NEW ZEALAND GEOTECHNICAL SOCIETY INC

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NZ GEOMECHANICS NEWS

Bulletin of the New Zealand Geotechnical Society Inc.

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Mackays to Peka Peka Expressway

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RETAINING YOUR BUSINESS IS OUR BUSINESS.

ENGINEERING EXCELLENCE
~ SINCE ~
1971

Over more than 40 years, Grouting Services has delivered some of New Zealand's most significant Ground Anchoring, Soil Nailing, Micro-Piling and Post-Tensioning contracts.

Reflecting a strategy of continual improvement, we are pleased to announce the arrival of our latest specialist drilling rig, the Comacchio MC400 MP proprietary hydraulic crawler-mounted drill rig with remote hydraulic power pack. It is especially designed for specialised work in narrow spaces, inside buildings / basements and small tunnels and therefore well suited to micro-piling applications.

The drill rig is able to operate all rotary and/or rotary percussion drilling systems and the advanced manoeuvrability allows for a wide range of drilling positions to be achieved.

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Our multidisciplinary operation specialises in the fields of ground anchoring, soil nailing, drilling, post-tensioning and grouting. The combination of capability and depth of technical expertise makes us a market leader and supports our reputation for providing value engineered solutions to our customers.

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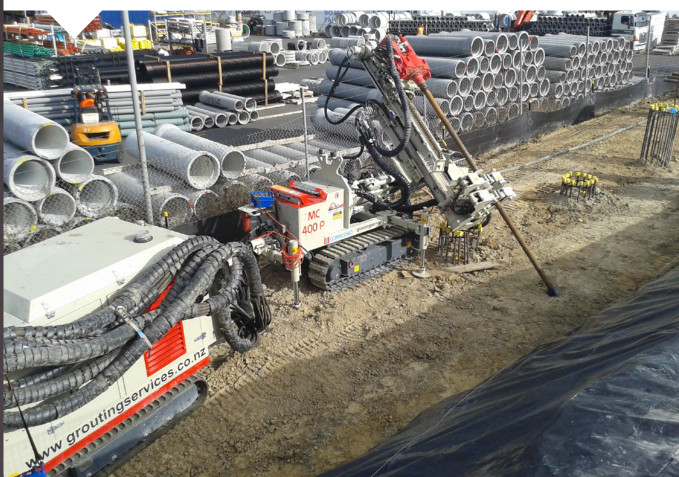
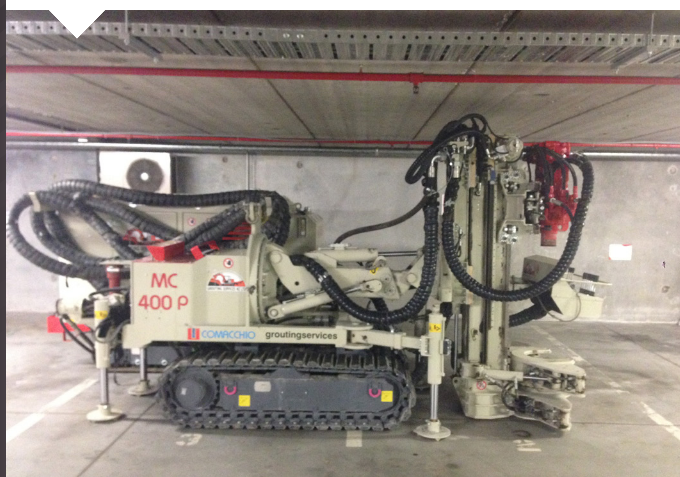
- ✔ Grouting
- ✔ Post-tensioning
- ✔ Drilling
- ✔ Seismic Upgrade

We're proud to be the sole distributor in New Zealand for SAMWOO Anchor Technology, BluGeo GRP Powerthread K60 Bar, Tighter (Kite) Earth Anchors and Grout Grippa Grout Sock (Australasia).

Functionality



Low Headroom



GROUTING SERVICES

Retaining your business is our business.

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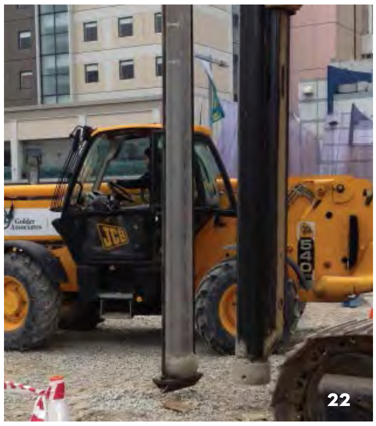
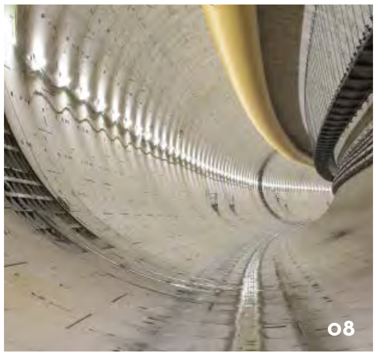


Society



COVER IMAGE: 15 meter section of a Totara log found in the peat at Peka Peka. The log has been given back to local iwi, Te Atiawa and is now being carefully dried out for future carving. Photographer Mark Coote.

Gavin has specialized in geotechnical engineering since graduating from Auckland University in the mid 1980's. Following graduation, he spent seven years with Arup Geotechnics in the UK and Australia working on large building and infrastructure projects. In that period Gavin spent a year at Imperial College, London and was awarded an MSc and DIC in Soil Mechanics and Engineering Seismology.

Gavin Alexander
Chair, Management Committee

CONSIDERABLE EFFORT CONTINUES to be put into the running of our Society and into contributions to the wider profession. The workload of your Committee and many other volunteers continues to exceed the time that people are able to make available, and I would like to thank all who provide a great deal of their discretionary time to contribute to our Society. I have set out the highlights from the last six months below.

INTERNATIONAL REPRESENTATION

Mick Pender, our local ISSMGE Liaison, has been asked to join the ISSMGE Technical Oversight Committee. This is a great honour for Mick, and reflects his high standing in the international soil mechanics community. It will allow him to help shape the future technical work programmes of the many Technical Committees of that society, and will keep him at the forefront of new thinking in his field.

Stuart Read, our local ISRM Liaison, has been nominated as the next Regional Vice President of that society. Providing his nomination is accepted, Stuart will take up this role in 2015.

Ann Williams completes her four year term as Regional VP for IAEG later this year. Following hard on the heels of the Convenor role for the IAEG Congress in 2010, Ann has invested a huge effort in that Association over a considerable period of time. Thanks Ann, your enthusiasm and commitment is highly valued. We will shortly be calling for nominations for a local liaison person while the Regional VP role is held by Mark Eggers from Australia.

CONFERENCES

Our 19th Geotechnical Symposium in Queenstown was an outstanding success on all fronts, and has certainly set the standard for future events. Tony Fairclough and his committee are to be congratulated for the way everything worked out. Thank you all.

Planning for the next joint ANZ conference to be held in Wellington in early 2015 is well advanced, with 290 abstracts submitted to date. There are still a number of sponsorship spots available, and I encourage you to make the most of this opportunity to showcase your organisation to a truly Australasian audience.

Later in 2015, the 6th International Conference in Earthquake Geotechnical Engineering will also require our support. Misko Cubrinovski is leading a strong team of volunteers to organising this.

SEISMIC GUIDELINES

Work on the first three modules of the Geotechnical Earthquake Engineering Practice continues (review of the existing Liquefaction module, and writing of guidelines on Foundation and Retaining Wall design) but at a frustratingly slow pace, with the result that MBIE has now overtaken our efforts and produced its own version of a retaining wall design guideline for residential development. While a somewhat inevitable consequence of relying on well intentioned specialist practitioners in the most in-demand sector of our membership, we really do need to give this the upmost focus. There are some initiatives being talked about, but if any of you have a strong interest in these areas and have some time to contribute, please get in touch with me. We've got to get these out the door.

INDUSTRY ENGAGEMENT

I'd like to close with a plea for help – we have a huge work programme and it's far more than your committee can complete without a lot of assistance. To those of you who have helped already and continue to be involved, my heartfelt thanks. To the rest of our membership, please think about getting more involved. You will gain useful insights into our profession, and develop strong connections with your peers.

THIS EDITION OF Geomechanics News is a particularly exciting one for the editorial team and, we hope, for our readers. Back in December we asked you for your feedback and the response was impressive; nearly a quarter of the membership filled in our survey.

You told us that the vast majority of you read more than half of the bulletin, but that some sections are too dry, long, or dull. You value the technical articles, project news, industry news and the events diary, but are less interested in some of the Society news. You gave strong support for maintaining a paper copy, but with a significant minority expressing strong interest in the idea of a digital version being available in parallel, potentially with additional or expanded content which cannot be fitted into a printed document.

Your advice has been invaluable, and we have made numerous changes that we hope will keep Geomechanics News relevant, valuable and enjoyable. The key differences are:

- Digital publishing in tablet formats (search for NZGS on your App Store) and online at www.nzgs.org, with a strong commitment to maintain a printed copy.
- A new, compact and more readable layout.
- More industry news and technical content, balanced by concise Society news.

We will continue to work on content, layout and distribution so please keep your feedback coming.

A highlight from the reader survey was the overwhelmingly positive comments on the quality of the publication, summarised by this individual response, "I think it's very well put together and it's evident a lot of hard work goes into making it happen. Good stuff!" This will be the last edition to be led by Hamish, who is standing down from the editorial team after three and a half years (7 Issues!). He has enjoyed the experience and engagement with a broad range of Society members, all passionate about their work. It has been rewarding to see Geomechanics News function as one of the platforms for maintaining a conversation around technical excellence and our unique ability to shape the communities and environments in which we work.

As our Chairman has noted in his corner, the Society relies heavily on volunteers. Geomechanics News is no different and we would like to take this opportunity to thank all of the individuals who put in so much effort to write the articles in this and past editions. We have a great selection of articles in this edition covering a very wide range of topics. The true breadth and depth of capability within our society is on display. We can speak from experience in saying that publishing an article of any length in Geomechanics News is a rewarding and often surprisingly easy endeavour. I encourage you all to give it a go, particularly if you've never written an article for us before. We publish articles of interest ranging from a paragraph of news to a full technical paper, and almost anything in between. Without you, Geomechanics News would not exist.

Tell us about your project, news, opinions, or submit a technical article. We welcome all submissions, including:

- technical papers
- technical notes of any length
- feedback on papers and articles
- news or technical descriptions of geotechnical projects
- letters to the NZ Geotechnical Society or the Editor
- reports of events and personalities
- industry news
- opinion pieces

Please contact the editors (editor@nzgs.org) if you need any advice about the format or suitability of your material.

Hamish is a Geotechnical Engineer with Tonkin & Taylor. He completed his Civil Engineering degree at The University of Auckland and has spent the past ten years in the T&T Auckland office. This has included a wide variety of projects with a focus on retaining wall design and landslip assessment and remediation. He is currently working on the Waterview Connection project.

Ross is an Engineering Geologist with Jacobs in Auckland. He trained in the UK at Edinburgh and Newcastle, and has since worked on projects ranging from motorways and railways to geothermal power stations and wharf structures. He has a particular interest in geohazard assessment, investigation and remediation. He has worked in the UK, Ireland, Australia, Java, Sumatra and New Zealand.

News – In Brief

KA-CHING BECOMES GAIA PRINCIPAL

Ka-Ching Cheung has rebranded the geotechnical discipline of Peters and Cheung, established in 2001, as Gaia Engineers Ltd. Selected to reflect the work of their geotechnical engineers, "Gaia" means "The Earth" in Greek. They moved into a new office at 5 Carmont Place, Mt Wellington in February 2014.

Currently Ka-Ching and his geotechnical team are currently working on the Tauranga Eastern Link and the Waikato Expressway Project for NZTA, and are expecting to start soon on Transmission Gully and Huntly Bypass.

Around 60% of NZGS members are also affiliated with IPENZ. This includes 278 who hold CPEng and 15 who hold PEngGeol. 57 NZGS members are also IPENZ Fellows or Distinguished Fellows, well above the IPENZ average of 10%!

IPENZ CELEBRATES CENTENARY

The rich heritage of the Institution of Professional Engineers New Zealand (IPENZ) will come to life this year with an exciting programme of events and activities held around the country. The Institution will also use the Centenary to look to the future as IPENZ positions itself to respond to the challenges of the next 100 years.

New Zealand's first professional engineering body, the Institute of Local Government Engineers of New Zealand, was formed in 1912. It soon became clear that a more representative engineering professional body was desired. This lead to the establishment of the New Zealand Society of Civil Engineers in 1914. These bodies merged in 1937 and the name of the organisation was changed to the New Zealand Institution of Engineers to better reflect the increasing number of members from disciplines other than civil engineering. The present name was adopted in 1982 to reflect the importance of the professional engineering ethos in the organisation.

IPENZ is now the professional body representing Professional Engineers from all engineering disciplines in New Zealand. The NZGS is affiliated to the Institution of Professional Engineers NZ as one of its collaborating technical societies.

For details of the events see the IPENZ website (https://www.ipenz.org.nz/IPENZ/Events_and_Awards/IPENZ_Centenary.cfm)

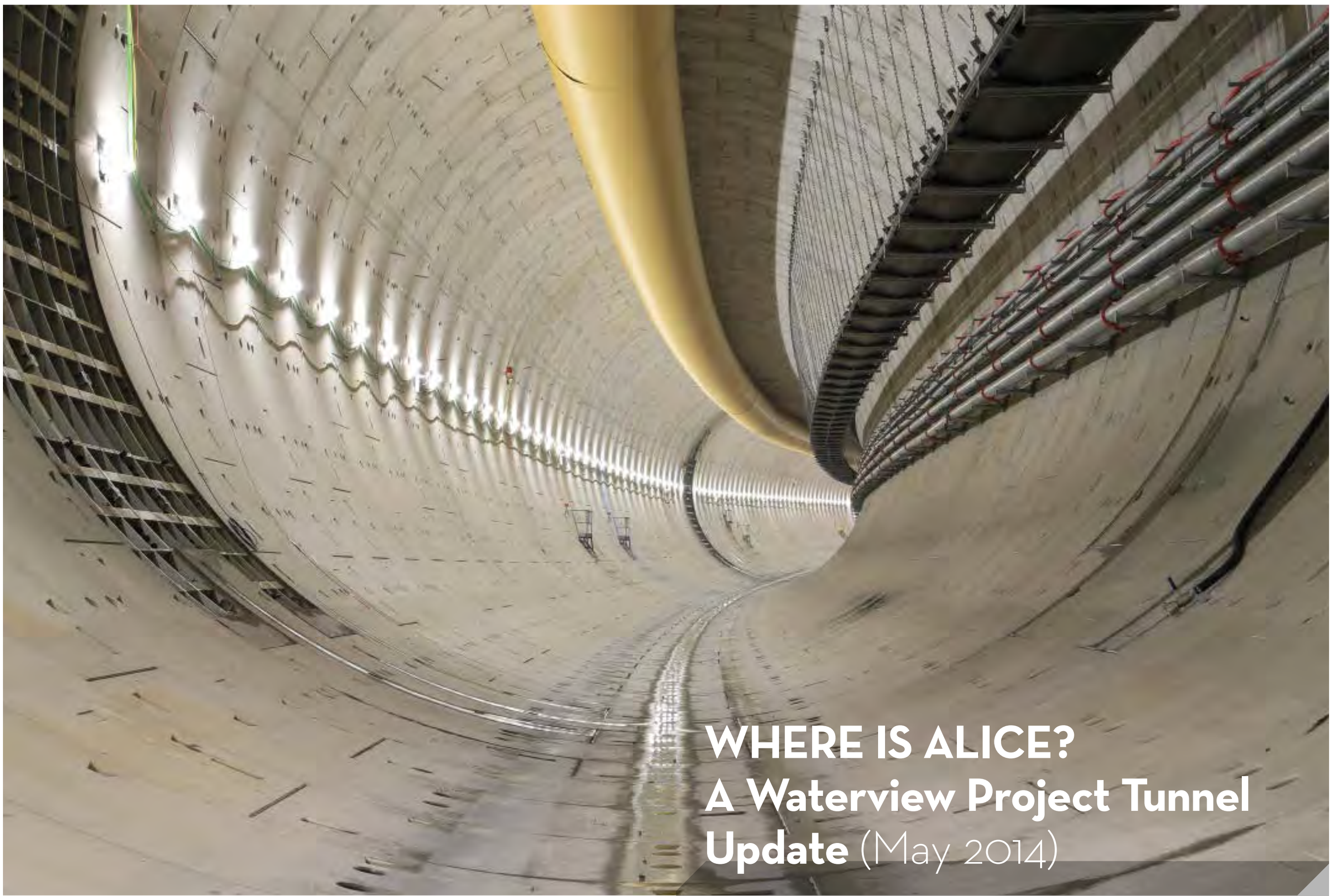
SKM MERGES WITH JACOBS

Jacobs Engineering and Sinclair Knight Merz (SKM) have combined to form one of the world's largest providers of technical professional and construction services across multiple markets and geographies.

SKM and its predecessor organisations (KRTA and Kingston Morrison) have been significant players in the New Zealand market since being founded in 1915 by Stanely Jones.

Engineering News Record (ENR) reported that Jacobs Engineering was the fourth largest global engineering design firm by design revenue in 2013. Their acquisition of SKM has increased their size and global reach by approximately 10%, leapfrogging URS to take third position on the ENR list behind AECOM and WorleyParsons.

The SKM brand will be phased out and replaced with Jacobs by July.



WHERE IS ALICE?
A Waterview Project Tunnel Update (May 2014)

As Alice the TBM creeps further on her journey, preparations are well underway for her breakthrough at Waterview in late 2014. Considerable planning is underway as turning the 3000T, 88m long machine around in the limited space of the Northern Approach Trench for the return drive will be no easy feat.

DISTANCE TRAVELLED 900m DEPTH 21.3m NO. OF RINGS INSTALLED 445 EARTH MOVED 147,380m^3

PROMOTING PEngGeol

On 3 April 2013 a register for Professional Engineering Geologists (PEngGeol) was established in New Zealand. The register recognizes the importance of professional engineering geological practice in the fields of civil and geotechnical engineering, and allows it to be distinguished from geotechnical engineering.

The establishment of the register fills an important gap that until now has been missing. Engineering geology has commonly been a hit-and-miss component of geotechnical engineering leading to unnecessary risk in engineering works. The greatest risk is to not sufficiently understand ground conditions and their implications for design. A PEngGeol is skilled in helping to limit that risk. The register provides the opportunity and the means for the quality mark of PEngGeol to be recognised by Councils and industry as a demonstration of confidence in geotechnical assessment and sign-off on matters that are engineering geologically based.

If you have a client requiring a specific engineering geological skill set, or requesting sign-off of engineering geological matters, the NZGS committee encourages you to discus this with your clients to raise their awareness of the register.

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MURRAY STEPS OUT

Upon leaving Jacobs SKM in April, Grant Murray issued the following press release: After eighteen long years Jacobs SKM (formerly Kingston Morrison) is relieved to announce that their Geotechnical Engineering Practice Leader Grant Murray has left their employ and is now operating as an independent consultant in geotechnical and dam engineering under the company name of Grant Murray & Associates Ltd. As many in the industry will appreciate, Grant has long been a burden on SKM's payroll and a significant hindrance to the success of their business and credibility in the market place. The NZGS suffered Grant's presence on the management committee between 1998 and 2005 during which time he was Treasurer, Editor of the Geomechanics News and, unbelievably, the Australasian VP on the board of the ISSMGE.

It may surprise some to hear that Grant is a Fellow of IPENZ, a Chartered Professional Engineer and a Category A, Recognised Engineer for Dam Safety. However, his track record speaks for itself and given that he has no friends and is unlikely to find any clients it is anticipated that his venture is doomed to an ignominious failure.

His ex-colleagues at Jacobs have taken pity on his plight and generously offered to support him by continuing to work with him on existing and future projects.

IPENZ CODE OF ETHICS UPDATE

The Society sought the views of members on aspects of an IPENZ consultation document on the revised (draft) code of ethics. As with our earlier internal consultation on registration of geotechnical engineers, the response was underwhelming. Our rules require us to abide by the IPENZ rules and code of ethics, so the lack of response was very disappointing. Our submission is reproduced on page 90 of this edition..

NZGS INDUSTRY PARTICIPATION

The NZGS committee has prepared a formal submission to the Local Government and Environment Select Committee on the Building (Earthquake-prone Buildings) Amendment Bill. This was developed in consultation with IPENZ, SESOC and the NZSEE, and our submission is available on our website.

NZGS Chair Gavin Alexander continues to represent us on the Engineering Reference Group (ERG) established by MBIE to overview building and construction policy and operational developments. The current focus is on regulation of the engineering profession.

In addition to existing NZGS representation on committees reviewing Site Investigations and Concrete Structures standards (Tony Fairclough and Kevin Anderson respectively), we have been asked to provide a representative on a committee reviewing NZS1170.5. Kevin Anderson has been nominated for that role.

NEW ZEALAND GEOTECHNICAL SOCIETY INC
www.nzgs.org

NZGS 2014 STUDENT PRESENTATION AWARDS POSTER COMPETITION

PRIZE MONEY
$1000 first
$500 second
$300 third

INVITATION TO PARTICIPATE

The New Zealand Geotechnical Society wishes to recognise and encourage student participation in the fields of rock mechanics, soil mechanics, geotechnical engineering and engineering geology.

The 2014 Student Presentation Awards will be a Poster Competition and is open to all students.

Posters will be displayed and awarded at local branch meetings. in late 2014.The top three posters will be displayed in the June 2015 issue of the NZ Geomechanics Bulletin. Submission date to be advised.

For further information or to join the Society (membership is free for students) please visit our website www.nzgs.org or contact the Society Management Secretary at secretary@nzgs.org

FULTON HOGAN INCREASES PROFIT

Fulton Hogan has announced profit of $64 million for the half year to December 31, 144 per cent above the previous first half. Managing director Nick Miller said the company had had a solid start to the year and the result was pleasing.

Fulton Hogan is currently involved in a number of large projects in New Zealand including a joint venture with John Holland for 18 months working mainly for KiwiRail, the relining of the Tekapo canals for Genesis Energy.

It was also now working in the water and irrigation infrastructure sector. A Fulton Hogan-John Holland joint venture is positioned to build the headrace canal and bridges for stage one of the Central Plains Water scheme.

The outlook for the rest of 2014 was positive and the company had $2.8b in forward orders in New Zealand and Australia, and is now focussing on securing a good share of the New Zealand Transport Agency road maintenance contracts.

2015 NEW ZEALAND GEOTECHNICAL SOCIETY SCHOLARSHIP

The NZGS Management Committee has agreed to provide funding for a NZ$10,000 scholarship that will enable a member of the Society to undertake postgraduate research in New Zealand that will advance the objectives of the Society. Through this scholarship the Society hopes to encourage members to enrol for post-graduate research or undertake research which would not otherwise be possible for them.

The fields of research would be in Engineering Geology and/or Geotechnical Engineering. The award of such a scholarship would include agreed milestones and deliverables including a publication or thesis. A nominated representative from the NZGS will act as a liaison with the scholar and the supervisor where applicable.

The Terms of Reference for the scholarship are available on the NZGS website.

TONKIN & TAYLOR LTD DUNEDIN MANAGEMENT BUY-OUT

Tonkin & Taylor has sold its Dunedin-based and Otago operations to local management. These now operate as GeoSolve Ltd.

As a stand-alone business the GeoSolve Ltd management will have more flexibility to tailor and pursue opportunities in the local market. One of these areas is the pavement analysis business that was developed and operated from the Dunedin team and this change allows both businesses to better respond to a rapidly changing environment with the introduction of new technologies. GeoSolve Ltd are keen to pursue emerging opportunities in this area.

Both Tonkin & Taylor and GeoSolve report advantages in maintaining a close relationship and have agreed to cooperate in a number of areas in the future. GeoSolve will be led by Graham Salt who played a key role in developing both the Christchurch and Dunedin Tonkin & Taylor offices.

GHD merger

Conestoga-Rovers & Associates (CRA) and GHD announced in March that they plan to merge the two companies. A key feature of the merger is that all ongoing employee shareholders in CRA will become shareholders of GHD. The transaction is subject to shareholder and regulatory approval, as well as other customary closing conditions. The transaction is expected to close in July 2014.

Once complete, this will be one of the largest true mergers to have occurred in the engineering and environmental industry, with the two firms combining resources and pooling their equity interests.

CRA is a 3,000-person multi-disciplinary engineering, environmental, construction, and information technology services firm. They have over 100 offices in the United States, Canada, and the United Kingdom with clients in over 60 countries.

Established in 1928, GHD employs more than 5,500 people across five continents and serves clients in the global markets of water, energy and resources, environment, property and buildings, and transportation. They do not have any association with hair straighteners.

FLETCHER LOOKS OVERSEAS

Fletcher Construction is looking to partner with some of the world's largest construction firms in order to win a share of an anticipated $4 billion-plus of private partnership contracts including the Puhoi to Wellsford motorway, Auckland's Central Rail Link, national school-building projects and the rebuild of Auckland Prison at Paremoremo.

Graham Darlow, Fletcher Construction chief executive, told NZ Herald that he hoped to bid with Acciona of Spain, France's Vinci Construction, Spain's Ferrovial and Europe's OHL. "These are very large international construction companies with experience in PPPs. These companies would provide much more in the way of funding and creating special purpose vehicles. We will provide the design and construction skills. These global businesses are able to manage PPPs through their term because most of the PPPs are 25 years long," he said.

"There's over $4 billion of work coming in the PPP form and that's why we need to configure ourselves for the market," he said, telling how executives from some of these businesses had already visited. "They like the opportunity that exists here. New Zealand is a very good place to do business. They're also probably talking to other builders," he said.

Fletcher already has $1.6 billion worth of work on, the biggest workload in many years and up on 2012's $1.1 billion.

But Darlow said that was only a portion of New Zealand's $11 billion to $12 billion annual construction market and Fletcher won only about a third of the jobs it tendered for.

TOP 10 FLETCHER CONSTRUCTION PROJECTS

1. Fletcher EQR (house repairs)
2. Stronger Christchurch Infrastructure Rebuild Team (in alliance with many other firms)
3. Waterview Connection (an alliance with many other firms)
4. MacKays to Peka Peka (alliance with New Zealand Transport Agency)
5. Wiri Prison public private partnership (new 850-bed facility)
6. Auckland Manukau Eastern Transport Initiative (contract with Auckland Transport)
7. South Pacific Games facilities, Papua New Guinea (new aquatic centre and main athletics stadium)
8. Fonterra headquarters (Wynyard Quarter head office)
9. The University of Auckland new science block (demolition and upgrade of campus facilities)
10. Rangiriri Bypass (NZ Transport Agency in the Waikato)

Earth-shattering detective work

Brendon Bradley has been awarded one of 10 prestigious Rutherford Discovery Fellowships providing $800,000 funding over five years to further his research. His research will make use of state-of-the-art analyses, to shed light on several profound ground motion observations from the 2010-2011 Canterbury earthquakes the research will develop a unifed understanding of the seismic response of urban areas residing on sedimentary basins with liquefiable soils.

Dr Bradley is a Senior Lecturer at Canterbury University. His research has covered a wide range of fundamental and applied topics in earthquake engineering related to the quantification of earthquake-induced ground shaking; seismic analysis of structures and geotechnical systems; and methodologies for assessing seismic performance. He has been heavily involved in numerous aspects of the Canterbury earthquakes reconnaissance, as well as similar efforts following the 2011 Tohoku, Japan earthquake and the 2009 Samoan Tsunami.

MacKays to Peka Peka Expressway

Philip Robins

Philip is a Technical Director – Geotechnical with Beca based in Wellington, with over 20 years' experience specialising in geotechnical analysis and design. He has been involved in the design and construction of major infrastructure projects in New Zealand, California, Hong Kong and Southern Africa. Philip's project experience ranges from planning and managing subsurface exploration programs including onshore/offshore drilling and sampling and in situ testing through site evaluation to the design of deep and shallow foundations, major earthworks, fill embankments and retaining structures. Philip was Chair of the NZGS Management Committee from 2009 to 2010.

Photograph 1: Earthworks underway at Sector 460 (Otaihanga to Waikanae)

A NEW EXPRESSWAY is currently under construction within the Kāpiti Coast Region of Wellington, New Zealand. The 18 km long, four lane, MacKays to Peka Peka Expressway is being built by the M2PP Alliance made up of Fletchers, Beca, Higgins and the NZ Transport Agency (NZTA). Beca has committed a dedicated team of 10 geotechnical engineers, geologists and hydro-geologists for the duration of the design programme which is due to wrap up towards the end of 2014.

The project includes 15 road and a number of pedestrian and cycleway bridges and is the first section to be constructed within the State Highway 1 Wellington Northern Corridor. The Wellington Northern Corridor runs from Levin to Wellington Airport and is one of seven Roads of National Significance (RoNs) that the Government has identified as essential state highway upgrades to support economic growth. After a major earthquake, the expressway is to form part of a life-line route throughout the Wellington Northern Corridor, along the Kāpiti Coast, providing access to the City of Wellington.

The M2PP Project is planned to take less than three years to build and will include:

- 3,000,000 cubic metres of earthworks and 2,500,000 tonnes imported aggregate.
- 70,000 cubic metres of concrete and 10,000 tonnes reinforcing steel.
- 45 ha landscape and wetland planting (over one million plants).

The high seismicity of the Kāpiti Coast region results in design peak ground accelerations of up to 0.98g in a 1/2500 year ultimate limit state (ULS) design event and 0.29g in a 1/100 year serviceability limit state (SLS) event. Extensive sections of the route are underlain by potentially liquefiable dune sands and silts interspersed by peat deposits. Groundwater levels are near the surface in low lying areas, and approximately 50% of the earthwork footprint is underlain by peat. The peat deposits are typically 0.5 m to 4.0 m thick and are characterised as very soft, highly organic and compressible. Challenges associated with construction of a road embankment over these weak peat deposits include large settlements,

GROUND INVESTIGATION

INSITU TESTING: CPT - Seismic - DMT

NEW 13 TON 4WD CPT TRUCK RIG

- 4WD with 13 ton push capacity
- AP van den Berg Hyson 200kN pushing system
- CPT and SCPT (digital icone)
- SDMT
- 40m+ depth capacity
- Soil sampling
- Piezometer installation

SMALL RIGS WITH BIG CAPABILITIES


Pagani TG63-150 (x2)


Modified Terrier CPT

Trailer Mounted Terrier Rig

- Compact rubber-tracked CPT rigs (15 ton capacity)
- Trailer and track-mounted Terrier drill rigs
- CPT, SDMT, SPT and dynamic probing (DPSH)
- Environmental sampling
- Piezometer installation

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Auckland
Ph (09) 950 1919

CHRISTCHURCH DEPOT:
38 Leeds Street
Phillipstown
Christchurch
Ph (03) 928 1101

Photograph 2: Lowering of reinforcing cage with O-Cell arrangement in test pile casing, Waikanae River Bridge

in particular post construction differential settlement, and temporary stability.

Local earthworks contractor Goodmans started construction at the end of February 2014. Bulk earthworks were started simultaneously along the centre of the Expressway alignment, within the area known as Sector 460 between Otaihanga to Waikanae and at the Poplar Avenue Interchange near the southern end of the project. Removal and replacement of the peat has posed some challenges of the Alliance team and lead to the interesting discovery of a 12 metre totara tree buried within the peat (see Geomechanics News cover image). The totara tree is believed to be more than 200 years old and has been carefully set aside to dry for about a year then handed over to iwi Te Atiawa who will use it as material for carving.

Brian Perry Civil Ltd is providing specialist ground improvements and piling for the project, including the installation of 3 metre diameter bored piles for the new bridge over the Waikanae River. As part of the detailed design a fully instrumented, 2.1 metre diameter, 35 metre-long test pile is has been installed with Osterberg Cells, strain gauges and LVDTs. Additional pile load testing utilising O-cell loading is proposed on bored piles at Wharemauku Stream and the Te Moana bridges (approximately 4% of all piles). Interpretation of pile load testing will be fed back into the design and revised parameters used to optimise the bored pile lengths.

Christchurch Polytechnic Institute of Technology Ground Improvement

Photo 1: Grout mixing station

BRIAN PERRY CIVIL and partner Keller Ground Engineering have successfully delivered Tonkin & Taylor's stabilised crust ground improvement design for the new Block RS.

Ground conditions in the upper five metres of the site generally comprised silts with a low susceptibility to liquefaction, but some layers of potentially liquefiable sand and silt layers were present. A significant layer between 2 m and 3 m depth was identified that required improvement. Trial pits were excavated to ensure the designer and specialist contractor gained a common understanding of ground conditions and objectives.

This process also confirmed that:

- Excavation and stockpiling on site of 7000 m^3, which represents the upper 2 m, could be economically performed given the site constraints, nature of the silts and ground water conditions.
- Mass Soil Mixing (MSM) of the 3500 m^3 of low plasticity silt and sand layers was achievable using a specialist wet mass mixing technology.
- Compaction of the stockpiled material to complete the deep raft / stabilised crust could be achieved.

The site was formally occupied by the Suffolk Brewery circa 1880. Excavation to 2 m was affected by the presence of a number of brick wells with artesian water pressures that had to be sealed and capped following removal of archaeological artefacts such as bottles and even a porcelain doll.

The MSM was carried out with a specifically design rotary head that can deliver and mix either dry cement or grout at up to 6 m depth. The maximum depth is dependent upon ground conditions including strength, grading, and groundwater. In this case grout was delivered directly from a self-contained grout mixing and pumping station.

Photo 2: Mass mixing in panels

Nick Wharmby

Nick is the Foundation Technical Manager at Brian Perry Civil. He has been working in the specialist geotechnical construction sector for over 25 years designing and delivering deep foundations, retaining structures and ground improvement solutions. With experience throughout Europe and SE Asia he has spent the last 10 years in New Zealand working on commercial and infrastructure projects with a greater focus on ground improvement for seismic mitigation more recently.

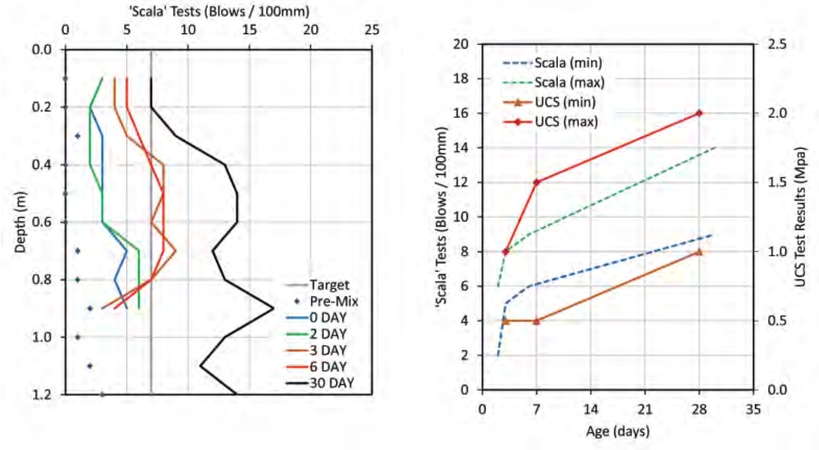

Figure 1: Panel H1 Scala and UCS Strength Data

The design required the MSM material to attain a strength represented by either field CBR >25, CPT qc > 6 MPa, or Scala Penetrometer C > 7 blows/100mm. Wet samples of the soil mix material were taken, cured, and UCS tests performed on them. The results from a typical zone are presented in Figure 1.

The data confirms that the both the Scala and UCS achieved the specified values at 6 to 7 days with some reduction at the upper and lower mixing interface zones. The scala test data presented indicates a range in the order of 50% above the minimum value observed. Such variability is attributed to the sensitivity to subtle changes the nature of the soil (grading, water content, chemistry, etc.). Furthermore, with ex-situ testing sampling, handling and specimen preparation of the material can adversely affect the results. The UCS data indicates the maximum strength could be more than double the minimum observed.

The Brian Perry Civil and Keller team were able to successfully deliver this ground improvement project using a combination of excavate & replace and wet mass soil mixing in accordance with Tokin & Taylor's design requirements to create a stabilised crust.

Design Efficiency: Ground Improvement with Uplift Resistance

James Dismuke

James is the Design Manager for Golder Construction and is based in Christchurch. He earned a BS in Civil Engineering from the University of California at Berkeley and MS in Geotechnical Engineering from the University of California at Davis. He has worked as a geotechnical consultant in the Western United States, Australia, and New Zealand, and his experience includes a wide variety of geotechnical earthquake engineering projects, including seismic hazard analysis, liquefaction assessment, foundation design, slope stability assessment, and design of ground improvement.

GROUND IMPROVEMENT TO mitigate liquefaction hazards and strengthen foundation soils is gaining popularity in both residential and commercial Christchurch Rebuild projects because it provides a mechanism for the geotechnical and structural engineer to work together to achieve an efficient performance-based design of the soil and structure foundation system.

Ground improvement is typically used as an alternate to piled foundations in subsurface conditions where the near-surface soils are soft, loose, or compressible. Piled foundations offer excellent bearing capacity and settlement control, but size of the structural members required to transfer all of the loads to the piles can be expensive to construct. In contrast, foundations designed to be supported on improved ground are often lower in cost compared to piled foundations because shallow mat or footing foundations can be adopted. One difference between most traditional ground improvement methods versus piled foundations is the ability of piled foundations to resist uplift loading. However, Rammed Aggregate Piers (RAPs) are a ground improvement technique that overcomes this disadvantage using an embedded uplift element. RAPs with uplift elements deliver both ground improvement and uplift load resistance using a single ground improvement element. RAP uplift elements have been installed on numerous projects in the United States, and more recently in Christchurch.

RAP GROUND IMPROVEMENT

RAPs are well-suited to addressing the particular design considerations presented by Christchurch subsurface conditions. RAPs are constructed using licensed technology developed by Geopier Foundation Company, Inc, based in the United States (www.geopier.com). The

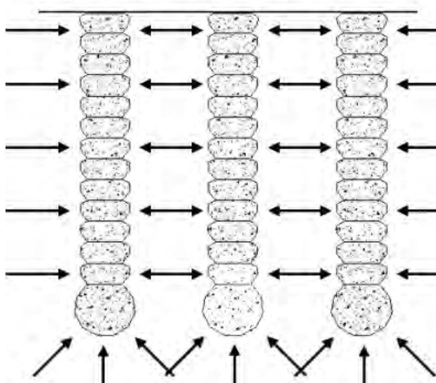

Figure 1: Schematic representation of RAP elements

RAP elements are vertically compacted elements of aggregate that are constructed by driving a hollow mandrel (steel tube with an inner diameter of 200 mm) to the design depth, and then vertically ramming angular aggregate out of the tube using the specially designed tamper head and high-energy impact densification equipment to create a compacted aggregate pier. The hollow-shaft mandrel, filled with aggregate, is incrementally raised from the target depth, permitting aggregate to be released into the cavity left below the mandrel. The mandrel is then lowered by a vertical ramming action to densify the aggregate and force it outward laterally into the adjacent soil. The cycle of raising and lowering the mandrel is repeated in approximately 300 mm lifts to the top of the pier elevation. This results in the formation of a highly densified and stiff pier typically about 600 mm in diameter, while also increasing the lateral stress in the matrix soil. Figure 1 shows a schematic representation of the constructed RAP elements.

RAPs densify and improve potentially liquefiable soil so that it is effectively no longer liquefiable at design ground motions. This is achieved by several mechanisms that result in ground improvement, soil reinforcement, and improved drainage:

- **Densification:** During RAP construction, aggregate is forced into the surrounding matrix soils to expand the cavity created by the mandrel. This action densifies the matrix soil, which results in an increase in soil density. Liquefaction is greatly affected by soil density, so the densification achieved by RAP construction provides a major improvement to liquefaction resistance.
- **Increased Lateral Stress:** The downward crowd pressure applied by the mandrel to build out the RAP element exerts large lateral pressures on the matrix soil that approach the Rankine passive pressure. These increases in lateral stress induced by RAP construction provide a significant increase in liquefaction resistance.
- **Overconsolidation:** The matrix soil is laterally overconsolidated after RAP construction, which increases resistance to triggering liquefaction.
- **Increased Stiffness:** The presence of stiff RAP elements and densified matrix soils create a RAP-soil composite material that has greater stiffness than the unimproved in situ soil. The increase in stiffness reduces the magnitude of cyclic strains induced by an earthquake, and consequently decreases the liquefaction potential of the matrix soil.
- **Drainage:** The inclusion of RAP elements within the matrix soils provides a network of vertical drains to speed consolidation of fine-grained soils or to dissipate the excess pore water pressure generated by earthquake loading. Since liquefaction is associated with excess pore pressure generation, vertical drains can contribute to mitigation of liquefaction triggering by reducing excess pore pressure generation.

Although not discussed in this article, RAPs increase lateral resistance for spread footing foundations supported on RAP reinforced soil. The high friction angle of the RAP elements provides an increased composite base friction coefficient for sliding resistance. Traditional passive earth pressure may also be included along the sides of the concrete footings and unimproved soil above the base of the footing.

RAP UPLIFT ELEMENTS

RAP ground improvement can be combined with an uplift element to provide an efficient design that provides an increase in liquefaction resistance and the ability to resist uplift loads on the structure. Uplift elements comprise a steel plate attached to two to four steel bars that are embedded in the footing, as shown on Figure 2.

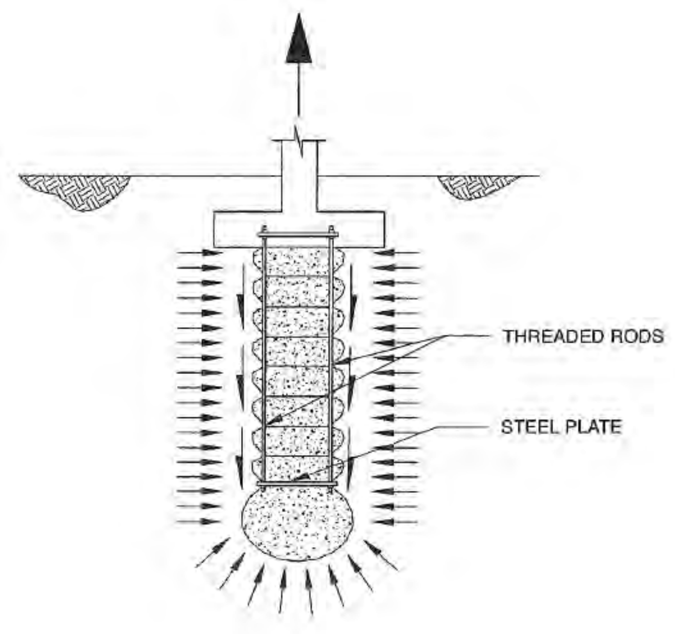

Figure 2: Schematic drawing of a RAP uplift element

Once assembled on site, the uplift element is installed with the same construction methods as described above. Figure 3 shows an uplift element in position for installation.

Figure 3: RAP uplift element in position for installation.

Uplift capacity is developed by the frictional resistance between the RAP element and surrounding matrix soil. The high lateral stress imparted by RAP construction allows significant capacity from a relatively simple uplift element. Uplift capacity was recently verified on elements installed in Christchurch. Pull out tests were conducted on several uplift elements. The pull out tests were conducted using a hydraulic jack and steel load beam. Conventional RAPs were located under each end of the steel load beam to provide reaction loads, as shown on Figure 4. Loads were increased incrementally and held for a period of time at each increment according to ASTM Test Method D3689-07, Procedure A. Load tests were conducted on 4 m and 7 m long uplift elements. The soil conditions at the site comprised: very dense gravel fill between the ground surface and 1 m below ground level (bgl); very loose to loose silty sand and sandy silt between 1 m bgl and 3 m bgl; and medium dense to very dense sand and gravel interbedded with thin layers of silt between 4 m and 7 m bgl.

Results from two of the tests are presented on Figure 5b. The results show that the mobilised geotechnical uplift capacity for the 4 m and 7 m long elements was in excess of 540 kN and 870 kN

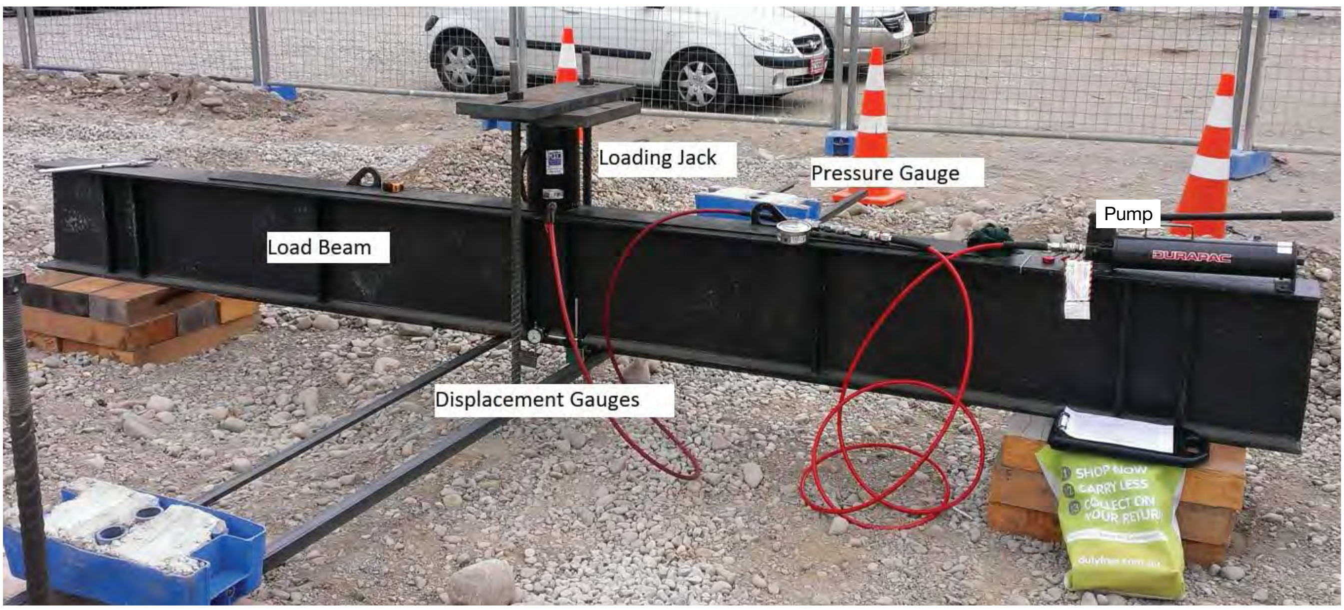

Figure 4: Pull out test set-up.

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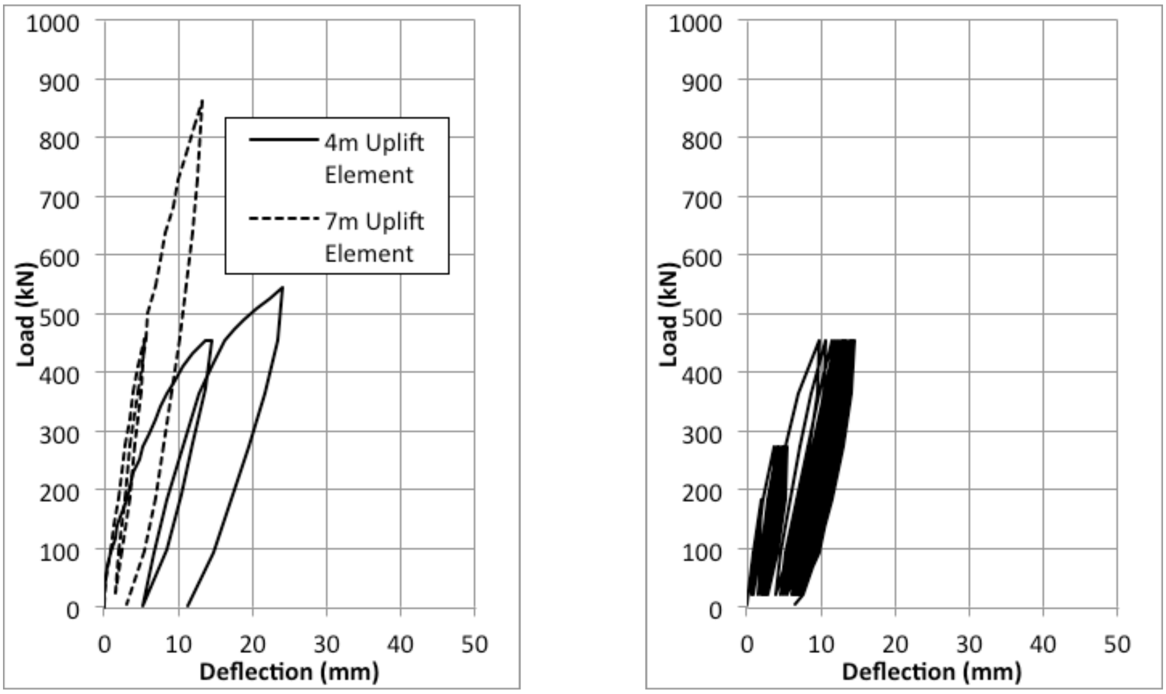

respectively. The test conducted on the 7 m long element was terminated at 870 kN because the loading jack reached the maximum load. The results of the tests on 4 m and 7 m elements indicate deflections of about 5 mm at the working loads of 300 kN and 500 kN, respectively.

In addition, one cyclic test was conducted on a 4 m long uplift element to assess whether the pull out capacity would degrade with repeated load cycles. Load increments were held for about 30 seconds during the cyclic load test. The results from the cyclic pull out test shown on Figure 5b indicate that the pull out resistance is essentially constant after 30 cycles of loading and provides a relatively elastic response within the working loads.

Back analysis of the tension capacity from the pull out tests indicates an average frictional resistance of 80 kPa to 100 kPa based on the ultimate load applied during testing with an average friction angle ranging from 34 to 40 degrees. The high frictional resistance is created by the unique tooling and vertical compaction, which develops a tight coupling of the RAP elements and matrix soil with lateral stresses approaching passive earth pressures.

CONCLUSION

Ground improvement is becoming an integral part of the Christchurch rebuild. Integrating the ground improvement with the structural foundation design can provide efficient and cost effective solutions. Ground improvement using RAPs can be used to strengthen foundation soils, reduce foundation settlements, and mitigate liquefaction hazards. RAP uplift elements can also provide uplift load resistance.

Figure 5: Pull out test results (a) 4m and 7m uplift element test results and (b) cyclic pull out test result for 4m uplift element.

Re-levelling Residential Properties Using Low Mobility Grout (LMG)

Nick Wharmby

Nick is the Foundation Technical Manager at Brian Perry Civil. He has been working in the specialist geotechnical construction sector for over 25 years designing and delivering deep foundations, retaining structures and ground improvement solutions. With experience throughout Europe and SE Asia he has spent the last 10 years in New Zealand working on commercial and infrastructure projects with a greater focus on ground improvement for seismic mitigation more recently.

BACKGROUND

After the seismic events that affected Canterbury and Cantabrians, initial thoughts of repairing the damaged housing stock have been gaining momentum from planning into repair activity. Initially home owners were introduced to technical classifications; TC 1, 2, 3 & the red zone for land damage. People became aware of the term, liquefaction, while insured and insurers scanned the small print in order to interpret entitlement under policy.

Any company or individual involved in the repair of homes will understand and have empathy for the position of home owners and tenants dealing with the current repair upheaval and uncertainty that comes commensurate with the process. MBIE issued repair guidelines consistent with international best practice, which forms the basis for the majority of repair strategies.

Low Mobility Grout (LMG) was first used in the USA during the 1960s to re-level large commercial grain stores. The structures had suffered settlement under the imposed live loads that affected functionality. Because the overall structural integrity had not been significantly affected compaction grouting using LMG was the process adopted to resolve the serviceability issues.

The process was developed by Denver Grouting which became Hayward Baker, a subsidiary of Keller Ground Engineering. Further development in the technique known as compacting grouting using LMG continued in response to the earthquakes in Denver, USA and Kobe, Japan as the process was used extensively to complete repairs. After the September 2010 seismic event Brian Perry Civil and Keller Ground Engineering identified the need for geometric re-levelling of foundations and the suitability of LMG in Canterbury's ground conditions. The RElevel joint venture was formed to bring together the experience and technical expertise to deliver the solution.

RECENT RE-LEVELLING WORK PERFORMED

During the past couple of years a significant number of properties have successfully been re-levelled in accordance with the MBIE guidance document categories for re-level and repair for Green Zone properties. For LMG this essentially provides limits for re-levelling of 100mm and 150mm for Type B and C foundation types. For these residential properties there is no requirement to improve the ground; the specific LMG application design carried out by RElevel was focussed on re-levelling the foundations whilst maintaining the overall performance of the ground.

To date LMG has been the adopted repair strategy for a significant number of properties with lifts of up to 200 mm. Properties have subsequently been subjected to ongoing seismic events and

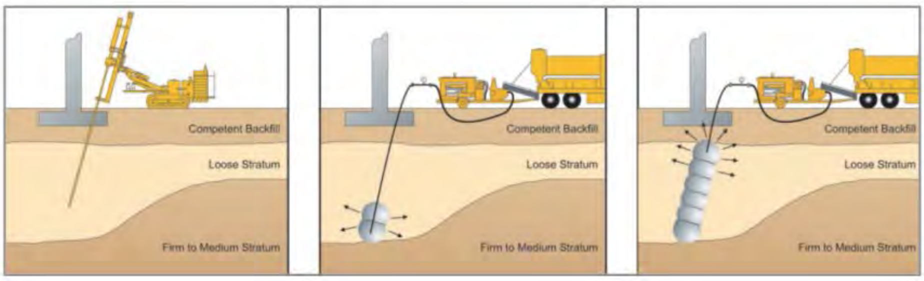

Figure 1: LMG methodology

performed very well. The following table represents the properties RElevel have completed in the last year:

a) Residential (Single dwelling)

Foundation Type	Soil Classification	Maximum Lift Range	Number of Properties
Type B	Green	50mm	1
Type C	TC2 / Green	30 – 90mm	75

b) Commercial / multi-unit dwelling

Foundation Type	Soil Classification	Maximum Lift Range	Number of Properties
Type C	TC2 / Green	200mm	6
Type C	TC3	140mm	4

The Southern Cross Hospital LMG implementation was specifically designed to re-level and provide improvement to potentially liquefiable layers. RElevel carried out trials, pre & post LMG injection testing and monitoring in 2011 / 12 which have shown that ground improvement is achievable albeit this is dependent upon the nature of the ground. This case study is documented in a paper by Wharmby et al (NZGS 2013). This structure has been surveyed recently which revealed that no discernable settlement has occurred over the intervening 2 years.

SHALLOW GROUND IMPROVEMENT COMPACTION GROUTING TRIALS USING LMG

EQC has funded a programme to investigate the suitability and effectiveness of different methodologies for shallow ground improvement. Although the results of injecting LMG were somewhat predictable, RElevel provided the equipment and resource necessary to inject LMG at shallow depths so that the trial could be completed.

The results confirmed that shallow improvement was not achieved due to the lack of confinement combined with the level of heave that occurred. In suitable soil conditions compaction grouting for ground improvement can be performed but this requires specifically controlled injection rates and heave limits. It is noted that the conditions and LMG injection methodology were not a representative re-levelling process.

BOWER AVENUE COMPACTION GROUTING TRIALS USING LMG

Following on from the EQC shallow ground improvement trials, a site was selected by Tonkin & Taylor where RElevel could inject LMG and lift test panels using a methodology more representative of that used for re-levelling. The site was selected as the ground conditions were TC3 and thus representative of the extreme / upper end of where re-levelling using LMG would typically be considered an appropriate repair strategy. Specific site investigation data on the site highlighted variation in the ground conditions across the small site area.

Three L shaped walls with gravity line loads representative of a Type B foundation were formed as shown in Figure 2 and target lifts of 50 mm, 100 mm & 150 mm adopted. The injection point layout and sequence adopted was designed to emulate that typically used in the re-levelling process.

Comparative soil testing was carried out pre and post LMG injection using seismic CPT (sCPT), Seismic Dilatometer (sDMT) and cross-hole shear wave methods at each of the panel locations. The results from the different test methods and different test walls are not well-ordered and represent a small data set in variable ground conditions. However, it is possible to conclude that the potentially liquefiable soil above the grout injection level could be triggered by a more frequently occurring seismic event.

Figure 2: Type B Foundation simulation and Shear Wave Testing

CHATEAU BLANC HOTEL CASE STUDY

The building is located on the corner of Kilmore and Montreal Streets and stands at just over 10.5 metres in height and is approximately 40 metres long. Structurally the foundation consists of a reinforced concrete slab, with internal masonry block walls supporting a cast in situ floor slab. The foundation of the four storey hotel building experienced 200mm differential settlement with vertical misalignment of 45mm, after the February 2011 earthquake. The site is classified as Green Zone TC3 Blue.

The owners at the time of the earthquake, decided on a settlement with their insurer, which facilitated the sale of the building in an “AS Is Where IS” condition. Prior to the current owners purchasing the building RElevel was contacted and asked for technical input in order to determine the feasibility of foundation re-levelling. On review of the structural and geotechnical reports combined with an assessment of the site to evaluate access, layout and floor levels it was determined that the Hotel building could be re-levelled using the compaction grouting process with LMG.

The ground conditions encountered are summarised by the example borehole and sCPT information provided in Figure 3. It should be noted that the site is in close proximity to the Avon River (approx. 200 lm) and that the geotechnical investigation indicated that the ground water table at the site was within 1 m of existing ground level.

Injection of the LMG was targeted at the sandy gravels located between 3.5m and 6.5m to achieve the required lift. The lift was achieved by a 20 person team based on site for 6 weeks, with daily lifts recorded at 20mm over the entire treatment zone. Seismic CPTs 4 and 4A presented in Figure 3 are located at the location of maximum lift, unfortunately the equipment was unable to penetrate beyond 4.5m due to the density of the sandy gravel. In general terms the individual CPT results do not show any change and whilst it could be interpreted that the shear wave testing shows some improvement it is possible that the grout inclusions are influencing the results.

The re-levelling of the structure was achieved and project was delivered on

Figure 3: Chateau Blanc Hotel building after re-levelling & during refurbishment

Figure 4: Casing installation inside and outside the building and grout delivery

time on a fixed price contract basis. The project is a good demonstration that, given the right ground conditions, LMG is a commercially viable option for re-levelling large buildings with high foundation loads.

CONCLUSIONS & LEARNING

The MBIE Guidelines provide a good framework in terms of the repair / re-level limits and geotechnical investigation and design. Work carried out and performance seem to confirm this. RElevel has an on-going exemption for residential repairs in Christchurch and applies for exemptions on a case by case basis for commercial buildings.

Cross-hole shear wave measurement is preferred as it represents a more direct measurement of the alluvial soil sequence as they are typically bedded horizontally. The sCPT and sDMT are less direct as the wave travel distance is increased and more likely to be affected by inclusions in the ground that can impact the results.

Individual CPTs need to be viewed with caution due to the variations observed. Trends should be considered and over-analysis avoided. Appropriate application of the LMG injection process is required as it may be possible for the potentially liquefiable soil above the grout injection level to become more susceptible to more frequently occurring seismic events. RElevel has the specialist design and methodology knowledge to mitigate this risk.

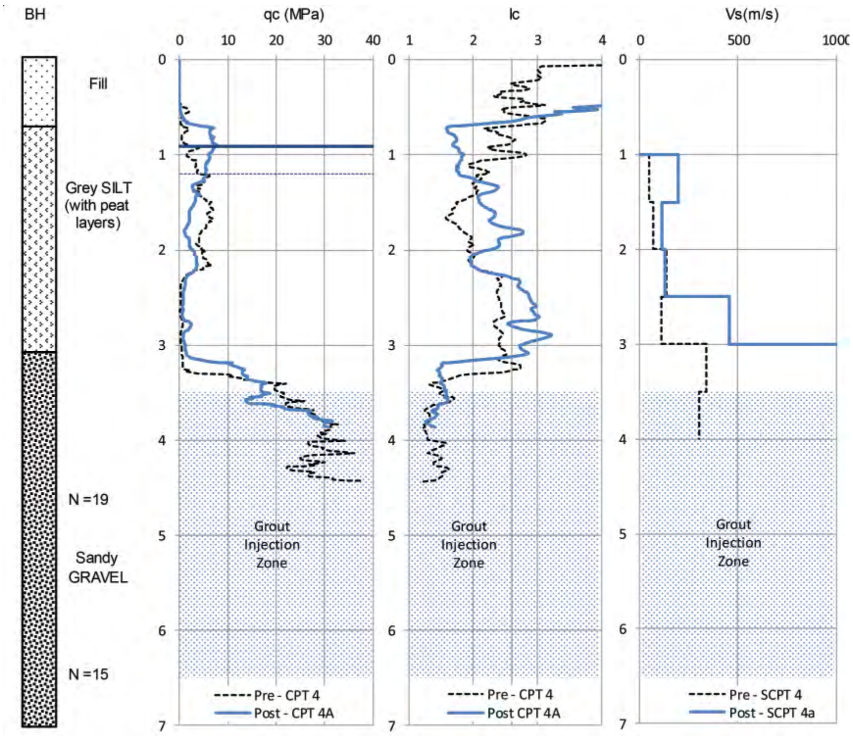

Figure 5: Pre & Post sCPT Results with LMG Injection Zone

For commercial properties / multi-unit dwellings the building surcharge and stiffening effect of the slab provide confinement that allows improved grout injection and seismic performance. Larger commercial properties / multi-unit dwellings have been lifted up to 200mm in TC2 & TC3 classified sites.

It is essential that an experienced specialist contractor carries out the design and implementation of the grout injection and re-levelling methodology.

Prepared by: Nick Wharmby and Andrew Muldoon, Brian Perry Civil

Academic News

UNIVERSITY OF WAIKATO

COURSES

Graduate degree structures at the University of Waikato have changed for 2014. Our traditional 240 point Masters degree is still offered under the title MSc (Research), and is joined by a shorter 180 point Masters, retaining the MSc title. This shorter degree takes 12 – 18 months, and involves a flexible mix of taught papers and a research project; it can be started in either the A (March) or B (July) semesters, and can be undertaken part-time. Both of these degrees can be taken within Earth Sciences, including Engineering Geology and Coastal Engineering options.

A possible development in the near future is the offering of Civil Engineering within our School of Engineering. At present we are considering a Civil programme and exploring possibilities for papers and specialities within such a programme.

Enquiries to: *Vicki Moon (v.moon@waikato.ac.nz)*

Above: Waikato Student Centre

RESEARCH SUMMARY

Melissa Kleyburg (MSc). The Hinuera Formation in the Waikato is a widespread alluvial fan deposit of Late Pleistocene age upon which much of our infrastructure is founded. A dichotomy exists between liquefaction potential suggested by screening techniques and instrumental methods. Mel is undertaking field mapping to establish whether or not past liquefaction events are preserved in the sediments in order to better define the liquefaction susceptibility.

Camillia Garae and **Amy Christophers** (MSc). Two related projects in the western Bay of Plenty are looking at rates and mechanisms of coastal bluff retreat within Tauranga Harbour, and the sources of beach sediment in the area. These projects are using field mapping, GIS and terrestrial laser scanning to determine rates of retreat, and numerical modelling to determine the fate of sediments derived from cliff and stream sources.

Ehsan Jorat (Intercoast PhD). Ehsan is nearing completion of his PhD which will be submitted to the University of Bremen in Germany. His work has concentrated on the CPT response of sensitive soils in the Bay of Plenty, including seafloor sediments in Stella Passage and landslide-prone coastal cliffs. As part of Ehsan's work we have set up a long-term monitoring site on a large, active landslide at Omokoroa; continued monitoring of this site will be undertaken by our next Intercoast PhD student, Max Kluger, who will be in NZ in the near future.

Neeltje de Groot (MSc). Neeltje has just submitted her MSc thesis examining sediment cores from beaches throughout the Bay of Plenty to hunt for remnants of Rena oil. Most cores showed no remnant oil one year after the stranding of the Rena. A few from the most heavily oiled regions showed indications of oil traces, but the amounts were too small to be quantified. We are confident that the extensive clean-up operations followed by natural biodegradation has returned these beaches to their original state prior to the stranding.

UNIVERSITY OF AUCKLAND

COURSES

The Master of Engineering Studies (MEngSt) in Geotechnical Engineering programme aims to build on the geotechnical content of the BE (Civil) degree and develop graduates with enhanced ability to contribute to geotechnical engineering practice. New Zealand is a stimulating country in which to practise geotechnical engineering with its young and varied geology, seismic activity and diverse rainfall patterns. Many unique problems occur here as a result and these present challenges for innovative and novel solutions. Moreover, there is a large demand for geotechnical engineers in the local workplace, as well as a worldwide shortage of geotechnical professionals.

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Details are available at: http://www.engineering.auckland.ac.nz/uoa/home/for/futurepostgraduates/fp-study-options/fp-admission-for-masters/master-of-engineering

Enquiries to: *A/Prof Rolly Orense (r.orense@auckland.ac.nz)*

Above: Auckland Engineering

RESEARCH SUMMARY

Lucas Hogan (PhD, recently submitted). Seismic Response Categorisation of New Zealand Bridges. This thesis investigates the in situ dynamic behaviour of bridges subjected to lateral loads through field testing of several bridge components and in-service bridges. The response of the bridges determined from this program was used to develop computational models to quantify the contribution of various bridge sub-components, including abutments, pile foundations and surrounding soil, to the overall dynamic system. Based upon the findings, design guidelines were created to aide in the development of integrated structure-foundation models of bridges.

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Bilel Ragued (PhD, started March 2010). New Zealand port characterisation and wharf seismic response. This research characterises the current state of New Zealand ports through collection of physical and economic characteristics from public sources and port companies. Using the data gathered, a general representation of the vulnerability of New Zealand port infrastructure to seismic and tsunami hazards is analysed. The aim of the research is to increase the resilience of New Zealand port systems to natural hazards.

Luke Storie (PhD, started September 2011): Soil-foundation-structure interaction in earthquake performance of multi-storey buildings on shallow foundations. This project investigates the influence of nonlinear foundation geometrical effects and nonlinear soil deformation effects on the earthquake performance of multi-storey buildings. Numerical modelling is undertaken to investigate uplift and soil deformation during strong shaking while centrifuge experiments were conducted to enhance the numerical models developed so that soil-foundation-structure interaction can be incorporated into earthquake resistant design of buildings on shallow foundations.

Chris Van Houtte (PhD, started December 2011). Engineering Seismology – Analysing shallow Christchurch earthquake data to build more accurate ground motion prediction models. The purpose of this research is to understand regional effects on earthquake ground-motion in New Zealand and incorporate these effects in a ground-motion prediction framework. The thesis will both adjust existing ground-motion prediction equations (GMPEs), and develop a new GMPE, to better model regional effects on earthquake shaking intensities in New Zealand.

Yasin Mirjafari (PhD, started March 2012): Soil Characterization using Screw Driving Sounding (SDS) data. The project makes use of SDS method, a new field testing technique which consists of driving a rod, with a screw point at the tip, into the ground at different loading steps while being rotated and measures the required torque, load, penetration speed and rod friction. The project will develop methodology for estimating soil types, liquefaction potential and other soil parameters from SDS-derived parameters.

Ravindranath Salimath (PhD, started May 2012): Experimental and analytical study of nonlinear earthquake response of shallow foundations. The research investigates the nonlinear rotational behaviour of shallow foundations, stress distribution profiles underneath the footing before and after lift-off, effect of L/B ratio using PLAXIS 3D finite element program. The results will be validated using large scale field experiments from which earthquake resistant design method for shallow foundations incorporating nonlinear soil behaviour will be developed.

Milad Naghibi Neishabouri (PhD, started July 2012). Electro-osmotic consolidation of soil. This research consists of a thorough investigation of the electro-hydro-mechanical behaviour of saturated clays subjected to different DC electrical potential levels through comprehensive bench-scale experiments. In addition, the experimentally-observed behaviour is modelled using the framework of the modified CAM Clay model. Based on the results, a new method of enhancing the efficiency of electro-osmosis consolidation technique at the field scale will be developed.

Vis Chen (PhD, started August 2012). Effect of near-fault earthquake characteristics on structure with footing uplift and soil-foundation-structure interaction (SFSI). This research performs shake table experiments and investigates the response of bridge with foundation uplift, SFSI and plastic hinge development under near-fault earthquake. The effect of ground motions with pulses and strong vertical component on structural response is addressed. Practical application of the outcomes can lead to a low-damage seismic design in near-fault regions.

Mohammadsadeq Asadi (PhD, started October 2012). Cyclic properties of natural soil containing pumice particles. In this research, undrained cyclic triaxial and simple shear tests are being conducted on undisturbed pumiceous samples obtained from selected sites. The cyclic resistances are then correlated to their pumice contents, quantified using their crushability and lightweight characteristics. Moreover, the relationships between penetration resistances and shear wave velocities obtained at the sites are investigated to formulate more rigorous liquefaction potential evaluation technique for pumiceous deposits.

UNIVERSITY OF CANTERBURY

NEW LECTURER IN GEOTECHNICAL ENGINEERING

Dr Jennifer (Jenny) Haskell has recently joined the Department as a lecturer in geotechnical engineering, having spent the last four years studying towards a PhD at the University of Cambridge with the support of a Woolf Fisher Scholarship. Her PhD research involved dynamic centrifuge modelling of pile groups in laterally spreading soil – testing that was undertaken in parallel with field reconnaissance following the Canterbury earthquakes, exploiting the rare opportunity to compare and refine experimental techniques and details on the basis of field observations of foundation performance. A graduate of the University of Canterbury, Jenny's research interests lie in the areas of geotechnical earthquake engineering and the physical modelling of geo-structures and construction, with the goal of providing useful, mechanism-based guidance for geotechnical design and decision-making. Her current research projects include the design and analysis of piles and pile groups in liquefying, laterally spreading soil and the seismic performance of dams and embankments. She teaches second professional year geotechnical engineering as well as supervising research in the geotechnics area, and is interested in taking postgraduate students.

UNDERGRADUATE PROJECTS

The Department of Civil and Natural Resources Engineering has recently introduced compulsory projects for its final year undergraduate students, and once again we have had strong interest from students wanting to undertake projects in the geotechnical area. These projects, undertaken in pairs, constitute 25% of the students' final year workload and represent a significant, extended piece of work. For many students, the project provides an opportunity to explore in more depth an area or topic that particularly interests them. This year's geotechnical cohort is investigating a range of topics, including a number of questions that have come to light in the 2010-2011 Canterbury earthquakes. These include experimental research into the settlement response of liquefied and layered deposits, and lateral pile interaction effects in liquefied and laterally spreading soils; in-situ liquefaction evaluation for residential properties using Swedish Weight Sounding (SWS) testing; and field data analysis of road damage and wastewater system performance in the 2010-2011 earthquakes using GIS. The students' project work culminates in the preparation of short conference papers and the presentation of their work at the annual CNRE Research Conference at the end of Semester 2.

Above: Canterbury campus

COURTSEY UNIVERSITY OF CANTERBURY

RESEARCH SUMMARY

Maxim Millen (PhD started May 2012): Integrated Performance-based Design of Building-Foundation Systems. This project aims to develop a design procedure that accounts for the major mechanisms and effects of non-linear soil-foundation-structure interaction (SFSI), allowing the designer to achieve better understanding and control of the seismic performance of building. Maxim will investigate the performance of buildings in the Christchurch earthquake sequence, experimental tests from literature and conduct non-linear time history analysis to understand how SFSI modifies the seismic response of buildings and how SFSI effects may potentially result in detrimental transient and residual deformations. The objective of the study is to develop key empirical relationships for design that allow to separately consider each major mechanism and quantify its effects through an appropriate modification of design parameters.

Saumyasuchi Das (ME started April 2012): Three dimensional formulation for the stress-strain-dilatancy elasto-plastic constitutive model for sand under cyclic behaviour. Recent experiences from the Darfield and Canterbury, New Zealand earthquakes have shown that the soft soil condition of saturated liquefiable sand has a profound effect on seismic response of structures. For a detailed evaluation of the seismic response of engineering structures, three dimensional Soil Foundation Structure Interaction (SFSI) should be considered required because foundation systems are three-dimensional in form and geometry, ground motions are three-dimensional, producing complex multiaxial stresses in soils, foundations and structure and because soil behaviour is sensitive to complex 3-dimensional stresses.

PERRY
GEOTECH

In the literature, majority of seismic response analyses are limited to plane strain configuration because of the lack of adequate constitutive models both for soils and structures, and computational limitation. Such two-dimensional analyses do not represent a complete view of the problem. The research aims to develop a three-dimensional mathematical formulation of an existing plane-strain elasto-plastic constitutive model for sand developed by Cubrinovski and Ishihara (1998).

Christopher McGann, Post Doctoral Fellow: Empirical correlation between CPT resistance and shear wave velocity. An empirical correlation for use in predicting soil shear wave velocity from cone penetration test (CPT) data has been developed from seismic piezocone (SCPTu) data compiled from sites in the greater Christchurch area. This work has shown that the unique depositional environment of the considered soils, and the potential loss or disruption of ageing effects brought about by the 2010-2011 Canterbury earthquake sequence differentiate the Christchurch soils from those used in the previous studies. This work also enables the use of the large, high density database of CPT logs in the Christchurch region for the development (currently underway) of both site-specific and region-wide models of surficial shear wave velocity for use in site characterization and site response analysis.

Mark Stringer, Post Doctoral Fellow: Evaluating the importance of Silty Soils to the observed Liquefaction in Christchurch. This research is targeting silty soils lying at relatively shallow depths (typically down to about 5m) are being targeted and represent soils which transition between the relatively well understood extremes of sandy and plastic soils, with Ic values falling between 2 and 2.6. When considering the likely damage to light structures such as roads and housing, during an earthquake, it is often soils lying at these shallow depths which can be the controlling factor. When the performance of these soils throughout the city are evaluated using conventional tools for practice, large areas of the city would be predicted to experience massive and damaging amounts of liquefaction during the Canterbury earthquakes. However, in the real test event, these same soils exhibited a wide range in response, varying from severe liquefaction damage through to no liquefaction damage. This project will characterise the behaviour of the silty soils using S and P-wave profiling and a careful soil sampling programme. The soil samples, being tested at the University of Canterbury will allow direct evaluation of the cyclic resistance of a range of different soil types to be determined through cyclic triaxial testing and the responses linked back to soil properties measured both in the laboratory and in the field.

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Improvement Mechanisms of Stone Columns as a Mitigation Measure Against Liquefaction-induced Lateral Spreading

– E. Tang, Tonkin & Taylor Ltd (formerly University of Auckland), R.P. Orense, University of Auckland

THIS IS A re-print of a paper selected as being of particular interest to NZGS members, originally presented at the NZSEE 2014 Technical Conference in Auckland.

Liquefaction-induced lateral spreading is a common phenomenon after strong seismic events. Typically lateral spreading occurs in sloping ground close to waterways in regions with liquefiable underlying soils and may result in significant damage. There is little literature on stone columns being used to mitigate liquefaction-induced lateral spreading. This paper presents findings of a study to evaluate the effectiveness of stone columns to mitigate liquefaction-induced lateral spreading. A case study from the recent 22 February 2011 Christchurch Earthquake was used as a basis of the research which was carried using effective stress analysis with the finite element software package FLAC v7.0. Current state-of-the-art design procedures for stone columns to prevent liquefaction have been used to assess its applicability to mitigate lateral spreading. The main improvement mechanisms of stone columns – densification, drainage and reinforcement and their individual effects on the improved ground have been investigated. It was found that considering the densification and drainage effects in the analyses improved the performance of the stone columns, while the reinforcement effect made only a small difference. Generally, stone columns remediation was found to be effective in reducing the lateral displacement that was caused by liquefaction due to the seismic event in the numerical analyses. However, complementary ground improvement measures may be required to eliminate lateral displacement at the crest of the waterway.

Elby Tang

Elby is a Geotechnical Engineer with Tonkin & Taylor. Following a Bachelor of Engineering degree at the University of Auckand, she has been working in the T&T Auckland office for four years. This has included a variety of projects such as the Waterview Connection project and various projects around the Christchurch Earthquake. In 2013, she completed a Masters of Engineering at the University of Auckland, with research project on "Stone columns as a mitigation measure against liquefaction induced lateral spreading"

1. INTRODUCTION

Liquefaction has been responsible for many failures of man-made and natural structures. Liquefaction-induced lateral spreading has been commonly documented after strong seismic events such as the sequence of Christchurch earthquakes that began on 4 September 2010. In this paper, two dimensional numerical analyses were used to assess the effectiveness of stone columns and its improvement mechanisms, in mitigating liquefaction-induced lateral spreading. The state-of-the-art design procedures for stone columns to prevent liquefaction were used in the numerical modelling as the basis of assessing their applicability to mitigate lateral spreading. A case study from the recent Christchurch 22 February 2011 Earthquake was used to calibrate the numerical model for the study. Focus is placed on the reduction in accumulated surface lateral deformation and excess pore water pressure within the improved ground.

2. STONE COLUMNS

The installation of stone columns mitigates the potential for liquefaction by increasing the density of surrounding soil and allowing drainage to control pore water pressure generated. The introduction of stiffer elements, which can potentially carry higher stress levels and reduce the stress levels in the surrounding soils (Priebe 1991), provides resistance to deformation. These effects may reduce the build-up of excess pore water pressure which in turn, reduces the liquefaction potential, and the associated ground deformations.

Recently, installation of stone columns to mitigate liquefaction-induced lateral spreading has been investigated (e.g. Elgamal et al, 2009) and it was concluded that stone columns were effective in reducing lateral deformation in sandy stratum. However, the current stone column design methods for liquefaction mitigation available in literature (Priebe 1998; Baez and Martin 1995) are largely focussed on its implementation on level ground and foundation design, and not for lateral spreading.

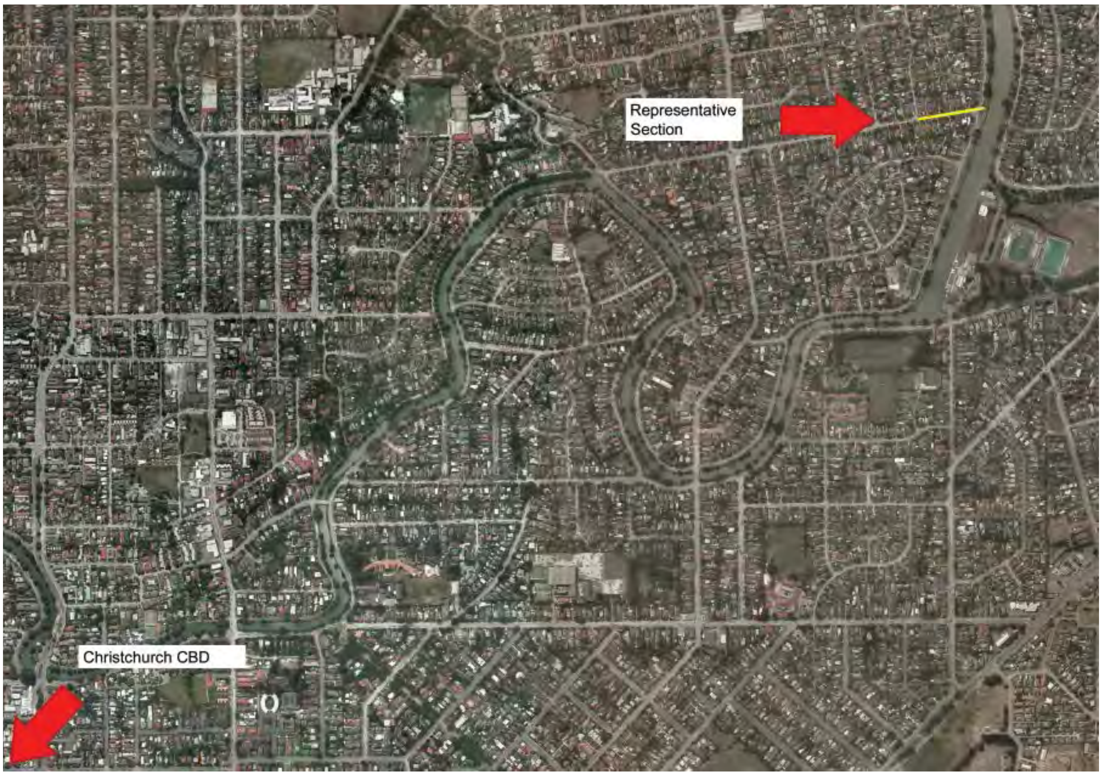

Figure 1: Site location map of the representative section

3. METHODOLOGY

3.1 Representative site location

The selected site for the analysis is adjacent to the Avon River in the suburb of Dallington. It is located to the east by the artificially straightened reach of the Avon River known as Kerrs Reach, about 2km from the Christchurch CBD. Figure 1 below shows the site location map of the representative section.

Following the 4 September 2010 and 22 February 2011 earthquakes, Robinson et al. (2011) took field measurements of lateral spreading. For the site location in this study, the results from the field measurements show that the cumulative displacement along the closest transect, which was approximately 200m away, was approximately 0.8m. The lateral displacement data from this study was used as basis to calibrate the FLAC numerical model.

3.2 Geological Section

To avoid complex geometries in the numerical modelling, the subsurface geological profile has been simplified to represent a generalised profile in the vicinity of the site and subsoil strata have been assumed to be horizontal. The slope geometry has been approximated from LiDar surveying results. Based on available CPT data (CGD 2012), the site is assumed to consist of three geological units: a sandy gravel crust 1.7m thick, overlying 8.2m of loose to medium dense sand which is underlain by dense sand with interbedded silt layers. Figure 2 shows a FLAC screenshot of the geological section used in numerical analyses. The groundwater levels which underlie the subject area are assumed to range from 0.9m to 3.2m below the existing ground surface.

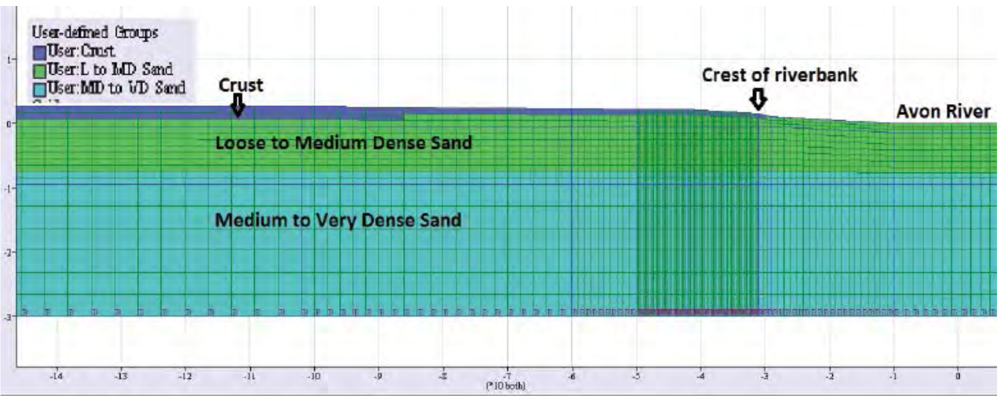

Figure 2: Screen shot of the FLAC geological section

3.3 Static and dynamic material parameters

Subsoil material parameters have been interpreted from the borehole and CPT logs. The materials subsurface shear wave velocities and dynamic characteristics were derived from the MASW geophysical testing results in the area. The dynamic characteristics of all soils in the model were assumed to be governed by the Seed and Idriss (1971) modulus reduction and damping ratio curves.

3.4 Strong motion record used for analyses

Seismic records from Riccarton High School (RHSC) station was considered to be a suitable station because no liquefaction was observed here. The strong motion record was corrected for direction and deconvoluted to the depth of engineering rock prior to input to the numerical model. Figure 3 shows the input motion for the numerical analyses.

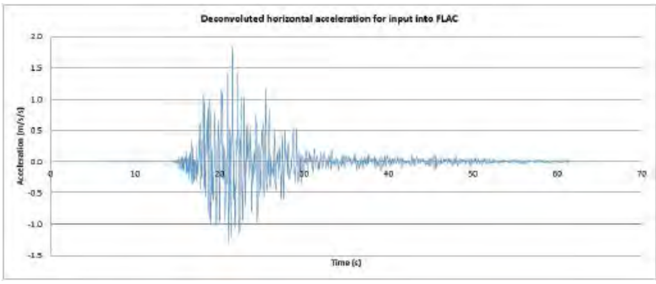

Figure 3: Deconvoluted horizontal acceleration for input into FLAC

3.5 FLAC numerical modelling

For this study the finite difference numerical analysis program FLAC v. 7.0 (Fast Langrangian Analysis of Continua) in 2D has been employed. A coupled effective stress analysis was performed using a simple material model to simulate the behaviour of the soils including liquefaction. The soil behaviour is based upon the Mohr-Coulomb plasticity model with material damping added to account for cyclic dissipation during the elastic part of the response and during wave propagation through the site. Liquefaction was simulated using the Finn-Byrne model, which incorporates the Byrne (1991) relation between irrecoverable volume change and cyclic shear-strain amplitude into the Mohr-Coulomb model. Further details of the modelling is presented in Tang (2012).

3.6 Stone column modelling

3.6.1 Stone column parameters

The basic design parameters of stone columns include the stone column diameter, *D*, pattern, spacing and the backfill material to be used. The diameter of the stone columns in this study has been chosen to be 750mm. For the purpose of this study, a square pattern has been modelled with an effective diameter (*De*) equal to 1.13*S* where *S* is the spacing of stone columns. The resulting equivalent cylinder of material having a diameter *De* enclosing the tributary soil and one stone column is known as the unit cell. For this site, Area Replacement Ratio, ARR (ratio of area of the stone column after compaction (*Ac*) to the total area within the unit cell) was determined to be 15%.

3.6.2 Modelling a 3D problem in 2D

To represent the 3D stone column grid in 2D, a series of parallel trenches was used. The stiffness as well as the permeability of both soft soil and coarse grained inclusion needs to be adapted in order to model the deformation behaviour and drainage conditions correctly. Hird et al. (1992) and Indraratna & Redana (2000) recommended methods to perform a conversion of permeability. These transformations are also applicable to smear effects.

3.6.3 Stone column mechanisms

3.6.3.1 *Densification effect*

The effect of granular pile installation on the modifications induced in loose to medium dense granular deposits was studied by Murali Krishna and Madhav (2009). This was presented in the form of design charts that can be used to design the required degree of treatment for the expected improvement or to estimate the improved values of treated ground. The improved SPT N_1 value for this case has been determined to be 26. Moreover, studies have shown that densification of the in-situ soil surrounding the stone columns decreases with distance away from the stone column (Obhayashi et al. 1999 and Weber et al. 2010). They determined that the extent of the disturbed zone is approximately 2.5 times the radius of the stone column and this was adopted in this study.

3.6.3.2 *Reinforcement effect*

As the current study is a 3D problem being modelled in a 2D model, the stiffness of the stone columns needs to be adapted in order to model the deformation behaviour correctly. In a 2D plane strain model, the stone columns will be represented as an infinite trench with a width equal to the diameter of the stone column rather than a single column. The equivalent vertical stiffness of the column material in 3D and in 2D were made to be equal.

3.6.3.3 *Drainage effect*

The drainage condition needs to be adapted from a 3D problem into a 2D simulation. The excess pore pressure dissipation should be similar in both systems – the radial drainage system must equal the plane drainage system. The Idraratna & Redana (2000) equations to estimate plane strain permeabilities were used in the study. Weber et al. (2010) studied the smear zone and densification zone

around stone columns and the smear zone was described as a strongly sheared and remoulded zone. In this study, the smear zone was assumed to be $^1/_3$ of the column radius, i.e. 0.125m.

4. NUMERICAL RESULTS

4.1 Control model – no stone columns

Figure 4 illustrates the calculated surface displacements by the FLAC numerical model and the measured cumulative lateral displacements at transect CH_DAL_15 by Robinson (2011). The figure shows that there is a similar conventional 'exponential decay' distribution where the spreading displacements rapidly decrease with the distance from the waterway. This is consistent with the conventional liquefaction induced lateral spread mechanism. The calculated surface lateral displacements by FLAC were compared to the field measurements by Robinson (2011). The magnitude of lateral spread between the field measurements and the FLAC calculations at the crest differed by about 20%. This could be due to the stream bank in FLAC to be constructed on the loose silty GRAVEL, where in real life the bank may be supported by vegetation or small man-made structures. The difference in lateral displacements between the calculated and measured values reduces to zero at some locations. Such difference is considered acceptable and comparable considering the displacement trend is reasonably similar.

Comparison of lateral surface displacement between Robinson (2011) field measurements and FLAC calculated displacements

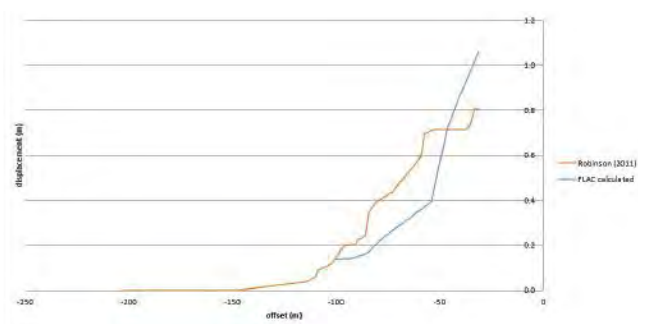

Figure 4: Comparison of lateral surface displacement between Robinson (2011) field measurements and FLAC calculated displacements

4.2 Stone column models

4.2.1 Individual effects models

The individual effects mentioned above were modelled separately and compared to the control model to assess their effectiveness. Figure 5 illustrates the final surface displacements from the crest of the river bank to 100m from the middle of the river for each of the individual effects model and the control model with no stone columns. It can be seen that all three mechanisms have reduced surface displacements at the end of shaking from the crest of the riverbank to approximately 55m from the centre of the river. Densification has reduced the surface displacement the most, by up to 49% at the edge of the improvement zone at approximately x=-39m.

The reinforcement effect reduces the surface displacements the least. At the crest of the riverbank, the reduction in surface displacement is minimal but the reduction becomes larger and reaches a maximum of approximately 25%. In theory, the cyclic stresses felt by the cross section will be concentrated in the stiffer areas (i.e. the stone columns) and the shear stress in the soil will be lower than without the stone columns. This could explain the relatively smaller reduction in surface displacements in the improved zone compared to that just outside the improved zone, as more shear stresses are borne by the improved zone.

The drainage effect is between the densification and reinforcement effect. The maximum reduction that was achieved by the drainage effect is approximately 37%. It can be noted that there is a significant change in gradient of the displacement curve in the improvement zone – the reduction of displacements compared to the control model becomes greater in the improvement zone. The

Comparison of surface displacements along the cross section for the different mechanisms and combinations at t=100s

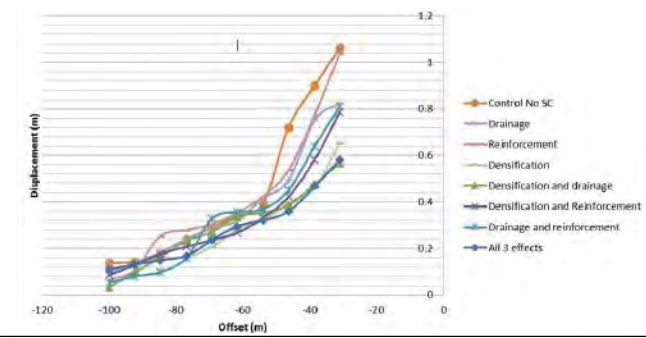

Figure 5: Resulting surface lateral displacements at t=100s.

provision of smaller drainage paths capable of dissipating pore water pressures more rapidly than they are generated during earthquake loading is an effective way to mitigate liquefaction potential.

Figure 5 shows that between approximately x=-54m and the crest of the riverbank, there is a significant reduction in lateral surface displacements where stone columns have been modelled. The maximum reduction in lateral surface displacements occurs at the crest of the riverbank, by a percentage of approximately 50%. For the geometry of the subject site it could be concluded that for an improvement zone of 8m, the effects of stone columns are significant up to 15m away from the edge of the zone of improvement. The reduction in lateral surface displacement between x=-54m and x=-100m is on average 25%.

4.3 Combinations of effects

Sensitivity analyses of each of the three effects were performed as well as the effects of different combinations of the effects to assess to importance of each effect on the overall system. Figure 5 illustrates the lateral surface displacements along the cross section at t=100s for the combinations of effects and those from the control model with no stone columns.

Of the three combinations, the combination drainage and densification effects resulted in the largest reduction in surface displacement at the crest of the riverbank, estimated to be approximately a reduction of 46%. This is consistent with the analyses on the individual effects where the densification effect resulted in the biggest reduction in lateral surface displacement, then the drainage effect. The combination of drainage and reinforcement resulted in the least reduction of lateral surface displacement, of approximately 24% at the crest of the riverbank and a reduction of 37% outside the ground improvement zone. It can also be noted that the amount of lateral displacement at the crest of the slope for the model with all 3 effects and the combination effects of densification and drainage is very similar.

It is noted that the results from this series of analyses cannot be directly related with the models investigating the individual effects as the increased weight of the stone columns compared to the in-situ soil was not considered in the individual effects models, while the increased weight was modelled for the rest of the models, including these combination models. To investigate this observation further, one case where the individual densification effect with the consideration of increased weight of the stone column zones was run in order to compare the results with the combination cases. The results indicated that the models for the individual effects with and without the consideration of the increased weight of the stone column zones resulted in a very similar magnitude of surface displacement along the cross section, with the model without considering the increased weight. It shows that for inside the improvement zone, the model that takes into account the increased weight of the stone columns results in a higher displacement. This confirms that the higher gravitational forces due to the increased weight in the columns may drive the soil mass towards the waterway more than without the increase in weight of the stone columns. However, there is only a difference in the crest lateral displacement of approximately 7% at the end of the model duration of 100s.

5. DISCUSSION AND RECOMMENDATIONS

The current study showed that the reinforcement effect did not result in a significant effect on reducing liquefaction potential and lateral spreading in this particular model. The design procedure used in this study focuses on the densification effect of the ground improvement related to the installation of stone columns. There are other procedures for example Baez and Martin (1995) where a loosely coupled method of designing stone columns for densification, drainage, and reinforcement effects. These effects can be used alone or in combinations when designing stone columns. From the results, it can be recommended that for this particular study or similar problems, the reinforcement effect need not be considered during design. The consideration of the combination of densification and drainage effects would be adequate. However, this may not be applied for all cases of stone column design against liquefaction and associated lateral spreading. Depending on site conditions, and method of installation of the columns, the influence of the three different effects may be different. A more comprehensive study on would be required to investigate this problem.

6. LIMITATIONS AND FURTHER STUDY

With this study, many assumptions have been made. These assumptions have largely been made on the basis of current literature, but it understood that there are various limitations of the study. These have been summarised below.

- Only one input ground motion has been used
- Only one cross section has been analysed
- Results compared to lateral displacement data that was recorded at a site 200m away
- Numerical model in 2D for a problem that is essentially 3D

Further studies would be recommended to produce design charts for stone columns used for mitigating liquefaction induced lateral spreading. A much more comprehensive parametric study analysing different slope geometries, subsoil parameters, groundwater levels and varying input motions would be required to come up with design charts that would determine the area replacement ratio and the extent of improvement zone required. It would be recommended that these studies performed using three dimensional numerical modelling to mimic the physical problem as close as possible. The current study could be further developed into a three dimensional analyses using FLAC 3D, and results from the 2D model and 3D model may be compared to investigate any differences and the validity of the current 2D model.

7. CONCLUSION

A study was carried out to assess the effectiveness of stone columns against liquefaction induced lateral spreading using the finite difference programme FLAC. For this purpose, a site in Christchurch was used which was affected by the February 2011 earthquake.

The three main ground improvement mechanisms associated stone columns – reinforcement, drainage and densification effects were investigated on how each of them improved the mitigation against liquefaction and associated lateral spreading. It was found that the densification effect resulted in the most significant effect on the ground improvement system while the reinforcement effect had the smallest effect on the system.

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Malcolm Bolton's Rankine Lecture & Stress-strain Properties of Auckland Residual Soil – Michael Pender, University of Auckland

BACKGROUND

Malcolm presented his Rankine lecture, *Performance-based design in geotechnical engineering*, in Auckland on October 02, 2013. The lecture had originally been presented in London early in 2012. The Auckland presentation was a decidedly spirited affair taking two hours and had the audience of about 100 people fully engaged over that time. There were several themes in the lecture. One of them was a wish to replace factor of safety design in geotechnical engineering with what Malcolm calls Mobilised Strength Design.

In Figure 1 there is a representation of the stress-strain curve for a typical laboratory soil strength test. Malcolm's point was that the central part of the curve, labelled "region of practical interest", was where our attention needs to be focussed. He uses two variables to normalise the stress-strain curves from widely different soils. First the shear stress was divided by the undrained shear strength of the specimen, thus the vertical axis on all strength test results then has a range of 0 to 1.0. The inverse of this ratio is referred to as the *mobilised strength ratio* by Malcolm and is denoted by M (so it is akin to a factor of safety on the available soil strength). The shear strain axis is normalised with respect to the shear strain when half the shear strength of the specimen is mobilised, that is when M = 2.

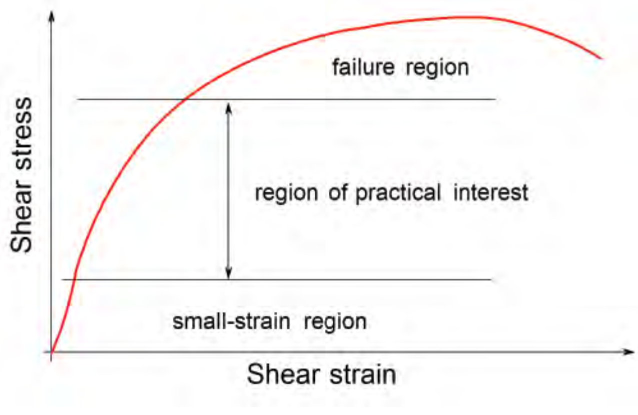

Figure 1: Idealised stress-strain curve for a laboratory strength test on a specimen of soil.

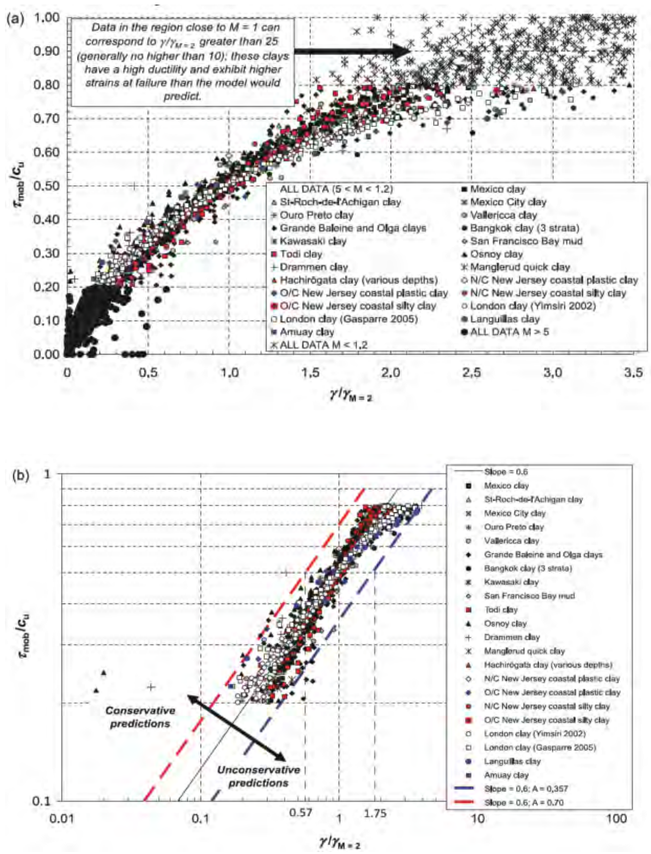

Figure 2:. Vardanaga and Bolton's re-plotting of a large collection of soil shear stress – shear strain data obtained from the literature. (Note that c_u in the vertical axis is the undrained shear strength, which I denote with s_u). (a) Stress mobilisation versus normalised shear strain, natural axes; (b) the same data as in (a) plotted on logarithmic axes.

VADANEGA AND BOLTON'S WORK

Malcolm Bolton and a graduate student examined a large range of test data from the literature and presented their results in a paper in the Canadian Geotechnical Journal (Vardenaga and Bolton (2011) and (2012)). One of their diagrams is shown in Figure 2. Now the interesting thing about the plots in Figure 2 is that within the region of interest, between mobilised strength ratios of 5 and 1.25, all the stress-strain curves fall into a narrow band; partly because all the curves have been normalised with respect to a point in the middle of this band (at 50% of the undrained shear strength and the strain corresponding the this stress). Even so, it is of interest that for such a wide range of soil types the data between M values of 5 and 1.25 are so tightly clustered. It is for this reason that Malcolm is proposing his ideas on mobilised strength design, his reasoning being that if we confine our attention to this range of stresses and strains then much of the variability of natural soils can be accommodated. In Figure 2b the data are plotted on logarithmic axes and define a region with a slope of 0.6, in other words the mobilised shear strength ratio is a function of $(\gamma/\gamma M{=}2)^{0.6}$ (where γ is the shear strain).

AUCKLAND RESIDUAL CLAY COMPARISON

Herein I present data from a small number of consolidated undrained and drained triaxial tests on Auckland residual clay and plotted the information in a similar manner; so whereas Vardanaga and Bolton have a wide range of soil types and origins I have a small number of results on just one soil type, Auckland residual clay. My data are from block samples carved from digger pits at a site along Fairview Avenue in Albany. The Atterberg limits for this soil are PL 33% and LL 74%, and the natural water contents are about 35 to 40%. Consolidated undrained and consolidated drained triaxial tests were done on specimens 38 mm in diameter and 76 mm in height trimmed from the blocks. All specimens were saturated by the application of back

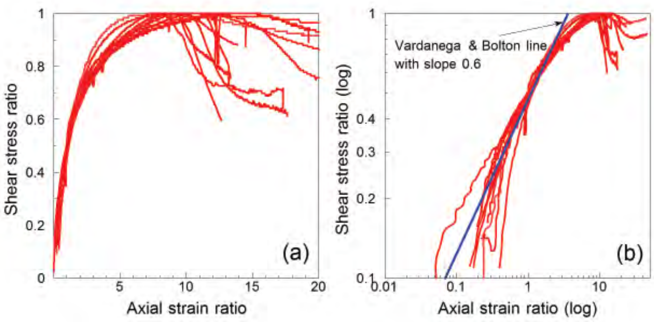

Figure 3: Mobilised shear stress – versus normalised axial strain for consolidated **undrained** tests on residual clay from Fairview Avenue, Albany. (a) natural axes, (b) logarithmic axes.

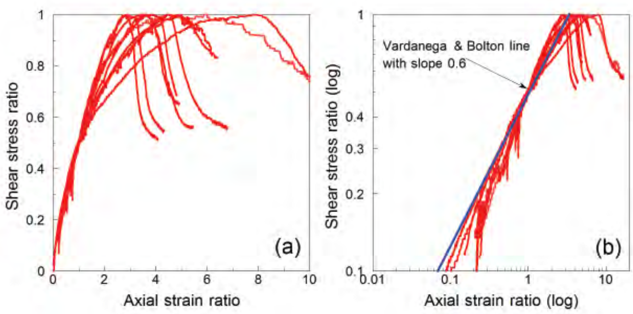

Figure 4 : Mobilised shear stress – versus normalised axial strain for consolidated **drained** tests on residual clay from Fairview Avenue, Albany. (a) natural axes, (b) logarithmic axes.

pressure before consolidation and shearing. These data are presented in Figures 3 and 4 using the normalisation scheme of Vardanega and Bolton. Figure 3 has data for 12 consolidated undrained triaxial tests and Figure 4 for 10 consolidated drained triaxial tests. In the case of the drained tests the normalisation is with respect to the peak drained strength and the axial strain (strictly speaking we should have used shear strain rather than the axial strain, however the difference is very small for these tests). The data from the logarithmic plots, Figures 3b and 4b, are located along the same line with a slope of 0.6 as the Vardanega and Bolton plot in Figure 2b.

CONCLUSION

Thus it seems that normalisation proposed by Vardanega and Bolton applies reasonably well to the limited number of triaxial test results on residual soil from Albany.

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Michael Pender

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His primary areas of interest in teaching, research, and consulting are: the elucidation of the geotechnical properties of NZ materials, particularly soils of residual or volcanic origin; the earthquake resistant design of foundations; limit state design in geotechnical engineering; the engineering behavior of closely jointed rock masses.

Why Does Critical State Soil Mechanics not Work for Auckland Residual Soils? – Michael Pender, University of Auckland

BACKGROUND

I first became acquainted with critical state soil mechanics while a graduate student at the University of Canterbury in the middle 60's. Tom Dodd, my supervisor, came into the lab one day with a book he thought might be of interest to me. It was Critical State Soil Mechanics by Andrew Schofield and Peter Wroth, published in 1968. On page 147 there was the solution to a problem that had been bothering me. At the time there was a theory in the literature that explained features of drained soil behaviour; but I needed to know about undrained behaviour, and was puzzled as to why this was not handled. The neat idea in Schofield and Wroth was that undrained behaviour, that is no change in volume during shearing, was possible if the sum of the recoverable volumetric strain increment was matched by an equal and opposite irrecoverable volumetric strain increment; a simple idea that enables the shape of an undrained effective stress path to be investigated. From here I got very much involved in the elegance of this conceptual framework. Part of the attraction was that it provided a way of integrating the dilatant volume change of soil with the shear response and treated drained and undrained behaviour in an integrated manner.

Subsequently, thanks to the then NZ University Grants Committee, I spent some time as a Post-Doctoral fellow with the Cambridge University soil mechanics group. There I had the good fortune to stumble on some ideas that enabled me to provide a small extension to the critical state framework to handle overconsolidated soil. A paper on this published in Geotechnique in 1978, still receives an occasional citation. When I took up a position with the University of Auckland in 1977 an obvious research topic was to investigate the behaviour of local soils from a critical state viewpoint. This was a challenging topic as the experimental basis for critical state soil mechanics had been developed from test data on artificial laboratory prepared soil. My idea was that it was high time to check critical state ideas against real soil behaviour. Peter Taylor cautioned me that he did not think it would work because of the variability of Auckland soils. Two PhD students, Zacheus Indrawan and Vaughan Meyer, produced much high quality data from block samples of local residual soil.

THE ESSENCE OF CRITICAL STATE SOIL MECHANICS

Although Critical State Soil Mechanics was formulated in the 1950s and 1960s it builds on earlier ideas proposed by Rendulic (1936 & 1938), Casagrande(1936), and Taylor (1948). The basic idea is that the shearing of soil, drained or undrained, proceeds such that at the end point of any test there is no further change in shear stress, effective confining stress, and volume (or pore pressure). In other words at all stages of the shearing the material is moving towards a state with fixed volume and effective stresses. To see this one plots test results in a three dimensional diagram with void ratio, shear stress, and effective confining pressure as axes. If critical state soil mechanics is valid, then in such a diagram the end points of all tests are expected to lie along a single line, the so-called Critical State Line.

LABORATORY DATA ON AUCKLAND RESIDUAL SOIL

The results of our laboratory testing on samples of Auckland residual clay did not reveal a well-defined relationship between the shear strength of the soil and the water content, or void ratio, at failure. Figure 1 shows data from many tests on specimens trimmed from block samples from a site at Albany. This was a clay with a plasticity index of 41% and which, to the naked eye, seemed to be very uniform. However, what we found from a large number of consolidated undrained tests is that there is no clearly defined relationship between water content and undrained shear strength for the natural soil recovered from the site. In Figure 1 there are also data for remoulded soil specimens prepared by shredding the natural soil very finely, mixing with water to form a slurry, and then reconsolidating. These test data from remoulded

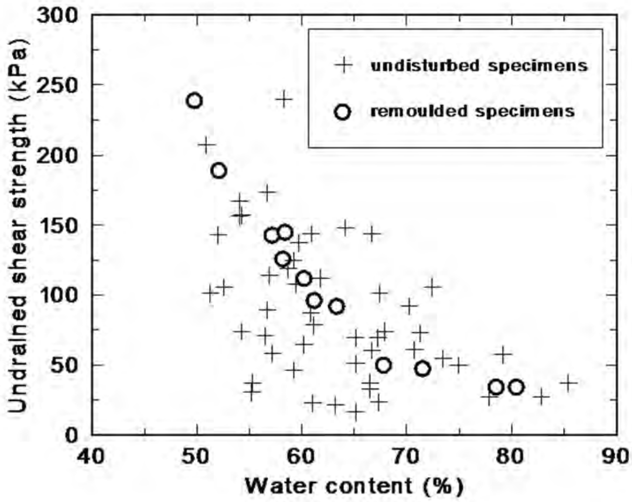

Figure 1: Shear strength – water content data for Auckland residual clay from a site near Fairview Avenue, Albany.

soil demonstrate the required well-defined relationship between water content and undrained shear strength, so it seems that the remoulded material might behave in a manner consistent with critical state soil mechanics.

The difference in Figure 1 between the scattered test results for the natural soil specimens and the comparatively well-defined relationship for the remoulded specimens suggests that something to do with the structure of the natural soil specimens might be the reason for the scattered soil strengths. Recently we have done some X-ray CT scanning work on small specimens of soil taken from a site adjacent the Northern Gateway extension of SH1 through the rugged country behind Orewa as well as some from the Fairview Avenue site, Pender et al (2009). The size of the CT chamber was such that we had to restrict ourselves to samples 40 mm high and 20 mm in diameter. We constructed a miniature triaxial cell and used several thicknesses of rubber membrane fashioned from the fingers of latex medical examination gloves. Each specimen was mounted in the triaxial cell and subject to a back pressure of 700 kPa to ensure saturation. The specimen was then consolidated to the required hydrostatic consolidation pressure and when the consolidation was complete the specimen was allowed to swell back to an effective consolidation pressure of 10 kPa. Once this was competed the specimen was removed from the triaxial cell with rubber membranes and end caps still in place and then taken to the CT scanning machine. Once scanned the specimen was returned to the triaxial cell and the next consolidation stage undertaken. In this way CT scans were obtained for effective consolidation pressures from 10 kPa to 800 kPa.

What we found from this is that there were "tube-like" macro voids, the largest of which have dimensions of the order of one or two millimetres, in the specimens at low effective consolidation pressure and that these were gradually closed as the effective confining pressure is increased, Figure 2.

The macro-void structure shown in Figure 2 is not surprising given that the materials tested are residual soils. Since these are not formed in a stress controlled environment, but rather in one controlled by chemical weathering, there is no factor operating which would tend to push the material towards homogeneity, so the macro voids shown in Figure 2 at low effective stresses are a consequence of the vagaries of the chemical weathering processes by which the Waitemata Group sandstone and siltstone is transformed to soil.

Thus our conclusion is that the reason for the scattering of the data in Figure 1 is the irregular void structure of the residual soil. In other words the standard calculation of void ratio includes the macro-voids that are shown in Figure 2 and that somehow these have a complicating effect on the overall behaviour of the soil.

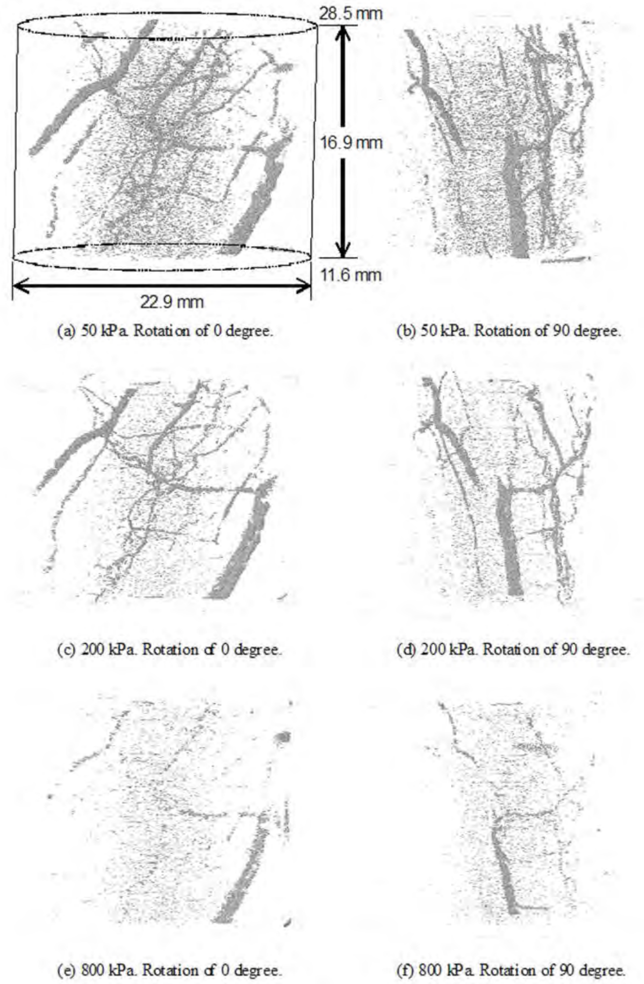

Figure 2: Vertical orthogonal views of the void structure of the miniature specimen from the Fairview Avenue site.

TWO FURTHER COMMENTS

A possible objection to my conclusion from Figure 1 would be to say that the scatter might be a consequence of differing states of overconsolidation for the various specimens. The immediate rejoinder is that being residual soil we have no basis for talking of overconsolidation.

Another comment might be that the tests from which the data in Figure 1 were obtained might not have been taken to sufficiently large strains to reach a critical state. Admittedly the achievement of a critical state requires large strains as the soil specimen must reach a state where there is no change in shear stress, or volume (or pore pressure for an undrained test). However, an early piece of evidence supporting the critical state concept came from Parry (1958) who showed that as the critical state was approached the rate of change of the stresses and pore pressure / volume change tended to zero, so even if one has not achieved the critical state there is a good indication of where things are heading. This is not the case for the test data on which Figure 1 is based.

A RESOLUTION?

The basic purpose of critical state soil mechanics is to provide a conceptual framework which is supposed to assist one in understanding the behaviour of particular specimens of soil. The idea is that this can be achieved if we have a framework in which shear stresses, mean principal stresses, and void ratio can be interpreted – hence the idea that the end states of tests from different starting conditions will plot along a well-defined line. Figures 1 and 2 show us that void ratio does not seem to be a useful parameter for residual soils. What we eventually found was that if instead of using void ratio we used volumetric strain then a more attractive picture emerged. That is one starts from the initial conditions and records the volumetric strain during the consolidation process and then adds any volumetric strain during shearing for a drained test or, for an undrained test, the volumetric strain is now fixed. This approach did give a much better picture of the soil behaviour. In one sense this is attractive, but in another it is poor second to the use of void ratio as, in effect, one is working with relative changes in the state of the specimen and correlating shear strains with volumetric strains during consolidation.

CONCLUSION

From the above information it seems that part of the reason the conceptual picture of critical state soil mechanics does not work for Auckland residual soils is that void ratio is a different parameter for soils formed within a stress controlled environment and those formed in a weathering environment. Formation of soil layers by sedimentary processes will tend to result in a more uniform distribution of voids. On the other hand chemical weathering processes have no such mechanisms promoting homogeneity.

In one sense it is disappointing that our local soils do not conform to the critical state framework; such is life when investigating the behaviour of real soil!

Consequently, although I remain an interested follower of critical state ideas, I have never become a critical state soil mechanics evangelist! However, I do acknowledge that there are some appealing ideas involved, ideas that have proved very useful in going beyond the conceptual picture to developing mathematical models for soil stress-strain-strength behaviour which integrate shear and volume change behaviour for loose cohesionless and normally consolidated cohesive soils as well as for dense cohesionless and overconsolidated cohesive soils.

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Tauroa Residential Subdivision: Landslide Remediation and Hill Slope Stabilisation for Earthquake Resistance

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Riley Gerbrandt

Riley, a Geotechnical Engineer with Opus in Napier, immigrated to New Zealand from California with his family in late October 2011. Working in New Zealand has been a wonderful professional experience for Riley. Whilst it took him several months to get up to speed with the local geology, different codes/standards and some innovative Kiwi designs, he has come to thoroughly enjoy the New Zealand engineering consultancy space.

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THIS IS A re-print of a paper selected as being of particular interest to NZGS members, originally presented at the NZSEE 2014 Technical Conference in Auckland.

The Tauroa residential subdivision is situated in the hills of southern Havelock North in Hawke's Bay, New Zealand. The hills are moderately steep and dissected by several incised gullies. This development hosts one moderately deep (<10 m) landslide that failed within mid-Pleistocene calcareous estuarine clay-rich silty mudstones of the Kidnappers Group. The development proposal includes removal of this landslide and replacement with an engineered fill slope. Utilising the pseudo-static method and the computer programme SLOPE/W, the seismic stability of the engineered fill slope was assessed. The pseudo-static seismic loads for the analyses were determined utilising specific application of NZS 1170 and an f_{eq} factor developed via the "seismic screening analysis" (Stewart, Blake & Hollingsworth, 2003).

To provide base data for a remediation programme, thorough geological, geomorphological, and geotechnical studies including subsurface investigations and laboratory testing were conducted. Utilising the resulting investigation data, the landslide hazards as a result of the design earthquake events were estimated. Static and transient seepage slope stability assessments were also conducted for completeness. The results indicate that portions of the engineered fill slope were unstable when subjected to ultimate limit state (ULS) earthquake loads. Therefore, a remediation/stabilisation programme was developed. This comprised removal of the landslide materials, subsoil drainage control and placement of a buttress fill. This paper presents some of the most important facts and implications of the assessment and design.

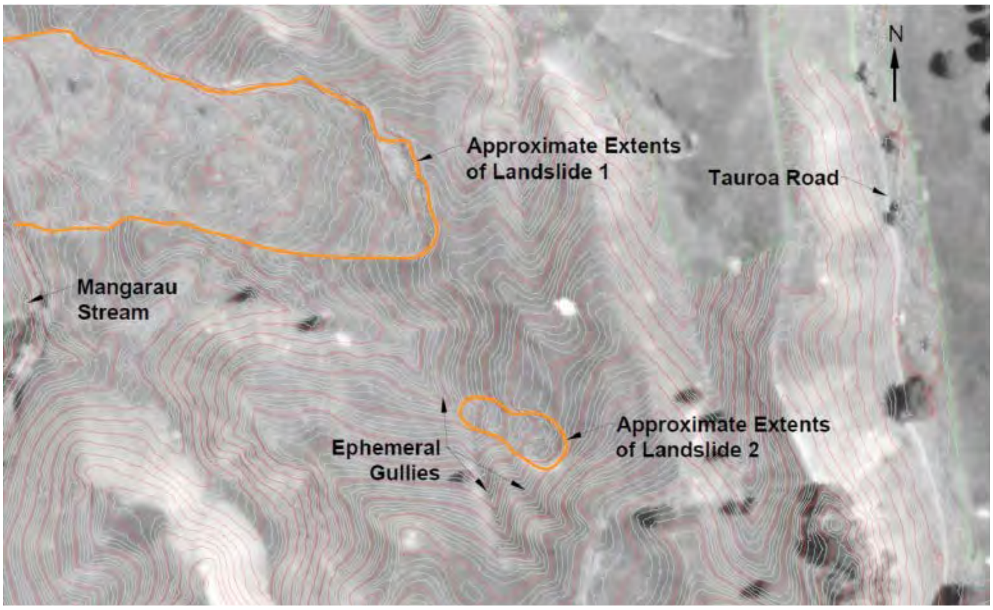

Figure 1: LiDAR topography of site on 1950 aerial photograph and showing key features within the vicinity.

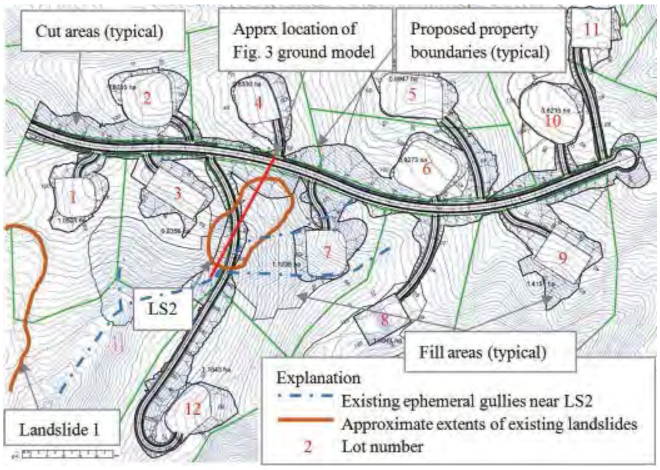

Figure 2: Tauroa residential subdivision, Stage 7 development proposal.

1. INTRODUCTION

Geologically, some of the most dramatic aspects of the hills to the south of Havelock North, New Zealand include the deep-seated to moderately deep landslides within the Kidnappers Group strata. Many landslides are visible in this area, and these can pose risks to nearby development. Assessment of the engineering stability of these landslides and of unfailed slopes in similar conditions is complex.

Stage 7 of the Tauroa residential subdivision is currently on-going, and the assessment of the stability of an engineered fill slope proposed at the site of an existing moderately deep (< 10 m) landslide was required. The assessment and design incorporated previous work as well as additional geotechnical investigations that were conducted during detailed design.

2. SITE LOCATION AND DESCRIPTION

The Tauroa subdivision is located at the southern end of the Havelock North township in the Hawke's Bay region of New Zealand. Stage 7 of the subdivision comprises approximately 10 ha of generally hilly terrain between Tauroa Road and the Mangarau stream. Several ephemeral gullies and two significant landslides are located within the area. The larger landslide ("Landslide 1") is approximately 7 ha in size and abuts the site to the northwest. The smaller landslide ("Landslide 2", hereafter referred to as LS2) is located in the northern half of the site and is approximately 0.2 ha in size. Refer to Figure 1 for the locations of these landslides and for a description of the site topography.

3. DEVELOPMENT PROPOSAL

The development proposal for Stage 7 of the Tauroa subdivision includes subdividing the property in order to construct 12 new residential building platforms and associated infrastructure. Due to the hilly nature of the existing site topography, some moderately significant earthworks will be carried out to form the roads and building platforms. During the initial stages of the project development, it was proposed to leave LS2 largely untouched. During the detailed design phase of the project, however, the design was altered to include removing LS2 and replacing it with an engineered fill slope. This design change allowed for a more stable road alignment, the construction of an access road for Lot 12 on top of LS2 and the formation of more robust building platforms on Lots 3 and 7. Refer to Figure 2 for the current development proposal.

4. GEOLOGIC SETTING

4.1 Geology of the Area

Tauroa subdivision is located within the western extreme of the forearc basin structural high that is associated with the Australian-Pacific plate margin. From the Miocene epoch through the middle Pleistocene epoch, the area was subjected to cyclic sea inundation and emergence as a result of tectonic movements and glacial periods (Kingma, 1971). During periods in which the land was submerged, sediments were deposited within the oceanic basin (Begg, Hull & Downes, 1994). The sedimentation thus principally resulted in the formation of mudstone, limestone and conglomerate rocks that were deposited within a shallow sea environment. Since the mid Pleistocene, the area has been above sea level, and the present drainage patterns were established (Kingma, 1971).

In the area of *LS2*, the rock strata comprise calcareous sandstones overlain by Kidnappers Group estuarine mudstone that dip approximately ten to 15 degrees to the west-northwest. The presence of layered carbonaceous materials (derived from vegetation) within the mud may provide low-strength layers on which slope movement can occur (Bell, 1991). These strata are overlain by interbedded volcanic tephra (typically fine pumiceous sands) and glacial loess silts, the most recent of which is typically 2 to 3 m thick and often contains an approximately 1 m thick cemented fragipan (Bell, 1991).

4.2 Seismic History

The Hawke's Bay region is one of the most earthquake prone in New Zealand. Oblique subduction of the Pacific plate beneath the Australian plate dominates the tectonic

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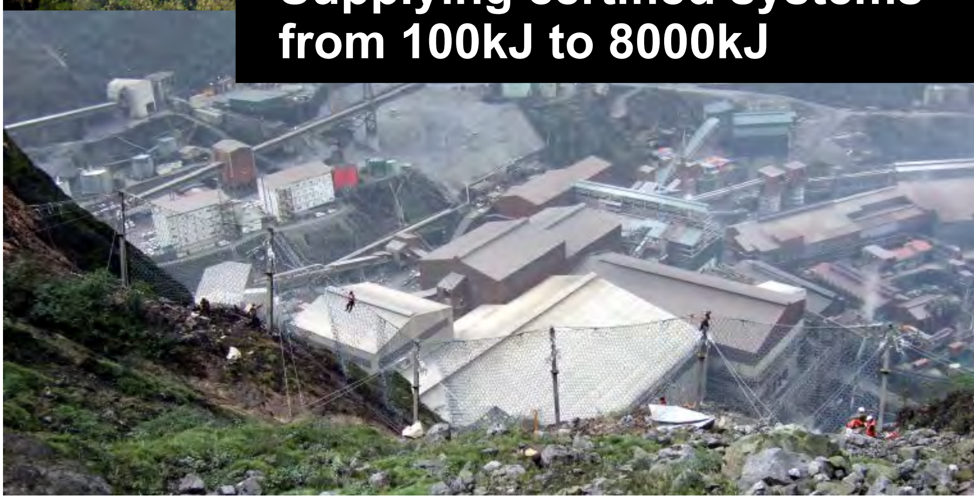

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activity of the region, which hosts a minimum of 22 known active faults and folds that are capable of producing very strong earthquake shaking. As strong earthquake shaking has been felt in Hawke's Bay on at least 19 occasions (Begg, Hull & Downes, 1994), earthquake shaking must be considered when assessing the slope stability hazard of developments.

4.3 Description of LS2

LS2 is a moderately deep (<10 m) landslide characterised by classic translational movement within a locally weak layer of the estuarine mudstone. The triggering mechanisms of similar, but larger, translational and deep-seated landslides some 500 and 150 m to the northeast are likely attributed to a combination of rainfall infiltration and of downcutting and lateral erosion of the toe by the Mangarau stream (Bell, 1991; Gray & Jowett, 1998). Seismic movement may also be a contributing factor. Due to the presence of two ephemeral drainage gullies near the toe of *LS2*, it is safe to postulate that the failure may have been triggered by a similar combination of factors.

5. PREVIOUS WORK

5.1 1991 Work by Bell

Bell published the initial Tauroa subdivision work in 1991. He mapped numerous landslide features and, utilising tephra and pumice markers as well as aerial photo interpretation, dated two secondary slide failures as having occurred between approximately 1800 and 100 years before present (BP). Bell (1991) focused considerable attention on the Goat Shed Slide, which is located approximately 500 m northwest of LS2. Several polished and/or slickensided surfaces were identified within borehole cores and were logged as failure surfaces, with the failure planes dipping approximately six degrees to the west. Samples of these failure surfaces were tested in the laboratory and returned average residual soil strength parameters of c_r = 5 kPa and ϕ_r = 11 degrees. A separate un-failed estuarine mudstone sampled from an adjacent borehole returned c_r = 6 kPa and ϕ_r = 16 degrees.

5.2 Work by Gray & Jowett (1998) and Gray & Watson (2012)

The subject property was first studied in the preliminary geotechnical appraisal (Gray & Jowett, 1998), and it was later assessed in more detail in a preliminary geotechnical report (Gray & Watson, 2012). Subsoil investigations identified the failure plane near the centre of *LS2* at approximately 6.65 to 6.90 m below the existing ground surface within stiff "dark brown CLAY; moderately plastic". Groundwater was not encountered in the exploratory borehole that extended to 15.45 m.

6. ASSESSMENT OF THE STABILITY OF LS2

6.1 New Geotechnical Investigations

As discussed previously in this paper, changes were made to the site development proposal between the publication of the referenced preliminary geotechnical report and commencement of the detailed design phase. In order to produce a substantially better product, these changes included remediation of *LS2* by undercutting and removing the landslide debris and replacing it with an engineered fill. In order to design the remedial works and the engineered fill, additional geotechnical site investigation and laboratory testing was required. Engineering design commenced upon completion of the site investigation and laboratory testing.

6.1.1 Field Work

Three mechanically excavated TPs were conducted at the site during September 2013. "*TP.1*" was conducted approximately 190 m to the south-southeast of *LS2*. "*TP.2*" was excavated immediately above the *LS2* head scarp to a depth of 3.4 m and exposed loess SILT interbedded with pumice sand; a cemented fragipan ("hardpan") was logged between 1.1 and 1.5 m below the existing ground surface. "*TP.3*" was excavated on the toe of *LS2* to a depth of 3.0 m, and it exposed silty CLAY colluvium (i.e. landslide material) and undisturbed estuarine muds; a potential slip surface was logged at 2.4 m below the existing ground surface. The silty CLAY encountered in *TP.3* was described as being stiff, moist and highly plastic. Shear vane tests with a Pilcon vane shear device were conducted during the excavation of the third TP. Average returned undrained shear strength (S_U) values at a depth of 2.5 m were 74 kPa (peak) and 23 kPa (remoulded), while S_U values at a depth of 3.0 m were > 175 kPa (peak) and 32 kPa (remoulded). Bulk samples were obtained from the material excavated from the TPs, and pushtube samples were obtained from TP.3 at a depth of 2.5 m.

6.1.2. Laboratory Testing

Samples retrieved during the additional geotechnical site investigation were tested in an Opus IANZ accredited soil laboratory. In order to evaluate the soil strength parameters for the engineered fill, consolidated drained direct shear tests were conducted on remoulded samples of the bulk soils that were obtained from *TP.1* and *TP.2*. A three stage consolidated undrained triaxial compression test with pore pressure recording was conducted on the pushtube sample to evaluate the in-situ soil strength parameters for the estuarine mud deposits. Utilising the laboratory test results, design ϕ' and c' values of 28 degrees and 15 kPa, respectively, were estimated for the sandy SILT (fill), while design ϕ' and c' values of 23 degrees

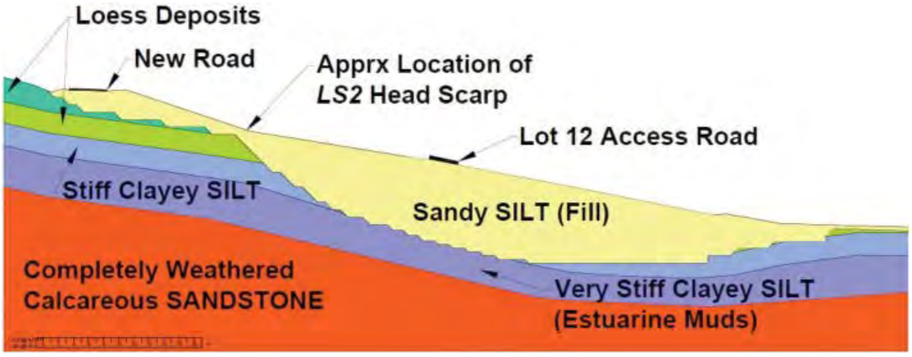

Figure 3: LS2 ground model for SLOPE/W (refer to Fig. 2 for location)

and 9 kPa, respectively, were estimated for the in-situ stiff clayey SILT.

6.2 Slope Stability Assessment

The geotechnical data was used to prepare an interpretive sub-surface ground model for the proposed engineered fill. Refer to Figure 3 for the presentation of this interpretive ground model, which formed the basis of the slope stability assessments. The slope stability assessments were conducted utilising numerical analysis using the computer programme SLOPE/W (GEO-SLOPE, 2012). In accordance with the local Engineering Code of Practice (Hastings District Council, 2011) and standard engineering practice for slopes that provide integral support for or direct loading on a structure, target factors of safety (*FS*) against failure of 1.5, 1.2 and 1.0 were established for static, transient seepage and seismic loading conditions, respectively.

Both circular and block-specified failure surfaces were analysed. The Morgenstern-Price method of slices was utilised to determine the *FS* for each failure surface. Groundwater was modelled within SLOPE/W using a phreatic surface(s) that, depending on the condition modelled, was either constrained to a certain (or several certain) strata or was unconstrained.

The development proposal includes a road above the engineered fill, an access road for Lot 12 down the face of the engineered fill and a residential building platform within the southern portion of the engineered fill. Therefore, critical case vehicle and building loads were applied as appropriate. It was assumed that the landslide colluvium would be completely removed below the slip surface and that properly constructed keyways and benches with subsoil drains would be formed during construction of the engineered fill. Furthermore, it was also assumed that quality assurance construction monitoring would be performed to ensure that the design compaction specifications would be achieved. The model was assessed at two cross-sections down the length (in profile) of the engineered fill slope and at two cross-sections across the width of the engineered fill.

6.2.1 Static Slope Stability Analysis

Geotechnical soil properties were assigned to the interpretive ground model strata using the results of the laboratory test data and experience with similar soils in similar geological conditions. Whilst groundwater was not encountered in the referenced site investigations, a prevailing groundwater surface was assumed at the interface of the completely weathered SANDSTONE and the clayey SILT.

6.2.2 Transient Seepage Slope Stability Analysis

The transient seepage condition was modelled first utilising an elevated groundwater level (i.e. phreatic surface) applied above the prevailing typical groundwater table. This surface was applied to all soil types. As the presence of groundwater perched above the fragipan is believed to have caused many of the numerous shallow surface failures observed within the Tauroa subdivision (Bell, 1991), the transient seepage condition was secondly modelled utilising the elevated phreatic surface (as above) in conjunction with a phreatic surface perched above the fragipan in the natural soils. Thirdly, failure of the slope subsoil drains was also modelled by applying the elevated phreatic surface in conjunction with a phreatic surface perched above both the natural fragipan and the engineered fill.

6.2.3 Dynamic (Seismic) Slope Stability Analysis

Due to the absence of loose, saturated sandy soils and sensitive fine-grained soils at the site, it is considered that seismic slope instability of the engineered fill would comprise an inertial instability. In inertial instabilities, the shear strengths of the soils remain relatively constant and any slope deformations result from temporary exceedance of the resisting forces by the dynamic earthquake loads (Kramer, 1996). Therefore, for the seismic condition, the slope was analysed by applying an equivalent pseudo-static horizontal acceleration (i.e. "seismic load") to the slope. This pseudo-static method has been the subject of many previous papers (e.g. Terzaghi, 1950; Seed & Martin, 1966; Seed, 1979; Makdisi & Seed, 1979; Hynes-Griffin &

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Franklin, 1984). In this method, the seismic load is generally taken as the equivalent seismic coefficient (k_{eq}) which, depending on which variant of the method is applied, is either equal to a specific acceleration (e.g. 0.1 g, 0.15 g, 0.20 g) or is equal to the peak ground acceleration (PGA) multiplied by a site seismicity factor (f_{eq}). The pseudo-static method is typically utilised to determine the yield coefficient (k_y) that reduces the FS to unity. Then, using a Newmark-type sliding block displacement method (e.g. Newmark, 1965) and the ratio k_y/k_{eq}, the displacement resulting from the design seismic event can be estimated.

For determining the k_{eq} to use in the analyses, the PGA was calculated utilising specific application of NZS 1170:2002 for residential dwellings with a 50-year design life and a Site Subsoil Class of Class C ("Shallow Soil"). PGAs of 0.519 g and 0.130 g were determined for the serviceability limit state (SLS1) and ultimate limit state (ULS) conditions, respectively. In this instance, SLS1 and ULS conditions correspond to 25-year and 500-year return periods, respectively.

As an alternative to conducting a Newmark-type displacement analysis of the slope, a simplified screen analysis procedure was adopted. In the absence of specific guidance on the use of the simplified screen analysis procedure within New Zealand, the "screen analysis procedure" presented in SP117A (California Geological Survey, 2008) was utilised as a best practice basis for which to develop appropriate f_{eq} values. This method was formulated to identify geographic areas that are potentially susceptible to earthquake-induced landslides (Blake, Hollingsworth & Stewart, 2002; Stewart, Blake & Hollingsworth, 2003). The Stewart, Blake & Hollingsworth (2003) equation for f_{eq} is

$$f_{eq} = \frac{NRF}{3.477} \times \left[1.87 - \log_{10}\left(\frac{u}{(MHA_r / g) \times NRF \times D_{5-95,m}}\right)\right] \quad (1)$$

where MHA_r/g = maximum horizontal acceleration of base rock; NRF = nonlinear response factor to correlate MHA_r/g to the spatially averaged peak amplitude of shaking within the soil slide mass (since earthquake shaking is often amplified or de-amplified by the soil overlying the bedrock); u = 5 or 15 cm; and $D_{5-95,m}$ = median duration from Abrahamson and Silva (1996) relationship.

Refer to Stewart, Blake & Hollingsworth (2003) for the equations for NRF and $D_{5-95,m}$. These equations require values for expected magnitude (M) and distance to the source (r). A 7.5 M event on either the Poukawa fault zone or the Mohaka fault is considered the likely design event for the site (Berryman, McVerry & Villamor, 1997; Hengesh et al., 1998; Hawke's Bay Engineering Lifelines Project, 2001), so worst-case values of 7.5 for M and 48 km for r were utilised to calculate f_{eq}.

Using this procedure, f_{eq} values were evaluated for the following situations: maximum slope displacements of less than 50 mm for slopes providing integral support of a building platform, and maximum slope displacements of less than 150 mm for slopes not providing integral support of a building platform. These threshold displacements are presented within the "screen analysis procedure" methodology and reflect the fact that landslides are capable of accommodating a limited amount of displacement (i.e. partial mobilisation) before complete mobilisation of the basal rupture surface and catastrophic ground failure occurs (Murphy & Mankelow, 2004). Whilst others suggest that higher thresholds could be used (Wilson & Keefer, 1985); Idriss, 1985), the author agrees with Stewart, Blake & Hollingsworth, (2003) who suggest the following: the 50 mm threshold is likely to distinguish between failures resulting in very little displacement from those resulting in moderate displacements, while the 150 mm threshold likely distinguishes between failures resulting in moderate displacements from those resulting in large displacements. Using Equation 1 and the PGA values determined earlier, calculations produced k_{eq} values of 0.31 g and 0.25 g for use in the ULS analyses for allowable deformations of 50 and 150 mm, respectively. Similarly, a k_{eq} value of 0.09 g was produced for use in the SLS analyses for both the 50 and 150 mm allowable deformation limits.

For this study, MHA_r in Equation 1 was set equivalent to PGAs determined by application of NZS 1170 for Site Subsoil Class C, rather than for Site Subsoil Class A or B. This was done to provide appropriate conservatism consistent with the nature of the development proposal.

It was assumed that the location of the seismic condition slip surface is generally consistent with the location of the corresponding static condition slip surface. As earthquake loadings are generally applied so rapidly that all but the most permeable of soils (e.g. coarse gravels and/or cobbles) are loaded in an undrained manner (Seed, 1979; Kramer, 1996; Duncan & Wright, 2002), it was assumed that the sub-surface soils at the site will not drain appreciably during earthquake loading. Thus, undrained shear strengths were used within the SLOPE/W analyses by utilising the programme's Mohr-Coulomb soil strength setting together with its option to keep the slice base shear strength unaltered when the dynamic force is applied.

To test the accuracy of this option within SLOPE/W, a homogenous slope model was created within SLOPE/W and analysed under static loading conditions. The resulting shear strengths at the base of each slice was computed. A new slope model was prepared utilising numerous thin horizontal soil strata, with each strata assigned an undrained soil strength equivalent to the shear strength at the base of the corresponding slice from the previous static analysis. Both the homogeneous slope and the thin strata slope were then analysed with an applied k_{eq}. Mohr-Coulomb soil strength settings were utilised for the first model whilst forcing the slice base shear strengths to remain unaltered. Undrained soil strengths were utilised in the second model. Both analyses returned effectively the same result, so it was inferred that this option within SLOPE/W was accurate for the intended purpose.

Lastly, it is widely accepted that degradation of soil strength occurs during the dynamic (e.g. earthquake) loading of a slope (Makdisi & Seed, 1977; Makdisi & Seed, 1979; Seed, 1979; Idriss, 1985; Kramer, 1996; Duncan & Wright, 2002; Murphy & Mankelow, 2004). For soils that exhibit small increases in pore pressure during cyclic loading, it is accepted that a "dynamic yield strength" equivalent to ≥ 80 per cent of the static undrained strength may be utilised to represent such strength degradation (Makdisi & Seed, 1977; Seed, 1979). Alternatively, the use of residual shear strengths may be utilised to model this strength degradation (Cole et al., 1998; Duncan & Wright, 2002). However, the author considers that the use of residual shear strengths in pseudo-static analyses is more applicable for situations in which the complete mobilisation of the basal rupture surface, which leads to large slope deformations, has occurred. As the engineered fill slope at the site is to be designed so that no to little slope deformation occurs as a result of a ULS design earthquake, the use of a "dynamic yield strengths" that are ≥ 80 per cent of the static soil undrained strengths is more appropriate.

However, as modelling the slope utilising soil "dynamic yield strengths" that are ≥ 80 per cent of the static undrained shear strength would require, first, computation of the soil static undrained shear strengths then re-analysis of the model utilising a percentage of the computed strength values, an quicker alternative method was sought. The author settled upon increasing the seismic condition target *FS* from 1.0 to 1.2. This approximates the dynamic strength degradation by increasing the amount by which the resisting forces must exceed the driving forces in order for the slope to be considered stable.

6.3 Summary of Stability Analyses and Design of Slope Surface

Save for the failure surfaces initiating from the north-western half of the Lot 7 building platform and extending north across the engineered fill slope, the *FS* values returned from the slope stability analyses all met or exceeded the target *FS* values. For the excepted failure surfaces, *FS* values were less than 1.2 for a k_{eq} of 0.31 g. In order to mitigate the potential for a slope failure resulting in moderate displacements to occur, the access road for Lot 12 was shifted slightly north and the toe elevation at this location was raised by 2 m. When re-assessed, these changes resulted in slope stability *FS* values that exceeded 1.2.

7. DESIGN OF REMEDIATION PROGRAMME FOR *LS2*

The remedial design includes undercutting and removing the existing *LS2* colluvium by up to 7 m to expose undisturbed deposits, forming keyways and benches with subsoil drainage within the exposed surface, placing up to approximately 13 m of controlled engineered sandy SILT fill in 0.2 m (compacted) lifts and forming a new ground surface with, typically, a 3H:1V to 4H:1V gradient. A cut-fill building platform is to be constructed for Lot 7 at the top of the engineered fill slope, and a buttress fill of approximately 2 m in height is to be constructed at the toe and along the lower face of the slope to the north (below Lot 3) of *LS2*. It is proposed to process the undercut colluvium for placement in both the on-site stormwater detention dams and the buttress fill below Lot 3.

Control of both surface water and subsoil seepage is considered critical to the success of the *LS2* remedial works. Therefore, in addition to the subsoil drains to be placed within the keyways and benches, the remedial design includes pavement cut-off drains along both the new roadway and the Lot 12 access road as well as subsoil drains placed within the ephemeral gullies and seepage areas to the south and west of *LS2*. The subsoil drains are to discharge via solid pipes to the stormwater detention dam to be constructed approximately 100 m northwest of the existing *LS2* toe. Surface water control is to be provided by drainage swales along the uphill side of the Lot 12 access road, around the back and eastern side of the Lot 7 building platform and along the uphill (eastern) side of the main subdivision road; the road is immediately east of the existing *LS2* head scarp. These drainage swales are to discharge to the reticulated stormwater system beneath the new road. The placement of gabion basket weirs within the ephemeral drainage gullies immediately west of the engineered fill slope is also planned in order to dissipate stormwater runoff energy and further limit erosion of the slope toe.

The sandy SILT material for use as engineered fill is to be sourced from borrow areas within the subdivision. The earthworks specification produced for the works provides appropriately stringent materials testing and compaction controls for the works. In addition to including material requirements for the bulk fill, the document specifies minimum values and testing frequency for bulk fill air voids, water content, material relative density and undrained shear strength. Monitoring of the fill-induced settlements of the subsoils and engineered fill is planned during placement of the engineered fill. Settlement monitoring is to continue after completion of the works and until at least 90 per cent of the settlement has occurred. Quality assurance testing and engineer observation is also specified so that preparation of a geotechnical completion report can be prepared following completion of the works.

Upon preparation of this paper, the proposed works have been initiated, and the area of *LS2* has been cleared and stripped. Subsoil drains have been installed within several of the ephemeral gullies near *LS2*, but undercutting of the landslide colluvium has not yet commenced.

8. SUMMARY AND CONCLUSIONS

Removal and replacement of *LS2* at Tauroa subdivision with an engineered fill slope is proposed. Static, transient seepage and seismic slope stability analyses of the engineered fill slope with a 2 m toe buttress indicate that the engineered fill slope will be stable under ULS conditions. As an alternative to Newmark-style slope displacement analyses, the pseudo-static analysis method was utilised for the seismic slope stability analyses with the seismic load determined utilising the simplified "seismic screening analysis" (Stewart, Blake & Hollingsworth, 2003). Whilst applying the simplified method, slope displacement thresholds were adopted to reflect that landslides are capable of accommodating a limited amount of displacement before complete mobilisation of the basal rupture surface and catastrophic ground failure occurs (Murphy & Mankelow, 2004). Displacement thresholds consistent with the Stewart, Blake & Hollingsworth (2003) method and appropriate for the importance level of each portion of the engineered fill slope were adopted for this study. The resulting remedial design and construction programme is within the bounds of normally accepted earthworks programmes for similar development proposals. Furthermore, the risk level is considered appropriate to the importance level of the proposed structures. Therefore, the analyses and remedial design approaches described in this paper can find useful application in similar hillside developments within New Zealand where the subsoils are not considered susceptible to weakening instabilities (e.g. flow liquefaction and cyclic mobility) and where brittle rock slope failures are not anticipated.

9. ACKNOWLEDGEMENTS

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Optimising Pavement Design for Local Conditions

– GeoSolve Pavements Group

AS A RESULT of concerns expressed by some roading authorities that Austroads pavement rehabilitation designs seem to call for much thicker overlays than considered necessary, the team at GeoSolve Pavements Group has been working for some time collating all historic deflection data from Falling Weight Deflectometer (FWD) results carried out in NZ (about a million in situ tests on in-service pavements) then going through a process to determine what potential there is for improving and optimising pavement design based on precedent performance of the country's pavements. Objectives were to consider firstly whether Austroads' pavement design criteria were ideal for New Zealand nation-wide, and secondly what "regional variants" to national pavement design procedures could be used to save costs.

NATIONWIDE PRECEDENTS

The provisional finding from the first objective is that the standard Austroads criteria are mostly appropriate for greenfield pavement design although in certain conditions there will be some under-design. However the implications of using Austroads criteria for rehabilitation design are more concerning: a small percentage of rehabilitations appear to be under-designed while a moderately high percentage appear to be significantly over designed for New Zealand conditions. 'Significantly' is here taken as being an overlay that differs by more than 50 mm from the ideal as observed from proven precedent performance on New Zealand roads that have been in service under known traffic loading, for many decades.

A study of 5 sites where pre-rehabilitation deflection testing was available, was carried out for NZTA, and Figure 1 shows the granular overlay design carried out using the Austroads requirements (X axis) plotted against the overlays warranted from "network precedent performance analysis" of a large database of deflection tests (dating back to 1993) from throughout New Zealand.

To some degree, this diagram supports the claim that many local pavements being rehabilitated to Austroads design criteria have thicker overlays than appear necessary because basecourse volumes could be halved in many cases especially where subgrade are soft. However there are wider implications in that in a minority of cases some under-design appears to be occurring although these instances are on the higher strength subgrades so deformation may be relatively minor. Overall, using CMP should typically result in not only lower costs (in the vicinity of 30% less aggregate used) but also greater reliability.

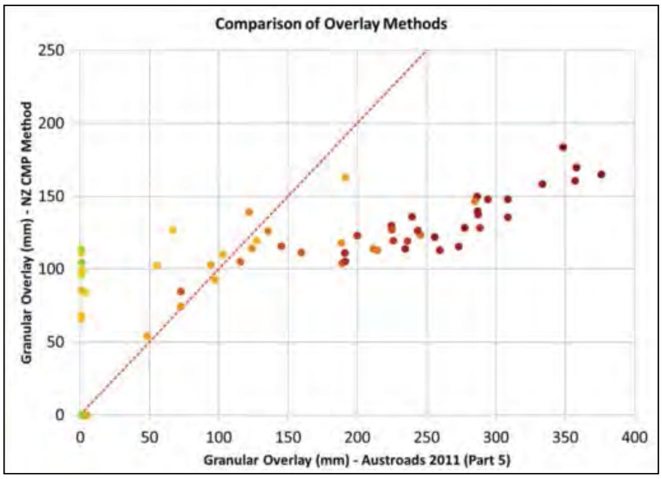


Figure 1: Austroads recommended overlay thicknesses compared with overlays based on precedent for New Zealand conditions. (Colours show subgrade CBR values grading from red low to green high.)

Overlay thicknesses using this Calibrated Mechanistic Procedure (CMP) are now being presented in standard FWD output spreadsheets alongside the traditional Austroads empirical and mechanistic overlay thicknesses for comparison to enable designers to readily assess both the improved reliability and cost savings. The findings from the study are still provisional, but are soundly based on a very large database of in situ tests on in-service pavements, which most importantly, are appropriate for New Zealand rather than Australian conditions. The value of the calibrated model is that it appropriately reflects New Zealand material specifications, construction practices, reseal frequency or other surface maintenance, surface/subsurface drainage practices and ambient environmental conditions.

REGIONAL VARIANTS

NZTA requires that state highway overlays are designed using the "TNZ Precedent Method" wherever appropriate, but the input data for use of this method are not always available. The mechanistic procedure if calibrated for the region, fills that gap, giving almost the same outcome in terms of design thickness and cost savings. Another simple alternative is to use a network structural analysis to readily establish empirical criteria for any particular subgrade type or region where it is known or suspected that Austroads procedures are inappropriate. A good example has been

determined for recent volcanic ash subgrades in the North Island. These pavements perform extremely well, even though they are on highly flexible subgrades, far exceeding the expectations of the Austroads design criteria.

Many empirical FWD parameters were explored to identify the ones suitable for characterising the 25 year pavement design life for these volcanic subgrades. The standard central deflection (D0s) and ratio of curvature to D0s were found to be the best predictors of performance. The D0s is a measure of the maximum deflection of a pavement (including the underlying subgrade) under loading of a standard axle, as shown in Figure 2. The D0-D300 curvature, widely used internationally and called the Surface Curvature Index (SCI), is similar to the Austroads curvature function (D0s-D200s), but is defined as the difference between central deflection and deflection 300 mm away from the loaded point under a standard axle load (D300s). The two measures are approximately related by (D0-D300) =1.55 x (D0-D200). Curvature reflects the amount of flexure in the pavement, and relates to its stiffness (a function of the modulus and thickness of the upper pavement layers). The ratio of SCI to D0s quantifies the relative concentration of pavement flexing within the first 300 mm from the loading point in relation to the overall deflection of the pavement. Low ratios show stiff upper layers in relation to the subgrade, the converse applies for large ratios. The ratio is useful for determining where the critical layer(s) is located. By plotting data gathered from FWD tests done on pavements on volcanic subgrades in the North Island, as well as those on standard (i.e. non-volcanic) subgrades, upper limits of D0s under different SCI-D0s ratios for different design traffic can be envisaged. Figure 3 and 4 show the upper bound limits for 25 year design traffic for D0s versus the ratio of SCI to D0s, which provides a "customary" value of upper bound D0s for various SCI-D0s ratios observed in New Zealand pavements (both on non-volcanic and volcanic subgrades). These charts clearly quantify the degree to which larger central deflections are likely to give satisfactory performance for pavements on volcanic subgrades.

Note that the charts are provisional only at this stage, until it has been through the full review process, but GeoSolve Pavements Group would appreciate any feedback from practitioners or users of the precedent data. A report discussing both empirical and mechanistically derived parameters from the

national study is expected to be available later this year, including a spreadsheet with charts that will let individual practitioners see where the critical parameters for any proposed new pavement design plot in relation to the extensive database of existing pavements. These can show national data or filtered for any specific locality/pavement type/climate/traffic loading).

This ultimate form of "reality check" should provide high level assurance of whether a specific pavement design is conservative with widespread precedent, is pushing the limits (as is often required to optimise efficiency), or is essentially breaking new ground with no precedent.

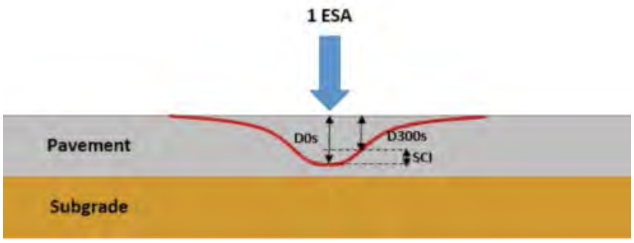


Figure 2: Pavement deflections under a load of one standard axle, defining Surface Curvature Index.

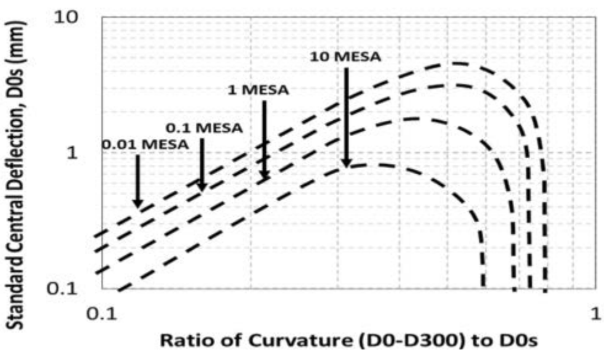


Figure 3: (D0s-D300s) to D0s ratio versus D0s for unbound granular chip-seal pavements on non-volcanic subgrades with provisional 25 year design life traffic lines.

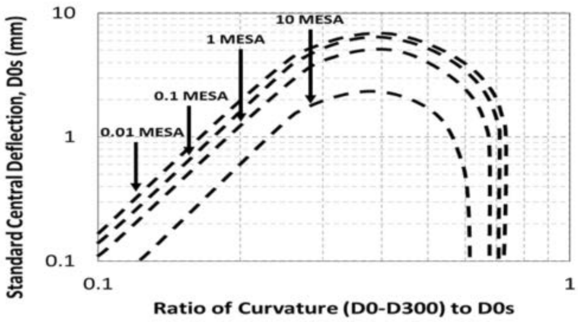


Figure 4: (D0s-D300s) to D0s ratio versus D0s for unbound granular chip-seal pavements on volcanic subgrades with provisional 25 year design life traffic lines. (D0-D300)=1.55 x (D0-D200)

Using the extensive national database of in situ testing to determine two relevant variables in this manner rather than a single variable as traditionally used in the Austroads empirical method, provides for substantially more reliable and cost effective design.

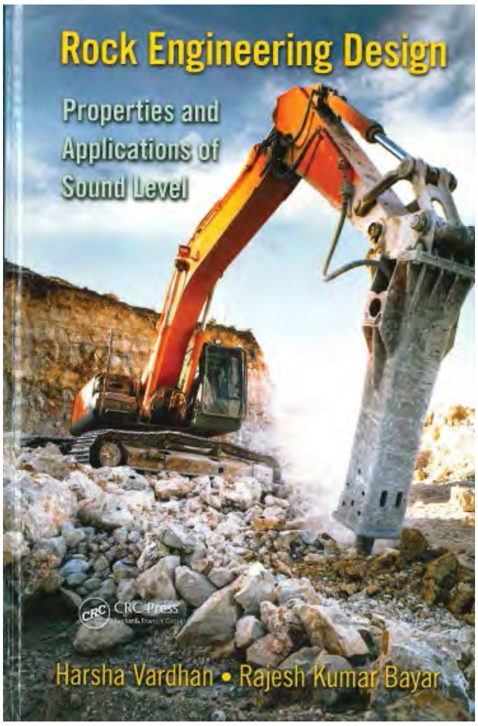
Rock Engineering Design, Properties and Applications of Sound Level – Harsha Vardhan and Rajesh Kumar Bayar

FEW OF THE numerous text books published on rock mechanics and mining engineering stray from the core subject matters of index properties, mass parameters and ground stress. This book is very different - not only does it address a non-core subject but it makes it the centrepiece of the book. The fundamental premise presented here is that acoustic emissions (AE), or the sound generated by the mechanised drilling of rock, can be used to indirectly determine other rock properties such as strength.

The book has its origins in India. Dr Harsha Vardhan is an Associate Professor in the Department of Mining Engineering, National Institute of Technology Karnataka at Surathkal and Mangalore. Dr Bayar was awarded his PhD from the same institute. The stated intent of the authors is for their book to present the basic concepts behind AE and the principles on which it can be used to cheaply and effectively solve rock design problems. The publisher's online description directly links the intent of the book to the effectiveness of blasting design, although strangely blasting is not mentioned at all in the book itself.

The interpretation of sound in a rock engineering context is not a new concept, although the existing literature tends to link AE to bulk excavatability or machine efficiency rather than as a substitute for established methods of determining index rock properties. At the heart of this book lies a series of laboratory tests in which AE readings (sound levels) were recorded whilst a total of 14 different rock types were subjected to drilling with carbide bits at range of rotation speeds and penetration rates. AE was subsequently plotted against a range of independently determined index properties including UCS, dry density, P-wave velocity, tensile strength, Young's Modulus as well as the Schmidt Rebound Number.

Having over the years gotten used to



many soil or rock property "correlations" resembling the product of a shotgun blast, I have to admit that I was surprised at the apparent strength of the relationships that were developed – all without having to resort to log-log scales. A sizable part of the book is dedicated to the use of Artificial Neural Networks as a means of assessing the inputs and outputs of the laboratory data. I must leave the validity or otherwise of that to others.

Although the book clearly succeeds in establishing the fundamental link between AE and a range of index rock properties, there were some areas of potential concern. The first is that of the 14 rock types tested in the laboratory,

Review by:
Kevin J. Hind

Kevin is an Engineering Geologist and Project Director with Tonkin & Taylor Ltd. Following completion of an M.Sc. at the University of Waikato and some formative years in the Middle East, he spent a decade in Western Australia specialising in large-scale rock engineering and offshore oil & gas projects. Kevin has spent the last 8 years in T&T's Auckland office where he leads the firm's engineering geology initiatives. His technical work focuses principally on natural hazards and water/wastewater projects.

Author	By Harsha Vardhan and Rajesh Kumar Bayar
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Web shopping	http://www.taylorandfrancis.com
Price	$169.95 (Hardback)

13 were igneous and one was metamorphic. Whether such strong correlations between index properties and AE would be seen with sedimentary rocks or those with a wider range of strength or weathering grade is something worth considering. The omission of sedimentary rocks is particularly strange given the fact that the one field-based case study given in the book was undertaken within coal measures

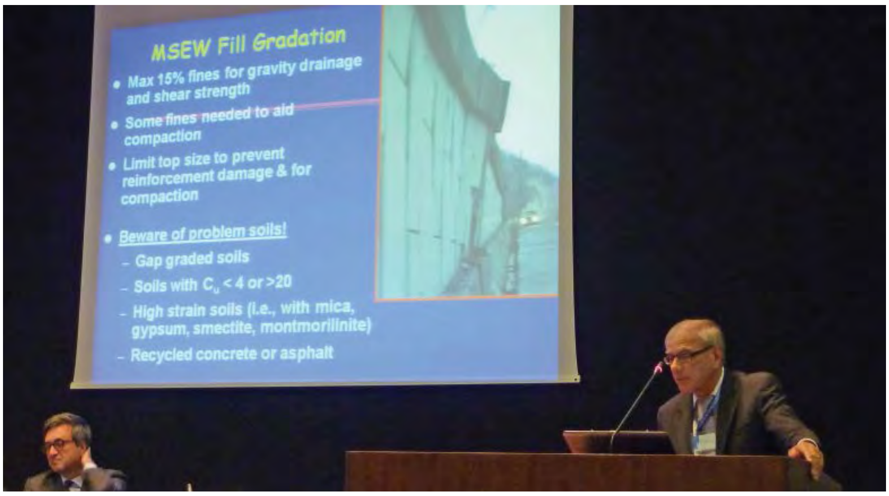
My biggest concern with this book however is its length. At a tiny 8mm thick sans hard covers I would not have expected to have found this book too long, however it most certainly appears that way. Much of the first half of the book presents discussions on the basics of noise, sources of noise in an industrial setting, noise standards around the world etc. None of this is applied in the work at hand, so it really comes across to the reader as padding. I quickly developed the distinct feeling that this research would have made a good conference paper or two. Publication as a book was a step too far. The book could have done with tighter editorial control. Nevertheless the authors appear to be onto something which, once its practical aspects can be exploited in the field, certainly has the potential for effective use in predominantly large-scale mining or extractive operations.

International Symposium on Design and Practice of Geosynthetic Reinforced Soil Structures

THIS SYMPOSIUM WAS held in honour of the work Professor Dov Leshchinsky, a world-renowned researcher and educator on reinforced soils and has been a professor of geotechnical engineering at the University of Delaware for more than 30 years. Over 100 attendees included leading researchers who had worked with Dov over the years attended the symposium. The 3-day Symposium (14-16 October, 2013) included the first two days held at the School of Engineering and Architecture, Bologna University with the third day of symposium included a joint sessions with the 26th Italian National Conference on Geosynthetics at Sala Topazio. The Symposium included keynote lectures and as well as presentations from a range of authors from around the world. New Zealand was represented by Cliff Edwards of Tonkin & Taylor and Gordon Stevens from Maccaferri NZ Ltd.

As the first keynote lecture Dov presented on Limit State design focussing on the dangers of considering cohesion in the long term performance of structures. This was followed by papers presented on centrifuge testing and design methodology. In the case of seismic stability a paper by Vahedifard and Leshchinsky showed the steeper the wall the more planner the failure mechanism whereas for flatter structures the failure tended to be curved. Nelson Chou presented a project in Taiwan for the repair of a large failed slope where soil nails were used and a connection system developed using geogrid to transfer load from the short geogrid lengths to the soil nails in the competent rock. Richard Valentine highlighted 45 failed structures that he had inspected. A mix of water from various source and the lack of adequate drainage were key factors. In total it was reported that 2 – 5% of walls in the USA are performing poorly.

The keynote lecture from Daniele Cazzuffi focussed on the use of vegetation on slopes and how the root mass can improve soil shear strength. This influence is reported to be up to a maximum of 2 m. Plant selection is important as this influences performance. Daniele suggested an increase in cohesion in the range of 2 – 15 kPa through root inclusion, but noted that without maintenance this cannot be relied upon.



Above: One of the many interesting presentations being delivered.

The other keynote lecture of the day was by James Collin on Shored MSE Wall research. There is now a manual from FHWA on the subject. It recommends a minimum L/H ratio of 0.3. It is important however to extend the upper layers of reinforcement beyond the interface to prevent a tension crack from forming.

The papers toward the end of the day looked at the use of geocells in pavements which included work with RAP infill and sand infill. The real benefit of geocells in pavement applications is where you have a fine grading or a single sized aggregate. There were also some useful papers on seismic design and behaviour of reinforced soil structures. The reinforcement becomes more effective and beneficial at higher seismic accelerations. The paper on Seismic Design of GRS Integral Abutments included some very good research. They used cement stabilised mix to limit settlement under a railway.

Day two started with a brilliant keynote from professor J Koseki on Mitagation of Disasters by Earthquakes and Rains/Floods by Means of Geosynthetic Reinforced Soil Retaining Walls. Jun highlighted a number of structures that survived the 2012 tsunami in Japan as well as showing examples of traditional structures that didn't. The Rikuzentakata GRS wall at the Kesen river bridge abutment was a good example of performance. The use of cement mix in the fill to reduce settlement is common practice in Japan. This however can be a problem which was highlighted by showing a

12TH AUSTRALIA NEW ZEALAND CONFERENCE ON GEOMECHANICS

PHOTO: Rob Brown

KEYNOTE SPEAKERS Confirmed

We are delighted to announce three of the keynote speakers now secured for ANZ 2015.

FRED BAYNES

Fred Baynes, Independent Consultant Engineering Geologist from Australia. Fred provides advice to major projects in the civil, mining and oil and gas sectors throughout the world. He regularly teaches engineering geology to both undergraduates and to provide professional development courses for practitioners. > Read More

JONATHAN BRAY

Jonathan Bray, Faculty Chair in Earthquake Engineering Excellence University of California, Berkeley, CA, USA. Prof Bray is actively performing research and conducting peer reviews in New Zealand on geotechnical aspects of the 2010-2011 Canterbury earthquake sequence. He is the Chair of the Geotechnical Extreme Events Reconnaissance (GEER) Association, and he served as Vice-President of the Earthquake Engineering Research Institute.
> Read More

GEORGE GAZETAS

George Gazetas, Professor in Civil Engineering Director of Soil Mechanics/Dynamics Laboratory National Technical University of Athens, Greece. Prof Gazetas' expertise includes seismic soil-structure interaction, elastodynamics, wave propagation in 1 and 2 dimensions, design of shallow and deep foundations against extreme loading, nonlinear foundation vibration, post-earthquake evaluation of soil and structural performance. Having served in the faculty of several universities in the USA, he has returned to his alma mater in Greece as a chaired Professor of Soil Mechanics/Dynamics. > Read More

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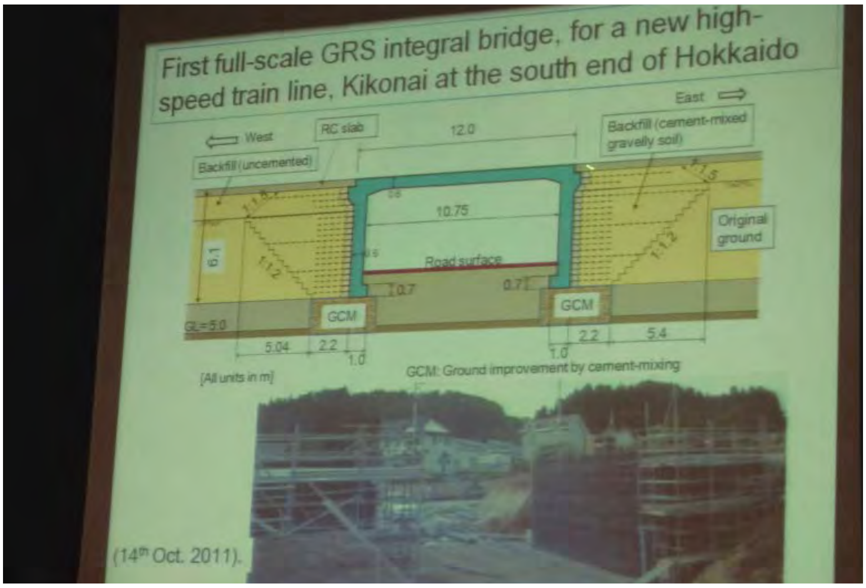

Above: Abutment detailing

very large Reinforced Earth wall that failed after a heavy rainfall event which at its peak reached 226 mm/h. The cement stabilised fill reduced the soil permeability which contributed to the failure of the wall.

We had a whole section on numerical modelling which is becoming more and more popular. The issue with this approach is the limited ability to model in reinforcement as well as the quality of the data and whether you are mixing up raw, mean, 95th percentile of other data types.

The highlight of the Wall/Slope Design session before lunch was the presentation by Pietro Rimoldi on the fully instrumented incremental concrete panel wall reinforced with Paraweb. The structure was funded by the State of Delaware and Professor Dov Leshchinsky has carried out all the review of the data obtained from site. Unfortunately 10 minutes was insufficient to do this very extensive research work justice.

Professor Tatsuako presented his keynote lecture on the importance of good compaction. This was a very interesting presentation and highlighted the fact that the internal friction and corresponding soil strength changes with change in density of the fill. Over-compaction can be a problem resulting in a lowering of the strength. In addition the degree of saturation of the fill material is possible a better measure than water content.

The final day of the Symposium started with a keynote lecture from Jerry DiMaggio on best practice in design and construction of GRS walls and slopes. Jerry has a very eloquent style of presenting and he covered this subject very well based on his experience in the USA. He stressed that the Geosynthetic Industry needs to do a better job at promoting, educating and supporting GRS walls and slope design and construction. There are too many structures that are not performing as they should and this could result in a move away from these systems to more conventional systems. The fill selection requires more consideration and compaction of this fill requires more attention.

Marco Vicari from Maccaferri presented a case study where artificially manufactured lightweight fills were used with steel mesh and geogrid reinforcement for an embankment. The fill is created by heating clay and then crushing it down to a grading of 0 – 32mm. The manufactured product has a mass of 350kg/m3 and a friction angle of 37 – 44 degrees.

The final presentation of the session was by Professor Tatsuoka who discussed the various geogrid reinforced soil structures along the Hokkaido high speed train line. Interestingly there are no conventional walls; they are all geogrid reinforced soil. The methodology adopted is to construct a geogrid wrapped wall with L/H ratio of around 0.3. The geogrid is wrapped around a soil bag. Once the structure has been formed then a rigid concrete wall is cast up against the structure. They have also done something similar for the bridge abutments. The cast concrete seeps in between the bags creating a firm connection between facing wall and reinforced soil wall.

The afternoon and final session of the Conference included a few interesting papers including a 42m high slope reinforced with geogrid supporting material excavated from a tunnel.

The Conference was closed with messages from the various chairpersons including Dov who thanked everyone's for their enthusiastic participation.

Reported by Gordon Stevens
Technical Marketing Manager,Maccaferri NZ Ltd

7th INTERNATIONAL CONGRESS ON ENVIRONMENTAL GEOTECHNICS

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REGISTRATION NOW OPEN!

The International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE), TC 215 Environmental Geotechnics is pleased to announce that the 7th International Congress on Environmental Geotechnics (7ICEG2014) will be held between the 10-14 November 2014 in Melbourne, Australia.

This Congress is the seventh in a series that started in Edmonton, Canada 1994. It is being organised by Engineers Australia and supported by the Melbourne Convention Bureau (MCB), City of Melbourne and the Australian Geomechanics Society.

The Organising Committee is compiling a first class program that will include the following Keynote Speakers:

Professor Craig Benson
Bs, Msc, PhD. P.Eng
Wisconsin Distinguished Professor and Chair
Director of Sustainability Research and Education
University of Wisconsin, Madison, USA

Dr Paul Brown
B.Sc. (Hons I), Ph.D.
Principal Advisor, Mineral Waste Management
Rio Tinto, Melbourne, Australia

Mr Shaun Davidge
MSc (Hons) in Geology, 1981, Auckland University, New Zealand
Manager, Water Strategies - GLNG Project, Santos Ltd, Brisbane, Australia

Dr Stephan Jefferis
MA, MEng, MSc, PhD, CEng, FICE, CGeol, FG
Director, Environmental Geotechnics Ltd., Oxford, U.K

Professor R. Kerry Rowe
PhD, D.Eng, FREng, FRSC, FCAE, FEIC, FACE, FIEA, FCSE, P.Eng.
Professor and Canada Research Chair - Tier I
Department of Civil Engineering, Ellis Hall, Queen's University, Kingston, Canada

Professor Charles Shackelford
Bs, Msc, PhD. P.Eng
Department of Civil and Environmental Engineering,
Colorado State University, Fort Collins, USA

Mr Mike Summersgill
MA, MSc, MBA, C.Eng, CEnv., SiLC
Chair, CLAIRE Technology and Research Group (TRG), Maidstone, Kent, UK

REGISTRATION INFORMATION

Further information on registration fees, entitlements, accommodation, social functions and all relevant terms and conditions are provided on the Congress website.

Visit www.7iceg2014.com/registration to register now.

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Company Profile – GeoSolve

ACQUIRED BY LOCAL management in October 2013, GeoSolve provides services in geotechnical engineering, as well as specialising in pavement structural testing, analysis and design. GeoSolve has thirty staff members, with offices in Dunedin and Cromwell and sub-offices in Christchurch, Queenstown, Wanaka and Invercargill, while pavement testing staff work throughout New Zealand and offshore, coordinating with Dynatest International.

Formerly a Group within Tonkin & Taylor, GeoSolve has set up independently to allow focus on the development of specialist roles. The two companies enjoy a cooperative relationship working on major projects. GeoSolve staff are embracing the new opportunities in the employee-owned organisation.

GeoSolve's team includes specialists in several related fields. Graham Salt, with predominantly geotechnical and pavements experience, heads the team with Mark Walrond and Colin Macdiarmid managing the Dunedin Geotechnical Group, while Fraser Wilson and Paul Falconer cover Central Otago and Southland. Dave Stevens manages the Pavements Group's national and international operations. Other roles include hydrology, geohydrology, mining, planning, and civil / environmental engineering. Staff are provided to Christchurch to assist EQC through Tonkin & Taylor's land damage assessment team.

Above: The heavy-duty dynamic cone penetrometer in action

GEOTECHNICAL ENGINEERING

The lower south presents an unusually wide range of geotechnical issues, with a variety of rock and soil types that present challenging slope instability and foundation engineering problems. The team is using their experience in the Christchurch earthquake recovery to advise appropriate solutions for built areas in the region that are at risk of seismic hazard.

To address the wide area of operation which includes South Westland and Stewart Island as well as Otago and Southland, GeoSolve has a readily mobilised heavy-duty dynamic cone penetrometer, for site investigation work in remote sites or where access is limited.

HEAVY-DUTY DYNAMIC CONE PENETROMETER

Examples of recent work include liquefaction susceptibility studies on reclamation fill and land underlain by soft saturated sediments. GeoSolve has also been involved with assessments and stabilisation of large scale creeping landslides, affecting multiple residential properties.

Work in the Southern Lakes covers a range of geotechnical issues, including investigations for development purposes, rock and soil slope stability assessment and remedial design, retaining walls, liquefaction risk, landslide and alluvial fan hazards, piling and ground improvement, construction inspections, earthworks testing and certification.

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in pavement structural testing, analysis and design. With staff from Auckland to Invercargill and three Falling Weight Deflectometer units, structural testing and evaluation can be efficiently programmed. Services are also provided in Australia and the Pacific Islands using either a full FWD or portable unit where necessary for projects on a limited budget.

The group now links with Dynatest International for high speed pavement condition assessment, and with a focus on research and development. The team is working on a wide variety of projects, both nationally and in the Pacific region, including high speed road condition data collection for Auckland Transport, pavement testing and analysis for local authorities, NZTA, contractors and consultants, and multiple ongoing research projects with the NPTG and NZTA.

GeoSolve director and Pavements Group manager, Dave Stevens, is enthusiastic about recent advances in technology. "It's exciting being involved in the research and development of new pavement analysis techniques that are enabling engineers to obtain improved understanding of what is happening in their pavements, translating into some serious savings for roading networks that are facing reduced funding allocations" he says.

Contact is Annabel Small
asmall@geosolve.co.nz

Company Profile – Jacobs

Figure 1: HOM Station Excavation, Hong Kong, where ground support was designed by Jacobs staff.

JACOBS HAS A strong team of geotechnical engineers, engineering geologists, and contaminated land specialists based in New Zealand. Our team has had the consistency, scale and flexibility to take on major projects in New Zealand and across the globe. We're now looking to grow our team and build on our international work to increase our presence in the local market.

In the past couple of years our team has worked on some landmark projects, often working closely with our specialists in geothermal energy, power distribution, water networks, and highways.

In Indonesia we work extensively with geothermal energy companies where we perform geotechnical design of their steamfields. We have undertaken geohazard assessments on new geothermal prospects, directed ground investigations up volcanoes, designed roads and wellpads on extreme slopes, and stablised landslides that threaten existing infrastructure where previous remedial attempts have failed.

In Hong Kong we are monitoring and verifying the construction, testing, and commissioning of the Hong Kong section of the XRL railway linking Hong Kong to mainland China. When completed, the US$9 billion Hong Kong section of the project will include 26 kilometres of twin-track tunnels, built using eight tunnel boring machines and drill and blast methods, and a 15-platform below-ground terminus station at West Kowloon. For the Kwun Tong Line Extension, our engineers have also led the detailed design of

Figure 2: Backscarp of large landslide which emergency works failed to stabilise. Our NZ staff went to the site and designed a de-watering system.

Figure 3: Steep pumice cuttings and a high MSE embankment over a gulley

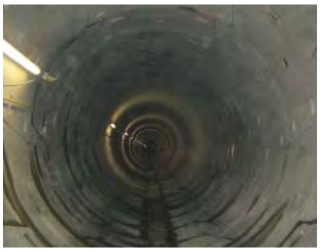

Figure 4: Hobson Tunnel

JACOBS

Jacobs and Sinclair Knight Merz have combined to form one of the world's largest providers of technical, professional and construction services across multiple markets and geographies, with 70,000 employees worldwide. We offer full-spectrum support to industrial, commercial, and government clients in multiple markets, including Aerospace and Defence, Automotive and Industrial, Buildings, Chemical and Polymers, Consumer and Forest Products, Environmental Programs, Infrastructure, Mining and Minerals, Oil and Gas, Pharmaceuticals and Biotechnology, Power and Utilities, and Refining.

temporary works excavation support with rock bolts and fibre reinforced shotcrete, open box rock excavation support (50m high rock slopes) and grout curtain for the extension of the Hong Kong MTR metro system and station at Ho Man Tin.

In New Zealand Jacobs were the main designer for the construction of a new two lane State Highway to the east of the Taupo for the Taupo District Council. Our geotechnical design services included new interchanges, various bridge and retaining structures, a network arch bridge over the Waikato River and a steel bridge over the full length of the Contact Energy site. The route of the new State Highway involved 1 Mm^3 of earthworks through geothermally altered soils, ignimbrites and pyroclastic deposits. Thermal blankets were provided at geothermal hotspots, with the team providing ongoing construction support for the project. We conducted a phased and detailed investigation of geothermal related subsidence involving monitoring, surcharging, trial pitting, CPT investigations, 2D electrical resistivity imaging and inclined drilling.

In Auckland we were heavily involved in Watercare's Hobson Bay sewer tunnel project. The existing 100 year old above ground concrete sewer was demolished and a new storage and conveyance tunnel was constructed beneath Hobson Bay. We carried out the detailed design for the project which includes a 3.7 m ID, 3 km long tunnel and associated shafts and pump station which are over 35 m deep and up to 25 m in diameter. We also produced the Geotechnical Baseline Report.

In Australia Jacobs has recently completed geotechnical design and construction supervision of rock anchors for a major new wharf for a marine supply base in Darwin. Three of our team stayed in Darwin during construction to assist our local design team with the geotechnical aspects of the project, and we are currently working on the Webb Dock Redevelopment in Melbourne. Our geotechnical engineers are completing the detailed design for a new wharf structure at Webb Dock West, strengthening works of the existing Webb Dock East wharves and an extension to the Webb Dock East wharf.

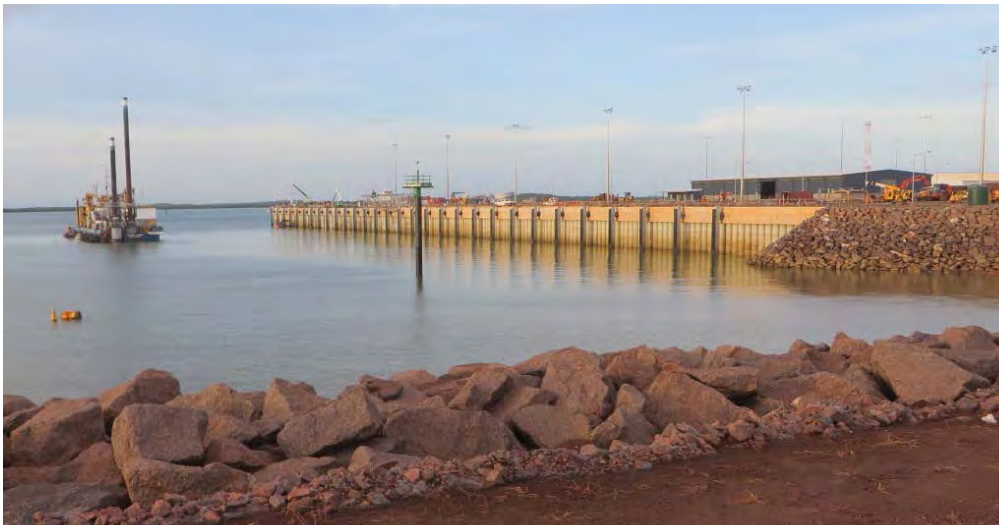

Figure 5: Completed wharf in Darwin supported with 91 anchors, each 40 m long. The anchor design and installation was supervised by our NZ staff.

NZ Geotechnical Society 2014 PHOTO COMPETITION

The 2014 theme is

ENTERIES CLOSE *October*

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5. Winning entries will be final and no correspondence will be entered into.
6. NZ Geotechnical Society members only may enter.

The winning photo and the top runners-up will be printed in the December 2014 issue of *NZ Geomechanics News* and be used on the NZGS banners. Your photo will be seen at events all over the country!

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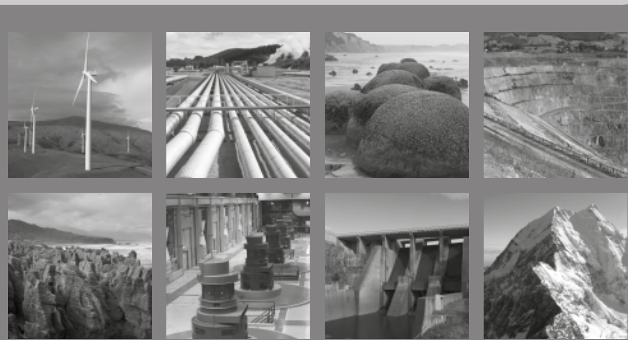

Obituary – Professor A.W. Bishop

Alan Wilfred Bishop (1920–1988) MA PhD DIC DSc was a British Geotechnical Engineer and an academic at Imperial College London. After his graduation from Emmanuel College, Cambridge, Bishop worked under Alec Skempton and obtained his PhD in 1952. He worked extensively in the field of experimental soil mechanics and developed apparatus for soil testing, such as the triaxial test and the ring shear, and the Bishop Method of assessing slope stability. His contribution to the science was widely acknowledged and he was invited in 1966 to deliver the 6th Rankine Lecture of the British Geotechnical Association titled "The strength of soils as engineering materials". Nowadays, a part of the Soil Mechanics Laboratories at Imperial College is named after him in recognition of his long-time work at the College. Recently Laurie Wesley was invited to write an obituary for the Bishop and Skempton archives at Imperial College, which has been re-printed here for the interest of NZGS members.

"I first met Professor Bishop in late September, 1964, at a social function at Imperial College to welcome those of us who had enrolled to take the one year post graduate course in soil mechanics. I was welcomed to the function by one of the PhD students; I think it was Derrick Petley. After introductions and some small talk he took me to meet Professor Bishop, who welcomed me and asked where I was from. I told him and he seemed sympathetic to New Zealanders as he had previously had some contact with students from my country. My first impression of Bishop was that he was unassuming and unremarkable in appearance, but not ordinary in personality or demeanour, impressions that would remain with me throughout that course and in later years when I returned to Imperial College to do a PhD under his supervision.

Soil mechanics at Imperial College was still in its golden years in 1964, with a team of very distinguished lecturing staff, made up of Skempton, Bishop, Bob Gibson, Nick Ambraseys, Norbert Morgenstern and Noel Symonds.

Left: Professor Bishop and his wife Myrtle at Whitstable in February, 1987.

Staff members were normally referred to using both first and family names, except for Skempton and Bishop. The class taking the M.Sc(Eng) course was not large, between 25 and 30 students if I remember correctly, so we got to know each other and our lecturers quite well. The latter were all very good, but Skempton and Bishop were undoubtedly the stars. Skempton was a brilliant lecturer; he had a commanding presence and gave a very polished delivery. Bishop had a less commanding presence, but he had a careful, systematic, delivery and a very dry sense of humour, which we students appreciated.

As students, I think we all liked Bishop the better of the two, primarily because he was happy to fraternise with his students and we came to know him well as a person. Skempton was more remote and tended to talk down to his class. I think the two personalities reveal an important truth about what really makes a good teacher, namely that it is not just about skilled presentation, but also about earning the respect and confidence of those being taught. Earlier in 1964, Skempton had delivered his Rankine lecture on residual strength and progressive failure of slopes. One member of our class was quite sceptical about Skempton's concept and questioned him about it, but did not feel he got a satisfactory answer. Later developments showed his scepticism was well justified. So while Skempton was an outstanding leader, and was the better presenter, I did not feel during the course that he had the same respect or confidence of his students that Bishop had.

In due course I obtained the M.Sc(Eng) and DIC qualifications, and returned to New Zealand. I travelled home via Canada to attend the Sixth International Conference on Soil Mechanics and Foundation

FIFTEENTH GEOMECHANICS Lecture

NEW ZEALAND GEOTECHNICAL SOCIETY INC

John Wood
Geotechnical Issues in Displacement Based Design of Highway Bridges and Walls

NZGS is pleased to be able to announce that the next Geomechanics Lecture is to be presented by John H. Wood. This award was established to honour individuals who have made a notable contribution to New Zealand Geomechanics.

John is well known to the geotechnical community for his work on the seismic design of various structures including retaining walls and reinforced earth structures. He has published many papers on testing, design, performance and strengthening of these structures. His thesis on earthquake induced soil pressures on structures was written early in his career and is still regarded as a standard reference.

John will tour his lecture around the country later this year, culminating in the formal address and presentation of the award at the ANZ 2015 Conference in Wellington next February. We look forward to hearing his anecdotes and insights from a long and influential career.

ABSTRACT

There is a growing emphasis on displacement based earthquake design for buildings, walls and bridge structures. The next edition of Section 5 (Earthquake Resistance Design of Structures) of the Bridge Manual, expected to be published in late 2014, will indicate that Displacement Based Design (DBD) is the preferred design method for highway structures.

For bridges and major wall structures, the damping and deformations within the foundation system have a major impact on the displacement response. In the past, the geotechnical input for the design of structures has focused on investigating and defining the soil strength parameters. For DBD there is now a need to investigate and assess soil stiffness as well as strength and to focus on soil-structure interaction analysis.

The shortcomings in the current site investigation methods of assessing soil stiffness and damping parameters for DBD will be discussed and the effects of the uncertainty in these inputs on the structural response in earthquakes will be illustrated by examples from the presenter's recent design and assessment experience.

SH 1 bridge across Waikato River at Atiamuri

< Reinforced Earth wall at SH 1 Ngauranga Interchange

BIOGRAPHY

John Wood is a consulting civil engineer specialising in bridge design, structural investigation, soil-structure interaction and earthquake engineering. Before setting up his consulting engineering practice in 1986, he was Head of the Ministry of Works, Central Laboratories.
His recent work includes peer reviews of seismic strengthening proposals and seismic risk assessment for hydro power stations. He has carried out bridge strengthening design and peer review for the New Zealand Transport Agency, and research into the earthquake performance of underground structures, reinforced earth retaining walls and bridge abutments.
John is a Life Member and past President of the New Zealand Society for Earthquake Engineering. He holds post-graduate degrees in structural and civil engineering from both the University of Canterbury and California Institute of Technology.

SCHEDULE NOVEMBER 2014

Tuesday 4th – *Auckland*
Wednesday 5th – *Hamilton (joint with Bay of Plenty)*
Thursday 6th – *Wellington*
Tuesday 11th – *Dunedin*
Wednesday 12th – *Christchurch*
Thursday 13th – *Nelson*
Wednesday 19th – *Napier*

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Engineering in Montreal, and also a two day "pre-conference" seminar at Laval University in Quebec City. The speakers at this seminar were Skempton and Bishop from Imperial College, Roscoe from Cambridge, and Rowe from Manchester. I guess they were the four leading figures in soil mechanics in England at that time. They stayed in the same university quarters as me and I had meals with them on a couple of occasions. I still recall one incident during that seminar quite clearly. Roscoe was giving his presentation on critical state soil mechanics which was quite new to me at the time. He presented nice curves of stress and volume change against strain showing that regardless of the initial state at the start of each test, they all ended up at a uniform "critical state". I can't recall whether Bishop interrupted Roscoe or made his comment at the conclusion of the lecture, but he pointed out that with clays failure was generally brittle in form, and took place on specific planes, so that the material tended towards the residual strength rather than the critical state. Roscoe replied, rather petulantly, "We know that, Alan, we know it (critical state) doesn't work with clay, I am talking about sand here". I guess my somewhat negative view of critical state soil mechanics began at that time and was further influenced by other negative comments Bishop made when the opportunity arose. I think it was Bishop who said that the "research approach" of Imperial College was basically to look for solutions to the many problems or challenges that were posed by practical situations, while Cambridge had the opposite approach, namely that they had a solution in the form of critical state soil mechanics and were looking for problems they could solve with it.

About seven years later, after working for the New Zealand government for another three years and the Indonesian government for four years, I wrote to Professor Bishop to ask whether he would accept me as a PhD student, and if so could he offer any financial help. He replied promptly in the affirmative to both questions. He had funding for a research project into the soft clays along the coast of the Thames estuary, which included the cost of employing three people. I was to do the laboratory testing, Richard Pugh (from England) was to look after a trial embankment that was part of the project, and Mamdouh Hamza (from Egypt) was to do sophisticated finite analysis linking field and laboratory test results with the performance of the embankment. Bishop had funding to employ us for three years. I was married with three children at the time and my wife, Barbara, and I were expecting our fourth child about six months after we arrived. So my PhD thesis had to be finished promptly on time in three years, or I would be in financial trouble.

I presented myself to Bishop shortly after arriving back in London, and he gave me a briefing on the project. It was linked to plans to raise the height of the levees along the Essex (north) coast of the Thames Estuary. Some work on the research project was already underway. In particular, the site had been selected near a village called Mucking, and a large number of undisturbed block samples had been obtained from a pit excavated at the site down to a depth of almost five metres. These samples were taken in steel cylinders having a diameter and height of about 25 cm. The samples were sealed top and bottom with a layer of tin foil and thick rubber held in place by rigid metal plates. The plates were clamped tight with bolts from top to bottom at each corner. I could scarcely believe my eyes when I saw those samples in the store room at Imperial College. There were about 25 of them, all neatly stacked in tidy rows. If I have any special gifts in the soil mechanics field they are as a laboratory experimentalist, and to me those samples were an absolute treasure chest. The thought that I was being let loose on them under the supervision of Bishop was rather exciting.

Bishop had told me when he first offered me the opportunity to do a PhD that I would be doing laboratory testing, and I was very happy about that. However, I had some reasonably clear ideas about what I would like to do, and indeed what I would not like to do. Among the latter was a very firm conviction that I did not want to use up a lot of time designing equipment. I was expecting to get some very clear instructions or at least some guidelines from Bishop on what he expected from me over the next three years. However, this proved not to be the case. I received from Bishop only some very general, if not to say vague, thoughts about what I was to do. One relatively clear expectation was that I was to do some "stress path" triaxial tests, meaning tests that would replicate stress paths in the field. He mentioned that I might well need to design some special equipment to do such tests. My heart sank a little at this prospect. However, after examining the various pieces of testing equipment in the laboratory, I could understand why he had made that comment. None of the devices were really suitable for stress path testing. Their vertical load application systems were all strain controlled and at that time this did not easily lend itself to controlled stress applications. The same problem did not apply to the horizontal stress as this was applied by the water pressure in the cell, so in effect it was already a hydraulic pressure system. It seemed, therefore, that a hydraulic loading system would be the only way to apply the vertical stress in a controlled manner.

So I attempted to design a hydraulic loading system for a conventional triaxial cell, making use of a bellofram piston and cylinder above the cell. I spent a lot of time developing several possible designs, none of which I was really happy with. I showed them to Professor Bishop, and he considered them carefully but generally had the same reservations about them that I had. I had learnt by this time not to expect clear instructions from Bishop. Instead, the way to work happily with Bishop was to come up with a work plan and then put it to him. If it did not immediately get his blessing then it should be put aside and an alternative developed. I had an idea in the back of my mind that maybe the hydraulic loading cell should be below the cell and apply its force to the pedestal on which the sample was mounted. I played around with this for some time, and eventually a design came together that I was very satisfied with. I had difficulty devising a convenient way of measuring the vertical deflection of the sample until I hit on the idea of bringing external vertical rods attached to the loading cylinder up through the base of the triaxial cell so that measurements of vertical deflection could be made by a gauge attached to the top of the triaxial cell. This ensured that only the deflection of the sample would be measured.

I drew up this latest design in some detail and once again took it to Bishop. He looked suitably impressed and I think it was only the following day that he told me to go ahead and get one made. There was a fine workshop and very helpful skilled technicians available for making the device. I don't recall how long the workshop took but the day soon came for me to put it together and give it a trial run. Naturally I was both excited and nervous about the device, and recall putting it together for the first time quite clearly.

Unfortunately, the first trial did not go well. There was far too much frictional drag, and it turned out that there was an error in the tolerances on the linear bearing above the hydraulic cell. This was corrected and from that time onwards the device worked like a charm. Bishop was quite impressed and we moved on to the control system for the hydraulic pressure. Bishop had already made use of small gear boxes to raise and lower the mercury pots of his pressure system and so I continued and developed this system. It was far from ideal but was the best available for me to use at the time. Compared with today's systems it was very primitive. When I had got a few results from the apparatus demonstrating its capability, Bishop and I wrote a paper on it which was published in Geotechnique. The result was that it became known as the Bishop Wesley stress path apparatus, and was produced and marketed commercially.

I should mention that the staff situation at Imperial College had changed considerably over the nine years since I did the M.Sc(Eng) course. Gibson, Morgenstern, Ambraseys, and Symonds had all moved on, and in their place were Peter Vaughan, Dick Chandler, Angus Skinner, and Gordon Green. I got to know them all very well, partly because of a fortuitous arrangement regarding facilities for coffee and lunch breaks. A mini-kitchen had been set up in one corner of the post-graduate soil mechanics laboratory, and all the staff members, except Skempton, made regular use of this facility. I felt at the time that Skempton placed himself fairly close to God, and did not fraternise or eat with lesser mortals in a make-shift kitchen in the corner of a laboratory. I was told this kitchen arrangement was not in the original plan, but came about because the academic staff did not like the long walk to the facility they were expected to frequent. This kitchen arrangement meant that we post graduate students had the opportunity to listen in on and indeed take part in conversations or debates between the academic staff. For me, those opportunities made my PhD years particularly memorable and worthwhile. I also had my first experience of teaching soil mechanics while doing my PhD. Gordon Green, who taught the first soil mechanics paper, resigned and went to America. I was approached by Peter Vaughan and Bishop to see if I would teach the course in his place. I agreed, and apparently from feedback or exam results I did a good job of it. I didn't quite teach the whole course. Skempton taught the introductory material on particle size, Atterberg limits, clay activity, and sensitivity. I understood he liked to teach this and did not believe that anyone else could do it properly, or as well as he did. He was very probably right.

As time passed and my testing programme progressed I got to know Bishop better and had discussions with him about many subjects other than soil mechanics. He was a Quaker and had quite wide philosophical ideas on many things, especially education. He was always keen to chat when the occasion arose. He had a habit of looking around the post graduate laboratory late in the day when most of the students had gone home. He would stop and look carefully at various tests in progress, or items of equipment that were new around the place. If there were things he was not happy with he would make a few remarks to the student involved when a suitable opportunity arose: the student would get the message and mend his or her ways. Bishop was not a robust person, and tended to be a hypochondriac. He could talk for a long time about his various ailments, and the range of pills or medicines he took to cope with them.

However, his health problems were real, and I was very sad when many years later I learnt of his death at the relatively young age of sixty eight. Bishop also got to know my family quite well, as Barbara and the children would sometimes call at the laboratory during school holidays to say hello, or to take me with them on a visit to one of the museums close by, especially the science museum which appealed to our children. Years later, when I applied for a lecturing job at Auckland University I named Bishop as a referee. I have not seen the reference he provided, as it was sent directly to the university, but I was told it made some positive comments about my wife and family. He was probably impressed that my children managed to visit the laboratory on numerous occasions without touching, let alone destroying, any of his precious equipment.

I became aware, from time to time, that not everyone got on as well with Bishop as I did, and to some extent I could understand this. Bishop was an unusual person in many ways, and had his idiosyncrasies. He was a bachelor, didn't drive a car, and was very attached to his elderly parents who lived at Whitstable on the south coast of the Thames estuary, not far from Canterbury. I understood that during the week he lived in an apartment in London and at the weekends he usually went home to care for his parents at Whitstable. In addition to not driving a car, he did not like travelling by plane. His attendance at conferences tended to be governed by whether it necessitated air travel. Bishop was also rather quick to criticise others, especially on mattes technical, as the incident at the Laval University seminar described earlier shows. The introduction to Bishop's Rankine lecture by Professor Nash recalls an example of "Bishop's keen critical sense which he mixed with dry humour" at the Paris ISSMFE conference when "he was engaged in spontaneous dialogue on the platform with the distinguished Dutch research worker Professor Geuze. Geuze was postulating that rheological phenomena could cause soils to lose an enormous percentage of their strength with time. Bishop pointed out that, if this were so, all the world would have become as flat as Holland!"

I wrote up chapters of my thesis as my testing progressed, and gave these to Bishop to read. As I explained above, it was imperative that I completed my PhD within the three years of my paid employment by Imperial College, as otherwise I would run out of funds to take my family home to New Zealand. Bishop indicated he was happy with my drafts, and made no significant criticisms of them. I completed my thesis about three months before my three years came to an end, and gave drafts of all chapters to Bishop. He gave no indication that he was not happy with them, so I went ahead and had my thesis bound in its final form, and submitted it formally. Bishop set in motion the steps for an external examiner to be appointed and a time set for the oral examination.

My external examiner was Professor Peter Wroth of Cambridge University. I had attended a series of lectures on critical state soil mechanics that he gave at Imperial College and he seemed a nice person and I was comfortable with having him as my external examiner. However, when I fronted up to Bishop and Wroth for the oral examination, I was given a very hard time by Peter Wroth, and began to wonder part way through whether I would be passed. Wroth began his questions by asking how many technicians I had helping me get through the volume of testing I had done. He didn't seem to believe me when I said it was entirely my own work. However, Bishop backed me up emphatically, and said my thesis was impressive because I had not only designed a very useful piece of equipment, but had also used it to carry out an excellent series of tests. Wroth was clearly irritated by the fact that I had not attempted to interpret my tests in terms of critical state theories. He pointed out a number of typographical errors in the first two chapters, and questioned me about how I would estimate the stability of an embankment on a soft clay. I think he didn't like my answer which was that I would base it on the undrained strength of the clay.

Eileen, who looked after the coffee and tea department at the corner of the postgraduate laboratory, brought in some refreshments midway through the interview, which relieved the tension somewhat. After about two hours I was invited to ask my examiners questions if I so wished, and I began by asking whether they were surprised by the low values of Poison's Ratio my tests showed for the soft clay. Both examiners looked completely blank, and fumbled around for answers. The interview ended quickly after that and I was sent out to wait while they deliberated on their verdict. After what seemed to me a rather long time they came out and Bishop told me I had my PhD. They both congratulated me along with other staff members and fellow PhD students who were in the laboratory at the time. We had coffee and tea together, in the course of which Bishop said very forthrightly: "Wesley's problem in his interview was that neither of his examiners had read his thesis"! I thought it was very decent of him for being honest, though he could hardly be otherwise as that was clearly the case, but I don't think Peter Wroth liked him for saying it so openly.

Not long afterwards, I said farewell to Bishop and other members of the academic staff and with my family returned to New Zealand to begin work with an Auckland consulting company. In my final chat with Professor Bishop we made plans for publishing a paper on my work. I was to write up my experimental work in a factual manner, and Bishop would edit it and place it in the context of the known behaviour of soft clays at the time. I wrote the draft of my part of the deal within a few months of returning to New Zealand and put it in the post to Bishop. I waited a long time for his response; in fact I waited in vain as a reply never came. Eventually, more than a year later if I remember correctly, I got a letter from Peter Vaughan (one of the staff members at Imperial College who had become a good friend during the course of my PhD) to inform me that Bishop had suffered a mental breakdown of some sort, and it was not at all clear when, or if, he would return to his former position. I was very sad to receive this news as I had enjoyed my time working with Professor Bishop. Also, it complicated the situation regarding the paper we were planning to publish. By that time I was well immersed in my new role in a consulting company, and had family obligations, not to mention building an additional bedroom to my house and a new garage. My motivation to get the paper published was slowly being eroded away by other demands.

I let the matter rest in the hope Bishop would recover and take things up where he had left off. However, a considerable time later, in 1986, I received a letter from Peter Vaughan bringing me an update on Bishop's situation. He wrote in general terms about several matters in his first page, at the end of which he concluded with the comment: "And you might like to sit down before you read the next page". I didn't sit down and on the next page I read "You will be surprised to learn that Professor Bishop has:

- Learnt to drive a car
- Got married
- Generally lost interest in soil mechanics."

Naturally, I was more than surprised. In fact I was astounded and sat down to ponder on this extraordinary news. Peter went on to give me an account of Bishop's illness and how it was that he had learnt to drive a car, and had married. When Bishop was recovering from his illness the psychiatrist looking after him told him that he needed some completely different interests from soil mechanics, and that perhaps learning to drive a car might be one of them. Bishop took this seriously and set about learning to drive. A widow living in Whitstable had known Bishop for many years, and was in touch with him during his illness. If I recall correctly their respective families had been friends for a long time. Her name was Myrtle and she offered to help Bishop learn to drive. In the course of those driving lessons the friendship flourished into a romance and they married. I was quite delighted to know that Bishop had regained full health and was happily married.

That might well have been the end of this story, but early in 1987 I had occasion to travel to London to be a witness at a contract arbitration case, and I took the opportunity to phone Bishop just to say hello and congratulate him on his new married status. He was very pleased to hear from me, and told me about his marriage and asked me if I had time to come to Whitstable to have lunch with him and Myrtle. I was delighted to accept the invitation and we arranged a date for my visit. I travelled to Canterbury by train and Bishop picked me up at the station. He first drove me on a sightseeing tour around Canterbury and a visit to the cathedral, and then took me to his home to meet Myrtle and have lunch together. It was a very nice occasion; they were obviously very happy and told me about the property up north they owned and where they spent part of the summer months. Bishop later drove me back to the station to catch my train to London. I don't recall soil mechanics being mentioned at all during my visit and I knew there was no prospect of getting any help from Bishop in finishing our paper. But my pleasure at visiting Bishop and Myrtle and seeing them so happy together far outweighed any considerations I might have had about a mere technical paper. I remain embarrassed by the fact that the paper is still waiting to be written.

Very sadly, the following year I received news of Bishop's death. He was only 68, and enjoying a very happy retirement.

Laurie Wesley
At the start of his career as a geotechnical engineer Laurie spent two terms of four years working for the Indonesian government interspersed by five years with the New Zealand Ministry of Works. Following this he completed a PhD at Imperial College, and returned to Auckland to work for Tonkin and Taylor for eleven years. He then lectured at Auckland University for 15 years, and still does some part time teaching, in Auckland, Indonesia, and Chile.

NZGS Honours Life Member

Above: Geoff with his Life Member certificate awarded to him by the current NZGS Chair, Gavin Alexander

CONGRATULATIONS TO
Geoffrey Farquhar who is elected a Life Member of the New Zealand Geotechnical Society in recognition of his significant contribution to the affairs of the Society over many years.

The election and presentation of a certificate were carried out at the annual general meeting of the NZGS in Auckland on 4 March 2014.

Geoff's contribution to our Society over the past 20 years is outstanding and includes:

- Co-editor of NZ Geomechanics News 1994-95
- NZGS Secretary 1996-97
- NZGS Management Committee Chair 1998-99
- Organising Committee for the 1998 Symposium – Roading Geotechnics 98
- Driving the revision to our rules (late 1990's)
- Geoff lead the change to incorporate the Society in the late 1990s and assisted with the change to charitable status in the mid 2000's
- Part of the team completing the update of the Field Descriptions Guideline through the early 2000's (published 2005)
- Chair of the organizing committee for the 9th ANZ Conference, 2004
- Provided key input in the development of the PEngGeol registration system for Engineering Geologists, including providing essential interaction with IPENZ
- Providing advice to David Burns as Chair 2011-12
- Representing NZGS interests on the IPENZ Board 2013-ongoing
- Reviewer on numerous occasions for NZGS symposia and ANZ conference papers, and
- A regular participant in Auckland Branch activities.

IPENZ Fellows

THE ANNUAL IPENZ Fellow's and Achievers' Dinner has honoured three prominent NZGS members. As well as recognising a remarkable group of engineers, the dinner officially launched the IPENZ centenary. Set against the backdrop of historic military aircraft in Christchurch Air Force Museum, the event on 21 March featured actors in 1920s costume and archival footage showing snapshots of IPENZ history. The 420 guests celebrated with the thirty eight new Fellows, three Distinguished Fellows, the winners of nine engineering awards and the new IPENZ Companions.

Companions are people whose qualifications are not in engineering, but who have obtained a position of significant responsibility in which they have interacted or are interacting with the engineering profession in a significant way. Companion Members have reached similar standing and recognition amongst the engineering community to an engineer who has reached or is approaching the grade of Fellowship, the most prestigious level of Membership.

ANN WILLIAMS – COMPANION
Currently the Technical Director of Engineering Geology and Hydrogeology, Ann has spent the last 17 years of her 22 year career with Beca. She is a graduate of the University of Auckland with the degrees of Bachelor of Science and Master of Science in Geology (Honours), and has continued her professional development with post-graduate studies in Resource and Environmental Management and in Hydrogeology.

Ann is the past Chair of the New Zealand Geotechnical Society and is Vice-President representing Australasia on the Executive of the International Association for Engineering Geology and the Environment (IAEG) for the period 2011 to 2014. She is a Fellow of the Geological Society of London (FGS) and member of the International Association of Hydrogeologists (IAH), and an associate editor of the international journal, Quarterly Journal of Engineering Geology and Hydrogeology (QJEGH).

Ann fully deserves this recognition equivalent to Fellowship for her hard work in these varied roles promoting and developing the profession.

The Turner Award recognises a continuing contribution to the engineering profession as demonstrated by a commitment to the ideals of a self-regulating profession.

WILLIAM GRAY – TURNER AWARD

William has specialised in the investigation, design and construction of projects in New Zealand, Australia and South-East Asia. His technical skills lie in geotechnical engineering, project management, pavement and earthwork design and aggregate characterisation.

He has held positions such as team leader, project manager and specialist geotechnical engineer on a myriad of major projects. He also plays a significant leadership role supporting over 400 staff on project management and specialist geotechnical development. He has published and presented a large number of technical papers, particularly on geotechnical issues and pavement design.

He is a member of the Nation Pavement Technical Group and worked on the review of the earthworks component relating to pavement stabilisation. He has lectured Diploma and Bachelor of Engineering Technology students on geomechanics in the context of land development. He has also spoken to community groups on topics like liquefaction and new building standards.

William was very active in his early years in scouting, school boards and his local church. In 2005 he joined a group of other Kiwis to participate in a Habitat for Humanity homebuilding project in Fiji. He is an active Rotarian, often leading other Rotarians in community projects.

His past and current work clearly shows he has contributed significantly to engineering and the community over his working career, making him an excellent recipient of the Turner Award.

IPENZ Fellows are Members who have made a substantial contribution to the development of the engineering profession, its practices or IPENZ itself. Fellowship is the most prestigious level of Membership. It recognizes outstanding individual engineering achievements or contributions by awarding Fellowships and Distinguished Fellowships.

IAN MCCAHON – FELLOW

Ian graduated from the University of Canterbury in 1975. He worked as a civil and structural engineer until 1986 when he was presented with a box of files and 2 text books and told he was a geotechnical engineer. Since then his main work area has been in geotechnical engineering, but he has also been involved in hydro power assessments and design throughout New Zealand and South East Asia.

Ian has been responsible for the geotechnical input into many building foundations in Christchurch. In 1990 he was responsible for the liquefaction chapter of the first detailed study of seismic hazard for Christchurch and this led to an involvement with the Christchurch engineering lifelines group as hazard advisor for 15 years.

Ian has been elected a Fellow of IPENZ for his contribution to the advancement of engineering practice, in particular his development of guidance for designing foundations for various ground soil and rock types in the Canterbury region. His detailed knowledge of soils and subsurface structures in the region has made him a key point of reference. He shares his knowledge with others through teaching at both local tertiary institutions and within learned society activities of the profession.

NZGS Submission on IPENZ and CPEng Code of Ethics

New Zealand Geotechnical Society

Submission on IPENZ and CPEng Code of Ethics

Wednesday 30th April 2014

The New Zealand Geotechnical Society (NZGS) has over 1000 members who practice across the fields of geotechnical engineering, engineering geology and rock mechanics. While our membership includes professional engineers and engineering geologists, and people working towards those qualifications, it also includes many others who work in different areas and at different levels. At present, our membership of just over 1000 includes 357 Professional or higher Members of IPENZ, 278 with CPEng registration and 15 with PEngGeol. 240 members of our Society hold other grades of IPENZ membership. Consequently, around 60% of our members are currently bound by the IPENZ/CPEng Code of Ethics and governed by the disciplinary procedures.

We are a Collaborating Technical Society (CTS) of IPENZ. Our rules currently require compliance with the Rules and Code of Ethics of IPENZ, however we have no mechanism for investigation of breaches or disciplinary action. As a result, while the spirit is clear, the linkage set out in our rules is somewhat tenuous. Our rules are currently being reviewed, and the revised version may include a less direct linkage to those aspects of the IPENZ Code of Ethics that are relevant to our wider membership. We feel that the value of and requirement for all CTS/TIG/SIG members to be bound by the Code of Ethics should be debated further, with due consideration of the relevance and compliance costs.

Our wider membership was given the opportunity to comment on the IPENZ consultation documentation, but less than 1% responded. Perhaps this in itself is a measure of the relevance of the Code to those members who aren't directly bound by it. This response has been prepared by the Management Committee and reflects the feedback from a small number of our members.

A significant issue for us stems from the wide range of levels of geotechnical practice across our industry. The level of competence required to provide geotechnical advice for a house site in an already prepared residential subdivision is orders of magnitude less than that required for, say, a new underground rail line through an existing city centre. Our membership covers the full spectrum, with many at the lower end potentially including "Geotechnical" as a practice field in their CPEng assessment documentation. Many civil or structural engineers feel competent to undertake simple geotechnical investigations and to provide foundation design recommendations for "straight-forward" sites and projects, sometimes with a lack of awareness of hazards or geotechnical considerations that might come to light during construction or affect the long term performance of the development. It is very difficult to take meaningful action against these practitioners when they miss geotechnical hazards that would be obvious to a specialist. While arguably principally an occupational regulation issue, the inclusion of negligence and incompetence under ethical requirements, together with the addition of diligence to the requirements will provide additional opportunities for these practices to be investigated. This must be a good result for our profession.

As mentioned above, some 60% of our members are already formally and directly bound by the IPENZ or CPEng Code of Ethics through their membership of IPENZ or professional registration. Many others operate in areas where such a full and formal code is not relevant and, therefore, warranted. With this in mind, the NZ Geotechnical Society's formal response to the consultation documentation is set out below.

Q1 What are your views on the applicability of the code of ethics and the terminology that should be adopted?

Some elements of the Code of Ethics are applicable to all members of the NZGS, while others are less directly relevant. Of greatest relevance to all members are 2. Act with honesty and integrity, and 3. Not act negligently or incompetently. Extending the code formally to include Collaborating Technical Societies such as the NZGS raises the bar of professionalism arbitrarily to a level beyond that which is appropriate for some of our members. Extending coverage will significantly increase the number of people subject to it and, potentially, the workload of bodies dealing with reported breaches. It will inevitably increase costs for our members, many of whom are already subject to the IPENZ/CPEng rules and code of ethics. On balance, the NZGS does not consider that the Code of Ethics should be extended beyond the current professional engineer and engineering geologist framework. As stated in our introduction, however, we feel that the value of and requirement for all CTS/TIG/SIG members to be bound by the Code of Ethics should be debated further, with due consideration of the relevance and compliance costs.

1: INFORM OF ETHICAL OBLIGATIONS

Q2 Do you agree with this obligation being included in the code of ethics, given its critical association with the principle to report adverse consequences (Rule 6)?

This question is not applicable in our case as we do not believe all of the ethical obligations are relevant to our members as a whole. Some of our professional members believe this should be a recommendation rather than an obligation.

Q3 What issues, if any, do you have anticipate arising with your client base in relation to this?

This question is not applicable in our case as we do not believe all of the ethical obligations are relevant to our members as a whole. Our professional members believe some clients may be uncomfortable with the Code of Ethics overriding commercial confidentiality, but that this transparent approach is correct.

2: ACT WITH HONESTY, OBJECTIVITY AND INTEGRITY

Q4 Are you comfortable with the proposed consolidation of these obligations into a single succinct standard? What do you see as the benefits or risks of the proposed consolidation of these obligations?

This aspect is fundamental to professional behaviour in the wider sense of the term, and is, therefore, applicable to our full membership. We see consolidation as beneficial, as it simplifies the Code.

3: NOT ACT NEGLIGENTLY OR INCOMPETENTLY

Q5 Do you agree the concepts of operating within one's competence and not acting negligently should be encapsulated within one principle?

These elements are inter-related, in our view, and it is, therefore, reasonable that they are encapsulated in one principle.

Q6 Should diligence also be included within this principle?

The addition of diligence would be beneficial in the areas of professional conduct that are of concern to many of our members, as set out in our introduction. It might encourage individuals to do more than the bare minimum and engage specialist advisers more readily. Linking diligence to the use of best endeavours is also useful in those instances where geotechnical and other professionals are called out to give urgent advice in emergency situations. The NZGS strongly supports the addition of acting with diligence to this element of the code.

4: PROTECT THE HEALTH AND SAFETY OF PEOPLE

5: SEEK SUSTAINABILITY

Q7 Do you agree with not delineating between environmental effects and sustainable management?

Environmental effects are intimately linked with sustainable management in the New Zealand context, so the NZGS considers that they are sensibly linked as proposed.

Q8 Do you agree the level of obligation should be lifted to an obligation to seek solutions that are sustainable from an obligation to have regard to the need for sustainable management? Should this be expressed as "shall consider solutions" or "shall endeavour to seek"?

Considering rather than seeking sustainable solutions is seen as a more appropriate target for our members, reflecting the commercial realities in New Zealand at present.

6: REPORT ADVERSE CONSEQUENCES

Q9 Do you agree this clause be included, and if so, has the level of obligation been set appropriately by excluding the test for immediacy?

While appropriate for professional engineers and engineering geologists, this element raises the bar too far for many of our members. As a Collaborating Technical Society, it is not appropriate for us to have a view.

Q10 Do the guidelines provide sufficient guidance to the process of reporting and discharging of one's obligations?

As a Collaborating Technical Society, it is not appropriate for us to have a view.

7: REPORT A BREACH OF THE CODE OF ETHICS

Q11 Do you agree this new obligation should be added as a means of demonstrating a commitment to raising the standard of professionalism of engineers?

While appropriate for professional engineers and engineering geologists, this element raises the bar too far for many of our members. As a Collaborating Technical Society, it is not appropriate for the NZGS to have a view. Our professional engineer and engineering geologist members are generally supportive, however, as it would help deal with the incompetence/lack of diligence issue that is occurring in some parts of our practice field.

Q12 Do you believe the level of misconduct to be reported is appropriately described? If not how would you like it described?

As a Collaborating Technical Society, it is not appropriate for the NZGS to have a view. From the perspective of our professional members, though, the definition of the term "serious" needs careful thought, with some examples given around each of the elements of the code.

8: MAINTAIN CONFIDENTIALITY

Q13 Do you agree a professional engineer's ethical obligations extend to disclosing matters of public interest (where there is actual or an unacceptable risk of significant harm or damage) above any commercial arrangements that may be in place?

As a Collaborating Technical Society, it is not appropriate for the NZGS to have a view. Our professional members generally agree with this extension of professional obligations.

Q14 Do you agree the obligation to inform other engineers should be removed, and if not, should it be reduced to only circumstances where issues are found, and not be in advance of conducting the review?

The NZGS sees the removal of this obligation as a backwards step, as early conversations can avoid misunderstandings around scope of services and other considerations that may have influenced the work undertaken. It is also a professional courtesy.

In closing, the NZGS endorses the proposed simplification of the Code of Ethics, and is pleased to see plans for a formal roll-out and training programme. While we do not believe it is appropriate that our Society comes fully under this code, there are elements that we will likely include in our forthcoming revised rules.

Gavin Alexander
Chair, NZGS Management Committee

30.4.14

2014 NZGS Scholarship Recipients

THE NZGS SCHOLARSHIP is intended to enable a member of the Society to undertake postgraduate research in New Zealand that will advance the objectives of the Society. The NZGS Management Committee is pleased to announce the joint award of the 2014 NZGS Scholarship to Kelly Robinson and Maxim Millen and is confident that their work will be of great benefit to the geotechnical community. Congratulations to Kelly and Maxim and we wish them all the best with their research.

KELLY ROBINSON – Liquefaction-Induced Lateral Spreading in the 2010-2011 Canterbury Earthquakes

Kelly arrived in New Zealand from California in July 2010 with hopes of gaining a masters degree in the field of geotechnical engineering in the Civil and Natural Resources Engineering Department at the University of Canterbury. Following the Darfield earthquake she began documenting lateral spreading in Canterbury, and following the Christchurch earthquakes of 2011 and the unprecedented opportunity to gather further data, upgraded her research project to a PhD. She is now focussed on analysing this diverse and complex dataset to aid in better understanding the observed deformations, assisting engineers in characterising lateral spreading hazard in future developments.

In 2010 and 2011, Kelly (supported by other students) undertook ground survey mapping throughout Christchurch and nearby townships, documenting the magnitude and distribution of lateral spreading movements (~ 150 locations). The results of the field survey are being compared to alternative techniques for measuring lateral spreading, including photogrammetry, LiDAR, and geodetic surveys. Analysis of the dataset includes scrutinising empirical and semi-empirical models used by engineers to predict the extent and magnitude of damaging ground deformations. This analysis provides valuable information with regard to the limitations of our ability to model this complex problem.

Kelly is further evaluating the lateral spreading dataset with respect to key physiological and topological properties (e.g. soil properties, site topography, geologic and seismic conditions, etc.) in order to characterise the main factors contributing to the observed displacements. Using the findings of this in-depth analysis, the research strives to provide guidance for predicting lateral spreading in future seismic events, from site specific studies to informing regional hazard models.

MAXIM MILLEN – Integrated Performance-based Design of Building-Foundation Systems

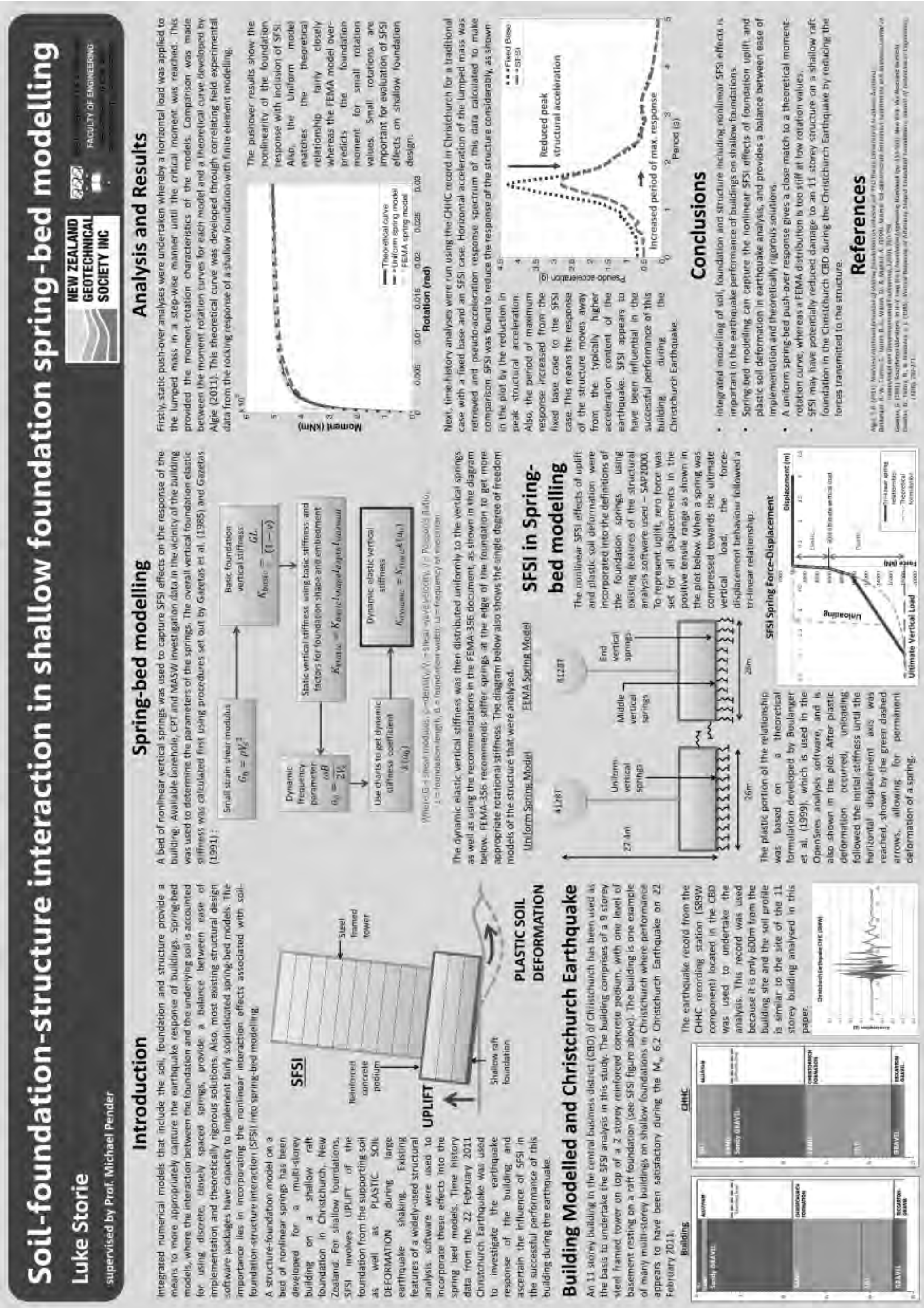
Maxim is a PhD candidate conducting his research at the University of Canterbury. He is based in the Civil and Natural Resources Engineering Department and is 18 months into his research. Maxim's thesis intends to explore the influence of non-linear soil-foundation-structure-interaction (SFSI) on the seismic performance of buildings and modify current design methodologies to account for these effects.

Two dimensional numerical modelling of frame buildings resting on non-liquefiable soft soils as well as analytical hand calculations and experimental works from other researchers will support the quantification of SFSI and the effectiveness of the developed design procedures. The non- linear behaviour of the soil, the foundation and the superstructure will all be considered. The assessment of the building behaviour will be against specific engineering demand parameters to assess the performance level of the building under different hazard intensities.

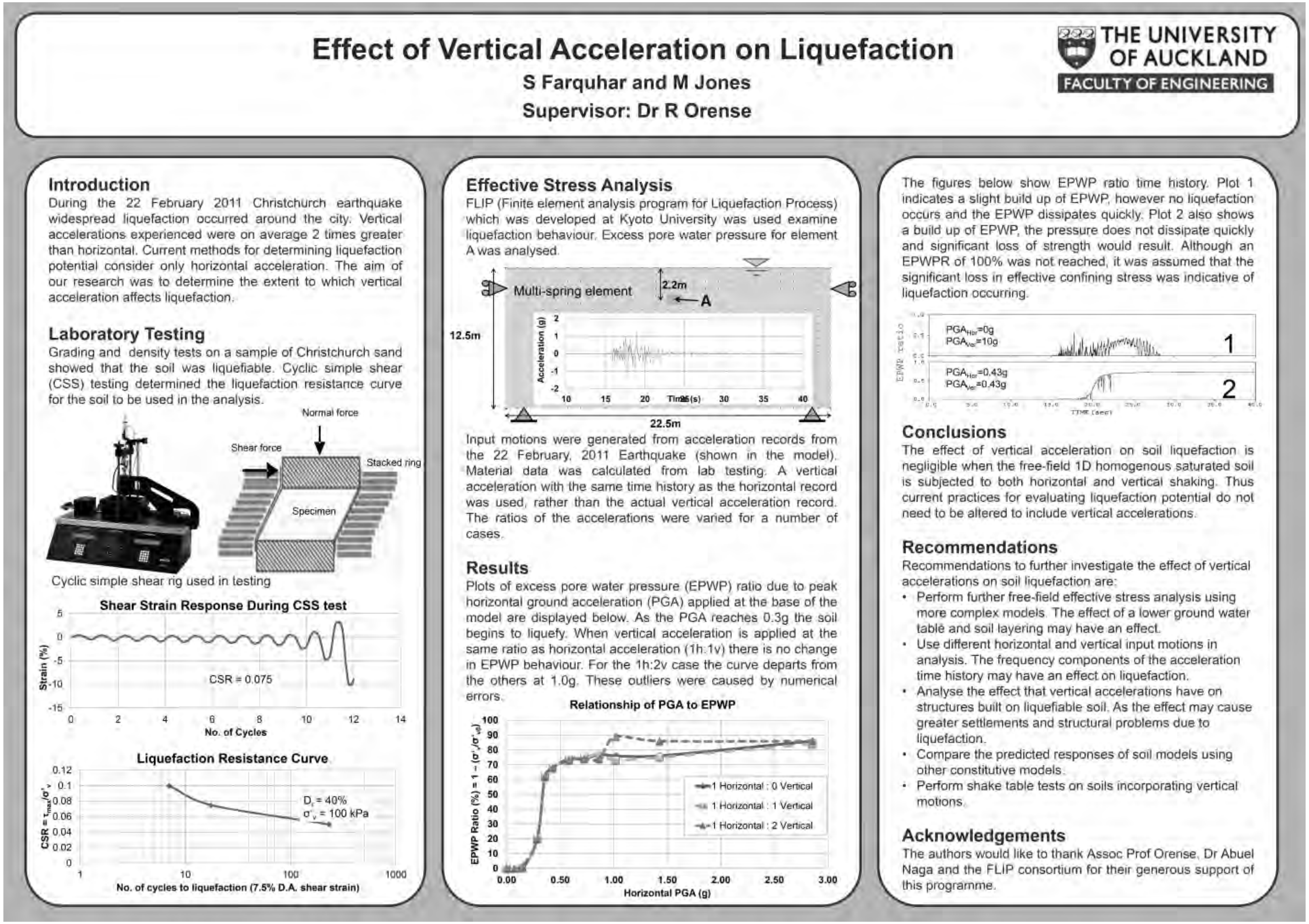
The significant research that already exists about the effects of SFSI and the seismic performance of the buildings in Christchurch during the 2010-2011 earthquake sequence will be used to calibrate a macro-element (soil-foundation interface) model. This macro-element model will then be used in a controlled parametric study consisting of several investigations into the effects of SFSI on seismic response of two-dimensional frames. The data from these analyses will be used to make modifications to the force-based and displacement-based design framework to more rigorously account for various issues relating to SFSI.

New Zealand Geotechnical Society Student Awards

The New Zealand Geotechnical Society Student Awards are presented to recognise and encourage student participation in the fields of geotechnical engineering and engineering geology. The 2013 Student Awards comprised a poster completion with posters displayed and judged at the 2013 NZGS Symposium in Queenstown. The winners of the 2013 Student Awards are noted below along with the winning posters.



Luke Storie – Soil foundation structure interaction in shallow foundation spring bed modelling (First)



Effect of Vertical Acceleration on Liquefaction

S Farquhar and M Jones
Supervisor: Dr R Orense
THE UNIVERSITY OF AUCKLAND
FACULTY OF ENGINEERING

Introduction

During the 22 February 2011 Christchurch earthquake widespread liquefaction occurred around the city. Vertical accelerations experienced were on average 2 times greater than horizontal. Current methods for determining liquefaction potential consider only horizontal acceleration. The aim of our research was to determine the extent to which vertical acceleration affects liquefaction.

Laboratory Testing

Grading and density tests on a sample of Christchurch sand showed that the soil was liquefiable. Cyclic simple shear (CSS) testing determined the liquefaction resistance curve for the soil to be used in the analysis.

Cyclic simple shear rig used in testing

Effective Stress Analysis

FLIP (Finite element analysis program for Liquefaction Process) which was developed at Kyoto University was used examine liquefaction behaviour. Excess pore water pressure for element A was analysed.

Input motions were generated from acceleration records from the 22 February, 2011 Earthquake (shown in the model). Material data was calculated from lab testing. A vertical acceleration with the same time history as the horizontal record was used, rather than the actual vertical acceleration record. The ratios of the accelerations were varied for a number of cases.

Results

Plots of excess pore water pressure (EPWP) ratio due to peak horizontal ground acceleration (PGA) applied at the base of the model are displayed below. As the PGA reaches 0.3g the soil begins to liquefy. When vertical acceleration is applied at the same ratio as horizontal acceleration (1h:1v) there is no change in EPWP behaviour. For the 1h:2v case the curve departs from the others at 1.0g. These outliers were caused by numerical errors.

The figures below show EPWP ratio time history. Plot 1 indicates a slight build up of EPWP, however no liquefaction occurs and the EPWP dissipates quickly. Plot 2 also shows a build up of EPWP, the pressure does not dissipate quickly and significant loss of strength would result. Although an EPWPR of 100% was not reached, it was assumed that the significant loss in effective confining stress was indicative of liquefaction occurring.

Conclusions

The effect of vertical acceleration on soil liquefaction is negligible when the free-field 1D homogenous saturated soil is subjected to both horizontal and vertical shaking. Thus current practices for evaluating liquefaction potential do not need to be altered to include vertical accelerations.

Recommendations

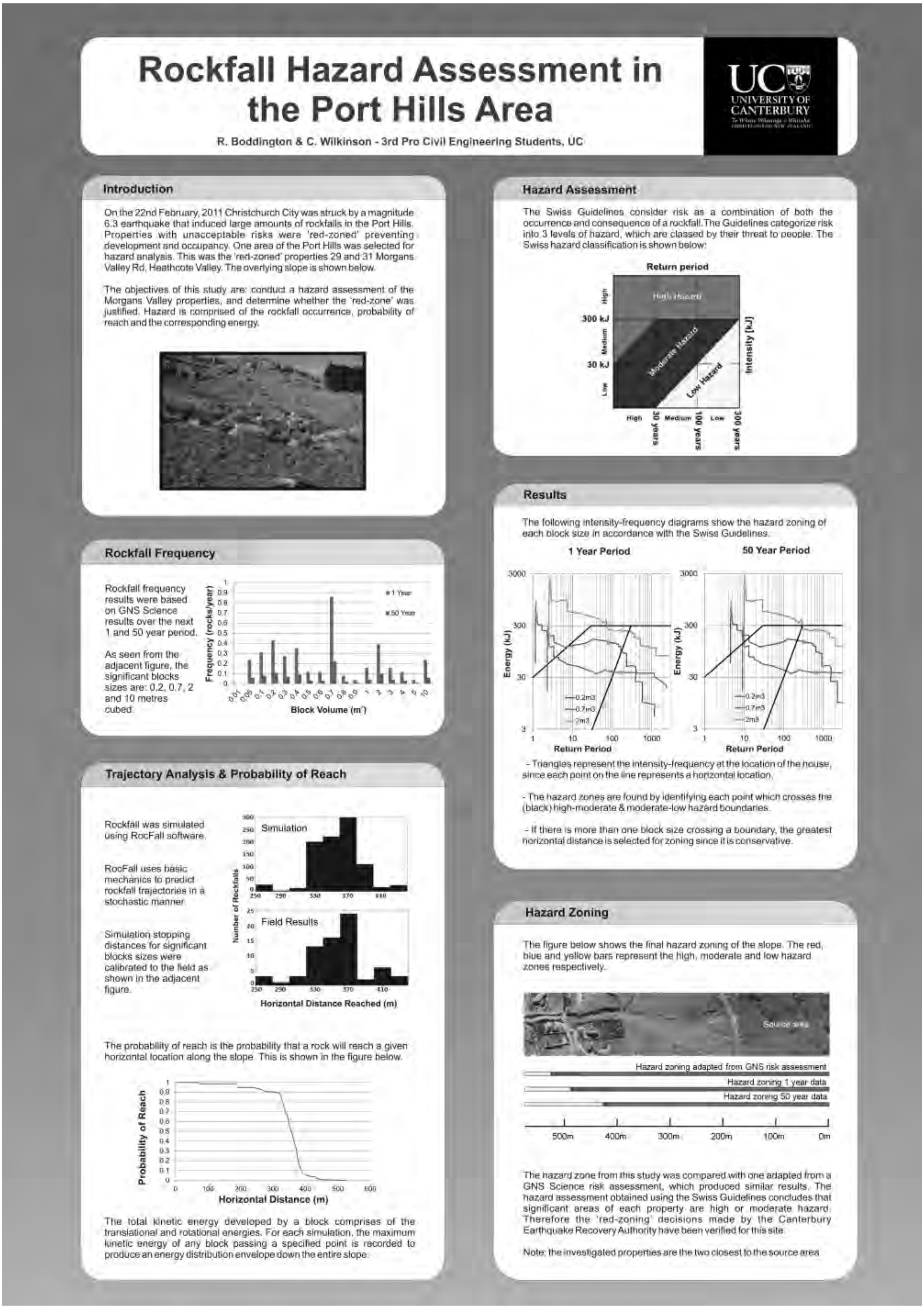
Recommendations to further investigate the effect of vertical accelerations on soil liquefaction are:

- Perform further free-field effective stress analysis using more complex models. The effect of a lower ground water table and soil layering may have an effect.
- Use different horizontal and vertical input motions in analysis. The frequency components of the acceleration time history may have an effect on liquefaction.
- Analyse the effect that vertical accelerations have on structures built on liquefiable soil. As the effect may cause greater settlements and structural problems due to liquefaction.
- Compare the predicted responses of soil models using other constitutive models.
- Perform shake table tests on soils incorporating vertical motions.

Acknowledgements

The authors would like to thank Assoc Prof Orense, Dr Abuel Naga and the FLIP consortium for their generous support of this programme.

Simon Farquhar [Co-author: *Michael Jones*] – Effect of vertical acceleration on liquefaction. (Second)



Robert Boddington [Co-author: *Charlie Wilkinson*] – Rockfall probability of failure and hazards assessment in the Port Hills area. (Third)

International Society of Soil Mechanics and Geotechnical Engineering

NEXT ISSMGE BOARD MEETING IN NEW ZEALAND
The first Board Meeting of the term of the new President, Prof. Roger Frank, was held in London on 18-19 March. Future meetings have been scheduled for Goiania, Brazil (Sep 2014), Wellington, NZ (Feb 2015), and Edinburgh, UK (Sep 2015).

21ST ICSMGE 2021
Members would be aware that the next (20th) International Conference on Soil Mechanics and Geotechnical Engineering will be held in Seoul, Korea in September 2017 and of the inability of the AGS to win our bid for this conference. Graham Scholey (former Chair of AGS) has kindly agreed to lead another AGS bid for the 2021 conference. With Graham's assistance, the AGS Chair, Darren Paul, in February wrote a letter to the ISSMGE Secretary-General, Prof Neil Taylor, advising him of this decision and also to note the following motion to be tabled at the Edinburgh Council Meeting in September 2015, "In consideration of the commitment shown through six previous bids, the Australian Geomechanics Society be granted the right to host the ICSMGE in Sydney, Australia in 2021". The Board is broadly supportive of the AGS bid.

TECHNICAL COMMITTEES
A new TC has been approved which is concerned with geomechanics associated with energy generation. A letter has recently been sent to member societies and TCs regarding the need to renew the TC membership, and length of tenure for TC Chairs.

FEDIGS (FEDERATION OF INTERNATIONAL GEOTECHNICAL SOCIETIES)
Prof. Jean-Louis Briaud (ISSMGE Immediate Past President) has been elected to the position of President of FedIGS for the term 2014–2018. FedIGS consists of 4 societies (ISSMGE, ISRM, IAEG, IGS [Geosynthetics]). During his presidency, Jean-Louis aims to: (1) foster greater cooperation between societies; (2) not to compete with and respect the freedom of member societies; (3) Dissolve the 3 JTCs; and (4) enhance cooperation between practitioners and researchers. FedIGS holds one board meeting per year.

ISSMGE FOUNDATION
The Foundation, which provides support to members from developing countries, now has charitable status and does not incur taxes. By necessity, the Foundation is a separate entity from the ISSMGE and has three trustees (Roger Frank, Neil Taylor, Michael Davies).

ISSMGE FINANCES
The society's finances are robust. The society is aiming to maintain a balance of £500,000 in term deposits. Excess funds are invested in the ISSMGE Foundation to assist with members from under-developed member societies.

BRITISH GEOTECHNICAL ASSOCIATION (BGA)
The BGA Chair, Chris Mentiki, provided a brief report on the BGA. Useful points relevant to NZGS include:

- 1,300+ members
- Outreach to high school students: Best traction is gained with developing and including material directly into the school curriculum. Other initiatives are far less effective.
- The BGA runs an annual, one-day conference, which is free to members, attracts 400+ participants and includes presentation of research papers in the morning and practice papers in afternoon. Lunch and refreshments are provided.
- The BGA has a vision document (BGA 2020 Vision) which is available on their website.

Mark Jaksa
Mark is Head of the School of Civil, Environmental and Mining Engineering at the University of Adelaide. Over the last 25 years Prof Jaksa's research at the University of Adelaide has concentrated on probabilistic methods, geostatistics, artificial intelligence, ground improvement, expansive soils and geo-engineering education. He has published over 125 journal and conference papers on these topics.

David Beck
Dr David Beck is General Manager of Beck Engineering. David's research area for his PhD was simulation of instability and induced seismicity in deep level hard rock mining, and he now specialises in rock mechanics, fracture mechanics, induced seismicity, multi-physics simulation and large-scale 3-dimensional discontinuum non-linear numerical modelling.

International Society for Rock Mechanics

2014 ISRM CONFERENCE ON SOFT ROCKS (ISSR2014), BEIJING, 6-7 JUNE

ISRM is delighted to invite NZGS members to participate in the 2014 ISRM Conference on Soft Rocks (ISSR2014) to be held in Beijing, China, June 6-7, 2014. This Symposium is an event of the ISRM Commission on Soft Rocks.Topics covered will include classification of soft rocks, mechanical characterization of soft rocks, stability analysis, monitoring of soft-rock slopes and design.

ONLINE LECTURES ON PRINCIPLES OF ROCK MECHANICS

Following the lectures on Rock Mechanics, prepared by Erik Eberhardt, and the lectures on Petroleum Geomechanics by Maurice Dusseault we now have available on the ISRM website a series of lectures on Key Principles in Rock Mechanics, prepared by John Hudson of London's Imperial College.

Go to http://www.isrm.net/gca/?id=912 to view the lectures online.

ISRM CONGRESS 2015, MONTREAL DEADLINE EXTENDED

The deadline for submission of abstracts to the ISRM Congress 2015 was extended to 1 June.
Check the Congress website for updates.

FIFTH ONLINE LECTURE BY DR. JOHN READ ON 10 APRIL.

The fifth ISRM Online Lecture will be broadcast on 10 April, at 9 a.m. GMT. Dr. John Read will present "Implementing a Reliable Slope Design".

RESERVOIR GEOMECHANICS: A FREE ONLINE COURSE BY MARK ZOBACK FROM STANFORD UNIVERSITY

This interdisciplinary course encompasses the fields of rock mechanics, structural geology, earthquake seismology and petroleum engineering to address a wide range of geomechanical problems that arise during the exploitation of oil and gas reservoirs.

David Beck

International Association for Engineering Geology and the Environment

AWARDS

The recipient of the Hans Cloos Medal 2014 will be Roger Cojean, past Professor and research director at the Ecole Nationale Supérieure des Mines de Paris. He will present his Hans Cloos Lecture at the IAEG Congress in Torino.

Council agreed unanimously that the first recipient of the Marcel Arnould Medal (for service to IAEG and the profession) should be Dr Brian Hawkins of the UK in recognition of his service to IAEG and in particular his role as Editor of the Bulletin of Engineering Geology.

The Richard Wolters prize will be contested in Torino. New Zealand will be represented by Dr Chris Massey. We wish him well.

Ann Williams

Ann has spent the last 17 years of her 22 year career with Beca. She is a graduate of the University of Auckland with the degrees of Bachelor of Science and Master of Science in Geology (Honours), and has continued her professional development with post-graduate studies in Resource and Environmental Management and in Hydrogeology. She is a past chair of the NZGS, Vice President representing Australasia on the IAEG and an associate editor of the Quarterly Journal of Engineering Geology and Hydrogeology.

NEWSLETTER

Don't forget to view your IAEG Newsletter on the IAEG (www.iaeg.info) and NZGS websites. Please submit contributions to Amanda Blakey at secretary@nzgs.org.

TOKENS

Please be aware that the token for journal access is issued only the very first time access is activated. Once the member has followed the instructions and registered at Springerlink http://link.springer.com/, he/she will not receive a new message every year. The account remains active with the login details the customer has chosen.

50TH ANNIVERSARY BOOK

It is the 50th Anniversary of IAEG and a commemorative book will be issued to those attending the IAEG Congress. I believe it will be available for sale following that event. Look forward to seeing you in Torino!

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 NZGS. 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. Remember, if you are a NZGS member under 35 years of age, you are automatically a YGP!

LATEST ACTIVITIES:

Student Awards

The New Zealand Geotechnical Society Student Awards are presented to recognise and encourage student participation in the fields of geotechnical engineering and engineering geology. The 2013 awards were again run as a poster competition following on from the success of the new framework introduced in 2012. The posters were displayed during the NZGS Symposium in Queenstown 21st-23rd November 2013. Judging was conducted by a panel of three judges along with a people choice vote – thanks to Amanda for diligently encouraging all symposium attendees to cast their vote! Congratulations to all the students who participated in the event and especially to Luke Storie, Simon Farquhar and Robert Boddington who won prizes. These top three posters are published within this edition of the Geomechanics News.

We will shortly be calling for registration and abstracts for the 2014 Student Awards. Again these will be in poster format. Three prizes are available for the Student Awards – 1st, 2nd and 3rd place with monetary values of $1000, $500 and $300 respectively. Please encourage any students to register an abstract and join the NZGS as student membership is free! Further information can be found on our website: http://www.nzgs.org/awards/new-zealand-geotechnical-society-student-awards.htm

YOUR YGP REP

At the end of 2013, Luke Storie stood down as the NZGS YGP Rep. I would like to thank Luke for all the time and effort he has invested over the last couple of years superbly representing our younger members. I'm looking forward to representing YGPs in this the role and taking over where Luke has left off. If you are keen to get involved with YGP events or have any questions or queries for the NZGS Committee please don't hesitate to get in contact with your YGP Rep!

10TH ANZ YGP CONFERENCE

The 10th Australia New Zealand YGP Conference will be held on 3rd -5th of September 2014 at Noosa in the Sunshine Coast, Queensland, Australia. Congratulations to the NZGS members who have had abstracts and papers accepted. Again we are fortunate to receive funding from the Earthquake Commission (EQC) and NZGS for the Young Geotechnical Professional Conference Award which assists up to ten NZGS members to attend the conference. Abstracts are currently being judged by a panel to select this year's award recipients. Further information on the awards can be found here http://www.nzgs.org/awards/young-geotechnical-

Frances Neeson

Frances is an Engineering Geologist with Opus in Christchurch. She holds a Bachelor of Science (Geology) and Post Graduate Diploma in Engineering Geology. Over the last five years Frances has enjoyed working on small and large projects in the North and South Islands including numerous infrastructure projects, earthquake remediation and the Ferrymead Bridge Replacement. Frances is excited to be able to represent the growing numbers of YGP members of NZGS and promote YGP orientated activities!

Frances.Neeson@opus.co.nz

professionals-conference-awards.htm and successful applicants will be notified once judging has been completed.

YGP EVENTS AT ANZ2015

ANZ2015 is quickly approaching and YGP specific events are currently being planned by the conference committee. Following the terrific attendance at last year's NZGS Symposium special presentation "Poulos and Macfarlane unplugged" another similar presentation is being planned. An award for the best paper by a YGP will also be presented at the conference. Further details as they become available will be on the ANZ2015 website.

LIAISON GROUP AND REGIONAL EVENTS

In 2013 a YGP Liaison Group started to be formed. The idea of the Liaison Group is to gather a group of young professionals from different centres around the country and from different companies to share ideas about what the YGP group and NZGS can do for members aged 35 years and younger, and to organise events in different locations. We are currently seeking enthusiastic YGPs interested in joining this liaison group in the main centres across NZ. In particular we would like to find someone to replace Luke Storie in Auckland, as well as additional people in the Waikato-Bay of Plenty and Wellington regions. If you are interested or know someone who would be perfect for this please get in touch. Last year the YGP's and Canterbury Engenerate joint forces to facilitate a site visit to the Ferrymead Bridge in Christchurch. If you have any ideas for events, presentations or site visits please let us know!

UPCOMING ACTIVITIES AND IDEAS:

- 2014 Student Presentation Awards
- Expansion of the YGP liaison group of interested young professionals throughout the country;
- Further liaison and combined events with other young professional groups such as Engenerate;
- Promotion of the NZGS at Universities;
- A YGP forum on the NZGS website with involvement from senior members;
- Social media groups;
- Social events – quiz night, rock climbing.

Most importantly my role is to represent YGPs on the NZGS Committee so please don't hesitate to get in touch with questions, queries, feedback and ideas!

Branch reports

AUCKLAND

After the summer break the Auckland branch's year kicked off with the NZGS AGM on the 4th of March. The AGM discussed changes to NZGS rules and new appointments to the committee. Sarah Bastin from the University of Canterbury followed the AGM with an insightful geological view on liquefaction. In late April Evan Giles and Wataru Okada presented on the challenges of working with volcanic soils. The first of two Waterview Connection lectures have been presented with the second to come in late June. Look out for presentations by Warwick Prebble and others later this year!

James Johnson has handed over the reins (and the NZGS banners!) to Kim Rait. James is leaving NZ on an overseas adventure, and we thank him for all of his boundless help and hope he has an exciting and awesome time. We welcome Kim to the Auckland Branch and are very grateful that she has volunteered to assist.

BAY OF PLENTY

The Bay of Plenty regional branch has been relatively quiet lately, with very little happening at a local level – despite the number and size of developments occurring in the region.

A planning (start-up) meeting has been tentatively booked for early April, where ideas for fieldtrips, presentation and visits to suppliers can be discussed and planned for the upcoming year. This will be run as an informal catch up so that local practitioners can network, plus provide input into what they would like to see for the year ahead.

CHRISTCHURCH

The Branch has had a steady start to the year, with several presentations occurring (roughly once a month). We continue to maintain a link with presentations by other bodies, most notably the Canterbury Technical Forum, and a goal of ours is to provide a variety of informative, relative presentations, without overloading the busy technical community. We have had a variety of presentations this year from interesting speakers including Randy Over (President of American

Society of Civil Engineers), Albert Yeung (Past Director ASCE Region 10), Paul Burton from Geotechnics and Jeff Bachuber from Fugro Consultants in San Francisco.

Ed and Shamus thank the members, and sponsors, for their continuing support of the events. We extend our thanks to the University of Canterbury for providing the great facilities to host many of our evening presentations. We are happy to hear from any of you with ideas for future presentations.

HAWKES BAY

The Hawkes Bay NZGS Branch has become involved in the "joint meetings initiative" spearheaded by the local IPENZ branch. The initiative aims to achieve cross-pollination between local professional groups such as ACENZ, NZIA, IPENZ, NZGS, et cetera by inviting members of other groups to our local meetings. This initiative allows for local geo-professionals to meet professionals from other disciplines and also widen our professional presentation exposure. Some recent "joint meetings" have been well attended, and our NZGS Branch is successfully co-sponsoring a "joint meeting" on contaminated land assessments with IPENZ in May. Recent discussion has also flourished regarding the trialling of the New Zealand Geotechnical Database (formerly the Canterbury Geotechnical Database) in the Hawke's Bay Region. A regional council sponsored meeting was held in March in Hastings to discuss uploading and sharing geotechnical sub-surface data on the new database.

NELSON

There has been very little activity in the first quarter this year. Everyone is busy building a better world at present.

OTAGO

At the time of writing, a branch meeting is planned for late May 2014, supported by two short presentations. David Barrell (GNS Science) will present findings from a recent re-evaluation of landslide hazards in the Dunedin district, and Ioannis Antonopoulos (Opus) will report on the Ross Creek Reservoir refurbishment project in Dunedin City. Ioannis has kindly volunteered to become a Branch Co-ordinator along with David Barrell. As a senior engineering geologist with Opus International Consultants in Dunedin, Ioannis has over 18 years of experience in geotechnical engineering and engineering geology, on projects ranging from reservoirs, roading, slope stability, surface & deep foundations, cut & cover, tunnelling, seismic risk, geotechnical earthquake engineering, hydrogeology and land development. He has particular interests in numerical modelling and soil-structure interaction.

WAIKATO

The Waikato Branch will be heading to the Cambridge Section of the State Highway 1 (Waikato Expressway for a site visit to see the Karapiro Gully viaduct and associated infrastructure. This visit is scheduled for Wednesday 21st May 2014 with HEB Structures.

Planning is also underway for a presentation by Nick Wharmby – Foundations Technical Manager of Fletcher Construction / Brian Perry Civil on the recent and current construction of the NZTA Ngaruawahia Bypass and Rangariri Bypass bridge structures including ground improvement works required. Date and location TBC.

Further local branch event prospects for this year include:

- Avalon – case studies
- Liquefaction in the Waikato – further advancements following from the Rolly Orense 2013 presentation
- Rangiriri Section site visit
- Students and young professionals presentation evening
- Late 2014 proposed for Dr John Wood "The earthquake performance of soil retaining structures" present to a combined Waikato and Bay of Plenty event held at Wintec campus in Hamilton

WELLINGTON

In the last few months a range of interesting presentations have been made to the Wellington Branch. Several branch members, including the branch coordinators, have commented that collaboration and closer working relationships with the other technical groups is vitally important. This was particularly obvious following the response to the 2013 Cook Strait earthquakes, and in the last year there have been an increasing number of presentations of the local SESOC, NZSEE and Geoscience Society groups that have been extended to the NZGS community (and vice versa), highlighting the opportunity for our local branch activities to help connect local professionals. A range of events have been identified by the branch coordinators, but we would heartily welcome any suggestions for presentations or field trips. If you have any good ideas or would like to volunteer a venue or sponsorship for an event, please get in touch with one of the branch coordinators.

Andy Hope will be leaving Wellington in the middle of the year, to embark on his OE. We would like to thank Andy for all his hard work in organising and running Wellington branch events over the last 18 months, and wish him all the best for his travels.

AUCKLAND

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

Luke Storie
Luke is undertaking a PhD at the University of Auckland on earthquake resistant design of foundations. He is investigating the response of buildings in Christchurch CBD following the earthquakes following on from research undertaken under the supervision of Professor Michael Pender. Previously, with a BE(hons) and BA, Luke was a Geotechnical Engineer at Coffey Geotechnics
luke.storie@gmail.com

Kim Rait
Kim is a Geotechnical Engineer with Beca Ltd. She completed a BSc(Hons) in Mathematics and Statistics at the University of Canterbury before working in accountancy for several years. Kim then returned to UC to complete a PhD in Geotechnical Engineering and has been working at Beca on various small projects over the last year while completing her thesis.
Kim.Rait@beca.com

SEE THE EVENTS DIARY OR WWW.NZGS.ORG FOR FUTURE EVENTS

WAIKATO

Kori Lentfer
Kori is a Engineering Geologist 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.
Kori.Lentfer@coffey.com

Andrew Holland
Andrew studied engineering at the University of Auckland, graduating in 2002. Since then, Andrew has worked in geotechnical consultancy on projects around the world including in London, Morocco and Saudi Arabia. Andrew is a Chartered Professional Engineer (CPEng) and is the geotechnical team leader in AECOM's Hamilton office.
Andrew.Holland@aecom.com

BAY OF PLENTY

Matthew Packard
Matthew is a Senior Geotechnical Engineer with Coffey. He has completed a BSc degree in Earth Sciences at Waikato University and a University of New South Wales Masters of Engineering Science. His main areas of interest are soft ground conditions, liquefaction and settlement analysis, soil-structure interaction and complex retaining structures.
matthew.packard@coffey.com

HAWKE'S BAY

Riley Gerbrandt
Riley, a Geotechnical Engineer with Opus in Napier, immigrated to New Zealand from California with his family in late October 2011. Whilst it took him several months to get up to speed with the local geology, different codes/standards and some innovative Kiwi designs, he has come to thoroughly enjoy the New Zealand engineering consultancy space.
Riley.Gerbrandt@opus.co.nz

WELLINGTON

Doug Mason

Doug completed bachelor degrees in geology and history and an MSc (Hons) in geology at Victoria University, and worked for GNS prior to joining Opus in 2004. Since then he has worked in NZ and the UK on a variety of geotechnical and geoenvironmental projects. His particular interests include geomorphology, rock slope stability, and earthquake and landslide hazards.

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David Molnar

David is an engineering geologist at Aurecon Wellington. He has 6 years of experience in projects throughout New Zealand, notably NZTA's SH16 Causeway Upgrade and SH2 Muldoon's Corner Improvements, also KiwiRail's North to South Junction which won the 2012 Railway Technical Society of Australia (RTSA) Biennial Railway Project Award.

david.molnar@aurecongroup.com

Aouyb Riman

Ayoub is a senior geotechnical engineer with more than 10 years of experience gained in several countries in the Middle East, Africa, Australasia and Europe. He has experience in the analysis and design of foundations, soil improvement and treatment, deep excavations, cut and cover tunnels, land reclamation, slope stability, seismic assessments

ARiman@tonkin.co.nz

NELSON

Grant Maxwell

Grant manages technical development for the MWH geotechnical team across the Asia Pacific region. He grew up in Nelson and has now returned home with a young family. Grant is especially interested in emergency responses and encouraging asset and community resilience to natural disasters. He has 16 years' experience working across NZ, Australia, Pacific nations and the UK.

Grant.J.Maxwell@nz.mwhglobal.com

CANTERBURY

Edwyn Ladley

Edwyn is a Senior Engineering Geologist with Riley Consultants. He is currently completing a Masters in Geotechnical Engineering through the UNSW, Sydney. Since the Canterbury earthquakes Edwyn has been involved with investigations and rebuilds in the CBD, and advising insurance companies on geotechnical hazards and risks in the Port Hills.

eladley@riley.co.nz

Shamus Wallace

Shamus is an Engineering Geologist with Tonkin & Taylor. Since completing his degree in 2002 he has worked around New Zealand and spent time travelling overseas (a particular passion) and working in London (not so much a passion). Always happy to go off on a tangent when discussions turn to Geology.

swallace@tonkin.co.nz

OTAGO

David Barrell

David is a geologist and geomorphologist at GNS Science in Dunedin. South Island born and bred. Since joining GNS Science, 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.

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Ioannis Antonopoulos

Ioannis over 18 years of experience in geotechnical engineering and engineering geology. He has worked in various projects including reservoirs, roading, slope stability, surface & deep foundations, cut & cover, tunnelling, seismic risk, geotechnical earthquake engineering, hydrogeology and land development.

Ioannis.Antonopoulos@opus.co.nz

Amanda has been the NZGS Secretary since 2008. She works from home in Glendowie, Auckland. She enjoys reading, food and sailing (preferably all at once). In the distant past she worked as a planner, but now juggles NZGS commitments with raising two children. She is also actively involved in a community health charity.

Please remember to contact the Secretary (Amanda) if you wish to update any membership, address or contact details. If you would like to assist your Branch, as a presenter or sponsor, or to provide a venue, refreshments, or an idea, please drop a line to your Branch Co-ordinator or Amanda. If you require any information about other events or conferences, the NZGS Committee and NZGS projects, or the International Societies (IAEG, ISRM and ISSMGE) please contact the Secretary on secretary@nzgs.org You may also check the Society's website for Branch and Conference listings, and other Society news: www.nzgs.org

Management committee

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EDITORIAL POLICY

***NZ Geomechanics News* is a biannual bulletin issued to members of the NZ Geotechnical Society Inc.**

Readers are encouraged to submit articles for future editions of NZ Geomechanics News. Contributions typically comprise 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 of any length**
- **feedback on papers and articles published in NZ Geomechanics News**
- **news or technical descriptions of geotechnical projects**
- **letters to the NZ Geotechnical Society or the Editor**
- **reports of events and personalities**
- **industry news**
- **opinion pieces**

Please contact the editors (editor@nzgs.org) if you need any advice about the format or suitability of your material.

Articles and papers are not normally refereed, although constructive post-publication feedback is welcomed. 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 will be forwarded to the author for a right of reply. The editors reserve the right to amend or abridge articles as required.

The statements made or opinions expressed do not necessarily reflect the views of the New Zealand Geotechnical Society Inc.

NZGS Membership SUBSCRIPTIONS

An increase in annual subscriptions from $100 to $105 per member will become effective 1st October 2014. First time members will still receive a 50% discount for their first year of membership; and student membership remains free. Membership application forms can be found on the website http://www.nzgs.org/membership.htm or contact the NZGS Secretary on secretary@nzgs.org for more information.

NEW ZEALAND GEOTECHNICAL SOCIETY INC

The New Zealand Geotechnical Society (NZGS) is the affiliated organization in New Zealand of the International Societies representing practitioners in Soil mechanics, Rock mechanics and Engineering geology. NZGS is also affiliated to the Institution of Professional Engineers NZ as one of its collaborating technical societies.

The aims of the Society are:

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.

All society correspondence should be addressed to the Management Secretary (email: secretary@nzgs.org).

The postal address is
NZ Geotechnical Society Inc,
P O Box 12 241,
WELLINGTON 6144.

Letters or articles for NZ Geomechanics News should be sent to editor@nzgs.org.

MEMBERSHIP

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

Full details of how to join are provided on the NZGS website http://www.nzgs.org/about/

ADVERTISING

NZ Geomechanics News is published twice a year and distributed to the Society's 1000 plus members throughout New Zealand and overseas. The magazine is issued to society members who comprise professional geotechnical and civil engineers and engineering geologists from a wide range of consulting, contracting and university organisations, as well as those involved in laboratory and instrumentation services. NZGS aims to break even on publication, and is grateful for the support of advertisers in making the publication possible.

			SPECIAL PLACEMENTS		
TYPE	BLACK AND WHITE	COLOUR	INSIDE FRONT OR BACK COVER	OPPOSITE CONTENTS PAGE	SIZE
Double A3	-	$1200	$1400 (front A3)		420mm wide x 297mm high
Full page A4	$480	$600	$990	$990	210mm wide x 297mm high
Half page	$240	$300	-		90mm wide x 265mm high 210mm wide x 148mm high
Quarter page	$120	$150	-		90mm wide x 130mm high

Flyers/inserts	From $275 for an A4 page, contact us for an exact quote to suit your requirements as price depends on weight and size.

Notes
1. All rates given per issue and exclude GST
2. Space is subject to availability
3. A 3mm bleed is required on all ads that bleed off the page.
4. Advertiser to provide all flyers
5. Advertisers are responsible for ensuring they have all appropriate permissions to publish. This includes the text, images, logos etc. Use of the NZGS logo in advertising material is not allowed without pre-approval of the NZGS committee.

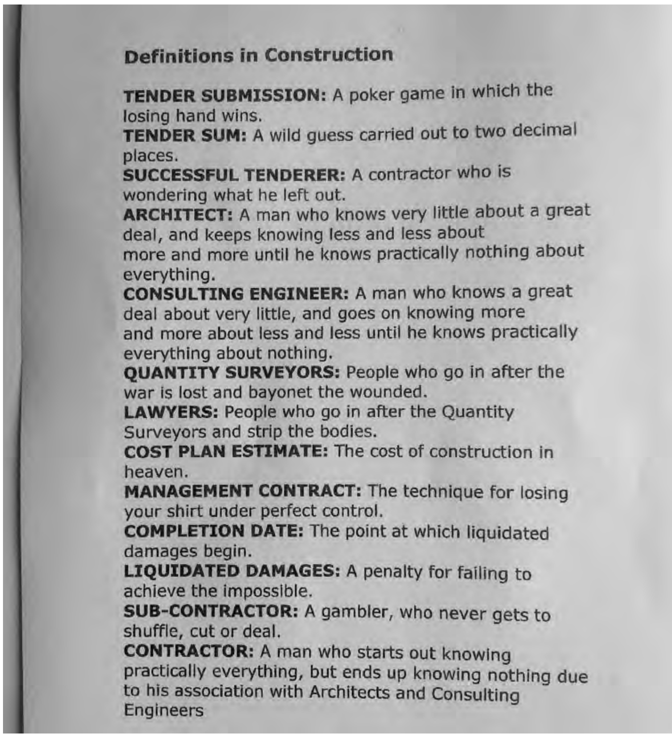
Around the Office

'Around the Office' is a collection of humorous snapshots spotted around the offices of NZGS members. Please send any suitable material to the Editors.

FIELD ASSISTANT JOB VACANCY

We need a young man, strong and true
for to help the auger through,
to stoop and pull with a dollop of skill
not much too it, other than will,
and note the earth he does thus pose
truly and in the best of prose,
to log and tick the boxes too
and work away the long day through.
With a sunhat and a long sleeved shirt
he will work away at that dry dirt,
and if perchance there be a shower
he may for a short spell retire,
but quickly back into the fray
before the boss can show dismay.
If you think you have the stuff,
apply online with all your guff.
We will not tarry or enquire
for if we do, it will expire.

Aidan Nelson
(Earthtech Consulting)



Definitions in Construction

TENDER SUBMISSION: A poker game in which the losing hand wins.
TENDER SUM: A wild guess carried out to two decimal places.
SUCCESSFUL TENDERER: A contractor who is wondering what he left out.
ARCHITECT: A man who knows very little about a great deal, and keeps knowing less and less about more and more until he knows practically nothing about everything.
CONSULTING ENGINEER: A man who knows a great deal about very little, and goes on knowing more and more about less and less until he knows practically everything about nothing.
QUANTITY SURVEYORS: People who go in after the war is lost and bayonet the wounded.
LAWYERS: People who go in after the Quantity Surveyors and strip the bodies.
COST PLAN ESTIMATE: The cost of construction in heaven.
MANAGEMENT CONTRACT: The technique for losing your shirt under perfect control.
COMPLETION DATE: The point at which liquidated damages begin.
LIQUIDATED DAMAGES: A penalty for failing to achieve the impossible.
SUB-CONTRACTOR: A gambler, who never gets to shuffle, cut or deal.
CONTRACTOR: A man who starts out knowing practically everything, but ends up knowing nothing due to his association with Architects and Consulting Engineers

Above: No babies to be put in the shredder???

National and International Events

24 JUNE, AUCKLAND BRANCH
Waterview Geotechnical Team – Second Presentation, speakers team. Location TBC, contact branch coordinator

22 JULY, AUCKLAND BRANCH
Short Presentations, TBC

24 JULY, HAWKES BAY
Applicability of the MBIE Canterbury Guidance for Liquefaction Assessments to the Hawke's Bay Region. Chaired by Riley Gerbrandt. At Opus House, 6 Ossian Street, Ahuriri, Napier

4 - 19 NOVEMBER FIFTEENTH GEOMECHANICS LECTURE
★*John Wood*
Travelling to Auckland, Hamilton, Napier, Wellington, Nelson and Christchurch.
Further details on page 83, or visit **www.nzgs.org**

2014

25-27 AUGUST 2014 SEOUL, SOUTH KOREA
Eight International Symposium on Geotechnical Aspects of Underground Construction in Soft Ground
www.is-seoul2014.org

3-5 SEPTEMBER 2014 NOOSA, AUSTRALIA
10th ANZ Young Geotechnical Professionals Conference
David Lacey – dlacey@globalskm.com

15-19 SEPTEMBER 2014 TURIN, ITALY
XII IAEG Congress 2014 – Addressing Geological Uncertainties in Major Engineering Projects
www.iaeg2014.com

14-16 OCTOBER 2014 HOKKAIDO, JAPAN
8th Aisian Rock Mechanics Symposium, SRMS8, the 2014 ISRM International Symposium
www.rocknet-japan.org

5-6 NOVEMBER 2014 SYDNEY, AUSTRALIA
AusRock 2014: Third Australasian Ground Control in Mining Conference
www.groundcontrol2014.ausimm.com.au/

8 NOVEMBER 2014 XI'AN, CHINA
3rd ISRM International Young Scholars' Symposium on Rock Mechanics
caimeifeng@ustb.edu.cn

9-14 NOVEMBER 2014 MELBOURNE, AUSTRALIA
7th International Conference on Environmental Geotechnics
www.7iceg2014.com

17-19 NOVEMBER 2014 SYDNEY, AUSTRALIA
15th Australasian Tunnelling Conference 2014
http://www.atstunnellingconference2014.com/

2015

10-13 MAY 2015 MONTREAL, CANADA
13th International ISRM Congress 2015
www.isrm2015.com

10-12 JUNE 2015 OSLO, NORWAY
International Symposium on Frontiers in Offshore Geotechnics 2015
www.isfog2015.no

13-17 SEPTEMBER 2015 EDINBURGH, UK
XVI European Conference on Soil Mechanics and Geotechnical Engineering
www.xvi-ecsmge-2015.org.uk

24 SEPTEMBER 2015 ISLE OF ISCHIA, ITALY
Workshop on Volcanic Rocks and Soils
www.associazionegeotecnica.it

7 OCTOBER 2015 SALZBURG, AUSTRIA
EUROCK 2015 – ISRM European Regional Symposium – the 64th Geomechanics Colloquy.
http://www.oegg.at/

15-18 NOVEMBER 2015 BUENOS AIRES, ARGENTINA
Sixth International Symposium on Deformation Characteristics of Soils
www.conferencesba2015.com.ar

25 MAY 2016 XI'AN, CHINA
GEOSAFE: 1st International Symposium on Reducing Risks in Site Investigation, Modelling and Construction for Rock Engineering
xtfeng@whrsm.ac.cn

29 AUGUST 2016 ÜRGÜP-NEVȘEHIR, TURKEY
EUROCK 2016 – ISRM European Regional Symposium
resat@hacettepe.edu.tr

1 OCTOBER 2016 BALI, INDONESIA
ARMS 9 – the 9th Asian Rock Mechanics Symposium
rkw@mining.itb.ac.id

LINKS ARE AVAILABLE FROM THE NZ GEOTECHNICAL SOCIETY WEBSITE WWW.NZGS.ORG