GA2012 / www.seags.ait.ac.th/conference.html

17-18 December 2012
Hue City, Vietnam
INTERNATIONAL WORKSHOP ON Geo-engineering for responding to climate change www.husc.edu.vn/huegeo2012/

2013

10-12 January 2013
Bengaluru, India
Fourth International Seminar on Forensic Geotechnical Engineering
http://img.masterbuilder.co.in/edata/Workshops/ISFGE-4.pdf

29 January – 8 February 2013
Kiryu, Japan
Engineering Geological Mapping Summer School Course
http://web.env.auckland.ac.nz/course_pages/geology701/

21-23 February 2013
Tunisia
3rd International Conference on Geotechnical Engineering (ICGE'13)
http://www.icge13.com

1 March 2013 (to be confirmed)
Lahore, Pakistan
International Conference on Geo-technical Engineering. http://www.pges-pak.org

14-16 March 2013
Tabarka-Ain Drahem, Tunisa
International Conference on Landslide Risk (ICLR13). http://www.iclr13.com

26-28 April 2013
Wellington, New Zealand
NZSEE Annual Conference, 2013 – Same Risks – New Realities
http://db.nzsee.org.nz/2013/

29 April – 4 May 2013
Chicago, Illinois
Seventh International Conference on Case Histories in Geotechnical Engineering and Symposium in Honor of Clyde Baker
http://7icchge.mst.edu

12 May 2013
Pan Pacific Hotel, Perth, WA
Shotcrete Design and Performance Workshop
www.acg.uwa.edu.au/events_and_courses
info-acg@uwa.edu.au

13-15 May 2013
Perth, WA
7th International Symposium on Ground Support in Mining and Underground Construction
www.groundsupport2013.com
info-acg@uwa.edu.au

16-17 May 2013
Perth, WA
Ground Support Technology Workshop – a WASM/CRC Mining Workshop
www.acg.uwa.edu.au/events_and_courses
info-acg@uwa.edu.au

29-31 May 2013
Singapore
18th Southeast Asian Geotechnical Conference. http://www.18seagc.com

30-31 May 2013
Napoli, Italy
II International Symposium on Geotechnical Engineering for the Preservation of Monuments and Historic Sites
www.tc301-napoli.org/

16-22 June
Bulgaria
13th INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE AND EXPO - SGEM 2013
http://www.sgem.org/

16-19 June 2013
Norway
Strait Crossings 2013 – Extreme Crossings and New Technologies
http://www.SC2013.no

23-26 June 2013
San Francisco, USA
47th US Rock Mechanics
www.armasymposium.org

1-3 July 2013
Torino, Italy
TC215 Symposium on Coupled Phenomena in Environmental Geotechnics
http://www.tc215-cpeg-torino.org

31 August – 1 September 2013
Paris, France
5th International Young Geotechnical Engineers' Conference
http://www.lepublicsystemepco.com/events.php?IDManif=696

2-5 September 2013
Paris, France
18th International Conference for Soil Mechanics and Geotechnical Engineering
www.issmge2013.org

21-26 September 2013
Wrocław, Poland
EUROCK 2013 ISRM International Symposium
http://www.eurock2013.pwr.wroc.pl

24-25 September 2013
Beijing, China
International Symposium & 9th Asian Regional Conference of IAEG

19-22 November 2013
Queenstown, New Zealand
19th NZGS Symposium – Infrastructure and Lifelines. http://www.nzgs13.co.nz

2014

9-14 November 2014
Melbourne, Australia
7th International Conference on Environmental Geotechnics

2015

TBC
Christchurch, New Zealand
6th Intl, Conference on Earthquake Geotechnical Engineering

NEW ZEALAND GEOTECHNICAL SOCIETY INC.

Management Committee Address List 2012

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	NZGS Web Manager	Contact: webmanager@nzgs.org	Website: www.nzgs.org

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

ADVERTISERS DIRECTORY

ANSWER

Answer to June 2012 Issue 83 Crossword

Across

1 **RINGSHEAR** – Lab test using sample confined laterally, under constant normal stress and a constant rate of rotation applied (4,5)
6 **EARTHFILLCORE** – Controls seepage through earth dam (9,4) –
8 **RANGITOTO** – Youngest cone in Auckland basalt volcanic field
11 **CENTRALOTAGO** – NZ's largest gold rush (7,5)
14 **CURTAINGROUTING** – Cement filled boreholes to reduce K in dam foundation (7,8)
15 **MATAHINA** – North Island dam that suffered core erosion on first filling in 1967
18 **SILL** – Intrusive volcanic feature
20 **MOERAKI** – Named concretionary boulders on Otago beach
22 **GPR** – Acronym for geophysical method used to locate cavities, buried objects, boulders, etc
23 **FLOWNET** – Groundwater seepage diagram
24 **INFILLING** – Material within boundaries of defects
25 **INSITU** – Latin for in position (2,4)
29 **PYRITE** – Metallic sulphide mineral
31 **MARUIA** – Geothermal area near Lewis Pass
32 **CORESTONE** – Often found in granitic soil profile
33 **RIPRAP** – erosion protection measure (3,3)
34 **SCREE** – Loose rock present on Mt Ngaruhoe
36 **NZED** – Acronym for Government Dept. controlling NZ electicity grid prior to ECNZ
38 **NEPHRITE** – Type of jade highly valued by Maori
40 **COLLUVIUM** – Eroded soil deposited under gravity forces
41 **GREYWACKE** – Generally hard feldspar-rich sedimentary rock
42 **ARNOLD** – River with hydroelectric scheme on West Coast
43 **NELSON** – Area of NZ with deepest karst systems

Down

2 **HANDLENS** – Field tool for examining samples (4,4)
3 **SYNCLINE** – Type of folded rock sequence
4 **TRANSLATIONAL** – Landslide mechanism
5 **FILTER** – Part of earth dam to control internal erosion
7 **REACTIVATION** – term for new activity on old inactive landslide
9 **TRASHRACK** – excludes debris from dam outlet conduit
10 **OVERTOPPING** – Mode of dam failure
12 **CRUSHSEAM** – Zone of parallel boundaries with angular fragments in between (5,4)
13 **MASS** – Non-homogeneous rock or soil
14 **CAMBRIAN** – Geologic Period of oldest NZ rocks
16 **DIAMOND** – 10 on the mineral hardness scale
17 **MOHIKINUI** – Meridian put a hold on this hydro scheme recently
19 **HALLOYSITE** – Mineral found in andesitic ash in high proportions
21 **CALIPER** – Borehole logging method inferring lithology from borehole profile
22 **GEOTHERMAL** – Source of approximately 13% of NZ electricity
26 **FIORDLAND** – 2009 magnitude 7.8 NZ earthquake
27 **LATERITE** – Red soil with concentrated oxides of Fe and Al
28 **LOESS** – Soil covering much of Christchruch's Port Hills
30 **PILLOW** – Form of submarine lava
35 **HOEK** – Famous rock mass engineer
37 **BRUNNER** – Deep lake on NZ West Coast
39 **PILE** – Common foundation system
40 **CLEAVAGE** – Foliation which a material breaks along

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	$100
Students	Free
Annual IPENZ service centre fee applies to all NZGS members who are not members of IPENZ	$51.75

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

International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)	$35.00
International Society for Rock Mechanics (ISRM)	$35.00
International Association of Engineering Geology & the Environment (IAEG)	$35.00
(with bulletin)	$80.00

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

NZ Geotechnical Society Inc, P O Box 12 241, WELLINGTON 6144

The Secretary
NZ Geotechnical Society Inc.
The Institution of Professional Engineers New Zealand (Inc)
P.O. Box 12-241, WELLINGTON 6144

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): ……………………………………………………………

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EXPERIENCE IN GEOMECHANICS: ……………………………………………………………………………………

STUDENT MEMBERS: ……………………………………………………………………………………………………

TERTIARY INSTITUTION: …………………………………………………… SUPERVISOR: ……………………………………

SUPERVISORS SIGNATURE: …………………………………………………

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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 …………………………………………………………

ADVERTISING INFORMATION

NZ Geomechanics News is published twice a year and distributed to the Society's 800 plus members throughout New Zealand and overseas.

The bulletin 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.

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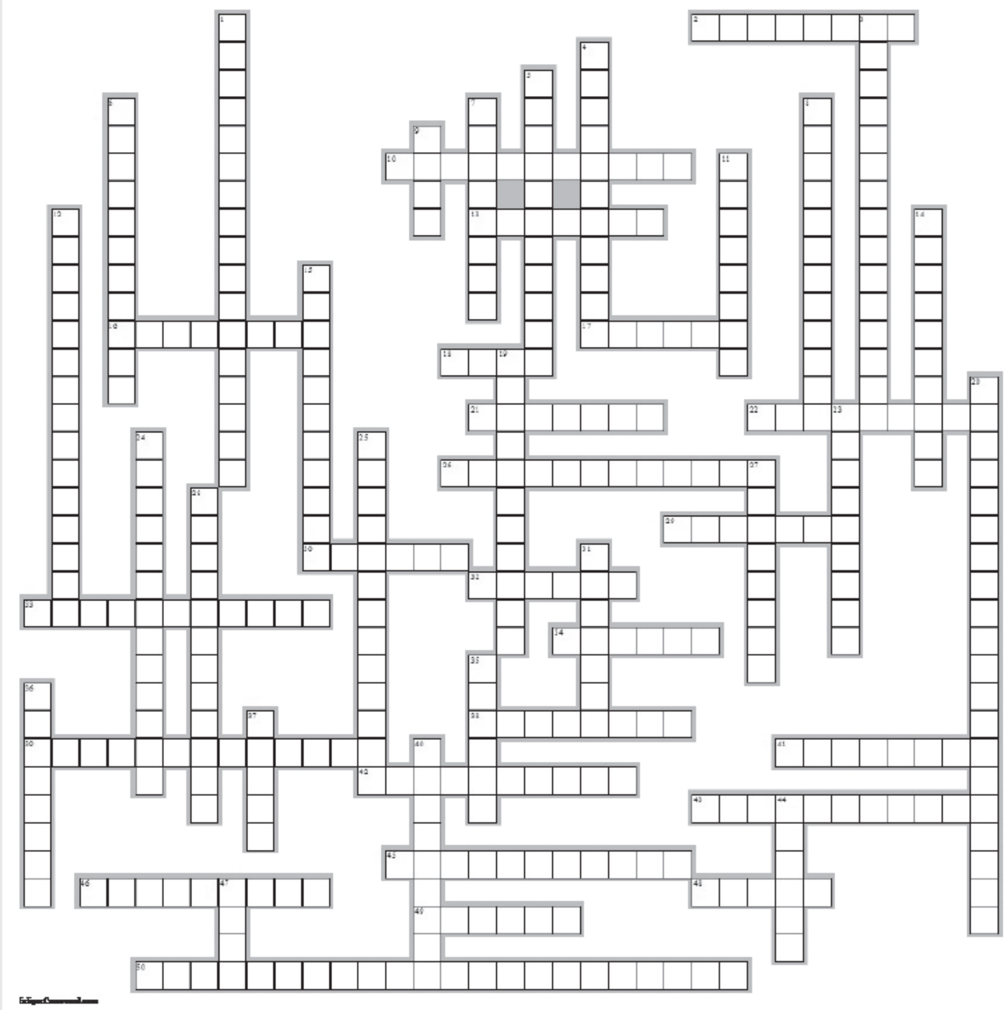
email: secretary@nzgs.org

GEOTECH CROSSWORD



Across

2 Small cracks (8)
10 For example pad or pile (11)
13 The red nosed helper for Father Christmas (7)
16 Who published the first text in Soil Mechanics (in German) in 1925 (8)
17 A man-made tubular void normally found underground (6)
18 Celestial body followed by the three kings (4)
21 The water content at which the maximum dry density of a soil is obtained using a specific effort of compaction (7)
22 Could be rotational or translational for example (9)
26 Highest Mountain in Antarctica (6,6)
29 Structure Father Christmas squashes down (7)
30 Songs of the season (6)
32 Festive bird (6)
33 The systematic description of rocks in hand specimen and thin section (11)
34 Akashi-Kaikyo is the world's longest what? (6)
38 Hung up by the fire the night before (8)
39 Volume change due to dissipation of excess pore pressure from static loads (13)
41 A professional practitioner concerned with applying scientific knowledge, mathematics and ingenuity to develop solutions for technical social and economic problems (according to Wikipedia) (8)
42 Typically polypropylene or polyester fabric (10)
43 The rock of change (11)
45 Retaining wall largely relying on its mass to function (7,4)
46 An extraterrestrial body derived from the Asteroid belt (9)
48 981 kN/m³ is the unit weight of what (5)
49 False (6)
50 A measure of how hard the ground shakes in a given geographic area (4,6,12)

Down

1 eg volcanoes, landslides, tsunamis, earthquakes etc (10,7)
3 The portion of the total stress supported through the soil particles (9,6)
4 The water content at which a soil changes from plastic to liquid behaviour (6,5)
5 A common method of tunnel construction (3,3,5)
6 Pore water pressures exerted under conditions of no groundwater flow where the magnitude of pore pressures increase linearly with depth below the ground surface (11)
7 Cement, aggregate and water (8)
8 Sudden loss of shear resistance associated with the collapse of the grain-supported framework in an underconsolidated sediment (12)
9 What a "naughty" child receives from Father Christmas (4)
11 An approximately circular depression commonly found in a particular sedimentary rock (8)
12 A clay structure that may swell 20x its original volume when saturated (15)
14 A hole in the ground (10)
15 A mass of soil having different properties in different directions (11)
19 Harold Wellman discovered this New Zealand Geological feature (6,5)
20 Downward movement of adjacent soil relative to foundation element (8,4,8)
23 The volume of flow of the pore fluid through a porous medium per unit time is proportional to the rate of change of excess fluid pressure with distance (6,3)
24 A collection of structural elements which should substantially decouple a superstructure from its substructure resting on a shaking ground (4,9)
25 According to the song, what did my true love bring to me on the 11th day of Christmas? (6,6)
27 A volcanic vent, from which no magma would erupt (8)
28 A phase of relative warmth during a major glacial (12)
31 Bottom of the ground model (7)
35 The manner in which light reflects from a mineral surface (6)
36 An rapid form of mass movement by falling under gravity (8)
37 Error (5)
40 The volcano that produced the most powerful eruption of 20th Century when it erupted in 1912 (9)
44 Christian term for the days leading up to the 25th December (6)
47 For example basalt or sandstone (4)

> The answers will be printed in the JUne 2013 issue of NZ Geomechanics News, and also posted on the website.

Crossword supplied by Camilla