

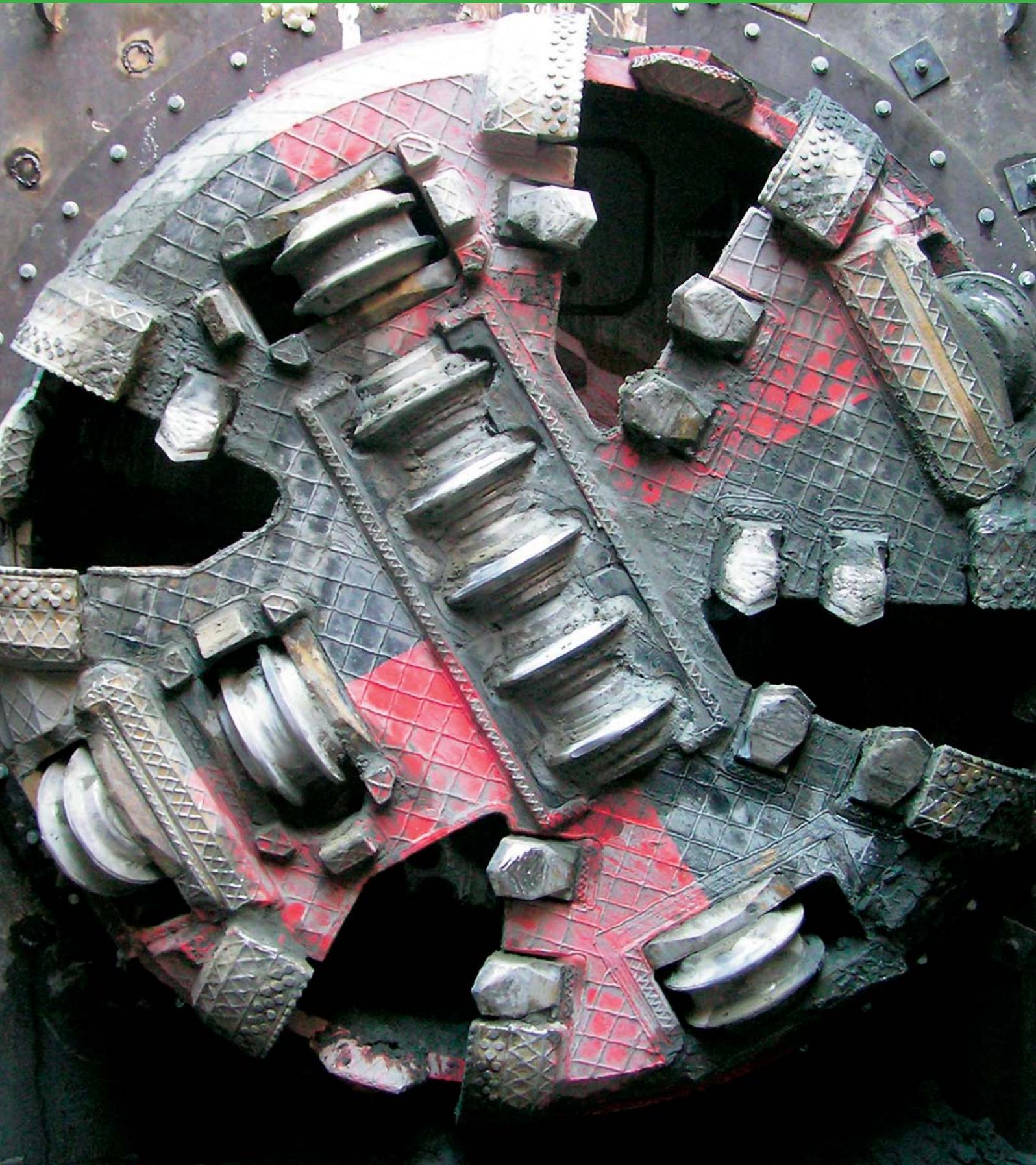


Newsletter of the New Zealand
Geotechnical Society Inc.

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NZ Geomechanics News

December 2007



NEW ZEALAND GEOMECHANICS NEWS

DECEMBER 2007, ISSUE 74

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Cover photo: The MTBM hole through on completion of Reach 1 of the Christchurch Ocean Outfall Project.

Photo Credit: Tim Evison of Christchurch City Council.

CHAIRMAN'S CORNER

Welcome to the December issue of the Geomechanics News for 2007.

Conferences

Much has happened these last six months. Some of you would have had the opportunity to attend the highly successful 10th ANZ "Common Ground" Conference on Geomechanics held recently in Brisbane. Dr Do Van Toan, our 13th NZGS Geomechanics Lecture recipient delivered a lecture with a topic close to his heart – "A geomechanics view on heavy duty pavements". For those who missed out, he will be touring the country to present this lecture. Dr Misko Cubrinovski of the University of Canterbury had the distinction of being awarded the ANZ Joint Societies Award for the "most valuable conference paper, excluding invited or special papers". His paper was entitled "Key Parameters in Pseudo-static Analysis of Piles in Liquefying Sand" – well done.

Two sub-committees have been formed to organize conferences for next year – these being our society's two yearly Geotechnical Symposium and the ANZ Young Geotechnical Professionals Conference. The 18th NZ Geotechnical Symposium which coincides with the Society's 50th anniversary will have the theme "Soil-Structure Interaction – From rules of thumb to reality" and will be held in Auckland between 4th to 5th September 2008. It promises to be exciting with sessions to cover a wide range of topics such as Modelling, Seismic behaviour, Deep excavations, Foundations, Slopes, Pavements and Tunnels. We've also organized for Professor John Atkinson to be the Keynote speaker. Submission of papers is now invited and will close on 15th March 2008. For more details, visit the Society's website www.nzgeotechsoc.org.nz or contact the Convenor, Gavin Alexander (gavin.alexander@beca.com).

Our society will also be hosting the 8th ANZ Young Geotechnical Professionals (YGP) conference to be held in Wellington between 5th to 8th November 2008. In addition to financial awards available for the best submitted abstracts to assist with attending this conference, the Society has now instituted a new fellowship – the NZGS Young Geotechnical Professionals Fellowship for the best NZ paper presented at this conference. This Fellowship, worth up to \$4,000, will be used to enable the holder to attend the next international YGP conference. So for those of you under 35, do start writing and send your abstracts to the Convenor, Dr Elisabeth Bowman (Elisabeth.bowman@canterbury.ac.nz).

People

After completing a 3 year term as Vice-President of the ISRM (Australasia), Dr John St George has stepped down

in July and will continue to be the NZ representative to ISRM. The Society would like to thank John for his contributions as VP.

Kate Williams will continue in her role as editor of this publication following Nathan McKenzie's decision to step down in the co-editor role. Many thanks, Nathan for your past efforts.

Regional

There has been two new appointments to branch co-ordinators – David Stewart for Wellington and Nick Harwood for Christchurch. They replace Grant Dellow and Tim McMorran who have been co-ordinators for many years and we'd like to thank them for their voluntary efforts which have benefited regional members. I understand that most of us are busy on the work front – but any assistance you can provide to our branch co-ordinators would be much appreciated. So for those of you who are able to, do get in touch with your regional co-ordinators!

Education

I'm keen to improve on training courses available to you. To date, I've observed that technical professional development in engineering geology and geotechnical engineering has generally been on an ad-hoc basis with short courses or seminars put together by material suppliers and academic institutions frequently coinciding with visits by academics. I do not believe we have tapped the expertise of local practitioners and would very much like to see a series of courses targeted at various levels rolled out on a regular basis. To do this, a number of willing and able people in this industry first needs to be identified. If you think you can help with this, or have ideas on what courses you would like to see offered, please let me know.

C Y Chin

Chairman, NZGS

Email: cy.chin@maunsell.com

Chin is a Principal in the Geotechnical engineering group of Maunsell Limited based in Auckland. Educated in the UK about 20 years ago, he completed a PhD at Cambridge University and worked with Ove Arup & Partners. Further work saw him going to Borneo working as a Resident Engineer with the Public Works Department in Brunei Darussalam, followed by a lecturing stint in one of Singapore's Universities before arriving in New Zealand. Prior to joining Maunsell, he was a Lead Geotechnical Specialist at Beca.

EDITORIAL

Business Time

So where did this year go? It seems that when we blink another year passes ever so quickly and we all have been working harder and harder to keep up with the demand of business and pleasure. So getting down business.

It's been another exhausting year for the Society, the management committee, our society members and the editorial team. Thank you to all NZGS members that have made the process of putting these newsletters together relatively easy with great content, articles, profiles, photos and suggestions although deadlines seem to remain tight!

This edition of the newsletter shows just how busy around the country we have all been with interesting projects reported on in both the South and North Islands. The local Branch activities throughout New Zealand have been increasing along with participation of members and the appointments of two new coordinators in Wellington and Christchurch.

We congratulate Dr Do Van Toan on being awarded the prestigious NZGS Geomechanics Lecture Award and have reprinted his paper in full.

The 10th ANZ Geomechanics Conference in Brisbane was a huge success and our congratulation goes to Dr Misko Cubrinovski for being awarded the "most valuable conference paper" for the ANZ Joint Societies Award. Reports on the conference are included in this newsletter.

Now on to pleasure.

Bring on 2008 and the NZGS 50th Anniversary. Next year will be even bigger and busier with the NZGS Symposium to be held in Auckland and the ANZ YGP Conference to



be held in Wellington. Lets keep the festivities going and celebrate 50 years of the Society in style.

The June 2008 issue of the NZ Geomechanics News will be the 75th Issue so get the fingers typing and send us your best content for this momentous celebratory newsletter.

Finally, from the NZ Geomechanics News Editorial Team and the NZGS Management Committee we would like to wish everyone a joyous festive season and a well deserved break over the Christmas – New Year period. Happy reading.

Kate

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THE EDITORIAL TEAM



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WANTED – Content for publication in the New Zealand Geotechnical Society, Newsletter *NZ Geomechanics News*. Please support the editorial team and the Society by contributing your submissions for future issues.

THE SECRETARY'S NEWS

We are now at the end of 2007 and planning has started for the 18th New Zealand Geotechnical Symposium and 8th ANZ YGP conference to be held in the latter half of 2008. Please keep a look out for emails updating these events.

Branch Events are for You

Dr Do Van Toan, our 13th NZGS Geomechanics Lecture recipient will be delivering his lecture to all the branches so look out for the email flyers.

Did you also know that you have a great opportunity to network with fellow members at your local branch events? Look out for the email flyers for various branch lectures and field trips.

Membership Clears the 600 Mark

We now have 619 members in total. 25 new members joined in the month of October alone. Since June 2007 we have also had 11 new students join. So welcome to everyone. Membership application forms are now able to be downloaded from the New Zealand Geotechnical Society Webpage.

Subscriptions

You would have received your subscription invoices for 2007/2008. Please do not file them in the pay sometime later file. PLEASE PAY YOUR SUBSCRIPTIONS PROMPTLY. Thank you.

Please do contact me for any assistance you might require or any queries you might have.

Imrana Azimullah

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EDITORIAL POLICY

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

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

General articles for publication may include:

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

Submission of text material in camera-ready format is not necessary. However, typed copy in Microsoft Word is encouraged, particularly via email to the Editor or on floppy disk or CD. We can receive and handle file types of almost any format. Contact us if you have a query about format or content.

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

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

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

INTERNATIONAL SOCIETY REPORTS

ISRM Council Meeting in Lisbon July 2007

The 42nd Council Meeting of the Society was held at LNEC in Lisbon with representative from 34 National Groups present as well as 6 Past Presidents. The Society has 48 National groups, with 5380 members and 135 corporate members. Membership for the year increased by over 13% with most of the new members coming from the Asian Region. This is the last Council meeting for the President, Professor Nielen van der Merwe and the current Board.

The accounts for 2006 and the budget for 2008 were presented and approved. The USA raised the issue of the major budget item on the News Journal of €27000, suggesting that this large expense could be directed to other activities if the News Journal was distributed electronically. The matter was referred to the new Board for consideration.

The extensive revisions to the ISRM Statutes and By-laws proposed by the Board, were approved by Council. The changes were necessary to bring them into line with current practice and including amendments to incorporate the website, election of the president, selection of Congress, publication of the News Journal and distribution of the Newsletter.

The 2008 Rocha Medal winner was Dr Liang Zhengzhao for his thesis entitled "Three Dimensional Numerical Modelling of Rock Failure Process" from the Northwestern University China.

The 5th Asian Rock Mechanics Symposium to be held in Teheran, Iran in November 2008 was approved by Council as the ISRM International Symposium to host the 2008 Board and Council meetings. Other sponsored meeting are as follows:

- *6th International Symposium on Ground Support in Mining & Civil Engineering Construction*: Cape Town, South Africa – an ISRM Regional Symposium 2008 March 31 - April 3.
- *U.S. Rock Mechanics Symposium* – San Francisco California, USA – an ISRM Regional Symposium. 2008 June 28 - July 2,
- *SINOROCK 2009*: approved by the Council, in Lisbon, as the 2009 ISRM International Symposium. 2009 May 19 - 22, Hong Kong, China
- *Harmonizing Rock Mechanics and the Environment*: the 12th ISRM International Congress. 2011 October 16 - 21, Beijing, China

There were reports on the activities of the following ISRM Commissions:

- Application of Geophysics to Rock Engineering
- Case Histories
- Education
- Maintenance and Repair of Underground Structures in Rock Masses.
- Mine Closure
- Testing Methods

From Interests Groups, Interest Group on Underground Waste Disposal and Joint Technical Commissions

- JTC2, Representation of Geo-Engineering Data in Electronic Form
- JTC7, Soft Rocks and Indurated Soils

The book "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006" was launched during the 11th ISRM Congress in Lisbon. The "Blue Book" was edited by Professors Resat Ulusay and John Hudson. The book was published by the ISRM Turkish National Group and can be purchased from them and also from the ISRM Secretariat.

Following the election, in 2005, of Prof. John Hudson as President of the Board of the ISRM for the term 2007-2011, the Council elected the following Regional Vice Presidents:

- for Africa: Francois Malan (South Africa)
- for Asia: Abdolhadi Ghazvinian (Iran)
- for Australasia: Anthony Meyers (Australia)
- for Europe: Nuno Grossmann (Portugal)
- for North America: Derek Martin (Canada)
- for South America: Alvaro Gonzalez (Colombia).

Dr Tony Meyers will be looking after our interests at the executive level and I shall act as the New Zealand liaison, so any queries or requests can be directed through me

Mrs Maria de Lurdes Eusébio, the Executive Secretary of the ISRM, is retiring after serving the Society for 40 years. She has attended all 41 Council meetings since 1967 and worked with all Presidents of the ISRM with the exception of the first one.

John St George

ISRM - VP Australasia, July 2007
ISRM Liaison for New Zealand

ISRM Australasia VP Report: October 2007

ISRM Issues

In June, at the 2007 ISRM Congress in Lisbon, the new Board of the ISRM was appointed. The Board has a four year term and therefore the previous Board had been in place since 2003. The Regional Vice President for Australasia on the previous Board was New Zealand's own John St George from the University of Auckland.

I would like to take this opportunity to formally thank John for his considerable contribution to the Society over his term in office. Much of this work went on in the background, as do so many of the administrative tasks required of the VPs. However, the significant work he did, including his valuable work to update the by-laws, assisted the Society to grow as a professional organisation. I also would like to thank him for all of the assistance he provided with my ISRM liaison activities in Australia. I wish him all the very best for his future activities and look forward to continuing to work with him in the future.

So who is this person now taking on the role of Regional VP?

Well, briefly, I come from a family with a long history in the mining industry. It stretches back to the iron ore pits in the Hartz Mountains, Germany, in the 1700s. In the 1800s they mined tin around Cornwall, UK and the in the copper mines at Wallaroo, South Australia. In the 1900s they owned a gold mine in Tennant Creek, Northern Territory and sought the elusive gold around Ballarat, Clunes and Wychitella, Victoria.

Keeping up the family tradition, I studied Mining Engineering in the late 1970s, worked for Broken Hill North and Western Mining in New South Wales, Western Australia and South Australia then had a stint as a Field Services Engineer in the petroleum industry with Flopetrol Schlumberger in the early 1980s. It was here that I took an interest in the characteristics of rock materials. In the late 1980s I was offered the opportunity to develop further this interest by doing a PhD in Rock Mechanics at the University of Adelaide. My studies aimed to improve the techniques being used at the time to assess rock mass strength. I partially funded these studies by taking on consulting work in Rock Mechanics for the mining, petroleum and civil industries and, in the mid 1990s I registered my business; Rocktest Consulting. During my PhD candidature I also took on a part-time lectureship position in Introductory and Advanced Rock Mechanics in the Department of Mining Engineering at the University of South Australia. I continued in this role until 2003 when the University took the unusual decision, in the light of the predicted massive demand for Mining Engineers and courses, to close down its Mining Engineering program. I took the opportunity to slip full time into Rocktest Consulting where I remain today.

Prior to becoming involved with the ISRM Board, I imagined the Society to be a top heavy bureaucracy located in an expensive office staffed by overpaid executives doing little but going to meetings around the world accountable to none and far removed from its membership. However I've now found the truth to be very different.

The ISRM actually comprises only a couple of paid staff who have to look after a vast amount of administrative tasks required to keep the Society in existence. They work out of a very basic office donated by the *Laboratório Nacional de Engenharia Civil* (National Civil Engineering Laboratories) in Lisbon, Portugal. Everyone else, including the Board members, are volunteers who rely predominately on the good nature of their employers and National Groups to provide them with the time and the funding necessary to do work for the Society.

So what then is the ISRM? Well it's really nothing more than you, me and our 5,380 colleagues in 48 countries all working in the area of Rock Mechanics. Without the members there is no ISRM.

Having attended the recent Congress in Lisbon, I got the opportunity to see what many of our colleagues overseas are doing; the fantastic research, the exciting projects and the cutting edge equipment and techniques. They're doing it from the most sophisticated high tech labs in Asia and Europe to the mines in the developing countries of the Middle East and South America. Unfortunately, we're all so busy these days that it's almost impossible to keep up with these or any activities much beyond our national borders. It would be so useful if there was a mechanism by which we could do so. Providing this mechanism is the *raison d'être* of the ISRM. Basically the Society exists for no other reason than to be a focal point at which all of us in the community can come together to share our experiences. Already the new Board has been active trying to come up with ways to make this process happen even better. All Board members have submitted a series of ideas for improving the ways the Society enables members to interact. These ideas have been collated into a discussion document which we're now reviewing. I'm aiming to keep you in the loop about any developments in this area and any other discussions at Board level.

However, keep in mind that the Society is really no more than you and me and the other members so if you have any thoughts of ways that it can assist all of us then please feel free to send them though to me. This way we can all work towards strengthening our Rock Mechanics community.

Tony Meyers

ISRM - VP Australasia

IAEG President Report: October 2007

1. I commenced as IAEG President on 1 January 2007. My last report was dated 5 February 2007.
2. I chaired meetings of IAEG Council and Executive in Vail, Colorado in June 2007. My proposal that IAEG restructure its budget to allow for some costs of travel by the President was accepted. Otherwise the meetings were successful but uneventful. Minutes of the meetings can be provided on request.
3. I have contacted the Australian Federal Government – Minister Julie Bishop – but failed to obtain any funding to support my travels. I vaguely recall that AGS was going to approach Engineers Australia to obtain further funding for my travel. A progress report on this would be useful. I would like AGS and NZGS each to allow A\$3,500.00 each year to support my travel expenses and would be grateful if each society could confirm that commitment.
4. I chaired a meeting of FIGS in Paris in June immediately following the Vail meetings. If ISSMGE approves the FIGS Co-operation agreement in October 2007, then there will be another meeting in January 2008 and FIGS can be inaugurated and a new FIGS President can be chosen.
5. I travelled to Los Angeles in September 2007 to present IAEG plans for the future of Engineering Geology to the 50th Anniversary AEG congress.
6. I am gradually developing a forward plan for my tenure as president of IAEG and currently I aim to focus on the following:
 - Meeting with and getting to know engineering geologists around the world.
 - The support and development of teaching and research directed towards engineering geology.
 - Improvement in the quality of practice through the initiation of IAEG Commissions in new and interesting aspects of engineering geology, professional training (CPD), encouragement for professional registration, engaging with young professionals, involvement with FIGS.
 - Continue to improve the Bulletin and website to support these endeavours.
7. I intend to:
 - Travel to Seoul, Korea in October 2007 to attend the 6th Asian IAEG Regional Conference.
 - Travel to Brisbane in October 2007 to attend the ISSMGE Council Meeting and the ANZ Geotechnical Conference.
 - Travel to Hong Kong and London in November 2007 at the request of the Geol Soc of London to present papers as president of IAEG.
8. All of the meetings that I attend will be opportunities to promote the 11th IAEG congress in Auckland 2010.
9. Could AGS National Committee and the NZGS Management Committee please contact me to discuss any issues related to IAEG as I am interested in anything that either Society has to say that can help me in my role as President of IAEG.

Dr Fred Baynes, 5 October 2007

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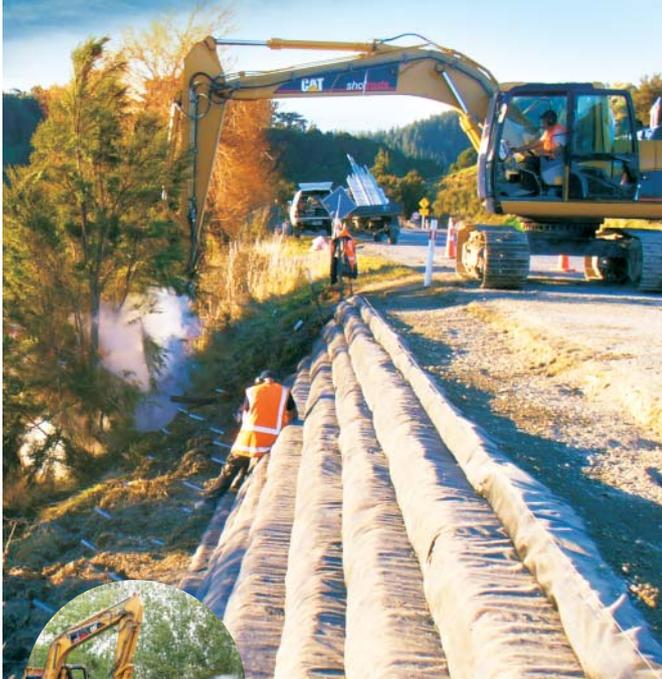


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ISSMGE Regional VP Report: November 2007

Introduction

This report contains a summary of the highlights of ISSMGE-related activities for the latter half of 2007.

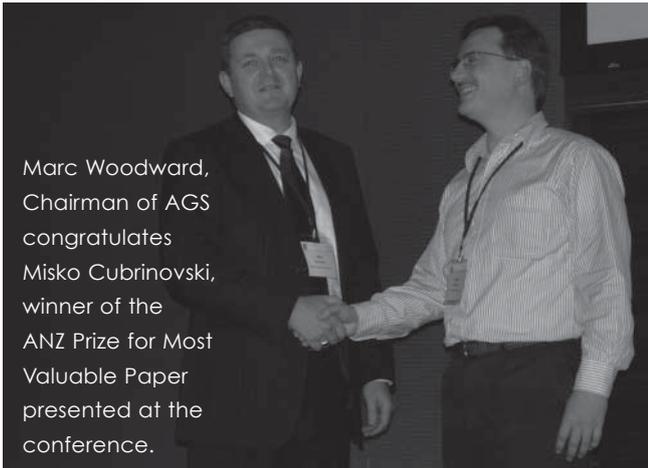
Australia – New Zealand Regional Conference

The 10th Australia-New Zealand Conference on Geomechanics was held in Brisbane from the 21-24 October 2007. By all measures and accounts it was an outstanding success and a great achievement by the talented and hard-working conference organizing team, who provided delegates with a magnificently planned, executed and catered event. This conference, held approximately every four years, provides a great opportunity for the geotechnical communities of New Zealand and Australia and delegates from further afield to come together on "Common Ground". The theme selected for the conference, apt in a variety of ways, set the tone for a very enjoyable and informative few days.

The conference broke new ground in a number of ways. With a slick but well thought out format, it offered a lot for the average geotech, of both a technical and non-technical nature. And much was able to be offered this time around because of the significant level of very welcome corporate sponsorship. Coffey Geotechnics was the Conference Patron, while Keller, Parsons Brinkerhof, CPTS, Golder Associates and Geovert were Major Sponsors, and Menard, GHD, Techsoft and Queensland Department of Main Roads were Conference Sponsors.

The conference kicked off to a great start with an excellent Keynote Lecture delivered by Dr Peter Mitchell on the topic of "The Continuing Problems Associated with Expansive and Collapsing Soils". The brackets on the opening day were closed off very nicely by Dr Do Van Toan who delivered the New Zealand Geomechanics Lecture with the title "A Geomechanics View on Heavy Duty Pavements". Day 2 of the conference proper also started in great style with Robin Fell's delivery of the John Jaeger Lecture entitled "The mechanics of internal erosion and piping of embankment dams and their foundations". New ground was definitely broken again on day three, which started with an International Lecture presented by Dr John Christian who remained for the occasion on his home turf in Cambridge, Massachusetts (courtesy of MIT). John's image and voice were delivered to us in Brisbane in real time, very clearly through the ether via the magic of modern electronic communications. Meanwhile his Powerpoint slides appeared in sequence on a second big screen in Brisbane. This surely set the example for the delivery of future international lectures.

Another innovation for the conference was the inclusion



Marc Woodward,
Chairman of AGS
congratulates
Misko Cubrinovski,
winner of the
ANZ Prize for Most
Valuable Paper
presented at the
conference.

of several Debates. These were conducted on the pair of propositions: "Further geotechnical engineering research is no longer justified" and "For routine practice, laboratory testing of soils is outdated and should be abandoned in favour of in situ testing". These proved to be a very popular addition to the conference program, with a good mix of serious debate and just a modicum of levity. Perhaps future conferences may consider running each as a plenary activity, so that both debates can be savoured by all.

The ANZ Joint Societies Award for the "most valuable conference paper, excluding invited or special papers" was announced at the closing ceremony by the AGS Chairman, Marc Woodward. This distinction was awarded to Dr Misko Cubrinovski of the University of Canterbury for his paper entitled "Key Parameters in Pseudo-static Analysis of Piles in Liquefying Sand" (see accompanying photograph).

Another distinguishing feature of this particular conference was the fact that the ISSMGE chose this occasion in the geotechnical calendar to hold both its

Board and Council meetings. AGS, NZGS and the conference organizing committee are honoured that ISSMGE selected Brisbane and this conference as the time and place for these meetings.

I feel sure that most who attended would agree that this "Common Ground" conference was a great success, notable for many things but especially for the quality of the submitted papers and their presentations, the quality of the refreshments and victuals, and for the many new friendships made or old ones reconnected. The organisers deserve our sincere thanks for making this possible and for setting a high bar for the hosts of the next gathering in this ANZ series, to be held in Melbourne in 2011.

Other ISSMGE News

Brief highlights include:

- The 8th ANZ Young Geotechnical Professionals (YGP) Conference will be held in Wellington on 5th-8th November 2008 (for ISSMGE, ISRM and IAEG members) The organising committee is led by Dr Elisabeth Bowman, a lecturer in Geotechnical Engineering at Canterbury University.
- The 17th International Conference of ISSMGE will be held in Alexandria, Egypt, from 5-9 October, 2009
- Next International Conference on Environment Geotechnics will be held in New Delhi, India, in 2011.
- The ISSMGE Bulletin has been revamped and is now issued quarterly, so please watch out for it. It can be downloaded from: <http://www.issmge.org/home/page.asp?sid=296&mid=2&CatId=3624>

John Carter
ISSMGE VP Australasia
November 2007

Stephen Crawford
ISSMGE Liaison for
New Zealand

ISSMGE Australasia VP Report: October 2007

Introduction

This report contains a summary of the highlights of the activities of the New Zealand Geotechnical Society (NZGS) and the Australian Geomechanics Society (AGS), for the period since the last Council meeting in Osaka, in 2005.

NZGS Activities

- NZGS has a new chairman, Dr C Y Chin. Dr Kevin McManus will stay on the NZGS Management Committee for another year as immediate past chairman. Steve Crawford takes on a role as ISSMGE liaison for NZ, supporting Prof. John Carter as ISSMGE Vice President for Australasia.
- NZGS Membership is over 600. Affiliation of NZGS

members with ISSMGE currently stands at 340. This total may seem modest, but it represents probably the highest national per capita affiliation rate of any member society. New Zealand's population is just over 4 million, and so the affiliation rate is approximately 3 in 40,000 or the best part of 1 in 10,000, which is exceptional.

- NZGS will celebrate its 50th Anniversary in 2008, with celebrations planned for the New Zealand national symposium, to be held in Auckland in September 2008. The theme of the symposium is Soil-structure Interaction. Further details may be found at <http://www.nzgeotechsoc.org.nz>.
- One of the main highlights of the NZGS's activities recently has been the planning and successful bid for the

11th IAEG Congress to be held in September, 2010 in Auckland, New Zealand. As the Society's bid document and web pages clearly imply, geologically active New Zealand 'has it all':

"Active seismicity and volcanic fields, fault movement and ground shaking, liquefaction, slopes in tectonically deformed terrain, high intensity rainfall, geothermal fluids and ...

collapsing cones, sensitive soils, slippery slopes, mylonite and melange, rock slide avalanches, boiling mud and geysers, pumice, ignimbrite, tephra and weak rock of many kinds. ...

Aotearoa New Zealand is the country. Auckland is the city. *Geologically Active* is the theme. NZGS extends a personal invitation to you to come on over to our place. Active, Auckland, Aotearoa New Zealand."

Further details, including copies of the bid documents, can be found at the NZGS website: <http://www.nzgeotechsoc.org.nz>.

- The NZ Geomechanics Award is bestowed on the author(s) of papers that are distinguished in their contribution to the development of geotechnics in New Zealand. The award for 2005 was presented to S. A. L. Read, L. R. Richards and G. K. Cook for their paper entitled "Rock mass defect patterns and the Hoek-Brown failure criterion", Proc. 10th ISRM International Congress on Rock Mechanics, Johannesburg : 2, 947-954.
- *Geomechanics News* continues to set a very high standard as the flagship publication of NZGS. It appears twice per year, in June and December. Tables of contents of past issues can be found at: <http://www.nzgeotechsoc.org.nz/past-issues.html>.
- The Society's web page continues to service the Society and members. It is worth noting that income made from the employment opportunities section has made the web page and the associated internet fees self funding. The website can be accessed at <http://www.nzgeotechsoc.org.nz>.
- The 2007 NZ Geomechanics Lecture has been awarded to Dr D V Toan. Dr Toan will give his lecture entitled "A Geomechanics View on Heavy Duty Pavements" at the 2007 Brisbane ANZ Conference.
- The 2006 Young Geotechnical Professional (YGP) award for the best NZ paper at the 7th ANZ Adelaide YGP Conference was awarded to Lucy Coe.
- The next ANZ YGP Conference is to be held in Wellington in 2008. A committee of YGPs is currently preparing for this event.
- Professor Mick Pender was awarded the 2006 Turner Award, a prestigious award of the Institution of Prof. Engineers NZ [IPENZ]. Mr Terry Kayes was awarded

the 2007 Turner award. Both engineers are members of NZGS and ISSMGE, and were promoted by NZGS for this award to IPENZ.

- Four NZGS members were promoted to the class of Fellow IPENZ: Gavin Alexander, Stephen Crawford, Rodney Hutchinson and Kevin McManus.
- Recent overseas speakers at NZGS local events include Prof. John Atkinson on the use and misuse of c' and ϕ ; Dr Stuart Haig on Centrifuge modelling work done at Cambridge and its applications in geotechnical practice.
- NZGS warmly welcomes Prof. Michael Davies as the new dean of the University of Auckland Engineering School. Michael will soon relinquish the mantles of Chair of the British Geotechnical Society and the Scottish Geotechnical Society. Michael represented the UK at the ISSMGE Council in Osaka.
- NZGS has been active in many areas, with more focus placed on YGP activities. Local branch presentations occur monthly [sometimes more frequently with overseas speakers], particularly in the Auckland region. A cricket match was held in Jan. 2007, to set off the season with a six, and an annual purely social event is held at Old Government house to round out the year in December.
- Current and future issues for NZGS:
 - A Stability Guidelines Committee has been formed and is chaired by Steve Crawford and Grant Murray. Their initial task is to review the AGS Landslide Risk Management Guidelines. This is seen as a *benchmark* document and may be adopted/adapted as a regional guide to establish uniformity across the Australasian region.
 - A Geotechnical Earthquake Engineering Committee has been formed to develop a set of design guidelines for NZ conditions. A 1st draft of these guidelines is due soon for comment. The committee is chaired by Kevin McManus.
 - Electronic Data Transfer Guidelines – this is being advanced by Rodney Hutchinson and is being modelled on the UK guide, which Rodney was involved in establishing. It is hoped that this will be used as an Australasian guide and will be promoted to AGS in draft later this year.

AGS Activities

- Current membership of AGS is approximately 1100, with approximately three quarters of the members choosing to affiliate with ISSMGE. Australia's participation rate is therefore in the order of 1 in 20,000, behind New Zealand, but probably still amongst the other leading nations.
- Mr Max Ervin, a past ISSMGE Vice-President for

- Australasia was selected for the Geotechnical Professional of the Year Award for 2006.
- Professor Robert Mair visited Australia in May 2006 and delivered his 2006 Rankine Lecture in both Sydney and Melbourne.
 - Dr Del Fredlund visited Australia in September 2006 and re-presented his 2005 Terzaghi Lecture in Sydney, Brisbane, Melbourne, Adelaide and Perth.
 - Professor John Atkinson visited Australia in 2007 and presented lectures in major cities.
 - The 2006 D. H. Trollope Medal was awarded to Majidreza Nazem from Newcastle University for his paper entitled “Stress integration and mesh refinement for large deformations in geomechanics”, by Nazem M., Sheng D. and Carter J. P. (2006), *International Journal for Numerical Methods in Engineering*, 6(7), 1002-1027.
 - Patrick Wong and Ray Hatley were jointly awarded the 2004 Australian Geomechanics Award for the following two papers: “Ground Improvement Case Studies - Chemical Lime Piles and Dynamic Replacement” by P. Wong, *Australian Geomechanics*, Volume 39, No 2, pp. 47-60; and “Hydrogeology of the Botany Basin” by R. K. Hatley, *Australian Geomechanics*, Volume 39, No 3, pp. 73-91.
 - The 2005 Australian Geomechanics Award has been decided in favour of Stephen Fityus, Greg Hawkins, Mark Delaney and Stephen Morton for their paper entitled “An Overview of Engineering Geology and Geotechnical Challenges in the Newcastle Region”, *Australian Geomechanics*, Volume 40, No 1, pp. 5-28.
 - The 2007 E. H. Davis Memorial Lecture has been awarded to Dr Chris Haberfield.
 - The 2007 John Jaeger Memorial Award will be presented to Professor Robin Fell at the 10th Australia-Geomechanics Conference in Brisbane in October 2007.
 - Keynote Speaker at the 10th ANZ Conference in Brisbane will be Dr Peter Mitchell and Dr Jon Christian will be the International Lecturer.
 - The 2006 AGS - Don Douglas Youth Fellowship was awarded to David Piccolo at the 7th ANZ YGP held in Adelaide.
 - *Australian Geomechanics* continues to be published quarterly, in March, June, September and December, by the Institution of Engineers Australia, and is edited and produced by the Australian Geomechanics Society. It provides both a journal and news magazine for matters of interest to the Australian geotechnical community, with Patrick MacGregor continuing to provide sterling service as its energetic editor.
 - The Society has recently prepared and printed a series of articles and guides related to Landslide Risk Management. The comprehensive study that led to the development of these publications has received support from the Australian Government and local councils. The study was carried out by members of the AGS. A collection of these articles has been published in March 2007 issue of *Australian Geomechanics* and copies of them are also available on CD from AGS – see www.australiangeomechanics.org.
- Current and future issues for AGS:
 - Promulgation of the AGS Landslide Risk Management Guidelines.
 - The need for further engagement with younger geotechnical professionals.
 - The need to interest students in a career in the geotechnical profession.
 - The need to deal with the shortage of skilled and experienced geotechnical professionals, which is becoming more acute.
- ### 7th ANZ YGP Conference
- The 7th ANZ YGP Conference was held in Adelaide on 18-21 October 2006, jointly sponsored by the Australian Geomechanics Society, New Zealand Geotechnical Society, Engineers Australia, Institution of Professional Engineers New Zealand and the Australasia Institute of Mining and Metallurgy. Geotechnical engineers under the age of 35, with less than 10 years experience, from either a consulting or research background are encouraged to attend these conferences. At the Adelaide conference, the AGS - Don Douglas Youth Award was presented to David Piccolo, whose paper was judged the best paper from Australia submitted to the Conference. This award provides support for attendance at the international YGP Conference and is jointly funded by Don Douglas P/L and AGS. The 2006 YGP award for the best NZ paper at the 7th ANZ Adelaide YGP was awarded to Lucy Coe. The NZ Young Geotechnical Professionals Conference Awards, jointly funded by the NZ Earthquake Commission Research Foundation and the NZ Geotechnical Society, are made available to support the attendance of the recipients at the international YGP conference.
- John Carter**
ISSMGE VP Australasia
October 2007
- Stephen Crawford**
ISSMGE Liaison for New Zealand

IAEG Australasia VP Report: October 2007

Introduction

This is the IAEG Australasian region report to October 2007. The report is by Alan Moon (Vice President for the region) for submission to the New Zealand Geotechnical Society (NZGS). A similar report was submitted to the Australian Geomechanics Society (AGS) earlier this month.

IAEG issues

Fred Baynes is doing an excellent job as IAEG President and is keeping very busy. Everybody is impressed by his enthusiasm and his determination to represent, contribute to, and improve the profession. I understand that NZGS and AGS will provide the financial support for travel that Fred has requested and hope that the approaches by AGS to Engineers Australia and AUSIMM to provide further support have been successful.

I went to the IAEG Council and Executive meetings in Vail, Colorado in June 2007 and am learning more about how the association works. Working groups on financial matters and young professionals have been set up and new commissions are planned. Ann Williams and I am on

the young professionals working group and am interested in getting peoples views on how we can promote the profession to students and younger people in industry. On a less positive note there are still problems around the world with the distribution of bulletins. I understand that New Zealand members have been receiving their bulletins but there are some problems in Australia.

Ann Williams (IAEG Liaison for New Zealand) also went to Vail. Ann gave excellent presentations on the 11th International Congress of the IAEG which will be held in Auckland in September 2010 to the IAEG Council and Executive meetings and to the First North American Landslide Conference which followed.

At the IAEG Council meeting there was discussion about starting new IAEG national groups and increasing IAEG individual memberships. In our region most countries have very small populations and new national groups are unlikely. However, engineering geologists and other geotechnical professionals working in Papua New Guinea and the Pacific can become members by joining the NZGS or the AGS and individuals anywhere can register on the website.

The IAEG has awarded the Hans Cloos Medal (its highest award) to Professor Wang Sijing from China and the Richard Wolters Prize (for younger members) to Dr Marcus Scholz from Germany.

The next AGS geology for engineers course will be held in Adelaide April 2008 (prepared and presented by Alan Moon, Fred Baynes and Isabelle Lamb).

I plan to attend the next IAEG Executive and Council meetings in Madrid, Spain in September next year.

Alan Moon, 15 October 2007

OLC SOIL AUGER MACHINE

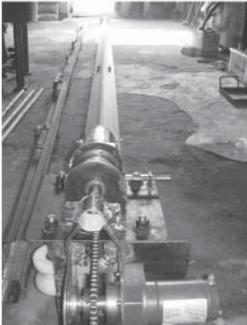
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Contact Details:
Mr Lian Ching Oh
Auckland, New Zealand
email: lianchingoh@yahoo.com.sg



NZGS BRANCH ACTIVITIES

Auckland Branch Activity Report

Our meeting programme for the year is now drawing to a close. It has been a full year, with a mix of site visits, regular meetings and special guest lectures.

We have also been fortunate to welcome Professor Michael Davies to the University of Auckland as the new Dean of Engineering. Prof Davies is very well known in the international geotechnical community and we look forward to continuing the strong relationship that has already developed with the Auckland branch.

The meetings programme since our last report and a brief synopsis of the presentations has comprised:-

June

Bernard Hegan (Tonkin and Taylor),
Tunnelling in Auckland – An Engineering Geological View of Waitemata Group Rocks
A presentation was made on tunnelling conditions in the Waitemata Group Rocks, as encountered in Auckland, including the recently completed Northern Gateway Alliance/ALPURT-B2 twin tunnels and the Vector Penrose to Auckland CBD tunnel.

July

Rodney Hutchison, (KGA Geotechnical Ltd)
Simon Humphreys, (Sinclair Knight Merz)
- The Electronic Transfer of Geotechnical Data - Creating Order out of Chaos
The concept of transferring data between interested parties in electronic form is widely used internationally. This minimises costs, time and the potential for errors occurring, as well as encouraging a more efficient use of the data. In 2006 NZGS formed a working party to review the existing electronic data transfer standard formats utilised in other countries. This work is now complete and a working draft of the NZ version of the electronic data transfer format is available.

August

Professor Michael C.R. Davies, University of Auckland - Boot-Straps and British Standards: Understanding and Designing Soil Nailed Systems

Soil nailing as a form of ground reinforcement was introduced in the United Kingdom in the mid 1980's. It has proved to be cost effective and applicable to stabilise new and existing embankments and slope cuttings, and strengthen existing retaining walls. The latest developments in both research and practice have been incorporated into the recently published CIRIA best practice guidance on soil nailing. In addition, the



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Rodney Hutchison is Principal with KGA Geotechnical Ltd - a small specialist geotechnical practice on Auckland's North Shore. They provide general geotechnical consulting services to a wide range of clients ranging from Territorial Authorities, other consultants, land developers to individual house builders. He is a geotechnical engineer who studied in London and then worked in Hong Kong and the UK before returning to NZ.



Yan Chan

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Yan Chan is Senior Geotechnical Engineer / Team Leader at Sinclair Knight Merz, Auckland. Yan graduated from Auckland University before working in UK and Malaysia, ultimately returning to NZ in 2000. Yan is also a committee member of IPENZ Auckland.



Steve Crawford

Auckland Branch Coordinator
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Steve is a principal of Tonkin & Taylor Ltd in Auckland and a past chairman of the NZ Geotechnical Society. He has been with T&T for 15 years. His current role is Geotechnical Team Leader on the Northern Gateway Alliance - ALPURT-B2 northern motorway extension project. Steve has been active in Auckland and Tauranga local branch activities and national management for the Society since 1994. He has a Bachelors degree from Auckland University and a Masters degree from Sydney University. Steve has worked as an engineer in NZ, Australia, Cambridge (UK), KL (Malaysia), Hong Kong and Seiyun (South Yemen).

CEN guidance on soil nailing construction is about to be published and BS 8006 is currently being revised to expand recommendations relating to the design of soil nailed systems.

August - Special Lecture

David Petley, Wilson Professor, Department of Geography, Durham University, Durham - The development of progressive failure in landslides

An investigation of progressive failure in rock and soil slopes was presented. A non-linear trend is commonly observed in inverse velocity – time space, with the nature of the trend being dependent upon whether the movement is controlled by brittle deformation processes or not. Bjerrum's hypothesis that progressive failure is due to rupture surface propagation (1966 Terzaghi lecture) is shown to be correct. This potentially allows better interpretations of landslide movement records and the development of more reliable warning systems.

September

Andy O'Sullivan, Engineering Manager, Hiway Stabilisers Environmental Ltd & Grant Murray, Geotechnical Section Manager, Sinclair Knight Merz
Soil Nailing – Design Guides, Theories, Models and Practice

Soil Nailing, like reinforced soil or geo-synthetically reinforced structures, has been around a long time and there are various design guidelines, codes of practice and standards written about the analysis and specification of these systems. The various methods used to reinforce or strengthen a soil mass were described and some of the issues associated with their use and application highlighted. Particular focus was given to examples of stabilising projects undertaken in NZ and the tools used to support the design decisions.

20th November

Prof Jonathan Fannin, University of British Columbia, Canada
Visiting Erskine Fellow, University of Canterbury,
"Debris flow risk management - experience in British Columbia"

The nature of debris flow impacts on roads, railways and private property in the coast mountains of western Canada was described with reference to recent events in British Columbia. Debris flow risk management requires an understanding of processes leading to initiation of the event, and to factors governing its travel distance.

Implications for risk management were considered, both from a technical as well as societal perspective.

27th November

NZ Geomechanics Lecture
Dr Do Van Toan, Beca Infrastructure, Auckland

A geomechanics view on heavy duty pavements

Geomechanics view on heavy duty pavements: outlining my journey from an initial PhD on "Effects of Basecourse Saturation on Flexible Pavement Performance" to research on deflection bowl due to wheel loading, the influence of clay minerals on New Zealand aggregates, the effects of the geology of sources of rocks on pavement friction characteristics. This led to the intricacies of design using different pavement materials including mix designs for Asphaltic Concrete, Portland Cement Concrete. Different methods of stabilising existing materials, including innovative use of very soft marine sediments for structural use in pavements and the application of underground injection to extend the life of damaged pavements are also described. Project examples are used to illustrate the interesting challenges of real problems and the fun of developing solutions.

[Dr Toan's NZ Geomechanics Lecture was first presented recently at the 10th ANZ regional conference in Brisbane on 22nd November 2007, and is reprinted in full in this issue of NZ Geomechanics News.]

December

The annual Christmas social gathering at Old Government House in the Auckland University grounds is planned for early December – date to be confirmed.

All of these events have been of exceptional quality and thoroughly appreciated and enjoyed by those who attended.

As always, the success of this programme is also due to the efforts put in by Yan Chan and Steve Crawford, without whom the programme would not happen.

Bay of Plenty Branch Activity Report

Tauranga branch have had a couple of meetings in the last few months.

The first was a trip to the site of a new stormwater tunnel being drilled to alleviate some of the stormwater problems that contributed to all the slips and flooding we experienced back in 2005. An excellent tour, arranged by the Council and covering all aspects of the project. Also well attended by about 16 local engineers / geologists. The second was a re-run of the presentation regarding the engineering geological characteristics of Matata, which was originally presented to the Auckland branch about 6 months earlier. The local practitioners obviously found it quite relevant and some interesting discussions ensued following the talk.

We've pretty much expired for the year now and are looking to plan some trips and talks for the 2008 year. As always, new ideas gratefully received!



Sally Hargraves

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Sally is an Engineering Geologist and director of Terrane Consultants Ltd, Tauranga. She studied geology in the UK, and gained her PhD in slope stability modelling before moving to New Zealand. She has spent the last eight years in Tauranga and more recently co-founded Terrane Consultants Ltd, a geotechnical consultancy, which started up in March 2005.

Waikato Branch Activity Report

No activity to report from the Waikato Branch.

If you would like to contribute more to your local Branch please contact your Branch Co-ordinators with ideas and inspiration.



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Wellington Branch Activity Report

I took over as Wellington Branch Coordinator from Grant Dellow in July.

Since then a number of meetings have fallen into my lap to organise. Talks have been held at a range of venues, but we plan to hold most future talks at the offices of Opus at the Majestic Centre, 100 Willis Street, in the central CBD area.

Talks held to date:

DATE	PRESENTATION
23 August	Development of Progressive failure in Landslides. Professor David Petley
31 August	Quantifying the global impact of landslides. Professor David Petley
19 September	Young Geotechnical Professionals Conference Award presentations. <ul style="list-style-type: none"> Terrace Tunnel Approach Walls. Beverley Curley. (OPUS) Silverstream Sedimentation Pond, Lessons Learnt in the use of Greywacke Fill. Andrew Kennedy. (T&T) Settlement of Embankments on Soft Soil. Sarah Stapleton. (T&T)
31 October	Recent Landslides / dam break hazards <ul style="list-style-type: none"> The 2007 Ruapehu lahar Event. Chris Massey, (GNS) Young River Landslide. Mauri McSaveney, (GNS)

Upcoming events planned are:

DATE	PRESENTATION
13 November	NZGS 13th Geomechanics Lecture. Geomechanics view on Heavy Duty Pavements. Dr Do Van Toan. (Beca)
February 2008	Liquefaction Trigger Mechanisms. Dr Katherine Butterfield.
March 2008	The Taihape Landslide. (GNS)
April 2008	Mitigation of liquefaction /lateral spreading potential at Centrepont, Port of Wellington. Stuart Palmer (T&T)

Some joint meetings with the Earthquake Society and also a talk on rock slope stability are also in the pipeline.

Offers or suggestions of other talks or site visits are welcome.

Meetings will normally be held at the Opus offices in the Majestic Centre on the corner of Willis and



David Stewart

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David Stewart is a Senior Geotechnical Engineer / Engineering Geologist with Opus International Consultants in Wellington. David initially worked in site investigations in the UK, returning to NZ to work as an engineering geologist in the Otago area – initially with the Cromwell Gorge Landslides project, followed by GNS Dunedin and Macraes Gold Mine. After completing a BE he has spent the last 6 years based in Wellington.

Boulcott Streets. Refreshments from 5.30pm at the Level 9 boardroom, with talk at 6pm. Contact the branch coordinator for confirmation of details.

Details of talks held

In August, we had two talks from Professor David Petley from Durham University, who was being hosted by GNS. Professor Petley is a leading researcher on landslides and landslide mechanics and director of the International Landslide Centre.

Professor Petley gave a presentation to the local branch and a second presentation at GNS which many members also attended.

23 August. Development of Progressive failure in Landslides. Prof David Petley Approximately 25 people attended this talk held at the IPENZ offices on the Terrace.

Professor Petley talked about methods used to predict failure behaviour in rock and soil slopes using a number of landslide monitoring datasets. He indicated that observed failure behaviour can be explained (at least partially) using a technique used by Saito (Japan) and a hypothesis from Bjerrum (Terzaghi lecture 1966).

Bjerrum's hypothesis that progressive failure is due to rupture surface propagation was observed to be correct. This potentially allows better interpretations of landslide movement records and the development of more reliable warning systems.

He also explained the technique used by Saito to predict the time of final failure, where measurements of the displacement of the landslide are converted into the inverse of velocity, and plotted against time. In many cases a linear trend results, and the time of final failure can be

predicted by extrapolating this linear trend to the time at which inverse velocity = 0. It was shown that a non-linear trend is also commonly observed, with the nature of the trend being dependent upon whether the movement is controlled by brittle deformation processes or not.

31 August. Quantifying the global impact of landslides. Prof David Petley

Approximately 30 people attended this talk held at GNS in Avalon.

This talk presented research, carried out through the International Landslide Centre (based at Durham University), on the global impact of landslides. Analysis of a database of global landslide fatalities shows that the spatial distribution of fatal landslides is strongly correlated with areas of high seismic hazard, even though most of the landslides are not earthquake-triggered. There is also a strong correlation of landslide fatalities with tropical storms (e.g. Monsoons). Most landslide fatalities are associated with one or other of the above two conditions.

A second research project involved analysis of a landslide database in Nepal; a marked increase in fatal landslides was observed over the past decade, which appears to be related to a period of significantly increased rural road building.

19 September. Young Geotechnical Professionals Conference presentations

Three young Geotechnical professionals from the Wellington area were provided with awards from the NZ Geotechnical Society to attend the 2006 ANZ Young Geotechnical Professionals Conference in Adelaide. The recipients of the awards presented the papers they presented to the conference, which covered different aspects of geotechnical projects in the Wellington area. The talks were held at the offices of Tonkin and Taylor with 23 attending. The talks were:

- Terrace Tunnel Approach Walls. Beverley Curley (Opus Consultants).

- Silverstream Sedimentation Pond, Lessons Learnt in the use of Greywacke Fill. Andrew Kennedy (Tonkin and Taylor).
- Settlement of Embankments on Soft Soil. Sarah Stapleton (Tonkin and Taylor).

30 October. The 2007 Ruapehu Lahar Event(s) - Chris Massey, GNS The Young River Landslide - Mauri McSaveney, GNS

Approximately 25 attended this meeting on the theme of recent landslide events and related natural dam break hazards. The meeting was held at the offices of Opus Consultants.

Chris Massey presented the main talk - a geotechnical analysis of the Ruapehu Crater lake dam breach that caused the major lahar in March. Regular inspections, detailed surveys (including 3D laser scanning) and analysis of subsurface (Scala) data were made prior to the event. This enabled groundwater / stability models to be developed to allow predictions to be made as to the stability of the dam as the water level rose in the lake. The dam breach occurred more rapidly than expected, with rapidly increasing seepage flows through the dam and related rapid headward erosion culminating in wholesale failure of the dam rim. The resulting Lahar event in the Whangehu valley has produced a huge amount of data for ongoing research.

Mauri McSaveney gave a brief presentation on the large landslide in August that blocked the Young River in Mt Aspiring National Park, and formed a large lake. From seismic records the event occurred in just over 1 minute in highly fractured Haast schist, with no obvious trigger. GNS have scanned the debris dam with a laser scanner and determined a volume of 13 million m³. Some debate of the likelihood and mode of dam failure occurred and we look forward to an update, if and when the dam fails!

Nelson Branch Activity Report

No activity to report from the Nelson Branch.

If you would like to contribute more to your local Branch please contact your Branch Co-ordinators with ideas and inspiration.



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Canterbury Branch Activity Report

The Christchurch Branch are revitalising the meetings calendar and are looking forward to a healthy 2008 list of fixtures commencing with the talk by Dr Toan (Beca) entitled Geomechanics View on Heavy Duty Pavements on Wed 14 Nov 2007 held at the University of Canterbury.

Further future details to be issued by email flier to Branch members and posted on the NZGS website.



Nick Harwood

Canterbury Branch Coordinator
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Nick took up the role of Canterbury Branch Co-ordinator in October 2007.

Nick is a consulting Geotechnical Engineer who leads the geotechnical group of the Opus Christchurch office, and also oversees the Opus' Christchurch materials testing laboratory. He graduated in 1990 with a BEng (Hons) degree in Engineering Geology & Geotechnics, followed by a MSc in Soil Mechanics & Engineering Seismology from Imperial College in 1994. Nick started out as a graduate working for British Waterways before moving onto Brown & Root (London) and Buro Happold (Bath) before finally escaping to New Zealand in 2002. He has worked for Opus International Consultants for five years with the last two based in Christchurch. He loves living and working in New Zealand, a place that combines sublime scenery and diverse assignments.

Otago Branch Activity Report

The Otago Branch had a very successful meeting on 18 October. Ian Walsh of Opus presented a talk on Risk Management which stimulated some very interesting discussion. About 18 people attended the meeting including some of our clients from Dunedin City Council.

Two more meetings have been organised for the remainder of 2007. Royden Thomson will be presenting a talk on the Manapouri project on 8 November in Queenstown and Phil Glassey will present the latest guidance on planning for landslides from the GNS on 13 December.



Christine Ramshaw

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Christine Ramshaw is a Senior Geotechnical Engineer with MWH in Dunedin. Christine moved to New Zealand in January 2006 from the UK where she had a varied geotechnical career starting off with Arup Geotechnics in London designing large diameter piles and contiguous bored pile walls for a underground shopping complex, Resident Engineer for a section of the CrossRail ground investigation, supervising various piling contracts, analysis and design of deep basements, contaminated land and landfill investigation/remediation in remote parts of Devon, a few years at Durham University undertaking research into numerical modelling of ground vibrations from pile driving and, most recently, working for Oasis (the software house of Arup) in geotechnical software development, technical support and training.

Since moving to Dunedin, Christine has been busy remediating several landslips and designing numerous gabion retaining walls for Transit and Dunedin City Council.



8YGPC

8th Young Geotechnical Professionals Conference

5 – 8 November 2008
Wellington, New Zealand

Are you or do you know a young geotechnical professional willing to accept the challenge to present a technical paper?

The 8th ANZ Young Geotechnical Professionals Conference is for geotechnical professionals from Australia and New Zealand, who are less than 35 years of age with a maximum of 10 years' experience. To nominate, simply complete the nomination form available from the conference website.

Nominations must be supported by a senior mentor and include an abstract of up to 200 words on a topic related to geotechnical research or practice. Successful nominations will be selected based on the quality and relevance of the abstract. Several awards to attend the 8YGPC will also be made, courtesy of EQC and NZGS.

Abstracts to be submitted by 29th February 2008.

Best paper prizes to be awarded at conference:

NZGS Young Geotechnical Professionals Fellowship

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For more information about these awards, please visit the conference website.

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Conference Website

www.nzgeotechsoc.org.nz/anz-ygp-conference.cfm

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New Zealand Geotechnical Society Geotechnical Symposium 2008

First Notice



3 Sep	Pre-Symposium Workshops
4-5 Sep	Soil-Structure Interaction – From rules of thumb to reality
6 Sep	Field Trip, Auckland

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Soil-Structure Interaction – From rules of thumb to reality

This symposium is intended to provide a forum for practitioners to meet and exchange ideas on a wide range of geotechnical engineering and engineering geological issues as they relate to the interaction between geotechnical conditions and structures.

The symposium will extend over two days at a central Auckland venue with an option for undertaking a field trip on Saturday 6 Sep 2008. Pre-Symposium workshops are proposed on Wednesday 3 Sep 2008.

The list of proposed topics includes the following:

- Modelling
- Seismic behaviour
- Deep excavations
- Foundations
- Slopes
- Pavements
- Tunnels
- Case studies.

The submission of papers is invited from 1 Dec 2007 and will close on 15 Mar 2008. All papers must be submitted in a prescribed format which will be available from www.nzgeotechsoc.org.nz/2008-Symposium.cfm commencing 1 Dec 2007.



For information on the symposium, please contact the Convenor, Gavin Alexander (gavin.alexander@beca.com) or visit www.nzgeotechsoc.org.nz/2008-Symposium.cfm. Online registration will be available on this website from Jan 2008.

STANDARDS, LAW AND INDUSTRY NEWS

Young Geotechnical Professionals Conference Update

Preparations are well underway for the 8th ANZ Young Geotechnical Professionals Conference to be held in Wellington, 5th-8th November 2008. This conference is held every two years in either Australia or New Zealand and is aimed at promoting the professional development of delegates through the sharing of ideas and experiences. Each delegate is required to prepare a written paper on some aspect of their work and to present their paper to peers and senior professionals.

The 8th YGPC organising committee consists of "Team Wellington" (Beverley Curley and Andrew Kennedy), "Team Auckland" (Lucy Coe, Paul Fletcher and Ross Kendrick) and "Team Christchurch" (Lis Bowman – can you have a team of one??). With a well balanced committee consisting of three geotechnical engineers and three engineering geologists, we feel it is very important to have a venue and field trip that speak to both disciplines in equal measure. Wellington (faults! foundations!) appears to be an ideal location for both.

We have had a number of teleconferences and one recent visit to Wellington in late October to look at field trip options and the intended venue for the conference itself. Requests for sponsorship have been sent out, the first call for abstracts (this issue of Geomechanics News) has been issued and the website set up:

<http://www.nzgeotechsoc.org.nz/anz-ygp-conference.cfm>

We welcome the support of the geotechnical community, both financially and for allowing the release of valuable people for a few days' professional development and mentoring. Note that the NZGS and EQC will be making several joint awards to attend the Wellington YGPC. Details on how to apply for the awards are available on the website. Please visit this website regularly, as it will be the focal point for new information as it is released.

Organising committee contacts:

Lis Bowman (Chair)

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Reported by: Lis Bowman

University of Canterbury



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Active, Auckland, Aotearoa

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IAEG
 CONGRESS 2010

Hosted by the New Zealand Geotechnical Society www.iaeg2010.com

IAEG 2010 Congress Update

IAEG 2010 Congress

The status of preparations for the 11th Congress of the International Association for Engineering Geology and the Environment to be held in Auckland, NZ in September 2010 (IAEG 2010) was presented to the Executive Committee of the IAEG on 2 July 2007 and to the Council on 3 July 2007 at the Inaugural North American Landslide Conference in Vail, Colorado. Issues arising were discussed with the Executive and feedback was very favourable. In particular, discussion of the particular incentives planned for young professionals lead into a subsequent discussion within the Executive on Young Professionals and development of a Young Professionals Working Group lead by Sebastien Dupray. We are providing inputs to this group.



Above. Australasian VP, Alan Moon (right) and President of the IAEG, Dr Fred Baynes (left) in Vail

The organising committee are pleased to have The Conference Company (TCC) on board as the professional conference organiser for IAEG 2010. Sponsorship packages will be advertised shortly. Should you wish to receive information on sponsorship opportunities, please contact Sally Hargraves at sallyh@terrane.co.nz or Tim McMorrان at Tim_Mcmorrان@URSCorp.com.

TCC ensured that our Congress webpage www.iaeg2010.com was live at the commencement of the Vail conference. We are now working with webpage designers to raise the profile and impact of the page.

Preliminary notice of the 11th IAEG Congress was distributed to delegates at the ANZ Conference in Brisbane and electronically to national groups. If you would like to receive hard copies of the double-sided flier for inclusion in your conference satchel or distribution to

your colleagues, please contact Debbie Fellows at debra_fellows@URSCorp.com.

IAEG WEBSITE www.iaeg.info

Discussion forums are up and running on the website, but only a small proportion of the membership has registered. If you would like to receive electronic newsletters, notification of new publications, access to standards etc, you need to register!

If you would like to have announcements distributed to members via electronic newsletters, contact Niek Rengers on rengers@itc.nl.

Quarterly Journal of Engineering Geology and Hydrogeology

The editorial board of the Quarterly Journal of Engineering Geology and Hydrogeology are seeking more input to the Journal from this part of the world.

Edited by M. W. Winter

Assistant editors: M. S. Rosenbaum, E. Bromhead and M. Streetly

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The Quarterly Journal of Engineering Geology and Hydrogeology is published by The Geological Society and is an established journal with a circulation of over 4000 in 47 countries. Papers are invited from, and about, all areas of the world on topics concerning geology as applied to civil engineering, mining practice and water resources, including: applied geophysics, engineering geomorphology, environmental geology, hydrogeology, groundwater quality, contaminated land, waste management, land use planning, geotechnics, rock mechanics, soil mechanics, geomaterials and geological hazards. The journal includes the prestigious Glossop and Ineson lectures, research papers, case histories, review articles, technical notes, photographic features, book reviews and periodic reports. Information for authors can be found at http://www.geolsoc.org.uk/gsl/publications/journals/qjegh/qjegh_authorinfo; please send submissions or any journal queries to the QJEGH Staff Editor: Helen Floyd-Walker – Helen.floyd-walker@geolsoc.org.uk.

Reported by: Ann Williams

IAEG Liaison for New Zealand

Electronic Transfer of Geotechnical and Geoenvironmental Data

The Problem

It is accepted that we generally have insufficient geotechnical data. In addition, the data that we do have is often difficult to access by all but the originator, either due to time constraints or the inability to read the data into an easily assimilated form.

All too often, geotechnical data for a project will come from multiple sources, possibly obtained over a wide period of time. Boreholes will be in different presentation formats, making them difficult to compare, laboratory test data will come in a mix of hard copy, computer spreadsheet and even computer text files, which renders collation impossible, except by manual transcription. This confusion of data presentation format is illustrated in Figure 1.

The Solution

It was established in the early 1990's that major benefits would accrue if geotechnical data were to be available in electronic form. The challenge to develop such a format was taken up by the Association of Geotechnical and Geoenvironmental Specialists (AGS) in the UK in 1991. In 1992 the first version of the AGS format was published and rapidly became the accepted standard for the presentation of geotechnical data in electronic form.

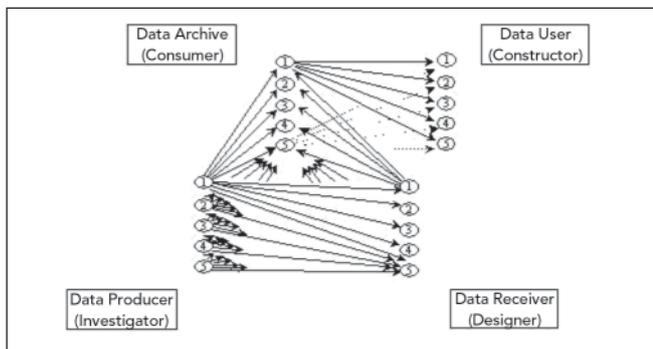


Figure 1. Before AGS

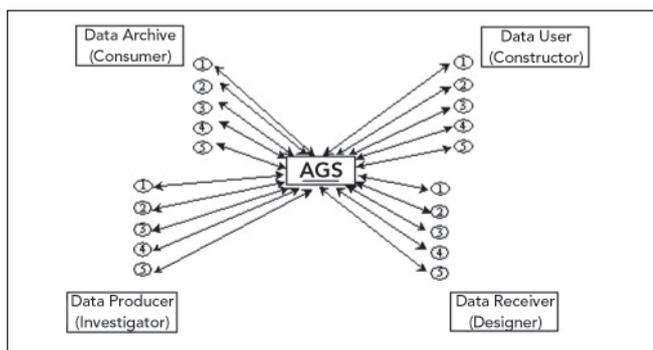


Figure 2. After AGS

The immediate effect of the AGS Format has been to eliminate the chaotic structure inherent in Figure 1 and replace it with an ordered structure typified by Figure 2.

In setting up the format, the AGS established a series of basic criteria to be met. These were that the format must:-

- be independent of any software package, proprietary or otherwise.
- be able to be incorporated into existing or future software either as an import filter or an export routine.
- be a file format protocol. It is NOT a database.
- be a simple ASCII text file.
- contain fundamental data only. Interpolated or derived data is excluded in order to avoid cluttering of data files.

By adhering to the above base criteria, universal access to the data by all is maintained.

Advantages to Data Access in Electronic Form

The overriding advantage of the use of the AGS format is that data can be transferred efficiently and accurately between users with no transcription errors. It also ensures that data can be read and shared by the entire project team, therefore maximising its use. **There is an old adage that one should enter computer data once and once only and that it must be done as early in the process as possible, preferably by somebody else!**

Access to data in electronic form using appropriate software provides immediate access to the information. Data does not have to be manually collated, plotted or drawn. Data can also be drawn from multiple sources and combined into a single data set.

Flexibility and Adaptation to New Zealand Needs

The key to the widespread adoption of the Format has been its inherent simplicity and flexibility based on the use of the data dictionary concept. Within the international context, local requirements can be accommodated by the addition of new fields to existing groups and also the addition of new groups where required.

To adapt the format to New Zealand requirements, the NZGS established a working party tasked with identifying local requirements. This has resulted in the adaptation of the basic format developed by the UK AGS. The proposed New Zealand version of the format has been put out to consultation through a Peer Review Panel and the final draft is now available on the NZGS website.

Software Availability

As part of the consultation process, the leading suppliers of geotechnical database/data management software were involved. As a result, at least one of these suppliers is now able to provide NZ AGS compatible import/export routines.

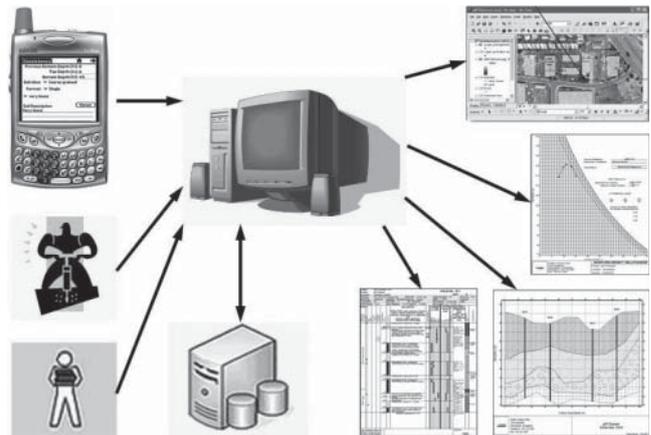
What can you do with AGS Data

Once the data is available in electronic form, it can be managed and output to a wide variety of applications:-

- Borehole logs
- Data plots
- Site plans and sections
- 3-D modelling
- Archiving

The Future

The current AGS data format is well established and has proven to be robust and reliable. However, it continues to develop. Work is underway on an XML based data transfer system, which will allow even greater benefits to be realised, although the practical application of this is still several years away.



AGS New Zealand

The current version of the Electronic Transfer of Geotechnical and GeoEnvironmental Data is currently available on the NZGS website. The working party welcomes any comments or feedback on the format as part of its continuing development. These comments should be passed to either of the two principal Working Party members below.

Rodney Hutchison

e. Rhutchison@kga.co.nz

Simon Humphries

e. Shumphreys@skm.co.nz

LANDSLIDE GUIDELINES

**FREE
CD**

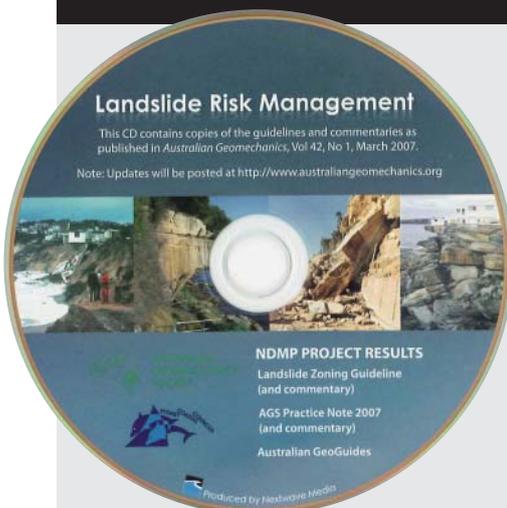
NZGS has 30 CD copies of the Landslide Risk Management [LRM] Guidelines to give away to members. These guidelines were produced by the Australian Geomechanics Society and published in the March 2007 issue of Australian Geomechanics News.

THE CD IS A WELL LAID OUT, 'EASY TO FIND' COMPILATION OF THE LRM GUIDES FOR:

- ▶ Planning (hazard and risk zoning)
- ▶ Geotechnical practice notes (these are especially useful)
- ▶ Simple geoguides for soil slopes, rock slopes, water and drainage management, retaining walls, hillside development, effluent disposal and coastal landslides.

If you want a copy of the CD, please contact the NZGS secretary at nzgs@paradise.net.nz. I recommend this to all geotechnical practitioners in NZ and seek your comments on what we should adopt or adapt for NZ conditions.

Stephen Crawford NZGS Stability Guidelines Committee scrawford@tonkin.co.nz





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CONFERENCE REPORT

10th ANZ Conference on Geomechanics Sets Industry Standard

The 2007 Australia New Zealand Conference on Geomechanics surpassed the industry standard by showcasing some of the best geotechnical projects and research in the world. Jointly organised by the Australian Geomechanics Society and the New Zealand Geotechnical Society, the conference is held every four years. This year's theme 'Common Ground' aimed to bring people together at all levels of the industry and from diverse backgrounds to discuss industry-specific issues.

Held in Brisbane in October, more than 450 researchers, practitioners, designers, constructors, engineers and geologists from Australia and New Zealand, attended the event. There was also a greater international presence at the 2007 conference than ever before.

Coffey Geotechnics was the Conference Patron and senior principal Professor Harry Poulos commenced the 10th Australian New Zealand Conference on Geomechanics by delivering the opening address in which he discussed the booming sector in the region.

During the three-day conference, more than 300 professionals from the geotechnical industry presented. The conference began with an excellent keynote lecture presented by Dr Peter Mitchell "The Continuing Problems Associated with Expansive and Collapsing Soils".

Additional highlights included the presentation of the *NZ Geomechanics Lecture* by Dr Do Van Toan 'A Geomechanics View on Heavy Duty Pavements'. It traced his journey from his PhD on 'Effects of basecourse saturation on flexible pavement performance' to the consideration of intricacies of design using different pavement materials and methods of stabilising existing foundation soils.

The *John Jaeger Lecture* was presented by Robin Fell on Day 2 titled "The Mechanics of Internal Erosion and Piping of Embankment Dams and their Foundations". Day 2 concluded with a spectacular conference dinner held 6km out of Brisbane CBD at the Hillstone St Lucia function centre with an array of entertainment including an aboriginal welcoming dance.

The International Lecture was presented by Dr John Christian on Day 3 via video link from the USA on 'The Reliability of Geotechnical Enterprise'. He discussed probabilistic methods that are increasingly being employed to estimate costs and schedules for projects such as highways and risk exposure for events such as future hurricanes in southern Louisiana.

The Joint Societies Award for the most valuable conference paper was presented to Misko Cubrinovski for his research 'Key Parameters in Pseudo-static Analysis of Piles in Liquefying Sand'. The paper clearly and simply identified key issues and parameters for piles in liquefying sands and provides guidance for their determination based on observations from case histories and full-size tests. Misko also highlighted some of the contentious and costly issues associated with piling on major projects in NZ and overseas.

The conference provided a great opportunity for attendees to meet and discuss issues faced by the industry such as difficult ground, ground improvement, slope stability and difficult geological conditions and to share their experiences and suggestions. It served to strengthen the links between the New Zealand and Australian geotechnical community even further as consultants working in the region shared snapshots of the projects and research undertaken during the past four years.

The consensus from delegates at this year's conference was that the event set the industry standard worldwide. The next Australia New Zealand Conference on Geomechanics will be held in Melbourne 2011.

Further reporting and comments about the conference are detailed in the ISSMGE Regional VP Report.



AWARDS

2007 Geomechanics Lecture Award

13th New Zealand Geotechnical Society Geomechanics Lecture 2007

This year the NZGS has awarded the prestigious New Zealand Geomechanics Lecture to Dr Do Van Toan. The lecture titled 'A Geomechanics View on Heavy Duty Pavements' was first presented at the ANZ Geomechanics Conference in Brisbane in October. A lecture tour of New Zealand NZGS branches will be undertaken over the next few months.

Dr Do Van Toan is a Technical Director focussed on geotechnical and airport engineering at Beca Infrastructure Ltd. Following his graduation with a PhD in Geomechanics from Auckland University in 1975, he has spent most of his time working in the geotechnical field. As Beca's Chief Geotechnical Engineer his responsibility covers projects in New Zealand and many of the Pacific Islands together with Malaysia, Indonesia, Papua New Guinea, and some parts of Australia where Beca has associated offices. His area of interest are land stability, coastal engineering, soft alluvial and marine soils and heavy duty pavements.



A Geomechanics View on Heavy Duty Pavements

Dr D.V. Toan, Beca Infrastructure Ltd, Auckland, New Zealand

Keywords: pavement, aggregates, clay minerals, friction, underslab injection, mudcrete

ABSTRACT

This paper outlines my journey from an initial PhD on "Effects of Basecourse Saturation on Flexible Pavement Performance" to research on the deflection bowl due to wheel loading, the use of time-temperature effects on concrete curing, the influence of clay minerals to New Zealand aggregates and the effects of the geology of rocks source on pavement friction characteristics. This work has led to consideration of the intricacies of design using different pavement materials including mix designs for Asphaltic Concrete (AC) and Portland Cement Concrete (PCC). Different methods of stabilising existing materials, including innovative use of very soft marine sediments for structural use in pavements and the application of underground injection to extend the life of damaged pavements are also described. Project examples are used to illustrate the interesting challenges of real problems and the fun of developing solutions.

1 INTRODUCTION

Pavement engineering is more typically the concern of highway engineers or transportation specialists rather than geotechnical engineers. My interest in geomechanics began in undergraduate courses sparked by Professor Peter Taylor whose excellent lectures on the complexity of soils, water and air offered challenges for youthful minds. Professor Geoff Martin offered me the chance to look into the interaction between a typical aggregate mix of crushed rock, sands and silts used in road construction, under a partially saturated state and subjected to dynamic wheel loadings. Back then I thought the topic straightforward only to find out how daunting it would prove to be and the older I get the more complex the topic is. So that was good fun.

With Beca, I have had opportunities to apply some of the pavement knowledge I gained. In the days when most pavement design was not in private engineering consultancies, we took the opportunity to look at some interesting tropical soils e.g. swelling clays, coralline rocks and floating islands. The government agencies did offer

roading research that progressed NZ's understanding in the effects of geological provenance of crushed rocks on the longevity of our highways. My interests then gravitated towards the heavy-duty applications of both bound or stabilised and unbound aggregates and the challenges our residual, alluvial and volcanic soils present as the subgrade on which our roads are built. I now spend a significant part of my time looking into pavements for the heaviest if not the fastest man made machines that use our pavements.

2 HEAVY DUTY PAVEMENTS

2.1 Design today

Pavement design is practised by a large number of engineers in the roading industry. It is often only a small part of a highway engineer's focus; geometric design, traffic volume, speed of operation and safety aspects are all consuming. For the standard truck axle loads of 8.2 tonnes (which consists of two sets of 2 tonne dual tyres) we use design charts from codes/guidelines. However digging further into this science, this is more empirical, really an art rather than science. For example we do not often effectively test for or measure the stiffness of pavement materials and subgrade that are used in the design programmes. The stiffnesses of the granular components of a pavement structure depend on both confining stresses away from the wheel loads and on the speed of loading.

The CBR test pushes a 50 mm plunger into the soils to cause a dent of 2.5 – 5.0 mm. Yet the pavement loads only induce much smaller deflections, and we hope only elastically not permanent deformations; such large plastic deformations would rapidly cause deep ruts. With more sophisticated tests, e.g. a plate load test we run into the stress levels and confinement effects problem. The stiffnesses we measure on exactly the same pavement profile differ depending on the size of the loading plate. The larger the plate, the greater stiffness we obtain.

Further complications come with the multi-layered elastic programmes often used for analyses e.g. CHEVRON, ELSYM5, CIRCLY, APSDS etc. all derived from the assumption that pavement materials all behave in a linear elastic manner. Well they do not. Their stiffnesses vary depending on the level of confinement. For instance, the shape of a deflection bowl cannot be predicted by CIRCLY. We do better using a finite element programme that allows for non-linear soils behaviour, but there has been no widespread database of non-linear material characteristics.

So our road designs generally work well, by dint of experience i.e. empirical design. When we face loads that are much higher than 8.2 tonnes, our empirical design methods require application of sound judgment and a

degree of innovation.

2.2 Heavy duty pavements

When wheel loads reach 25 – 30 tonnes with axles of up to 120 tonnes, it all becomes interesting and quite challenging. The general principles still apply. The materials we use just become stressed, a lot more.

One of the simple views is: with most well designed roading pavements for 8.2 tonnes axles (2 tonne per wheel) the factor of safety against failure is not a lot higher than about 2.0. So if the axle is 16.5 tonne, that road pavement is likely to suffer significant distress i.e. premature rutting, shoving, or cracking of the concrete slabs. Based on the Portland cement charts, a road slab designed for a 0.5 tensile stress factor would fail when loaded with twice the weight. The basic reason is that unreinforced pavement slabs would last under repeated flexural loading only if the failure tensile strain is not exceeded. A fully reinforced unjointed pavement slab would be cracked but such cracks would be fine and regularly distributed keeping aggregates interlock between the cracks.

Some pavement designers assume that criteria used for highways are applicable to heavy duty pavements, only to their sorrow; when the "design life" was thought to be "infinite", the pavements was found to fail only months after completion.

So for heavy duty pavements we need to address the heaviest likely wheel load and not just the most frequent vehicle/aircraft. (Figure 1 and Figure 2 show examples of airport pavements of different types, using AC or PCC compared with some typical roading pavements). The next step would be to realistically consider the number of passes for the intended pavement life i.e. allow the wander factor. It is also essential to use a suitable software e.g. CIRCLY (ref.: Wardle 2007) or APSDS (ref.: Rickards and Wardle 2003) to allow a more economical design of the pavement required. Such software would also allow predictions of deflections at various stages of progress to allow the design to be verified using a Benkelman Beam during construction.

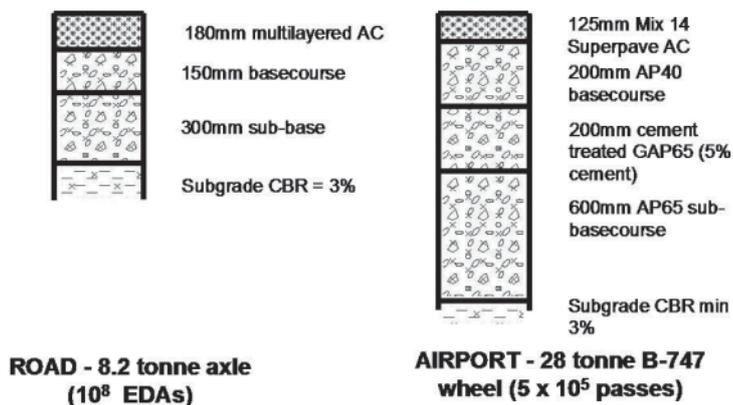


Figure 1. AC pavement

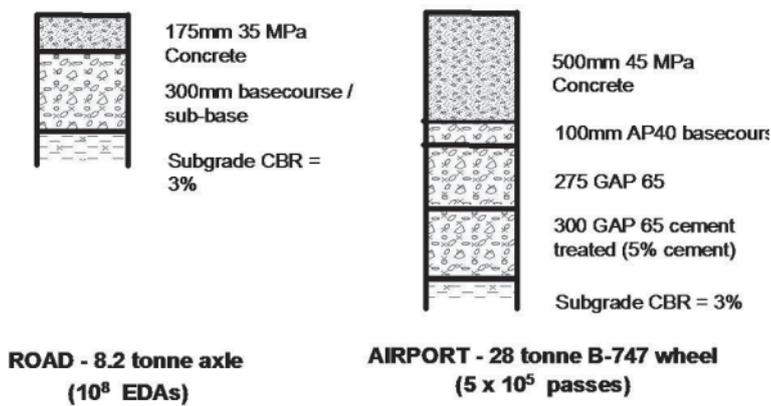


Figure 2. Concrete pavement

To design heavy-duty pavements economically it is necessary to dig deeper into the science (or art of pavement design) and look for alternative material sources and solutions to the problems we face.

The following sections outline a number of these challenges I have enjoyed solving.

3 PAVEMENT RESEARCH

3.1 Pavement structure

Typically a pavement would consist of a frictional, hardwearing seal that does not yield significantly under rolling loads. Frictional qualities help vehicles steer and stop or accelerate. This upper surface should not wear or deteriorate too fast, it needs to last 10 – 20 years or more, although our financiers and government tax officers would prefer 100 + years. The aspect not often focussed on is the need to minimise the cost of rolling resistance; rolling resistance is the effort a motor needs to overcome tyre deformation and the slope caused by the small hollow due to the deflection of a pavement under the wheel load. Minimising this deflection is the combined function of the surface seal be it asphaltic concrete or Portland cement concrete or just plain packed earth. Equally important is the longevity required of the pavement.

3.2 Influence of water

Even a very well drained and sealed pavement could not remain “dry”. The materials under the seal will almost always be damp. Moisture is attracted to a sealed pavement by vapour transport due to the diurnal effect of being heated during the day and then cooling during the night causing condensation to collect under the seal. Saturation could be caused by seepage through the seal, from rain onto the grass verge beside the seal or simply by a high ground water level.

It was commonly known that saturation would shorten the life of a pavement but understanding has not always been translated into action. For example, the US federal funding agency for airport development did not recognise subsoil drainage as part of the funding package until the last few years. In NZ early runway design included a soft bituminous seal surrounding the whole pavement structure to avoid water from the subgrade entering the pavement. However this didn’t work, as over time, the pavement was found to be in a “bath tub”; water entered, via moisture vapour condensation or seepage though the asphaltic concrete (yes, AC has low but finite permeability, not waterproof). Water that entered did accumulate above the soft bitumen seal, which we found to be well above the local water table under quite dry weather conditions.

3.3 Saturated basecourse

After much reading, as all PhD students do, we sketched out the research programme, the equipment and set about to find in some quantitative way how saturation would shorten the life of an unbound aggregate. In the early days of NZ history, rock aggregate was plentiful and typical pavements consisted of a thin seal, be it thin asphaltic concrete layer or more usually a chip-seal over thick compacted rock aggregates. The unbound rock aggregate did most of the work to spread the wheel loads and avoid deforming the subgrade too quickly. Equipment developed for my PhD research is shown in photo, Figure 3.

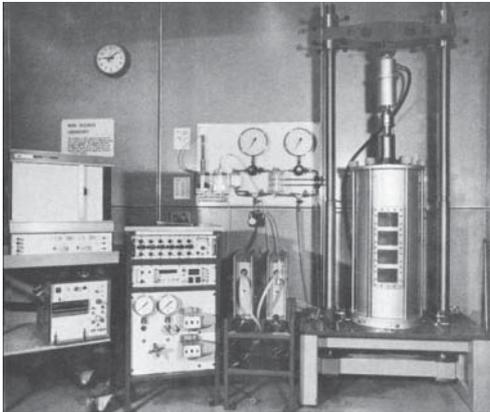


Figure 3. Dynamic triaxial apparatus

Drainage was not always efficient.

A saturated basecourse was found to be less stiff than a drained one, by 30%- 50% (the resilient modulus halved under low confining pressure or under a chipseal). It was also found that the creep rate in the basecourse increased by a factor of 2 – 5 when saturated. These two effects combined to accelerate the accumulation of rut depth and shortening of the fatigue life loading to both cracking of the surfacing and causing shallow depressions along the wheel path.

Figure 6. Relationship between velocity vs hydraulic gradient

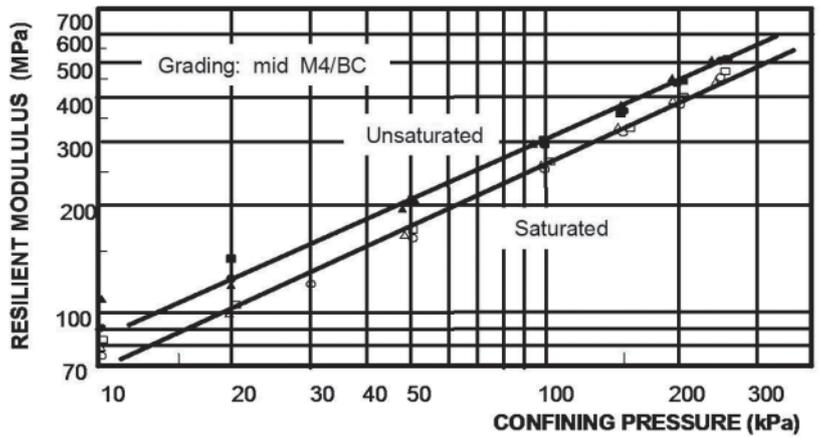


Figure 4. Resilient modulus vs confining pressure

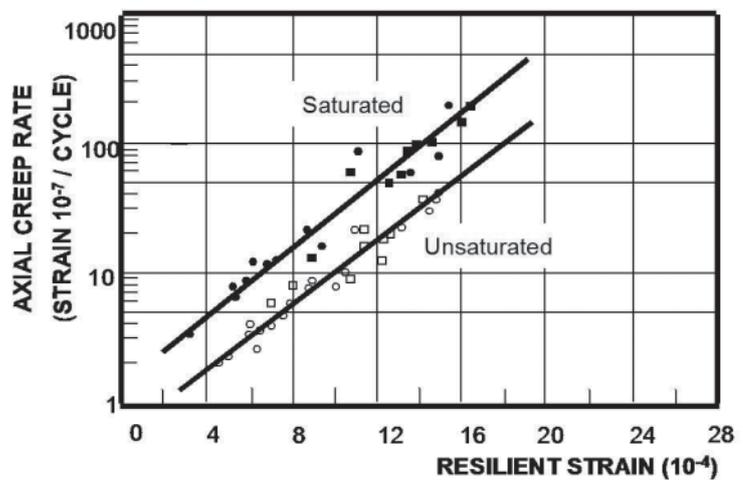
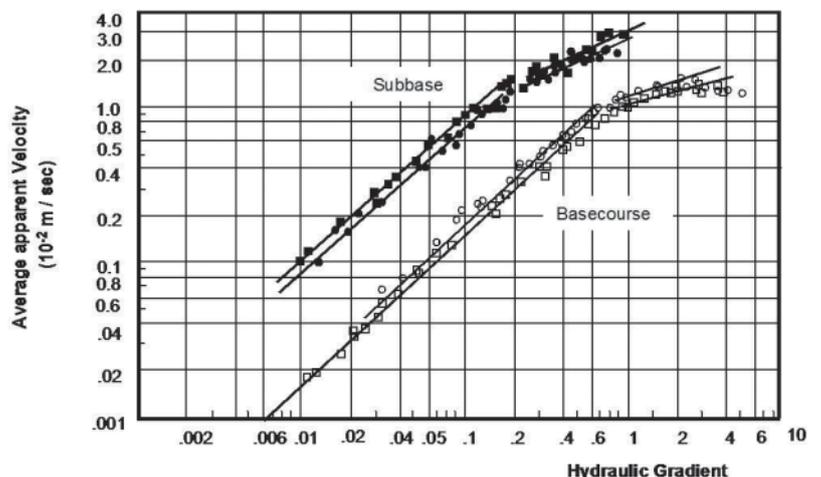


Figure 5. Effect of resilient strain on creep rate

3.4 Basecourse permeabilities

Findings I realised much later to be of interest to ground water flow studies were: basecourse permeability reduces significantly when fines are transported by ground water, and as flow velocities increase with increasing hydraulic gradients there exists a level at which the flow velocities would level out (refer to Figure 6), this was due to change in flow characteristics in the pore spaces.



It is surprising to note that fine sand particles were transported at lower hydraulic gradients as low as 0.1 compared to the commonly understood threshold of piping failure at 0.2. The transport was observed in a large permeameter with a clear window (Figure 7).

This window panel was made of steel to allow the aggregates to be compacted then carefully removed and replaced with a clear window panel of exactly the same shape. Once saturated, water flow was gradually increased to find the cause of reduction in permeability in some basecourse gradings, which appeared to have a high initial permeability. The reduction was caused by transport of the smaller particles, stopping in the smaller pore spaces, reducing the overall permeability by a significant factor. Better-graded aggregates tend to be less permeable initially but do not suffer such reduction once water flows are established, even if the hydraulic gradients applied were quite high.

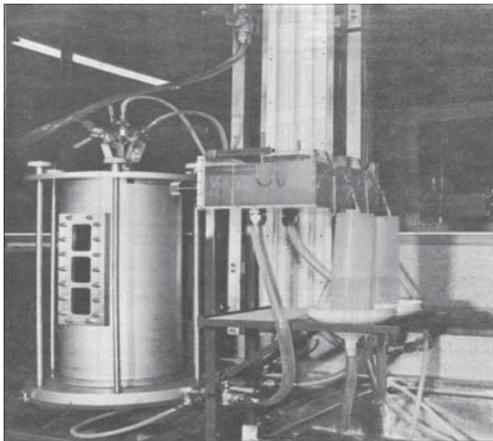


Figure 7. Permeameter & outflow measuring system

The provision of effective subsoil drainage is the key to the longevity of unbound pavements. (Even with the most permeable aggregates, placing those in a “bath” cut in clayey subgrade would not give longevity). With much of the upgrade work for our existing urban pavements, we found often the cause of poor performance have been either disrupted subsoil drainage due to poor trench backfilling or there was no subsoil drains.

Assuming that subsoil drains were provided, it is important to use a clean and well graded aggregate. As found in my research work, a small percentage of clays or silts in the aggregate mix would be sufficient to make a poorly graded material not “free-draining”; this would allow pore pressures to build up on a busy road thereby severely shortening the pavement life. The key aspect of pavement design is in material selection and specification, and the need to check during construction that the fines included in the aggregate mix are as low as specified.

3.5 Pavement bowl deflections

An intriguing finding I made was in one of the NZ National Roads Board research briefs into deflection bowl characteristics. Figure 8 shows beam deflections versus basecourse thicknesses and subgrade stiffnesses. The subgrade stiffness appears to be independent of the pavement structure, giving an effective tool to assess the stiffness of the subgrade more accurately than a large number of test pits and field tests. For the range of basecourse thicknesses there were the corresponding range of central deflections, however, at about 0.6m from the tyre, deflections remain relatively unchanged, reflecting the subgrade stiffness (refer to Figure 8).

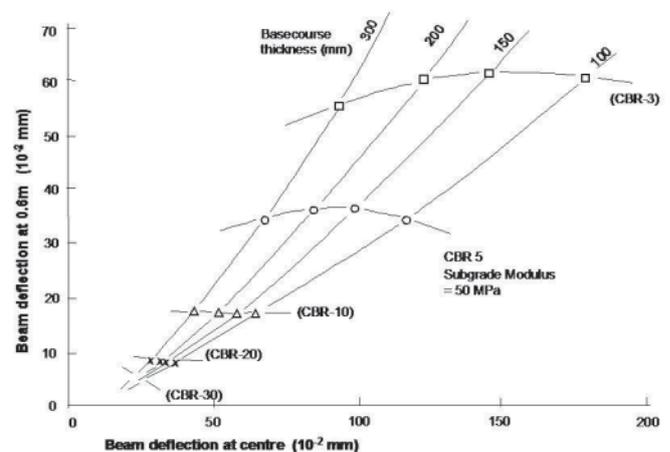


Figure 8. Beam deflections vs basecourse thickness & subgrade modulus

3.6 Time challenge of concrete curing

Working on concrete airport runways, we often face the frustrating pressure of having to wait for the concrete to set and become sufficiently strong to allow landing and takeoff. The standard 28 days used in the concrete industry is way too long and even the 14 days sometimes adopted is too costly in terms of down time. I heard comments made while I was attending a conference and found references in old concrete papers to the “Time-Temperature” technique to evaluate the strength achieved in the concrete. With some follow up laboratory testing of concrete cylinders immersed in a warm water bath, I soon found that the high curing temperatures expected in the typically 500 mm thick new airport slabs would allow the curing period to be significantly shortened.

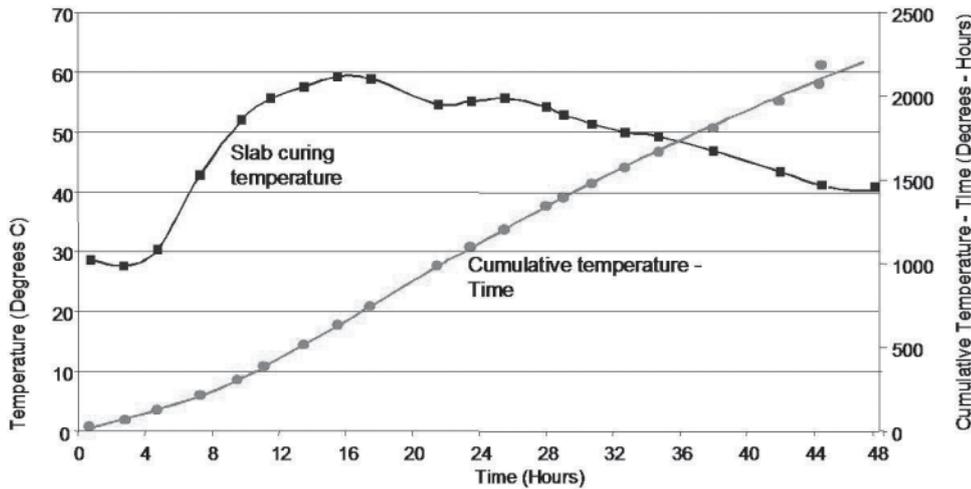


Figure 9. Concrete temperature - time

Figures 9 and 10 show the typical temperatures measured using digital thermo probes embedded in the concrete. The time-temperature graphs developed long ago proved quite correct. This allowed us to shorten the curing period to 4 days, allowing the 400 tonne aircraft to land on the recently poured slabs (not without some trepidation from those involved!).

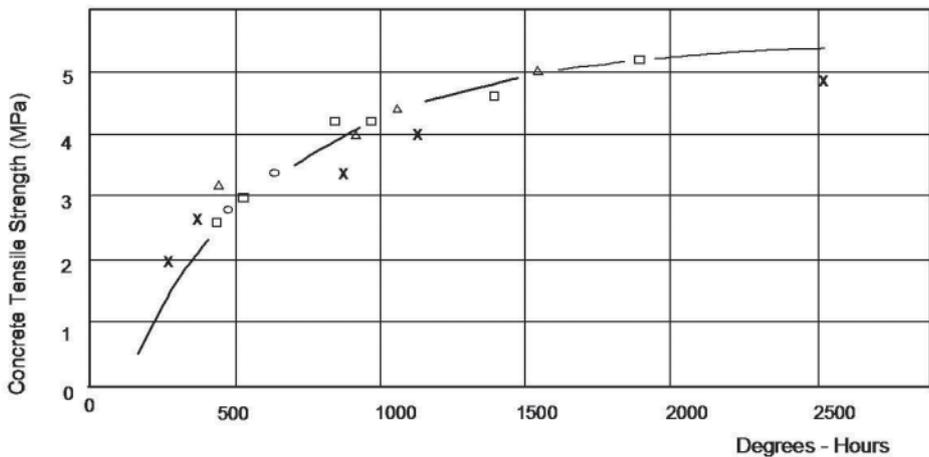


Figure 10. Concrete maturity testing in a heated water bath

4 GEOLOGICAL SOURCES AND MATERIAL PROBLEMS

4.1 Engineering geology

The appreciation of geology in pavement design has improved much in NZ today. A number of newsworthy failures have forced this upon us. In construction engineering we recall some painful cases that underlie our difficulties in bridging the geological and geotechnical sciences. Mostly geologists working together in close cooperation with geotechnical and civil/structural engineers, have now bridged this gap. These experienced geologists become “engineering geologists” that interpret the collected wisdom from the geological field to alert the engineers to aspects not always apparent.

4.2 Swelling clays

The first motorway section in NZ failed prematurely. This was caused by the presence of swelling clay minerals (smectites and montmorillonite) in the greywacke aggregates. These swelling minerals came from thin bands of argillite in the rock mass. When monitored during construction the quarried and crushed greywacke passed all the specified criteria for strength (high), grading (good), fines content (low), plasticity (low) etc. However the motorway paving failed in fatigue after only 2-5 years. When tested the aggregates showed high levels of plastic clays, rich in swelling clay minerals. These were released from the fine crushed particles on exposure to moisture over a very short time (short for the expected life of a crushed rock). Since then a number of steps have been adopted to control the risk of such failure:

- Geological inspection of quarries to assess the existence of advance weathering that may yield swelling clay minerals;
- Use of the Clay Index test to gauge the level of swelling clay materials in the aggregates mix;
- Use of stabilisation (cement or lime or both) to control the plasticity of the fines.

4.3 Aggregates sources

Various rock sources in NZ and the Pacific Islands have resulted in surprises in terms of pavement longevity.

- Greywacke:** greywacke is wide spread in the NZ North Island and has been a low cost resource for our building industry. Sufficient experience with the unfortunate inclusion of the finer grained thinner bands of argillite has allowed the use of resource with rare mishaps. However they still occur where the bad experiences above have been overlooked, resulting in the swelling clay minerals turning the basecourse/subbase plastic in a matter of months.
- Andesite:** Some andesites that are moderately weathered also contain swelling clay minerals, which similarly result in short-lived pavements.
- Coralline materials:** I was surprised to find the humble coral debris, which did not comply with typical roading specification laboratory tests produced quite serviceable roads for 20 – 30 years, the secret being the natural cementation of the carbonate rich coral. However the coral particles tend to abrade quickly or breakdown under higher stresses from heavy duty uses and are not readily

applicable in asphaltic concrete for high repetitions (i.e. ≥ 106 passes)

- Gneiss:** NZ's South Island provides plentiful aggregate supplies from the various alpine rivers. Greywacke, basalt, andesite and dacites cobbles and boulders well tumbled by flood flows (naturally selected) were ideal for roading with the exception of gneiss. Gneiss tends to release mica which does not yield the high strength associated with good compaction from other crushed gravels. Allowance for the existence of mica would allow its use on low traffic roads or as subbase i.e. well below the surfacing layer or by using stabilisation measures.

4.4 Friction properties in aggregates

Table 1 shows typical friction values measured on a range of NZ aggregates. These NZ aggregates have been found sufficient in the past, as our traffic was relatively light. In any case the use of chip seal did not exploit the friction properties of our rock aggregates to their full potential. With our increased traffic and the inconvenience caused by closing heavily trafficked sections of road for maintenance or reconstruction, our central roading authority (Transit New Zealand) is looking for better products. TNZ is looking for high friction values, but such high levels in Polished Stone Values (e.g. PSV ≥ 65) are rare in NZ. Only few natural sources would comply: the Moutohura aggregate in NZ meets these frictional values but it has not proven to last in terms of wear by disintegration (instead of polishing).

Table 1 – Typical NZ Aggregates

Description	Age (m. yrs)	SG (kN/m ³)	UCS (MPa)	Wear (PSV)	CBR (%)	Permeability (m/sec) [Rock Mass]	Crushing Resistance (kN)
Basalt	0.001 – 2	29 - 32	80 – 160	45 – 50	30 – 100+	10 ⁻² – 10 ⁻⁴	80 – 180
Andesite	10 – 20	26 - 28	50 – 200	40 – 55	20 - 80	10 ⁻⁶ – 10 ⁻⁹	60 – 100
Greywacke	140 – 200	26.5	150 – 300	50 – 55	30 – 100+	10 ⁻⁶ – 10 ⁻⁸	100 – 200
Argillite	140 – 200	26.5	0.5 – 100	NA	10 - 20	10 ⁻⁷ – 10 ⁻⁹	NA
Scoria	0.001 – 2	20 - 25	0.5 – 50	-	10 - 30	10 ⁻² – 10 ⁻⁴	40 – 80
Tuff	<1	19 - 21	0.5 – 20	-	7 - 20	10 ⁻³ – 10 ⁻⁶	NA
Parnell Grit	20 – 24	19 - 22	0.5 – 25	-	5 - 15	10 ⁻⁶ – 10 ⁻⁸	NA
Onerahi Chaos	21 [55-100]	18 - 25	0.1 – 50	-	-	10 ⁻⁶ – 10 ⁻⁹	NA
Waitemata Group	20 – 24	19 - 22	0.5 – 20	-	5 - 15	10 ⁻⁷ – 10 ⁻⁸	NA
Ignimbrite	<1	20	0.2 – 0.5	30 – 40	10 - 20	10 ⁻⁶ – 10 ⁻⁹	20 – 60
Rhyolite	<1	22	0.5 – 2	35 – 50	15 - 30	10 ⁻⁷ – 10 ⁻⁸	40 – 80
Coralline Limestone	0.1 – 10	17 - 25	0.5 - 5	20 – 30	15 - 30	10 ⁻³ – 10 ⁻⁴	30 – 60
Limestone	21-100	19 - 26	0.5 – 100	20 – 40	10 - 20	10 ⁻⁶ – 10 ⁻⁹	60 – 100

Focus on friction surfaces on NZ roads is recent. Friction is not understood in detail. For example a chip seal may look coarse and highly frictional but in fact could be quite poor. If the exposed coarse aggregates become polished, however “rough” the surfacing looked, it would behave like a pavement made of fixed polished marbles. Good friction requires both good micro texture (the roughness felt by hand as a coarse sand paper) for velocities below 60 km/hr and good macrotexture (visible texture – for velocities above 60 km/hr). Macrotexture in AC is a function of the grading of the aggregates used in the mix. An improvement to the traditional TNZ mixes would be the use of Superpave mixes developed in the USA. Superpave mixes have a number of advantages, namely a better texture, a higher stiffness, easier to place and it costs less, as the mix requires less bitumen. (Refer to Figure 11 showing a comparison of a Superpave grading and a grading currently specified by TNZ; it is noted that the Australian guide (ARRB Transport Research 2004) recommends gradings very similar to the Superpave without the “no-go” zone).

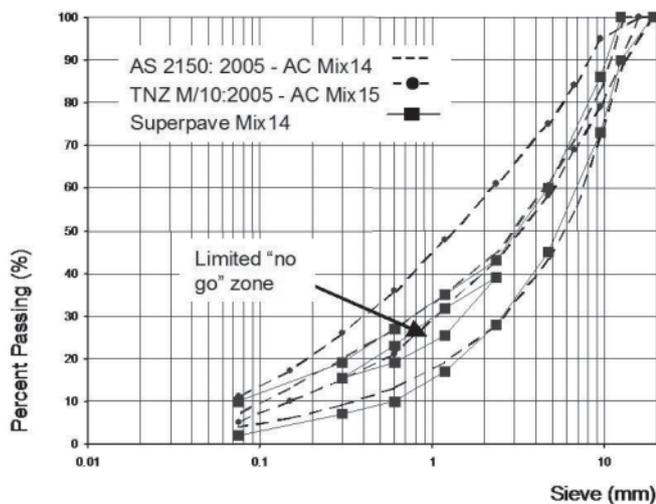


Figure 11. Comparison of asphalt Mix 14 – grading curve

The challenge in NZ is to produce a pavement surface with coarse crushed stones, having large textural depth that retains its sharp edges. For a reliable surfacing we had to import the aggregate e.g. calcined bauxite product from Japan, China or Germany!

A method of adding texture to improve high friction at speeds greater than 60km/hr is to use grooving. Airports have applied this technique i.e. by cutting 6 mm x 6 mm slots at about 35mm spacing on the pavement surface. Grooving is used on roads too in particular in regions affected by snow and sleet, albeit with faster rate of wear. The rate of wear is exacerbated by the need to remove snow by mechanical means. Similarly on airports the build up of rubber deposits from landing aircraft regularly

requires removal, which accelerates the wear of the pavement surfacing. The pavement industry is plagued by a set of difficult compromised choices!

Refer to Figure 12 showing some of the texture that relates to good macrotexture.

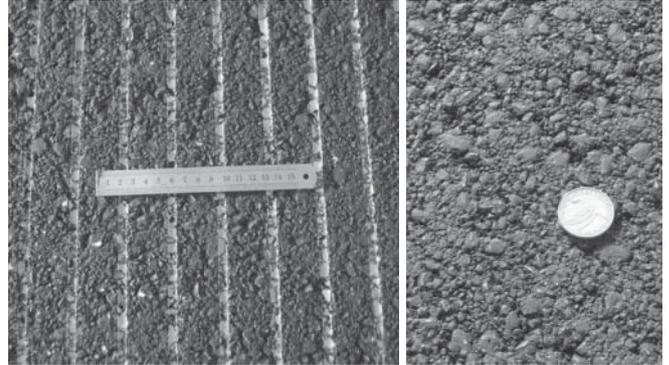


Figure 12. Grooved superpave Mix 14 pavement

4.5 Difficult NZ volcanic soils

NZ does not have the notoriously difficult swelling ‘black’ clays found in the tropical areas. However our volcanic soils produce puzzling and sometimes nasty surprises for the construction industry.

Allophanic Soils: when soils contain more than 7% allophanic clay minerals, we cannot readily establish compaction curves for fill compaction control. The usual way is to wet up or dry down soil samples to establish the optimum moisture content for a specific compactive effort. However with allophane, the soil samples change their behaviour as they dry down, becoming less plastic or sandier. This soil type is just a trick for the inexperienced.

Weathered volcanic soils: when cut these volcanic soils look firm, but when disturbed they often behave as soils close to their liquid limit. This is due to the puffy soil structure, which collapses on disturbance (as if “releasing” the water it holds). This makes it behave as a very soft, sensitive silt, a mud. To condition it requires much drying, from the near liquid limit state towards the plastic state (which would be then amenable to compaction). The difference between a typical near liquid limit natural moisture content of 60 – 80% and a suitable optimum moisture content for compaction i.e. near the plastic limit of 25 – 30% takes a long time to dry. Yet when dried these allophanic volcanic soils behave well and yield very strong fill with c' up to 10 – 15 kPa and ϕ' of 34°-36° (like a well compacted clayey sand – a rare soil in NZ).

When not well understood and not carefully provided for in contract documents in terms of construction season and work method (time and work area for drying), these highly sensitive soils can result in large cost and time overruns with many legal wrangles to resolve.

Similar problems are encountered with micaceous gravely/sandy soils and loess (wind deposited moraine silts found in the South Island of NZ).

5. STABILISATION AND INNOVATIONS

5.1 Range of stabilisation measures

With the increased rate of aggregate resource usage, and the greater difficulties surrounding the resource consent to develop new quarries (due to the increasing awareness of environmental effects) spring the need to use lower grade aggregates or recycle existing pavement material. This is an interesting set of challenges that has been fun to delve into.

Stabilisation has various techniques with a range of target levels e.g.

- Removing only the plasticity of the fines from an aggregate;
- Improving the stiffness of a weak aggregate to service a more demanding application;
- Providing a degree of cementation to increase the load spreading capacity;
- Allowing the reuse of old pavement material.

All these targets allow reduction in the use of the available resource instead of relegating them to land fill dumps.

These techniques include the use of lime, cement, bitumen and the more complex injection of epoxy plus hardener with a precisely targeted viscosity and set timing to cement the chosen pavement zone.

5.2 Common usages

Lime is often used from 1% up to about 3% targeted to reduce the plasticity in the fines in an aggregate grading. It is worth remembering that the use of burnt lime, which costs the same as hydrated lime by weight, but is three times more effective. Attention to adequate provision for health and safety measures must be taken when using burnt lime.

Lime at 2% to 4% is customarily effective to improve the strength of a weak plastic clayey subgrade.

At low percentages of 2%–3% cement could “condition” a poor aggregate and at 5% – 9%, cementation could be achieved. To ensure that a cemented aggregate behaves properly, a more complex fatigue analysis is required to be considered in design besides the simple requirement of sufficient degree of compaction.

Lower percentages of lime or cement as low as 1% - 3% or in combination have been used by some designers in the industry; these values showed high CBR values

when tested in the laboratory; however in some instances, I had the sad task of investigating the cases of early failures where such low percentages were used. The reasons were:

- Benkelman Beam tests on the still intact parts of the failed pavement showed the deflections to be large indicating the stiffness assumed from the laboratory tests not to be realistic – this meant that the laboratory CBR did not reflect as field stiffness. I have not found the CBR test to be an effective method of evaluating the effect of stabilisation due to the nature of gravel size particles confined in a steel mould, a simple UCS would reveal the effect of the low percentages used. The low percentages serve only to “condition” the aggregates and reduced the plasticity of the fines, but provided no real cementation that would correspond to the high laboratory CBR;
- Another cause of the poor performance of some of the cement stabilisation cases is the lack of cementation due to the small clay content in the aggregate, which neutralises the small percentages of cement used;
- The lack of effectiveness of low lime content was found to be not so beneficial in silty aggregates with low plasticity in some other cases.

Bitumen is used in an aggregate mix as the main ingredient to make AC; when used in recycled AC it achieves a degree of saving plus the environmental benefits of less transportation and quarrying energy used. About 15% of recycled milled AC is to be adopted in Auckland to be used in new seal. Higher proportions of recycled AC have been used elsewhere but often as material below the wearing course.

Foam bitumen is a technique to allow the use of mixed basecourse and milled AC to construct in situ a recycled structural pavement layer.

Recycled crushed concrete is viewed as a premier recycled material as it offers a relatively adequate grading and a degree of self-cementation.

5.3 Mudcrete

Born from the challenge of disposing of contaminated very soft harbour mud and the difficulty of constructing a pavement for port operation we “invented” Mudcrete. However it is not a new concept. Very soft marine sediments have been stabilised by subsurface cement injection (e.g. in northern Europe and Japan) to stabilise soft seabed materials to construct new port reclamation or a whole new airport. However our novel application is the simplicity of the technique that allows a very undesirable construction material (recent very soft marine sediments, which are a variable mix of mainly silts with some clays and sands) to be used. The addition of judicious percentage of

Portland Cement (80 – 110kg/m³) was found to produce a cemented material not too different from the tertiary sandstone and siltstone from our own Waitemata Harbour cliffs; the grain sizes are similar being eroded from these cliffs, the only difference is the lower dry densities as no compaction was applied.



Figure 13. Fergusson Wharf reclamation

This simple approach yielded a product with strengths in the range of 150 kPa up to 1000 + kPa (and corresponding moduli in the range of 80 MPa to 150 MPa, all for about \$45/m³. It also saves the cost of dumping the contaminated mud. This needs to be compared with the \$300/m³ when undersea injection is used. No complex plant is used. The mud is excavated using diggers from a barge, mixed in a container using a mechanically activated paddle mixer. The percentage of cement could be optimised (read reduced) when more efficiently mixing could be carried out e.g. in a pugmill (ref.: Priestley 1995, 1999 and 2001).

The technical aspects that needed to be resolved are the variable grain size distribution of the mud and the considerable variations in seawater content. A sandy mud can be made into Mudcrete on land but cannot be dropped in the sea, as it would “dissolve” in the seawater, losing much of the cement. Mud needs a degree of clay content to yield a “cohesive” Mudcrete to withstand being dropped in seawater without being “washed”.

Mudcrete was first used for the reconstruction of the Whitbread Race stopover wharf in the Viaduct Basin and then the America’s Cup base wharves; this significantly reduced the lateral loads and hence the cost of the wharf walls. Mudcrete was also used for the duplication of the Upper Harbour Highway embankment for the second bridges; this allowed the fill slopes to be made steep to avoid the loss of the environmentally important mangrove stand. The site where Mudcrete has been recently placed is Fergusson Wharf extension in Auckland (Refer Figure

13).

There is also the potential of excessive shrinkage on drying. However the degree of shrinkage was surprisingly low for Mudcrete placed in harbour reclamations, because when placed a few metres above sea level, the Mudcrete gained sufficient moisture by capillary pull to achieve a near ideal curing condition with very little shrinkage.

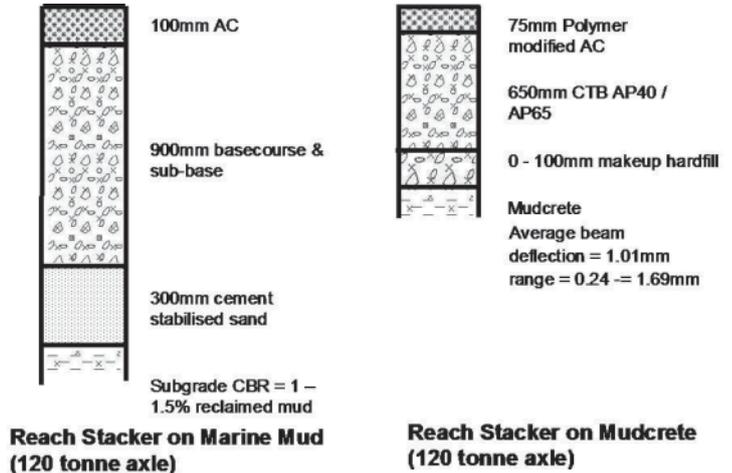


Figure 14. Container port pavements

The low densities inherent in a cemented mud (without compaction) make Mudcrete “tender” or easy to crush in pavement construction turning it back to a mud. But with a small increase in cement percentage and sufficient time to cure, Mudcrete can yield CBRs well in excess of 10% for pavement support. (Figure 14 shows an example of a port pavement with axle loads of 120 tonnes on Mudcrete, and Figure 15 and Figure 16 depict Mudcrete in a cut face and as a pavement subgrade).



Figure 15. Trenching in mudcrete



Figure 16. Completed mudcrete subgrade

Figure 17 shows the Mudcrete strength gain with time for the various cement dosages used for the Fergusson Wharf reclamation design. Experience with these various projects since the early 1990 has proven our confidence in the process and the use of more efficient mixing using a pugmill allowed us to use lower cement levels.

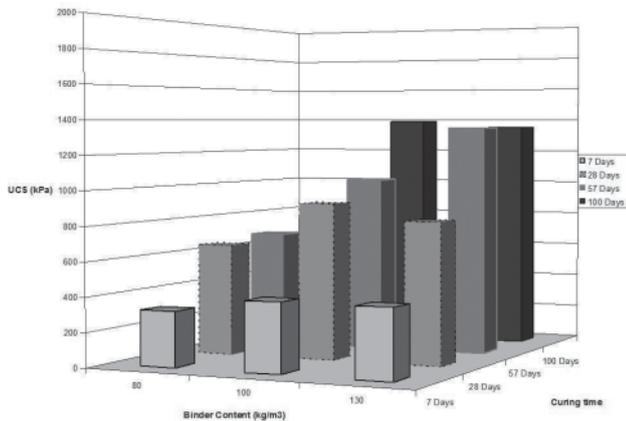


Figure 17. UCS v binder content v curing time

5.4 Underslab injection

Concrete used in buildings would have a 100-year “life” (according to the NZ Inland Revenue Department in terms of depreciation). Concrete structures could last much longer, 200 years or more. However on an airport, a runway pavement life made of concrete would rarely last more than 30 years. Airport concrete pavement slabs tend to be un-reinforced. These slabs flex each time they are loaded by the 25 – 30 tonne wheels from jet aircraft with an all-up weight of around 400 tonnes for the Boeing B-747. Failure in fatigue ensues, with first, longitudinal cracking, then spalling, with dire consequences in terms of debris that could be sucked into the jet engines. Once one slab cracks, damage rapidly extends longitudinally from slab to slab. 2 – 3 years after the onset of initial cracking,

the slabs tend to break into quarters or smaller pieces with much increased FOD (Foreign Object Damage – Refer to Figure 18).



Figure 18. Fatigued slabs



The challenge offered to us by Auckland International Airport was to research the use of epoxy injection to repair these cracks. It was claimed that a product was available to fill and rebind the cracks to repair the broken slabs. The bonding strength was claimed to be better than 60 MPa even for wet concrete. This claim was found sustainable for dry concrete; alas with damp concrete the bond strength achieved was quite poor.

The complication is due to the fatigue mechanism that induces cracking in a slab. The repeated bending stresses affected a wide zone on the underside of a slab. Once a crack forms it rapidly propagates upwards to expose a visible crack at the ground surface. As one fatigue crack is repaired e.g. by adequate bonding (in dry conditions) a new crack soon appears alongside. The reason is: the

concrete next to the original crack has already suffered near terminal fatigue, so the magic 60 MPa epoxy is not a solution.

The existing pavement profile at Auckland International Airport is shown in Figure 19.

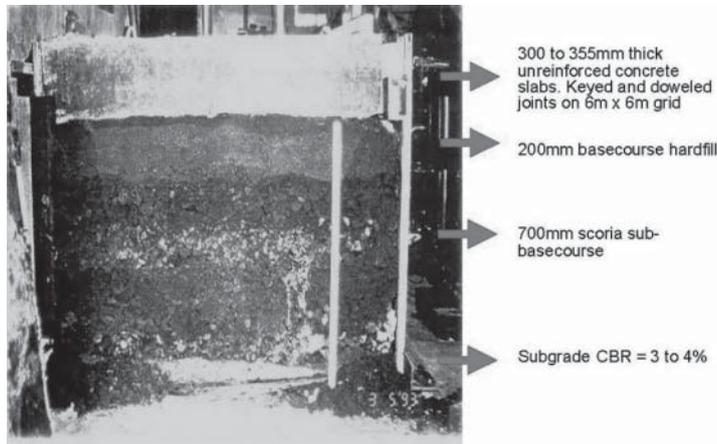


Figure 19. Old pavement structure (courtesy of Tom Watford, Auckland International Airport)

The concept developed was to form by injection a cemented beam under the crack, just as formed and poured concrete beams have been used to support the free edge of a slab. (Figure 20 explains the theory of underslab injection).

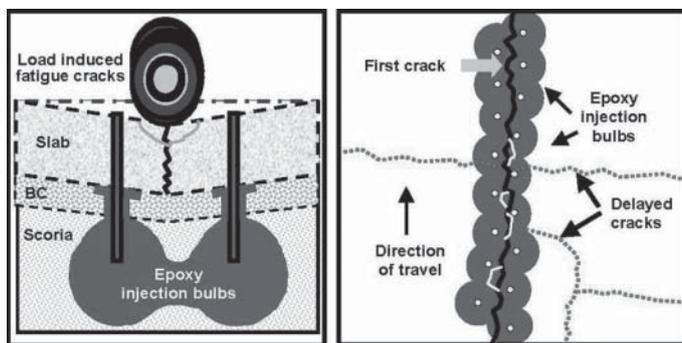
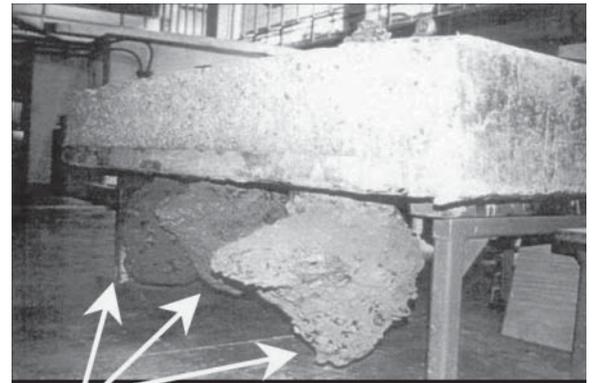


Figure 20. Reduce flexural stresses to delay further fatigue (courtesy of Tom Watford, Auckland International Airport)



Bulbs of cemented scoria
(University of Auckland test hall)

Figure 21. Epoxy underslab injection technique (courtesy of Tom Watford, Auckland International Airport)



Semi-contiguous cemented bulbs
(NB. Concrete removed)

Figure 22. Epoxy underslab injection technique (courtesy of Tom Watford, Auckland International Airport)

To achieve this we need to find a suitable product that penetrates damp or wet aggregates (the basecourse under the runway slab); sets to a high strength (like a roller compacted concrete); in a shape that forms a “beam”. If the epoxy were too free flowing it would have gone to the bottom of the basecourse and spread out in a thin flat layer. If it were too viscous it would have risen and spread under the slab to form a thin plate of epoxy. With patient testing, we achieved a series of roundish bulbs that “held hands” to form a “beam” (see photos on Figures 21 and 22).

The underslab injection was highly successful; this technique halted further deterioration to the cracked slabs, and allowed their use by jet aircraft for a good 10 years before they were replaced. This was highly beneficial from a net-present-value expenditure perspective.

6 CONCLUSIONS

It has been an enjoyable and fulfilling experience facing the challenge of understanding the effects of water and the saturated state that reduced the life of a compacted crushed rock under dynamic loading in traffic conditions. It was satisfying to research and gain such an understanding. I recommend that any engineer with a technical bent undertake some advanced research, be it for a PhD or for a major project. It will give the engineer the confidence to face other problems. The majority of technical problems are solvable (or they have to be avoided if they cannot be economically solved).

For civil engineers, it is very important to get in touch with the geological side. We can easily miss seeing a problem that in hindsight would become evident.

Innovative thinking is the spice of an engineer's life. I was immensely pleased to be involved in the development of an apparently simple process to make Mudcrete that costs 1/7th of the industry's known method; is easy (for contractors) to apply and has so many environmental benefits. To find a way of extending for ten years the life of cracked slabs loaded by 390 tonne aircraft traffic has also given me pleasure.

ACKNOWLEDGEMENTS

I have been fortunate in my Auckland University days to have been taught and mentored by passionate and very capable engineers in particular Professor Peter Taylor and Geoff Martin. I particularly would like to thank Sir Ron Carter at Beca who gave me time and encouragement as well as the freedom and independence to develop my inclinations for my subsequent work.

I also acknowledge the importance of our clients in giving us the challenge and opportunities to explore the mechanics and engineering solutions for their assets. I very much appreciate those that understand the engineering challenges to question the advice they receive; that is the test of the engineer. Our clients at Auckland International Airport and at Ports of Auckland have provided me with many challenges to apply our innovative solutions and extend our understanding of materials, and for that I am greatly indebted.

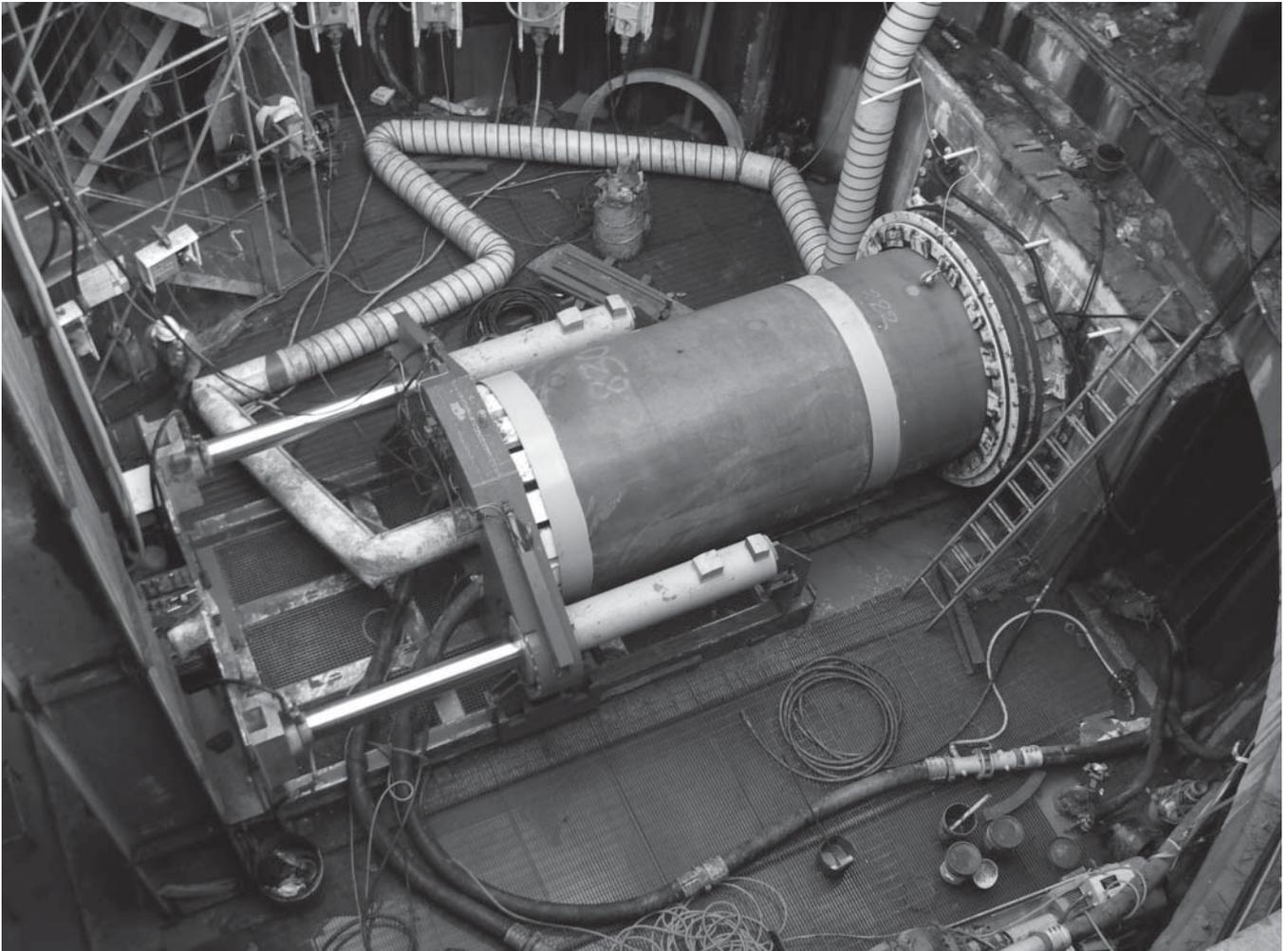
Finally, I would like to thank the NZ Geotechnical Society for inviting me to share some of the more interesting experiences in my career.

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PROJECT NEWS

Progress on the Christchurch Ocean Outfall Project



The Christchurch Ocean Outfall Project is currently under construction and it is one of the most significant local geotechnical projects. The outfall will transfer treated wastewater from the existing treatment ponds at the City waste water treatment plant to diffusers located 3 km offshore. The NZ\$87M project comprises a new pump station and 5 km of 1800 mm diameter pipeline with a design capacity of 6 cumecs. The pipeline comprises 2.3 km of concrete pipe installed by microtunnel/pipejacking and 2.7 km of HDPE marine pipe installed by dredge and lay. McConnell-Dowell Constructors are the main contractor for the pipeline and Works Infrastructure Limited are the main contractor for the pump station. The ocean outfall pipeline has been designed by URS and OCEL Limited.

The microtunnel is being constructed in three sections, firstly an 870 m section beneath a tidal estuary, secondly a 600 m drive along a sensitive residential street and thirdly an 830 m section beneath the dunes and surf zone out to the connection point with the HDPE marine pipeline.

Photo 1. Concrete pipes being pushed from the jacking station in South New Brighton Park

Three shafts have been constructed, a primary jacking shaft in South New Brighton Park (Photo 1), a receiving shaft adjacent to the new pump station site at the corner of the treatment ponds and a combined receiving and launching shaft in the South New Brighton dunes.

The concrete jacking pipes are being installed using a Herrenknecht AVND slurry microtunnel boring machine (MTBM). A fully automated bentonite injection system is being used and intermediate jacking stations are being installed about every 100 m. The microtunnel is being constructed from three shafts, up to 15 m deep, with the final recovery of the MTBM beyond the surf zone to be a “wet recovery” from a barge. The HDPE pipe is being assembled at Lyttelton Port and stored in the harbour until the seabed trench is completed (Photo 2).

The project is being constructed in Holocene



Photo 2. Launching a 380 m pipe string at Lyttelton Port. The pipes are stored temporarily in Lyttelton Harbour until ready for installation in the seabed trench.



Photo 3. Right on target! Hole through after completing Reach 1. Left to right: Tim Evison (CCC) Ron Fleming (URS) Gwyn Jones and Ian Campbell (McConnell Dowell) with "Dora the Bora".



Photo 4. A gaggle of excavators removing liquefiable sands from the new pump station site

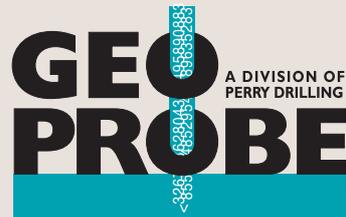
dune, estuary and near shore marine sediments of the Christchurch Formation, comprising mainly fine sand.

The first microtunnel reach from the South New Brighton Park shaft across the estuary to the site of the new pump station was completed between June and August 2007 (Photo 3). The reach might have set a microtunnelling record by pushing the whole 870 m of pipe without requiring use of the interjacks. The second reach along Jellicoe Street commenced in October and is expected to be completed during November. All microtunnelling is scheduled to be completed by February 2008, with the marine pipeline section, which is being constructed concurrently, due to be completed in April 2008.

The new pump station was designed by the Council's Capital Programme Group (formerly City Solutions), being part of the Christchurch City Council. URS undertook geotechnical investigations, design of ground treatment measures to mitigate liquefaction hazard, and geotechnical design for the foundations and pond embankments at the new pump station site. The ground treatment was completed by excavation and replacement of the soil to a depth of 7 m, recompacting the material at sufficient density to withstand 1000 year return period ground shaking. (Photo 4)

Reported by: Tim McMorran, Principal Engineering Geologist, URS New Zealand Limited

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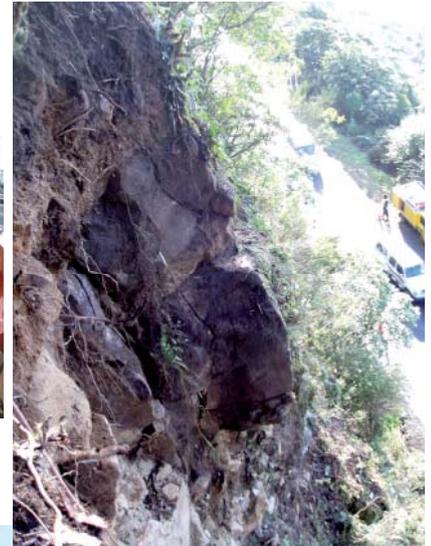




Look what came down!

SH 5 Tarawera (above) Marked and drilled then post blasting.

Bluff Hill, Napier (below) Before tree felling & scalingand after (below)



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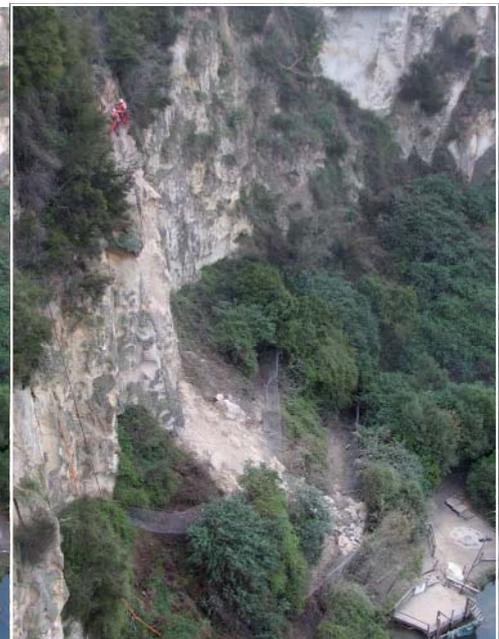
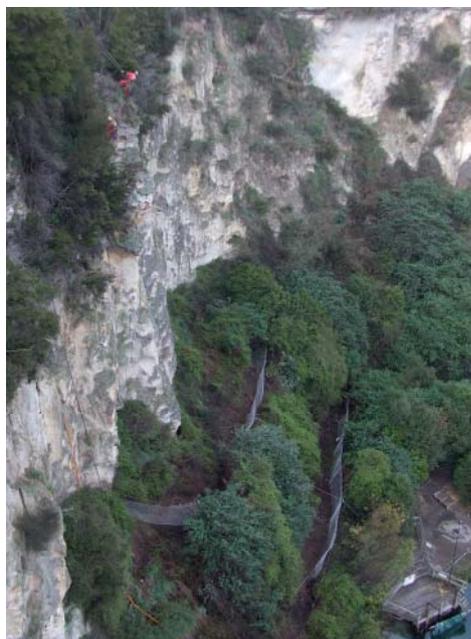


Waihi Hill, Turangi

The problem before (above) ...and after blasting (below)



Site investigation

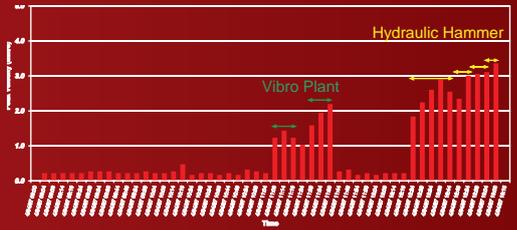


Taupo Bungy Temporary fences in place (left) and (right) material post scaling.



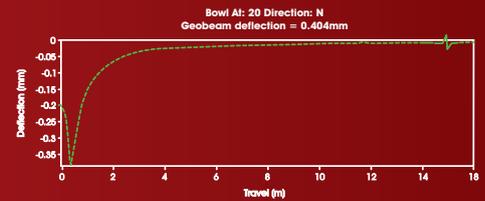
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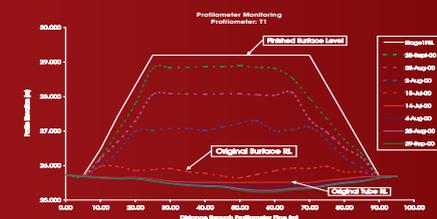
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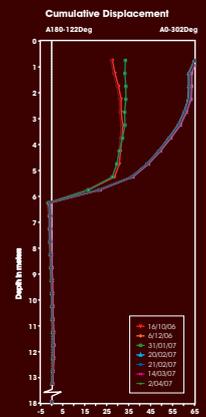
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0.30	612106	Standard Penetration Test (SPT)	45	01/12/06
0.60	3101007	Standard Penetration Test (SPT)	45	20/02/07
0.90	2102007	Standard Penetration Test (SPT)	45	21/02/07
1.20	1403007	Standard Penetration Test (SPT)	45	14/03/07
1.50	204107	Standard Penetration Test (SPT)	45	20/04/07



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Depth (m)	Result (Blows/300mm)	Diagram (N100 Values)	Notes	Remarks
1	1			
2	1			
3	1			
4	1			
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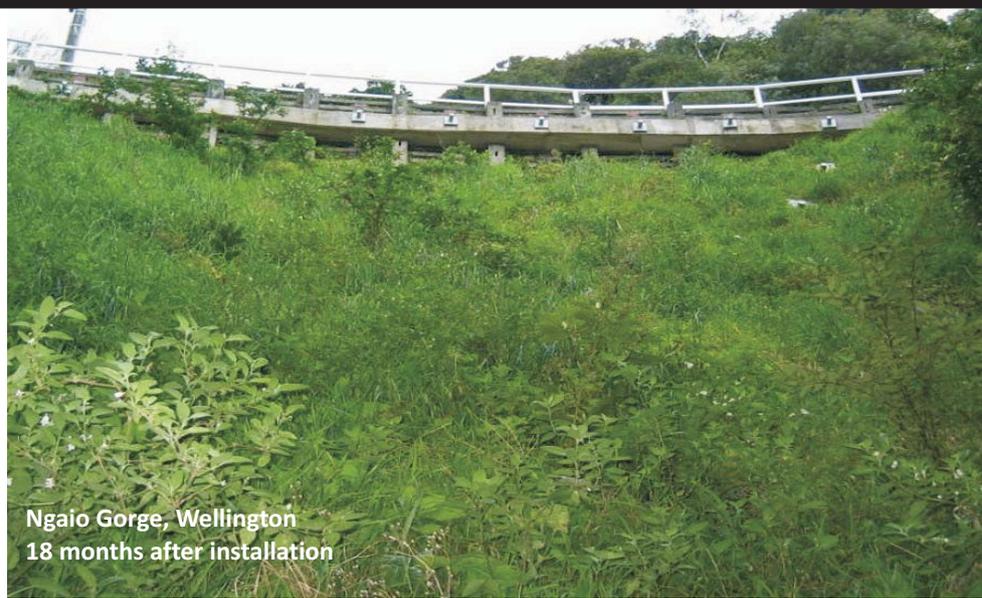
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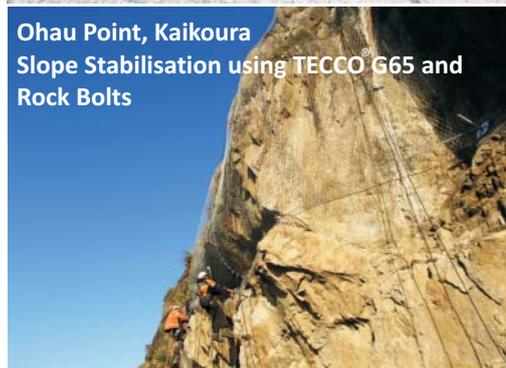
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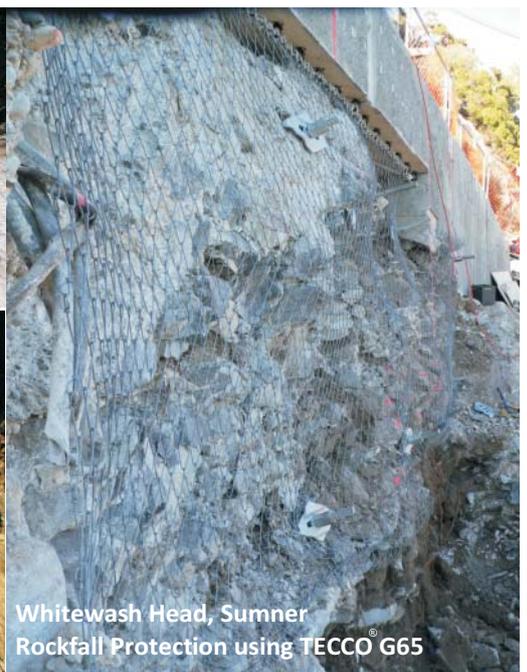
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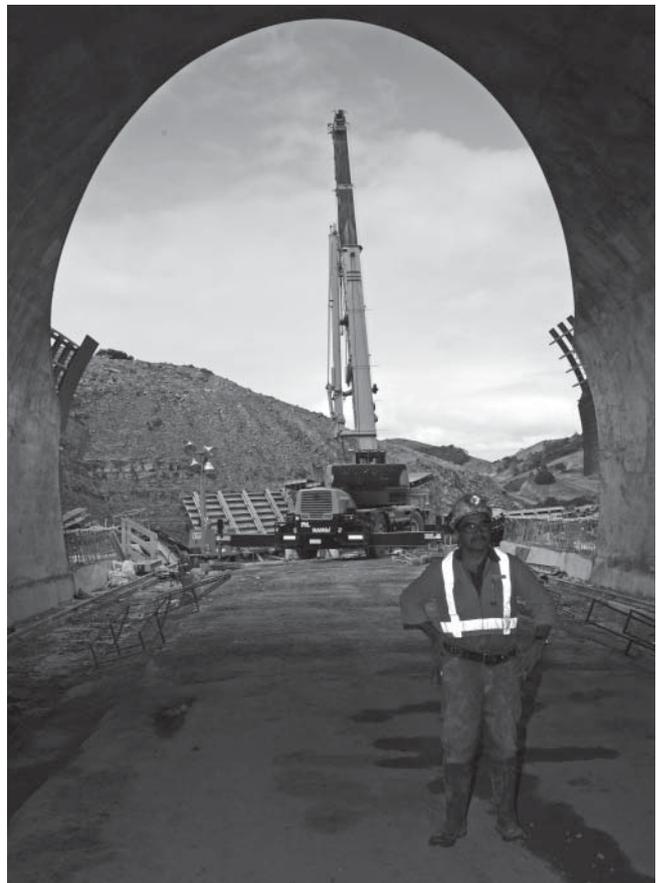
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Northern Gateway Alliance & ALPURT-B2

Progress Update

The following is a snapshot of progress on Transit NZ's largest roading construction project, which is being built by the Northern Gateway Alliance. The NGA is an innovative Alliance contract amongst the client Transit NZ, constructors Fulton Hogan and Leighton Contractors, and designers URS (NZ), Tonkin & Taylor and Boffa Miskell. Design started in 2004 and construction commenced in January 2005. Project completion is due in June 2009. The project is currently 6 months ahead of schedule. More detailed information can be viewed at the project website, www.northerngateway.co.nz



Tunnels: The permanent concrete lining has now been installed in both the Johnstone's Hill tunnels. At the southern portal, the cut and cover section for the southbound tunnel is complete and construction of the northbound cut and cover section is well underway. Trenching for ducting, drainage and fire mains is currently underway in the southbound tunnel. The roadheader has been sold and will be shipped to Brisbane to work on the north-south bypass project



Above: HDPE lining of Johnstone's Hill tunnels. **Opposite:** Bill guards the tunnels southern entrance



Above: Tunnels south entrance. Chin Hill on horizon. **Right:** Waiwera Viaducts Balanced Cantilever Construction. Oct07.

Structures: The twin Waiwera Viaducts are more than 70% complete. 320 of the viaducts' 356 segments have been match-cast and 235 of them have been erected. Completion of the viaducts is due in April 2008.

In early September, the Hillcrest Bridge load was transferred from the temporary concrete piles to the permanent steel raking piers. The four temporary concrete piles have now been removed.

The final beams for the Nukumea Eco-viaduct were lowered in place on 8th October with the final deck poured on the 17th. The truss is now disassembled and the focus is on barrier construction.

The Otanerua Eco-viaduct is now virtually complete with only barrier rails yet to install.

This viaduct is now being used by 80t earthmoving plant to cart soil and rock from Chin Hill south to Zones 2 & 3. The Orewa Interchange Bridge is now virtually complete.

Earthworks

Zone 1 - The northern end of the works, just south of Puhoi to Waiwera Viaducts: Work continues on the reinforced slope to the south of Titford's bridge (RW02) which is now approximately



Above: Hillcrest Bridge. **below right:** Chin Hill cut in Pakiri Rock. Otanerua Viaduct in background.

85% complete. The wooden retaining wall at the top of Johnstone's Hill is nearing completion. Earthworks at the northern portals for the Tunnel Utility Building (TUB) are complete. Diversion of SH1 traffic up the fill to the west of the tunnels is due to take place in April 08.

Zone 2 - Waiwera Viaducts to Hillcrest Road Bridge:

Good progress has been made in this zone with only the B5 fill to complete. This is the fill behind the pre-cast yard/'big brown shed' and is the final gully fill left on the project.

Four blasts have been let off on Chin Hill so far this season. A further 300,000 m³ of rock will be extracted (from a total 1 million m³) to finalise the 55m Chin Hill cutting.

Motorway network drainage has been installed in the Otanerua fills and some batter slopes in this area have been planted and closed out.

Zone 3 - Hillcrest Bridge to Orewa Interchange:

Work has begun on cutting to sub-grade at the Orewa Interchange while earthworks for the north bound on-ramp have been completed. Shear key stabilisation involving



removal of 15,000 m³ of material and replacement with stable material completed at the Hillcrest cut slopes. Pavement is due to be laid in February and tolling gantry construction and trials are to commence in March 2008. A sizeable amount of earthworks (250,000m³) is yet to be excavated beneath Hillcrest Bridge.



Above: Waiwera Viaducts. 400t Crane

400-tonne Crane

A 400t crane, one of only two in the country, was brought in to assist on the Waiwera Viaduct. The crane was used to lift pier segments in place freeing up the truss for span construction.

This took pressure off the programme created by earlier delays with the truss. After 3 days the pier segments were in place and the crane returned north to Whangarei.

Sub-base Pavement Trials

Pavement trials on a section of road to the north of Hillcrest Bridge have been successfully completed. The trials were conducted to establish the most efficient construction methodologies and the best combination of plant and materials.

'Plateau testing' determined the number of passes a roller required for the subgrade to reach the required density. Further trials determined the benefits of using a heavier roller in combination with smaller than usual aggregate, in line with international best practise.

Environment

During the course of August and September the following environmental benefits were implemented:

- Safety improvements north of Titford's Bridge, involving negotiations with submitters and consent authorities

– a positive outcome for all, avoiding an Environment Court hearing.

- Planting of native trees and plants on slopes above the tunnels south portal was completed. Late season planting underway in Zone 2 and at Orewa Interchange.
- Variation to consent for Waiwera Causeway, for a minor additional reclamation of 190/m² allowing 400/t crane to place pier segments.
- Tunnel Utilities Building (TUB), façade designed to ensure project vision is being acknowledged.
- Identify opportunities for reducing project carbon footprint by 3% over the 100 yr project lifetime

Reported by: Stephen Crawford

Geotechnical Team Leader

Northern Gateway Alliance

Email: scrawford@tonkin.co.nz

Rosedale Wastewater Treatment Plant Outfall

North Shore City Council (NSCC) has achieved a major project milestone with the award of a contract for a total of approximately \$91M to McConnell Dowell Constructors Ltd to design and construct the new Rosedale Waste Water Treatment Plant tunnel and outfall.

The existing Red Bluff outfall was built in 1958 with the design by Worley & Downey, forerunners of Maunsell Ltd. In 1999, the council decided to initiate a systematic upgrade of the Rosedale Wastewater Treatment Plant, including construction of a new outfall to replace the old short outfall and with sufficient capacity to cater for forecast population growth.

In late 2003, a Maunsell led team (in association with Tonkin & Taylor and Metcalf & Eddy) was awarded the contract for professional services for feasibility and procurement of the new outfall. After gaining variations to existing consents to suit alternative methods of tunnel and marine outfall construction, the team prepared a Specimen Design and contract documentation for a design and build lump sum tender. The tender called for an outfall of total length approximately 5.3km, with 2.6km being beneath land and 2.7km beneath Mairangi Bay and the Hauraki Gulf. The tender specified the use of Earth Pressure Balanced Machine (EPBM) capable tunneling / pipejacking equipment, to limit the anticipated risk of settlement induced damage to buildings.

Between the Assessment of Environmental Effects (1999) and award of the construction contract (2007), there have been a number of phases of land and marine based geotechnical investigations, predominantly comprising triple tube cored boreholes and Cone Penetration Tests. Investigations included two full-scale pumping drawdown tests, Tunnel Boring Machine (TBM) cuttability tests, seismic profiles of the seafloor, environmental baseline monitoring and numerous routine geotechnical tests. Since investigations commenced over 1000m of drillholes have been put down to investigate various alignments for the tunnel and outfall. During the tender period, a full-scale marine dredging trial was commissioned to identify the nature of marine sediments and the performance of seabed trenches cut at varying batters.

NSCC specified the use of a Geotechnical Baseline Report (GBR) to allocate ground risks under the FIDIC (International Federation of Consulting Engineers) design and build contract framework. GBR's have recently been introduced to New Zealand tunneling projects. The function of the GBR is to set out a clear expectation of what range of geotechnical conditions are to be allowed



Above: Trial dredging of marine sediments off Mairangi Bay

for and priced by the contractor as part of their offer, while the client accepts risks outside of the specified ranges. Being a design and build project with the potential for the Contractor to offer different tender construction methodologies, it was deemed appropriate to give the tenderers an opportunity to write an addendum document to the GBR. The end result is to have in place a contractually agreed set of baselines under which to manage claims for unforeseen ground conditions. The ultimate intention is to avoid or mitigate any disagreements during construction as to 'what was' and 'what should have been foreseeable'.

The interactive tender process has allowed the optimisation and development of design and construction methodologies by the now successful tenderer McConnell Dowell. This has included straightening and shortening the tunnel alignment by some 200m. Connell Wagner will undertake detailed design for McConnell Dowell. The proposed construction works include three shafts, approximately 3000m length of segmentally lined 2.8m ID tunnel using a Lovat EPB TBM, and 2100m of buried HDPE pipeline, terminating in a sea bed diffuser to optimize effluent dispersion.

Construction is due to start in early 2008, kicking off with shaft construction works off Constellation Drive on the North Shore. Following construction of a backshunt tunnel at the base of the main shaft, the main TBM tunnel drive is likely to start in late 2008.

Reported by: Jon Sickling,
Senior Engineer, Maunsell Ltd.

For further details of the project, please contact
bryan.smith@maunsell.com

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North Young Rockslide: A Photo Essay



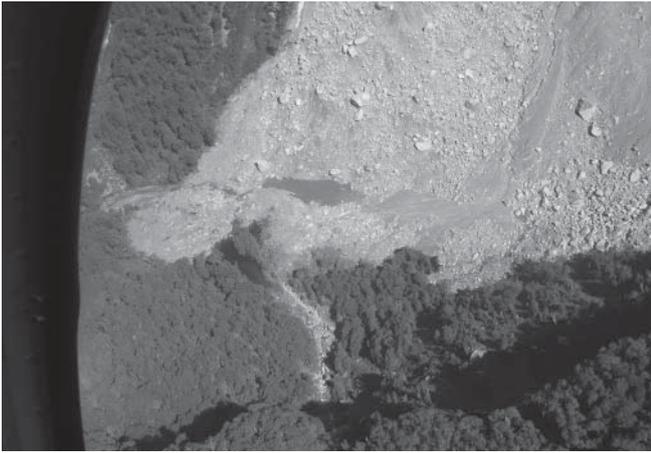
On the morning of the 26th September, a Makarora helicopter pilot returning from the West Coast with a hunter noticed a new lake in the North Young Valley that neither had remembered seeing on an earlier flight three weeks previously. The North Young is the less visited branch of the Young Valley that gets bypassed by the numerous trampers walking the popular Gillespie Pass circuit via the Wilkin-Siberia-Young Rivers. The latter river enters the Makarora Valley about 3.5 km upvalley from the nearest settlement, Makarora. About 50 people live in the valley between the confluence and the head of Lake Wanaka.

Returning later that morning, it could be seen that the new lake, measuring about 2 km long and 0.5 km wide (see Photo 1), had formed behind a recent rockslide. The water level at that time was around 15-18m below the lowest point on the debris dam. Discussions with locals revealed that rumbling noises were heard on September 19th; GNS has put a failure date of August 29th based on a recorded seismic signature characteristic of rockfalls.

Photo 1.



Photo 2.



Top left and clockwise: Photo 3, Photo 5, Photo 4.



The rockslide originated from a spur 1000 m up on the ridge flanking the west side of the valley. About 15 million m³ of blocky debris failed with the major part of the failure forming the bulk of the debris dam (Photo 2) and secondary amounts spreading as more mobile lobes down valley (Photo 3) and a minor amount spilling over as rockfalls on the upstream side. Rainfalls following the initial failure had activated numerous debris flows that had subsequently mantled the lower part of the debris cone and formed a mudflat apron in and around the downstream lobes.

Emplacement took place over an estimated kilometre of valley floor and filled to a height (river level to lowest

point on crest) of around 100-110 m.

Aerial inspection of the failure area revealed no obvious slip surface with the sole plane obscured by debris. Schistosity dips back into the hillside and is poorly developed in this area. Several irregular joint surfaces were visible on the rear scarp and there were, what appeared to be, steep, outward dipping exfoliation planes on the left flank. No other signs of instability were visible on lateral or upslope areas marginal to the failed area.

There were no obvious major rainstorms or earthquakes within the likely time frame that could have triggered the event. It is likely that relaxation following deglaciation of the valley gave rise to progressive rock mass degradation leading to catastrophic failure without any significant triggering mechanism. Rockslides are a common feature in this part of Mt Aspiring National Park. Previous work in the South Young identified ten major rockslides in the upper three kilometres of the valley including one of similar magnitude to its North Young counterpart. All of these are postglacial features with recent failures in neighbouring valleys indicating major rockslides are an ongoing landscape forming process of importance.

The bulk of the rockslide dam appears to be comprised of large to very large blocks in point to point contact as can be seen on the arcuate distal ridge abutting up against the opposite side of the valley (Photo 4). The low degree of comminution, low down valley mobility and absence of wind-blast effects on the adjacent forested slopes indicate a moderate speed of emplacement. On these grounds, a rockslide description appears more appropriate than a rock avalanche.

As the lake approached the low point on the crest, a wetting front established itself through the dam with seepage (equal to 5-10% of the flow into the lake) first noticed when the lake was within 3 m of overtopping.



Above and clockwise: Photo 6, Photo 7, Photo 8.

Over the next few days, the seepage increased over a broader front giving rise to an estimated 50% of the inflow escaping through the toe of the dam (Photo 5). The outflow was particularly turbid, more so than the lake water, indicating piping was mobilising matrix fines in and around the strongest flow paths.

On the evening of October 5th, the lake breached the crest and established a spillway channel across the middle of the dam (Photo 6). Heavy rain and snow over the next few days saw some anxious moments as the behaviour of the dam and overflow channel were closely monitored. New seepage points appeared higher up on the downstream face with accompanying sinkhole development aligned along the flow paths (Photo 7). The dam face held firm despite much of the finer debris flow material mantling the proximal side of the dam washing away as the springs coalesced. The overflow river also maintained its channel without any incision into the crest or lateral migration. Later inspections revealed no discernible channel changes despite intervening rainstorms doubling the width of the overflow at the crest.

In the days leading up to and following the overflow event, the Makarora community were briefed on the likely scenarios and consequences, the worst case being a catastrophic release of water following rapid downcutting of the overtopping water. Department of Conservation had already blocked foot access to the Young Valley shortly after notification of the dam formation. Fortunately, most of the inhabitants lived and worked on terraces that were set well back from the main river at least 14 km from the dam. A farm manager and his family were evacuated from the lowest lying dwelling as a precautionary measure during the night of the overtopping.

Otago Regional Council (ORC) staff set up crude, flood inundation, early warning devices at two locations downstream of the dam. These transmitted a radio signal back to the Makarora Civil Defence headquarters every minute that was monitored round the clock by staff and



volunteers. Later, this was replaced by a more robust system involving two float switches on a pole located on the berm of the North Young River just up from the junction with the South branch. High flows in the river will activate one or both switches and automatically send a message to pagers carried by members of the Makarora community. In addition, a pressure sensor at the same location measures water levels on a continuous basis and telemeters these in real-time to the ORC's Water Info (Young Valley) website <http://water.orc.govt.nz/waterinfo/showsite.asp?s=137>

At present, monitoring has been scaled back as the overflow channel appears to be stable despite fluctuations in river level of up to 1.6m as measured at the ORC monitoring site 3.5km downstream of the dam. There was also no obvious response to a 6.7 magnitude earthquake and after shocks centred about 160km to the west. The Spring period is characterised by heavy rainfalls and melting snow pack in the Southern Alps. There is still a potential for a damaging flood to come through and as such it is considered prudent to keep the valley closed pending further review.

Reported by: Jeff Bryant
Geoconsulting Ltd

TECHNICAL ARTICLES

Slope Behaviour in Otumoetai, Tauranga

Laurie Wesley

Introduction

The purpose of this article is to put on record some general observations on the slips that occurred in the Otumoetai area of Tauranga as a result of the May 2005 storm, and the results of some specific investigations at one particular slip. Shortly after the slips occurred, Bernard Hegan and I were asked by Tauranga City Council to inspect all the main slips and to attend a public meeting (to answer possible questions from the floor), and also to provide a report on our findings to the Council. I want to emphasise that this is an article rather than a technical paper. I am not an expert on soil conditions or geology in Tauranga and until May 2005, I had not had any major involvement with slope stability or slips in the Tauranga area. I had, however, gained the impression that Tauranga volcanic ash soils were rather different to the “brown ash” soils I had some knowledge of in Taranaki and the central plateau of the North Island, as well as in Indonesia. To some extent I undertook the assignment out of curiosity. Bernard had had considerable previous involvement in the Tauranga scene, and did his best to educate me (hopefully not without some success) about the local geology, especially the sequence and nature of the various ash layers. The main points of our observations, together with the results of some limited laboratory tests from one particular site, are set out in the following sections.

General Observations on the Slips

Our main observations can be summarised as follows:

1. Very few of the slips inspected could be considered surprising or unusual given the general steepness of the topography in which they occurred. They also appeared to occur in places likely to be vulnerable to intense rainfall, that is, places where the local topography concentrated surface run-off at the top of vulnerable slopes.
2. Most of the slips had the form of relatively shallow circular arc failures. They did not generally occur over the full height of the slopes, being restricted to the upper half (or two thirds) of the slope. This was natural because of the buttressing effect of previous slip debris at the base of the slopes. The most common form of failure is illustrated in Figure 1(a) below. The slip material generally disintegrated as it moved, and became mixed with water to form minor “mud flows”. The distance travelled depended on the shape of the slope, the sensitivity of the soil, and the quantity of water available.
3. One slip that was rather unique was the large slip in Vale St that pushed a house below it a considerable distance towards the road in front. This slip extended over almost the full height of the slope and had the form of a “block” slide, with movement occurring on a preferred layer with a gentle dip towards the road. The block of soil moved semi-horizontally taking the house with it. The block partly disintegrated as it moved. The form of this slide is shown in Figure 1(b).
4. At some of the slips vertical cracks or “fissures” were observed in the Hamilton brown ash layer. Such cracks would provide natural channels for water to enter the slope and could have the effect of providing an external water force on any potential failure block.
5. Figure 1(c) attempts to illustrate diagrammatically the way in which water induces slips in slopes. The mechanism is not one whereby previously “dry” soil becomes wet. All soils, especially those in Tauranga, which consist of fine-grained clayey materials, contain a large (and essentially constant) quantity of water all year round, and apart from a shallow zone near the surface, are fully saturated. The influence of periods of intense rainfall is to “pressurise” this water, and consequently to reduce the shear strength of the soil. The longer the time over which the site is subjected to abundant supplies of surface water, the greater will be the increase in pressure and the consequent weakening effect. (*Sorry if this is all very elementary*).

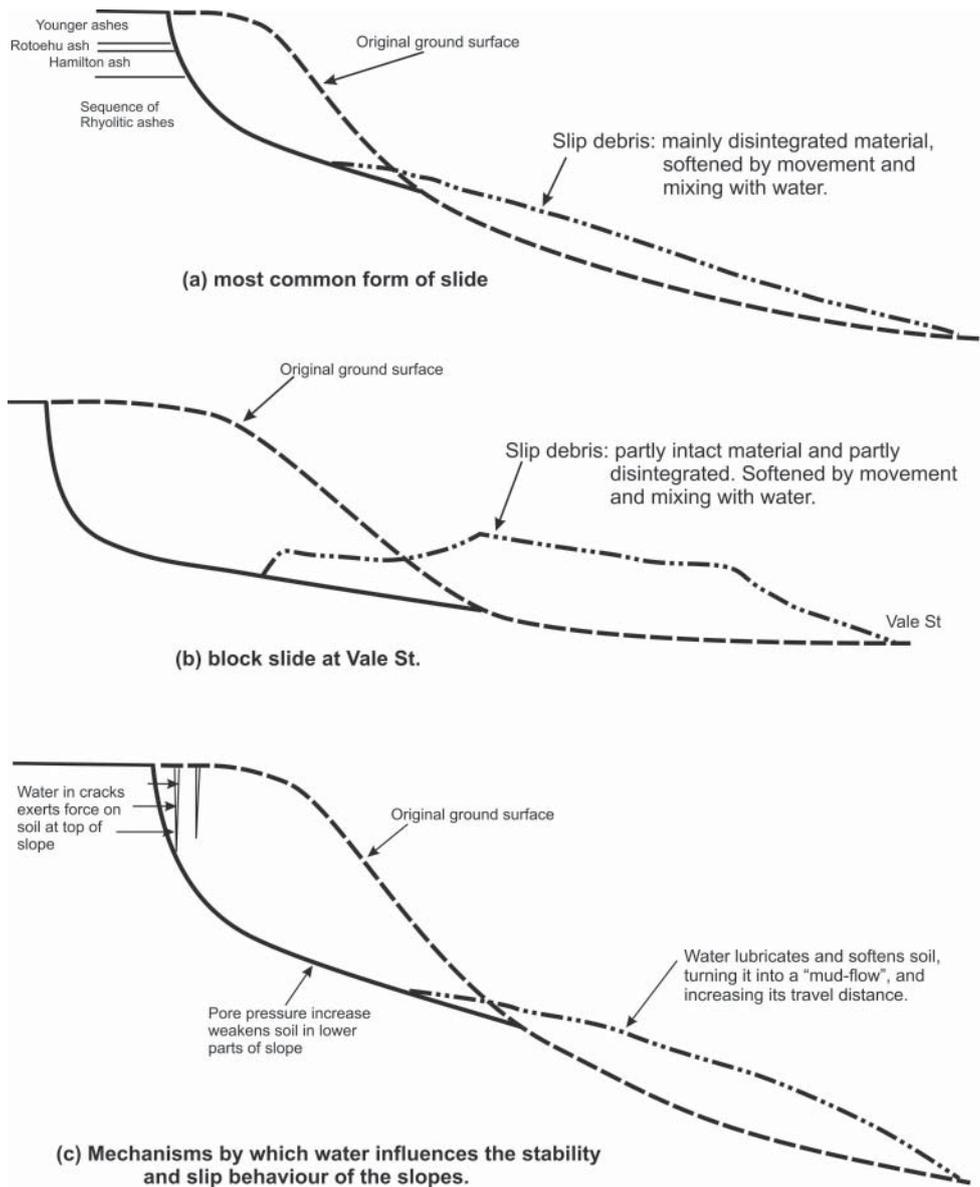


Figure 1. Forms of the slope failures.

6. The majority of the houses that suffered severe damage were at the foot of slopes rather than at the top of them. The damage was done by the impact of the slip debris material against these houses. A number of houses at the top of the slopes were left in precarious positions, although they had not actually suffered material damage. Many of these have since been removed.
7. The run-out distance of the landslide debris in general fell within a line projected at about 1V to 4H (14°) from the head-scarp (the top edge) of the slip.
8. Surface water run-off appeared to be an important contributing factor to many of the failures. A number of streets ended in cul-de-sacs sloping down toward the top of steep slopes, followed by driveways ending almost at the edge of the slope. These acted as surface flow paths, and local residents spoke of torrents of

water flowing down these driveways and then onto the slopes. In effect the streets formed streams and many driveways became spillways discharging the flow at the top of the slopes.

Despite what is said in Point 1 above, the slopes in volcanic ash soils in Tauranga seem to be more prone to slips than similar slopes in Taranaki or the central plateau. While most of the slips at Otumoetai occurred in old cliff slopes, there were a substantial number (possibly the majority) that occurred in the slopes of valleys that run “inland” from the old cliff line. The precise explanation for these valleys is unclear, but the horse-shoe shaped head of these valleys tends to concentrate surface run-off as well as seepage flow through the ground, so that these areas become particularly susceptible to continuing slope instability.

Geology and Soil Conditions

In very general terms the volcanic ash sequence, from the surface downwards, (as I understand it) in the Otumoetai area consists of the following:

- (a) Pale brown “younger ashes”, including the very sandy Rotoehu ash. The Rotoehu ash is found at an average depth of about 2.5m and is usually between about 0.5m and 1m thick.
- (b) The Hamilton “brown” ash, which is found immediately beneath the Rotoehu ash. This material is generally stiff to hard in consistency and about 1m thick.
- (c) Below the Hamilton ash there is a series of layers known as the Matua Subgroup. These consist mainly of creamy white fine grained rhyolitic ash, but which also contain a number of paleosols (old ground surfaces). These paleosols appear to be very similar to the Hamilton brown ash, being generally of higher strength, lower sensitivity, and lower permeability, than the intervening layers. At Otumoetai there are no true “basement” rocks and the ash sequence extends down to sea level. Elsewhere within Tauranga city, variably weathered ignimbrite and weakly cemented volcanoclastic sediments underlie the ash sequence.

The term “ash” is used here only to distinguish the various layers; they are all well weathered and geotechnically are now clays or silts, or something in between. The properties of the ash layers vary considerably and they no doubt influence to some extent the way failures occur. The Hamilton ash is believed to be derived from andesitic parent material, and appears to have very similar properties to other “brown ashes” found in Taranaki and the central plateau. They are assumed to contain a considerable amount of the clay mineral allophane. As some readers will know, I have been involved with allophane clays for some years (forty seven, to be precise). Allophane clays generally perform very well in slopes, and their geotechnical properties are good. However, the layers beneath the Hamilton ash are believed to be derived from rhyolitic ash, and have some rather different properties to the brown ash. In particular they are weaker and are often of high to very high sensitivity. These differences in properties are described in greater detail in the next section, giving an account of an investigation into one particular slip.

The Slip at 198 Grange Road

General Description

An opportunity to carry out some specific (but very limited) tests was provided by a reasonably large slip that occurred at 198 Grange Road. This slip did not immediately threaten any houses, and for this reason has been left more or less as it was when the slip occurred. A cross section of the slope is shown in Figure 2. This cross section is not highly accurate, but is a good approximation, having been determined with an electronic “Abney” level, backed up by direct tape measurements. As evidenced by the profile, the slope had been benched at some time prior to the slip. Two slips actually occurred in May 2005. The lower slip was by far the largest and extended a considerable distance laterally along the slope. The upper slip was of very limited lateral extent and had the form of a narrow gully. This upper slip may have been more the result of erosion than shear failure. The lower slip had the appearance of a typical circular arc failure. Hardly any of the material that slipped remained on the site; it disintegrated and disappeared into the scrub covered marshy area below the site. There was very little indication from the general appearance of the failure surface that its shape had been significantly influenced by any particular soil layer. It seemed to cut through all the layers in its path.

Figure 2 also shows descriptions of the layers, and the approximate boundaries between them. The arrows show the locations from which disturbed samples were taken for laboratory testing. Four of the layers had the appearance of typical “brown ash”. These are labelled as brown ash, and the samples taken from there were S1, S5, S9, and S11. It was very apparent at the time the samples were taken that the brown ash was strong (stiff to hard) and of low sensitivity, while the intervening light coloured soil was weaker and generally highly sensitive. The laboratory tests included natural water content and Atterberg Limits (natural and oven dried), on all the samples, particle size on six samples, and residual friction angle on four samples. A hand vane was used to measure the in situ undrained shear strength, and also the remoulded strength. These strength measurements were done later than the sampling, by which time the upper slip had been largely filled in so as to buttress the driveway above, making strength measurements no longer possible.

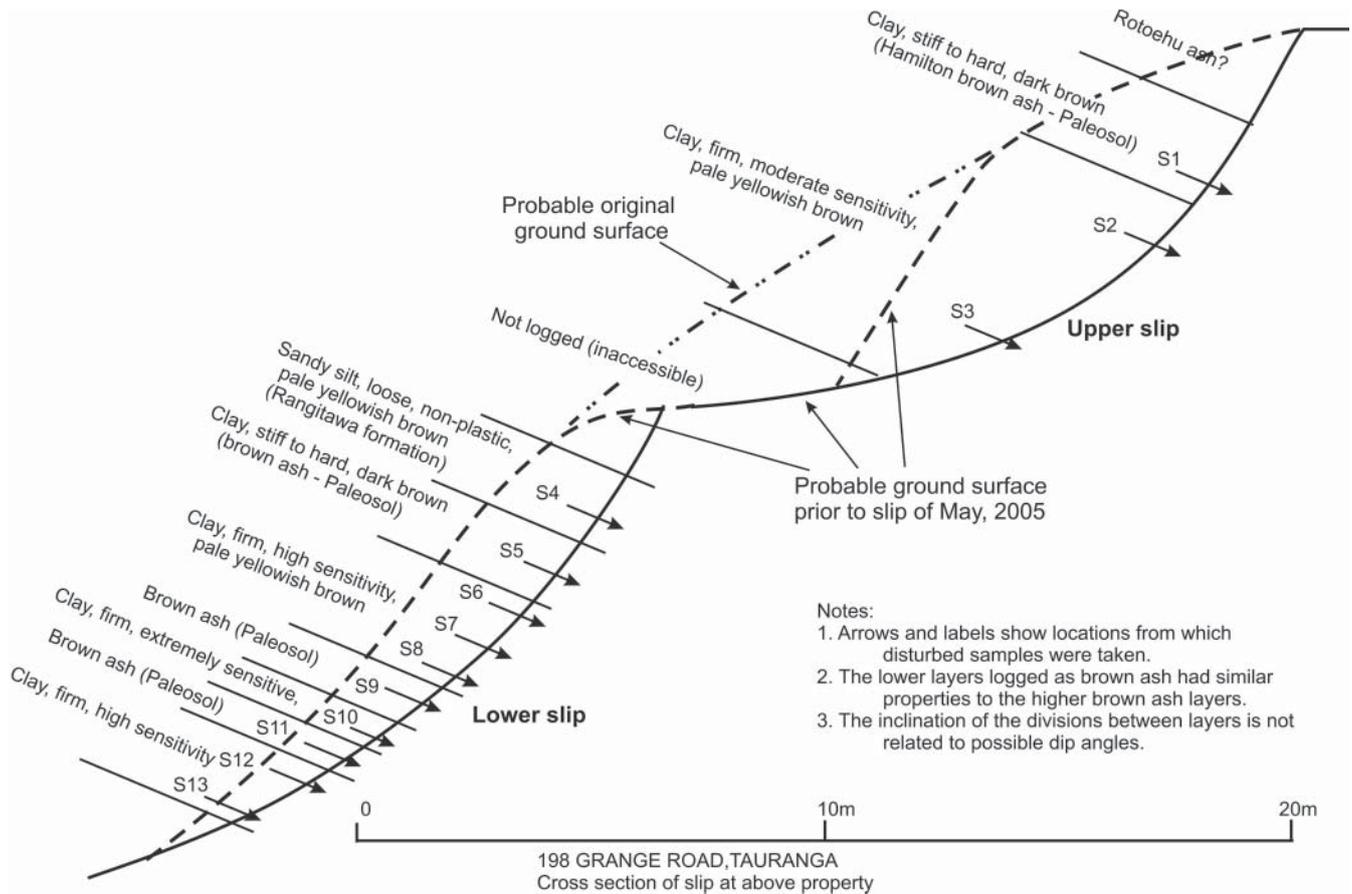


Figure 2. Cross section of the slope at 198 Grange Road, Tauranga.

Results of the Laboratory Tests and Undrained Strength Measurements

The results of the tests are summarised in Tables 1 and 2, and set out in graphical form in Figures 3 to 6. Comments on these results are as follows:

1. In Figure 4 the results are plotted against vertical depth below the highest point, this being the crest of the scarp at the upper slip. Plotted in this way the vertical distance between the samples is quite small, although when taken the distance between samples was much greater because of the angle of the slope. Samples S1 to S3 were from the upper slip and S4 to S13 from the lower slip. The top sample from the main slip, S4, was non-plastic sandy silt; only natural water content and particle size measurements were made on this soil. It is believed to be from a layer called the Rangitawa formation. The dip of the layers is not known.
2. The position of the Rotoehu ash layer in this profile is somewhat uncertain. It is probably the top layer of the upper slip. It was difficult to get access here but it seemed probable that the top brown ash layer was the Hamilton ash, in which case the layer

- immediately above it should be the Rotoehu ash.
3. The most striking features of the tests are the rapid changes in properties over short distances, and the extremely high sensitivity of some of the light coloured (rhyolitic) samples. Samples S1, S5, S9 and S11 were “brown ash” and generally of low sensitivity. The other (light coloured) samples were of high to very high sensitivity, as mentioned earlier. Samples S10 and S12 had natural water contents significantly above the Liquid Limit, giving them sensitivities around 100 and 70 respectively.
4. The samples occupy the normal position of volcanic ash soils on the Plasticity Chart (Figure 3) and all undergo some loss of plasticity after oven drying. In this respect, there is no significant difference in behaviour between the brown samples and the light coloured samples. Loss of plasticity is generally a good indicator of allophone content, at least in the writer’s view. These tests do not suggest that the allophone content is significantly different between the two soil types.

Sample No	Soil description	Natural w/c (%)	Atterberg Limits			Liquidity Index
			LL	PL	PI	
S1	CLAY, hard, low to medium sensitivity, homogeneous, brown ("Brown ash")	70.1	91	55	36	0.42
S2	CLAY, stiff, moderate sensitivity, pale yellowish brown, black specks	67.0	76	54	22	0.59
S3	CLAY, stiff, moderate to high sensitivity, pale yellowish brown, black specks.	85.3	93	50	43	0.82
S4	SANDY SILT, non-plastic, loose, pale yellowish brown (Rangitawa formation)	33.9	NP	NP	NP	-
S5	CLAY, stiff to very stiff, low sensitivity, homogeneous, brown ("Brown ash")	81.5	116	58	58	0.41
S6	CLAY, stiff to very stiff, high sensitivity, yellowish brown with many black specks.	94.8	96	55	41	0.97
S7	CLAY, stiff, high sensitivity, very pale yellowish brown with many black specks.	86.5	96	52	44	0.78
S8	CLAY, stiff to very stiff, high sensitivity, yellowish white with many black specks.	83.4	91	48	43	0.82
S9	CLAY, hard, homogeneous, non-sensitive, brown ("Brown ash")	61.0	90	58	32	0.09
S10	SILTY CLAY, stiff, low plasticity, very high sensitivity, pale yellowish brown with black specks.	68.7	60	55	5	2.7
S11	CLAY, hard, low sensitivity, homogenous, brown ("Brown ash")	75.7	104	65	39	0.27
S12	CLAY, stiff, very high sensitivity, pale yellowish brown.	92.3	85	52	33	1.22
S13	CLAY, stiff, low sensitivity, pale yellowish brown with some specks.	82.1	98	66	32	0.50

Table 1. Soil Descriptions and Basic Properties

Sample No	Undrained shear strength (kPa)		Sensitivity	Particle size			Residual friction angle ϕ'_r
	Undisturbed	Remoulded		Clay fraction (%)	Silt fraction (%)	Sand fraction (%)	
S1	-	-	-				
S2	-	-	-				
S3	-	-	-				
S4	-	-	-	19	13	68	
S5	129	15	7	44	41	15	20.7
S6	107	2	54				
S7	97	4	24	25	28	47	16.6
S8	100	3	34				
S9	207	60	3.5				
S10	97	1	97	16	34	50	
S11	210	38	5	44	43	13	24.2
S12	72	1	72	18	35	47	19.1
S13	77	13	6				

Table 2. Additional Soil Properties

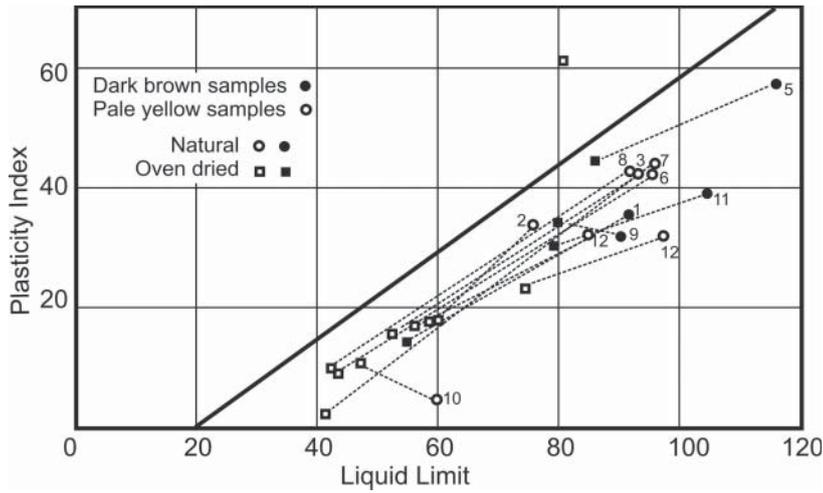


Figure 3. Atterberg limits on the Plasticity Chart.

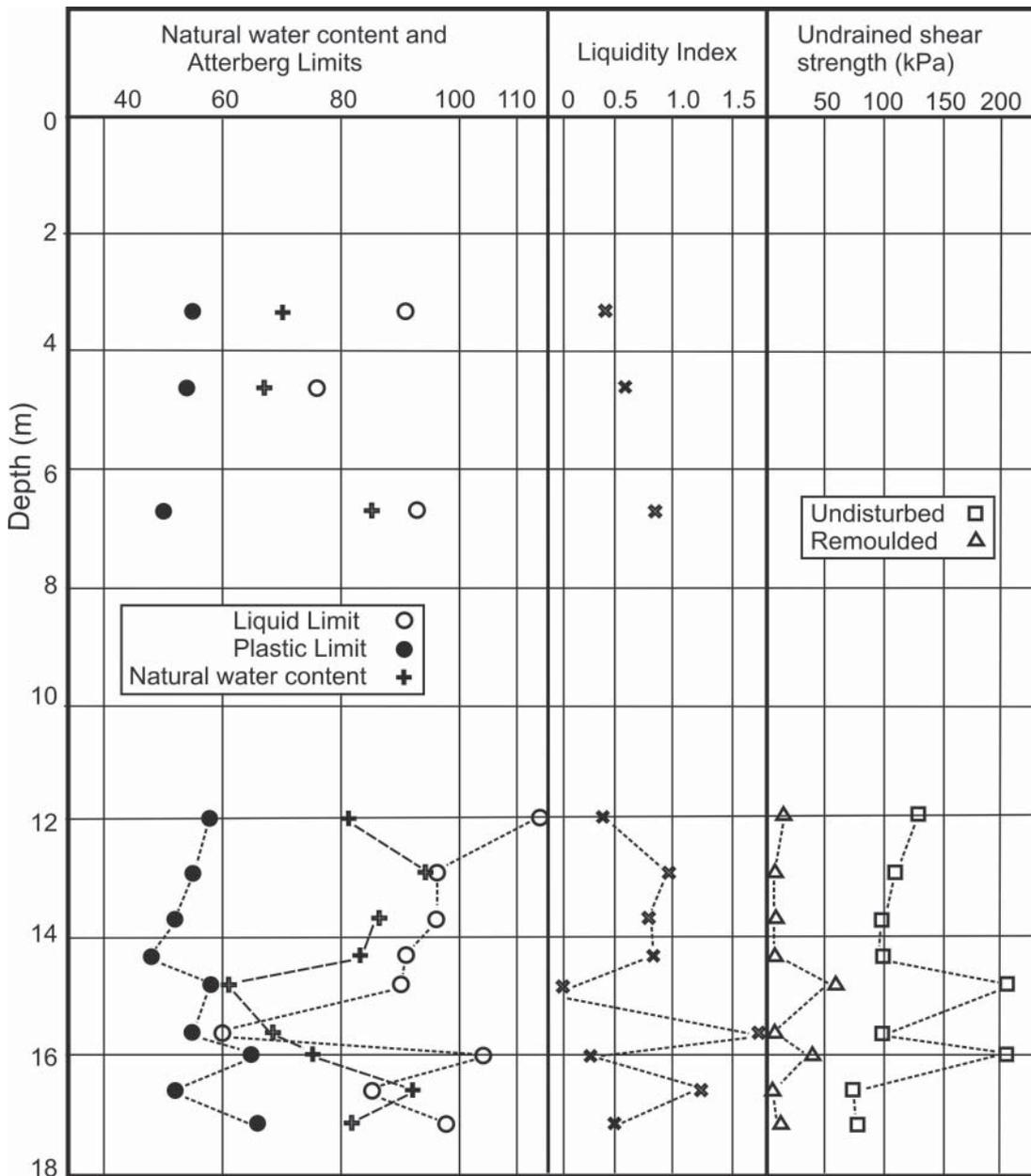


Figure 4. Results of tests on disturbed samples, plotted against depth.

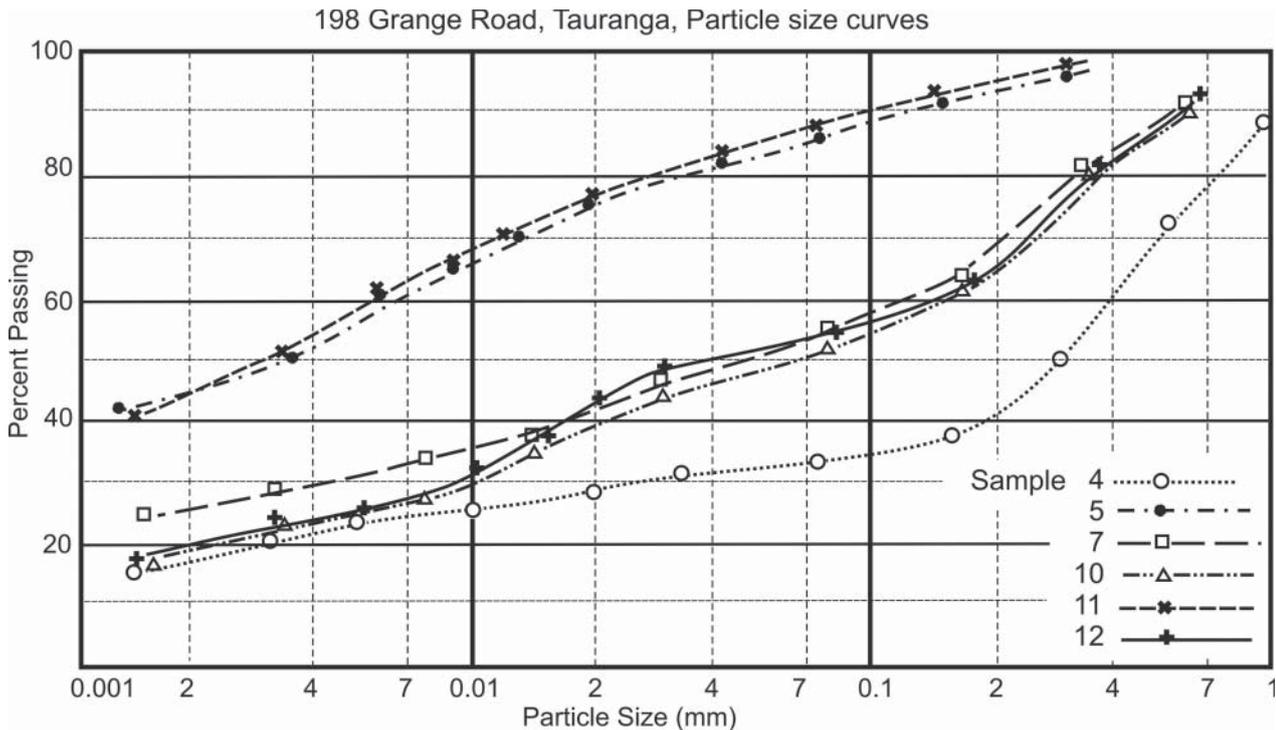


Figure 5. Particle size curves from four samples.

5. Two of the particle size curves (Figure 5) were from brown ash samples; these were S5 and S11. Another three were from the pale coloured samples, and the last from the non-plastic layer (Rangitawa formation). There is surprising similarity between the curves from the two soil groups.

To summarise, the most interesting finding from these tests was the rapid change in properties with depth because of the presence of the two soil types, and the extremely high sensitivity of the light coloured, rhyolitic soils.

Stability Analysis

Whether there is much to be gained from stability analysis in this situation is open to debate, since reliable information is not available on the seepage state in the slope or the shear strength parameters of the soil. Regardless of that, use has been made of the programmes SEEP/W and SLOPE/W to see what a theoretical analysis comes up with. Firstly, SEEP/W was used to establish a flow net and the way it would develop, assuming an initial low water table and continuous rainfall at the ground surface. This is easily done using the transient capability in the programme. The soil parameters adopted (somewhat arbitrarily, and subject to adjustments) for the seepage analysis and the stability analysis that followed are as follows:

Seepage analysis (the soil was assumed to be fully saturated):

Coefficient of permeability, $k = 0.05\text{m/day}$
 Coefficient of compressibility,
 $m_v = 1 \times 10^{-4} \text{ kPa}^{-1}$

Stability analysis:

Unit weight, $\gamma = 15.3 \text{ kN/m}^3$
 Cohesion intercept, $c' = 10 \text{ kPa}$
 Angle of shearing resistance, $\phi' = 35^\circ$

Despite the very high value of k and low value of m_v adopted, the time needed to establish an equilibrium seepage pattern was about 20 days. The seepage analysis therefore extended over 20 days with daily time steps. The long term seepage pattern this leads to is shown in Figure 6. It is of interest to note that the water table reaches the ground surface sometime between the first and second time step, that is between one and two days, but it takes a long time after this for the final steady state seepage situation to develop. The same phenomenon occurs with level sites. The time for the water table to reach the ground surface as a result of prolonged rainfall may not be very great, but the time for the pore pressures beneath the water table to reach equilibrium is very much longer.

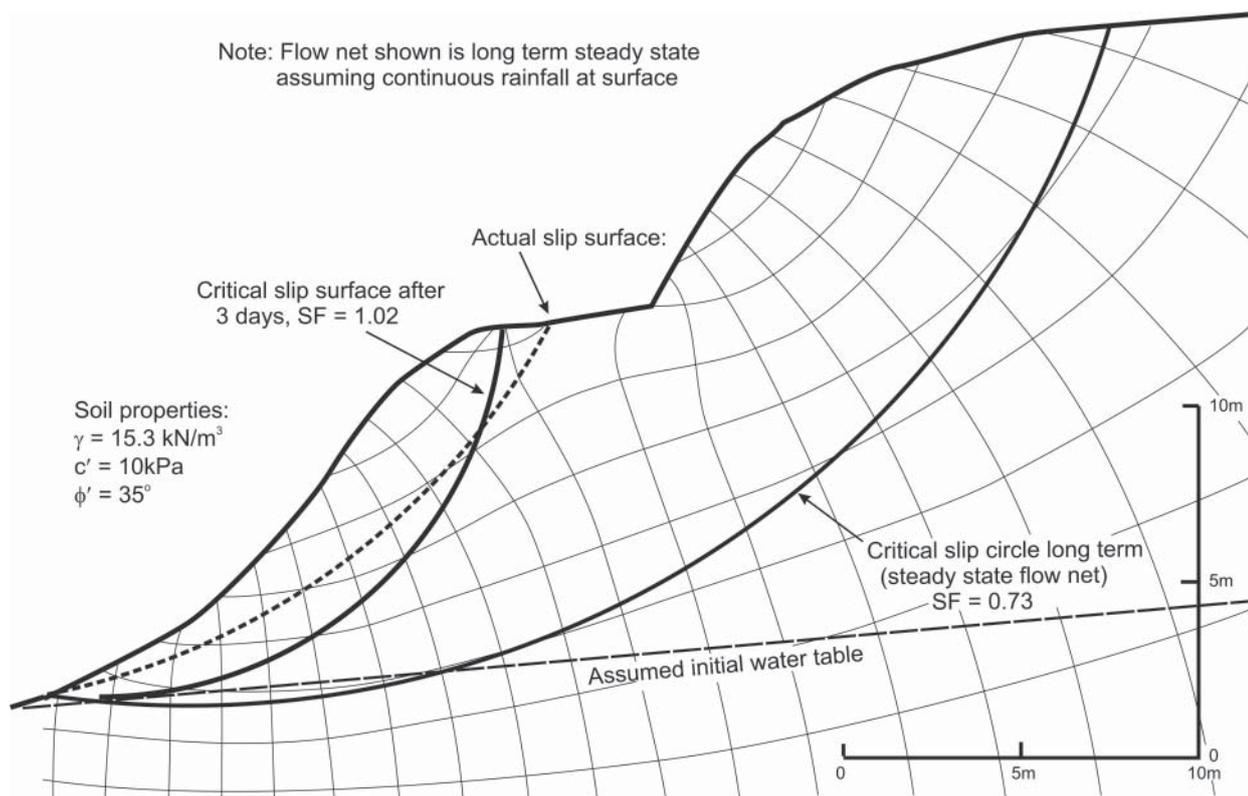


Figure 6. Slope cross section with flow net and failure surfaces.

As users of these programmes will know, SLOPE/W can carry out its stability analysis using the flow patterns determined from SEEP/W. This is a very convenient feature of the programmes made use of here. Safety factors were calculated at time steps of 1 to 4, then 6, 10 and 20. The steady decrease in the safety factor with time is illustrated in Figure 7.

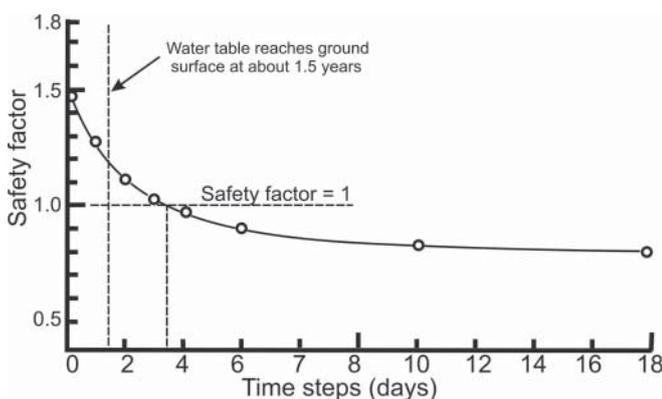


Figure 7. Decline in safety factor with time.

After 3 days the safety factor has decreased to unity; the corresponding critical circle is shown in Figure 6. If the rain continues to fall for 20 days (and the slope doesn't fail) then the steady state flow pattern would develop; the safety factor drops further to only 0.73 and the critical circle is in the new position in Figure 6. The critical circle

remains within the lower slope until day 4 when it moves to encompass the complete slope. It is seen that the critical circle at the time the safety factor falls to unity agrees surprisingly well with the actual failure surface.

It is possible, by trial and error, to determine a combination of parameters that give an even better fit to the actual failure surface. The combination is: $c' = 6 \text{ kPa}$, $\phi' = 35^\circ$, $r_u = 0.2$. The relatively shallow failure surface on the steepest part of the slope is indicative of a material in which the frictional component of shear strength is more influential than the cohesive component. An even better fit might be obtained by further reducing the c' value and increasing the ϕ' value. The time steps used in the analysis are rather arbitrary. It may be that the m_v parameter used was much too high. No one has measured m_v values in situ for any soil using the natural rise and fall of the pore pressure in the ground as the loading and unloading mechanism, so adopting a laboratory value may be a long way from the true value. Adjusting the parameters will alter the duration of the time steps but everything else will remain the same.

Discussion and Conclusion

The most interesting information to come from the study at Grange Road is the extreme sensitivity of some of the layers, and the rapid changes in sensitivity with depth. The presence of these sensitive layers is clearly the most significant property of the rhyolitic ashes, but the extent

continued on page 75 >

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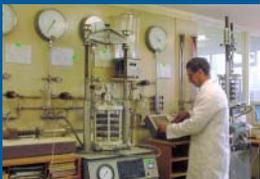
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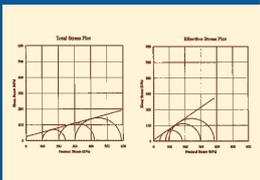
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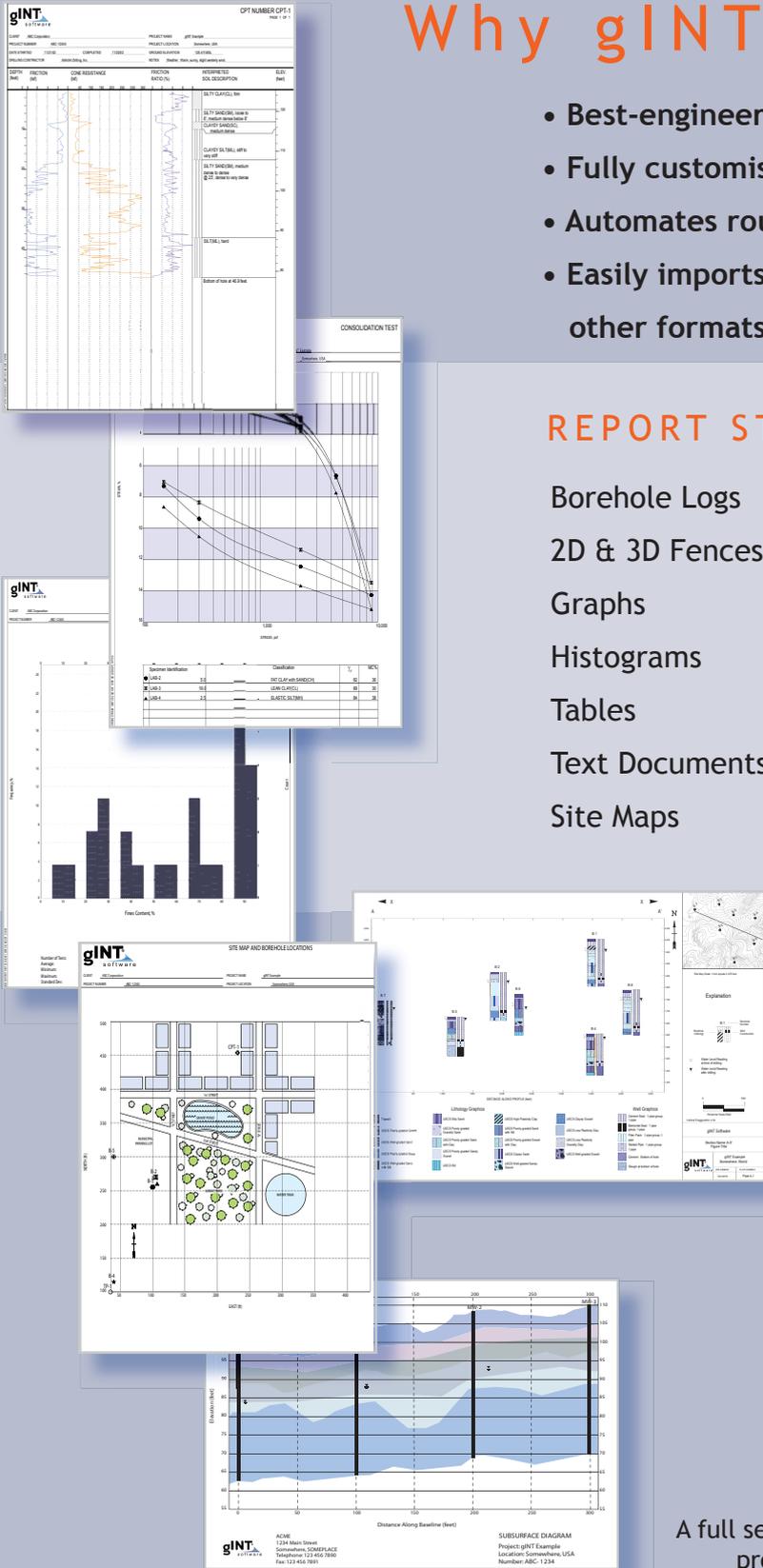
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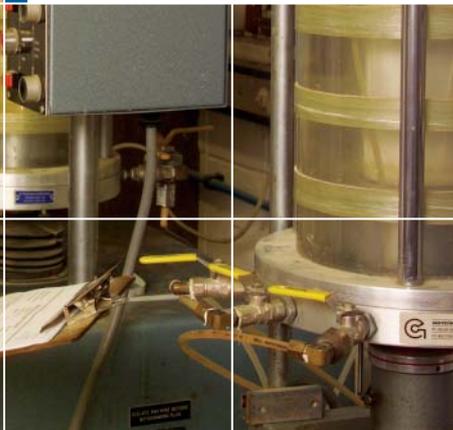
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to which sensitivity influences slope stability is not at all well understood. It is undoubtedly true that it strongly influences post failure behaviour. One of the reasons the slips in the May 2005 storm travelled as far as they did was the high sensitivity of the soil. The other reason was the abundant supply of water to further soften the soil after failure and lubricate the failure surface. The extent to which sensitivity influences pre-failure behaviour is problematical. It is certainly not the case that sensitive soils lose strength because they become wet. Neither is it the case that these soils liquefy and this causes the failure. Like any other soil, sensitive soils lose strength as pore pressures rise within them, eventually to the point of causing failure, and then liquefy as shearing continues. Their dramatic loss of strength occurs after failure.

Sensitive soils do not all behave in a similar manner. Their behaviour depends both on their sensitivity and on the ease with which they are remoulded. Some sensitive soils require very little energy to completely remould them while others require a lot of effort (or energy) to reduce their strength to its fully remoulded value. Not enough careful laboratory testing has been done on highly sensitive soils. This is probably partly due to the difficulty of obtaining good quality undisturbed samples, but also because relevant testing would require stress controlled triaxial equipment capable of measuring loads and pore pressures at low stress levels. The average confining pressure on the slip surface at Grange Road is probably about 20 to 30 kPa, so the measuring equipment would need to be accurate to about 0.1 kPa or 0.2 kPa. The most informative tests on the Tauranga rhyolitic ashes would probably be triaxial tests in which the sample is set up and subject to the effective stress state it exists under in the ground, and the pore pressure then slowly raised to induce failure. Such tests would be stress controlled tests rather than conventional strain controlled tests. Cyclic undrained triaxial tests would also be useful in evaluating their behaviour, especially their susceptibility to strength loss during earthquakes.

Apart from this sophisticated laboratory testing, it would be helpful to have a better understanding of the weathering process in these ashes. In particular the following questions arise from the situation at 198 Grange Road:

- (a) Are the brown ash layers identified here as paleosols derived from essentially the same parent material as the intervening pale coloured layers?
- (b) Why are the properties of these brown layers distinctly different from the pale coloured layers? Is it because exposure at their original surface results in a different weathering process, or does it simply accelerate the weathering so that these layers represent a more advanced stage of weathering?

Not too much should be read into the theoretical analysis above, but the following points should be noted:

- (1) The theoretical rate (based on parameters from laboratory tests) at which pore pressures rise in slopes is generally much slower than that indicated by storm events like that of May 2005, in Tauranga. As mentioned above, the coefficient of permeability used in the analysis was far higher than that obtained from laboratory measurements, but still indicated a relatively slow response time for the pore pressure state. It is also possible that the true m_v value of the soil may be much lower than that used here.
- (2) It is likely that the actual seepage and pore pressure state in the slope may not bear much resemblance to that indicated by theoretical analysis. The theoretical analysis here assumes uniform soil properties, which is clearly not the case. The presence of fissures and discontinuities further complicates the picture and these may be the predominant channels by which the pore pressure rises in the slope.

As for practical relevance, the conclusion to be drawn from the above investigation is that the soil characteristic most likely to be an indicator of the susceptibility of a slope to failure would be the presence of highly sensitive layers dipping in a direction favourable to slip movement. This is probably not saying anything more than is already known by those familiar with the Tauranga situation. However, exactly how these sensitive layers should be taken into account in assessing slope stability is not clear. At an analytical level, my observation would be that if a safety factor of 1.5 is considered acceptable for a non sensitive soil, then a safety factor of 1.7 or 1.8 would be appropriate for a highly sensitive soil. This is not entirely an arbitrary judgement. My understanding is that there are always overstressed zones within a slope if the safety factor is less than about 1.7. In other words, some yield occurs, but does not normally lead to failure. With highly sensitive soils this internal yielding may be more serious, and lead to loss of strength and possibly failure. Using a higher safety factor would minimise this possibility.

Acknowledgement

I want to express my thanks to the following: Firstly, Tauranga City Council for their invitation to be involved in the aftermath of the May 2005 storm. Secondly, a number of people from the geotechnical fraternity in Tauranga for their observations and assistance, in particular I want to thank David Milner, Sally Hargraves, and Marriane O'Halloran. Finally, I want to thank Mr and Mrs French, the owners of the property at Grange Road for allowing me access to their property.

Aspects for consideration in the design of soil structures reinforced with inclusions

Andy O'Sullivan, Engineering Manager, Hiway Stabilizers Environmental Ltd, Grant Murray – Geotechnical Section Manager, Sinclair Knight Merz

Introduction

The approach adopted in current design codes for MSE structures, or any structures reinforced by inclusions including soil nail walls, is essentially to carry out an overall static equilibrium analysis of the slope assuming the reinforced block is a stable mass. Provided global stability outside the reinforced block of soil is satisfied the designer is then only required to determine the strength and spacing of individual reinforcing elements within the soil block to resist internal failure.

It is the opinion of the authors that this approach is often inefficient and fails to incorporate the combined group effects which these reinforcing elements, or inclusions, have on the stability of the soil block. Also, in most cases, the approach does not adequately account for the mechanical properties of the individual inclusions that contribute to the behaviour and stability of the combined system.

The authors believe that appropriately calibrated Finite Element (FE) analysis of soil structures reinforced with inclusions offers significant advantages to the designer when it comes to understanding the effects of the multiple mechanisms and material characteristics involved in contributing to the stability of these systems. This article is based on presentations by the authors to the NZGS Auckland Branch Meeting in September and, using a simple case study example, attempts to introduce some of the concepts discussed to the wider NZGS audience.

Case History

Figure 1 shows the site of a common shoulder “drop-out” failure following a severe storm event during the winter of 2006.

Aside from the obvious catastrophic movement on the face, detailed site inspection identified two pre-existing longitudinal cracks in the carriageway indicative of additional slip mechanisms. The investigation concluded that the sidling cut/fill embankment had a marginal factor of safety ($F_s \geq 1.0$) and the extreme rainfall event caused the face failure.

The solution considered for the remediation of this failure was:

- Excavation of slump debris and softened soils on slope face.
- Reinforce exposed soils with launched soil nails.
- Re-construct the shoulder and slope face with a geosynthetically reinforced structure.



Figure 1.

Theory

Launched soil nails (LSN) are hollow steel rods, 40mm diameter and 6m long, which are fired into the ground using a high pressure air cannon. The nails are installed at close spacing, typically less than 1 per m^2 slope face.

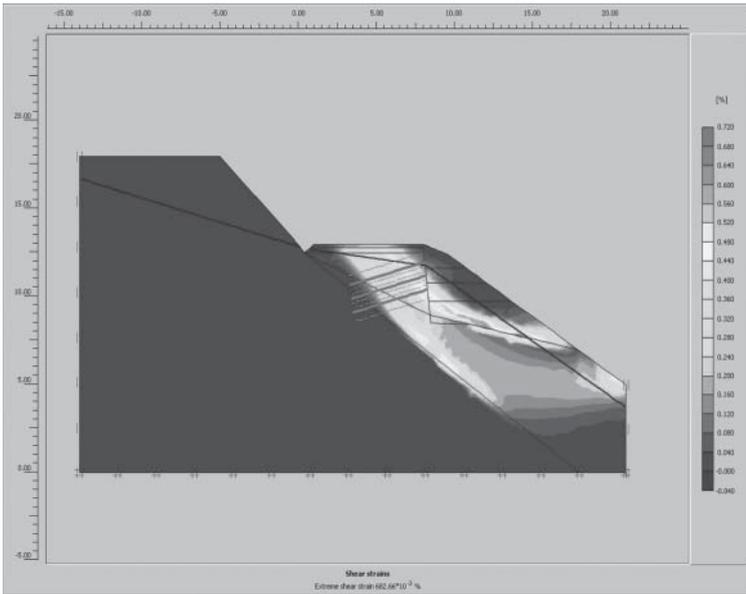
Launched soils nails can be used to support steep excavations in unstable cuts as long as the nails are installed concurrent with the excavation. In this case a near vertical face of 4m high was to be formed adjacent to the road carriageway in order to re-construct the road shoulder with a GRS buttress.

Conventional limit equilibrium analysis software used to assess the stability of this excavation incorporating the LSN's as temporary supports generates an unacceptably low $F_s = 0.7$.

The main reason for this low Factor of Safety is that the analytical procedure in the software only allows for the additional stabilising force generated beyond a critical slip surface by the assumed mobilised bond strength between the nails and the surrounding soil mass. This is often referred to as the “Pull-Out” capacity. Whilst this analysis approach is consistent with most design guidelines for soil structures of this nature, it is fundamentally flawed since it ignores other stabilising contributions to the soil mass from the inclusions such as shear and bending.

Analysis

If the problem is examined using a FE-based analysis to model the excavation the proposed methodology does work. One of the most important and useful aspects of a FE analysis is that the problem can be modelled



through a series of stages that represent the development of the site. The software tools permit the experienced user to back analyse the original slope and simulate the observed failure. Having developed a failure mechanism in the model that appears to represent the site, remedial stabilising measures can be introduced to the model and the relative effects or benefits can be observed.

Figure 2 shows the back analysis of the slope and the output clearly shows the development of shear bands or slip mechanisms propagating through the section that are coincident with the tension cracks on the road surface. As discussed above, the design philosophy for this site was to remove and replace the catastrophically failed material on the slope face with a GRS buttress

Figure 2.

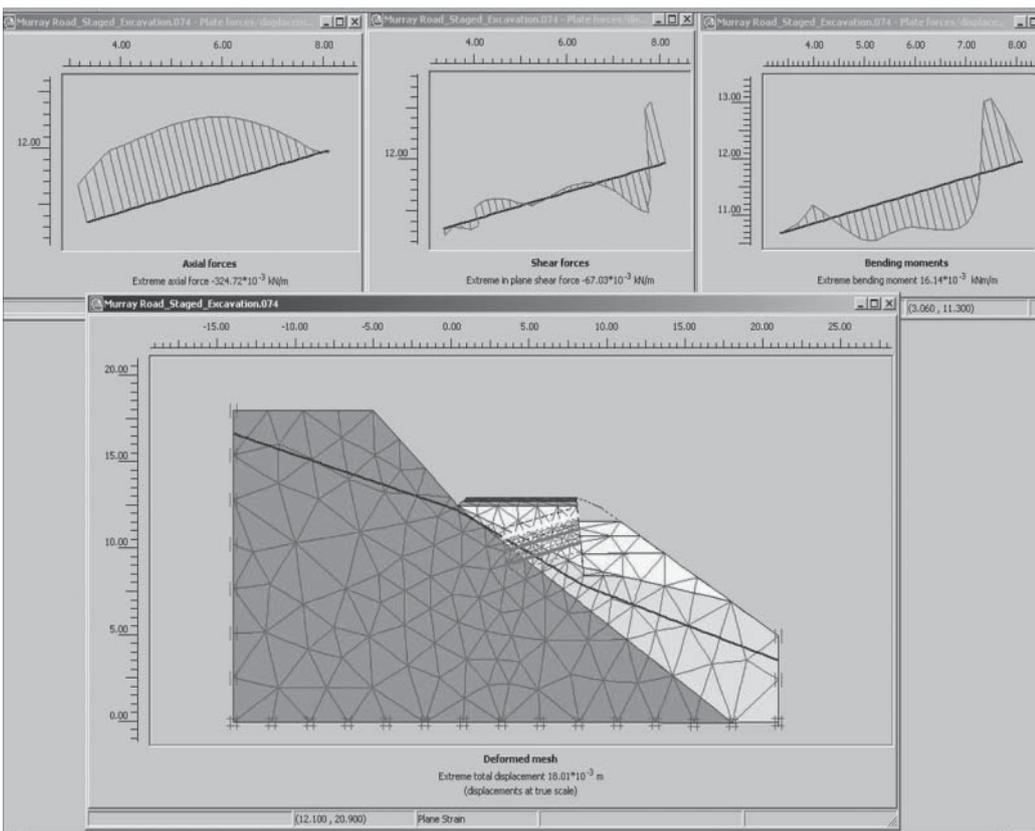


Figure 3.

but in order to construct this safely these shear bands also have to be stabilised. This process is modelled in Figures 3-7.

Figure 3 shows the first stage of excavation and three plots of the axial, shear and bending moment forces on the soil elements that represent an imaginary

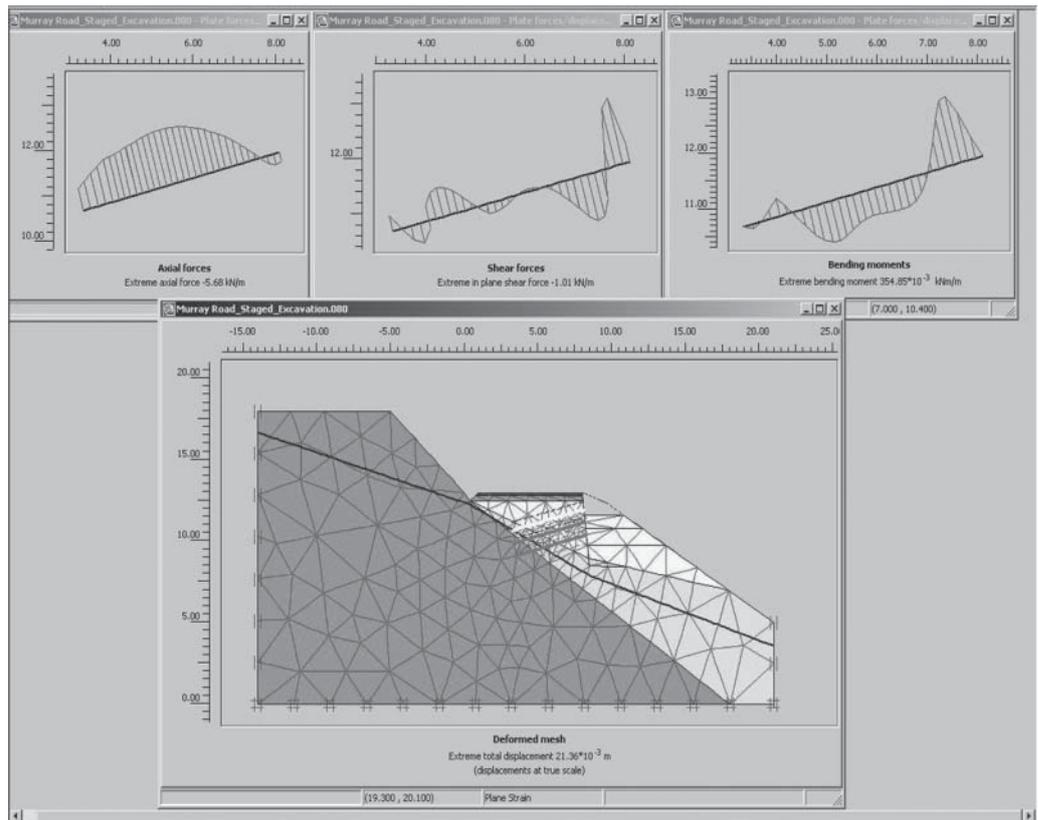


Figure 4.

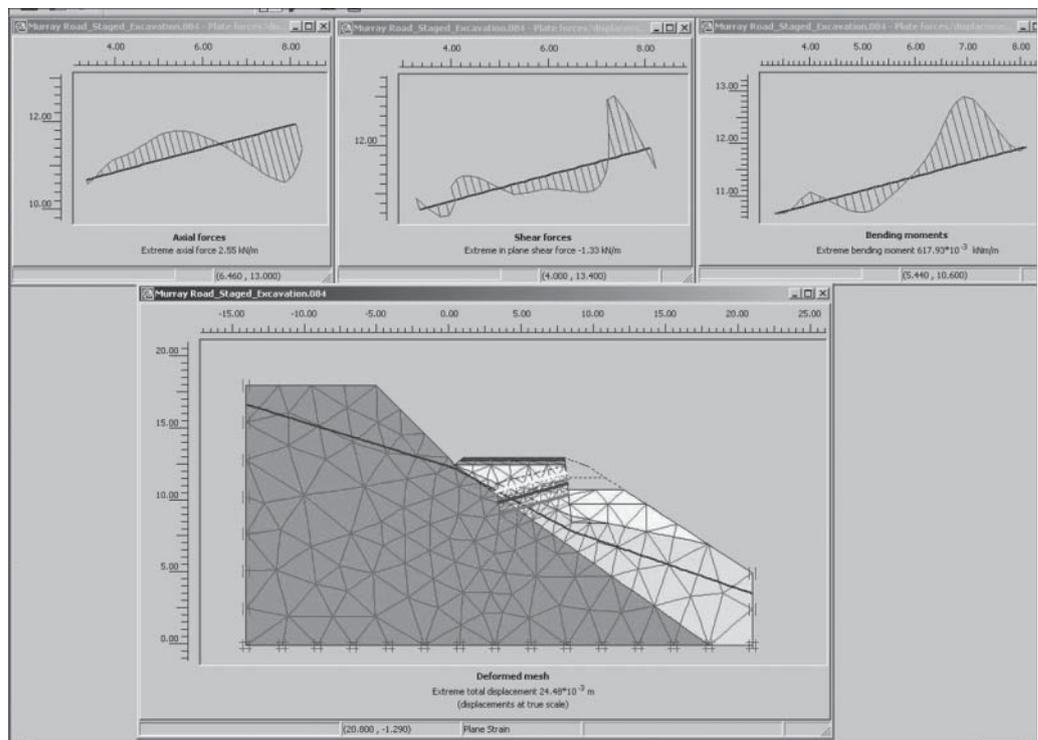


Figure 5.

plate where the top soil nail will be installed. Since the nail has not been installed at this stage of the analysis this “plate” has no structural properties and the most important aspect to note is the apparent shear stress across the “plate” close to the face of the excavation and coincident with the shear band identified in the original

back analysed slope (Figure 2).

Figures 4, 5, 6, & 7 show the effects of subsequent stages in the construction process. Figure 4 represents the installation of the first row of nails and the establishment of “structural” properties for the plate. Figures 5, 6, & 7 represent the installation of the second and third row of

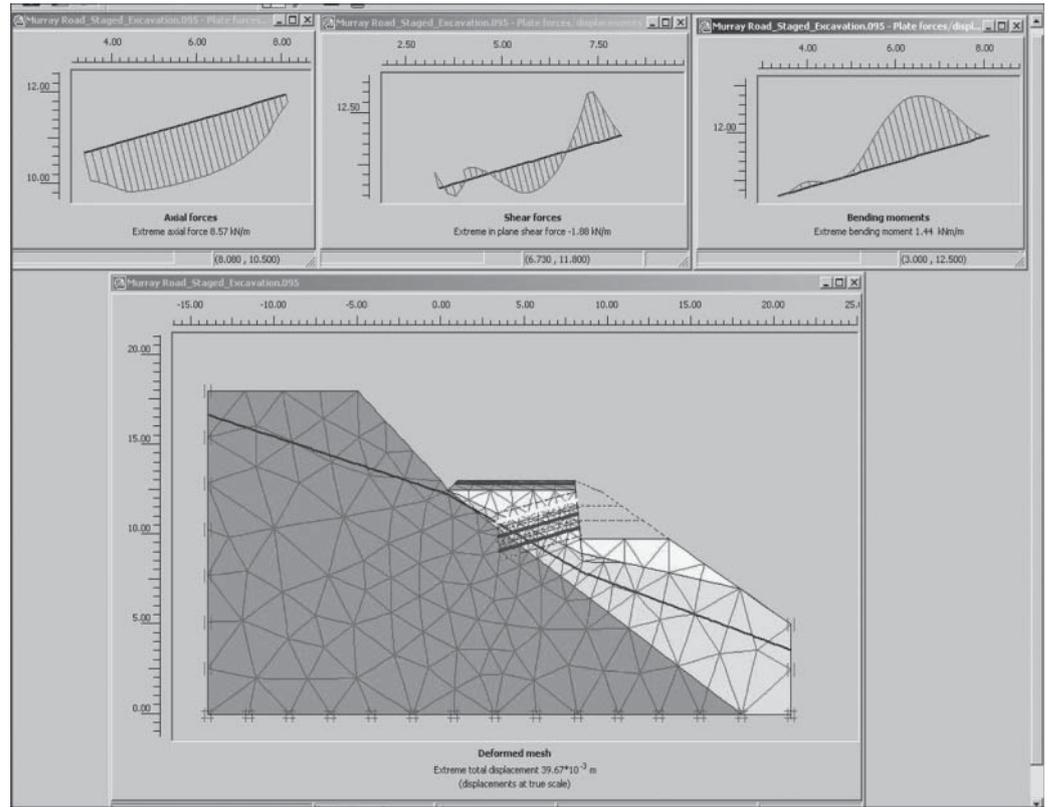


Figure 6.

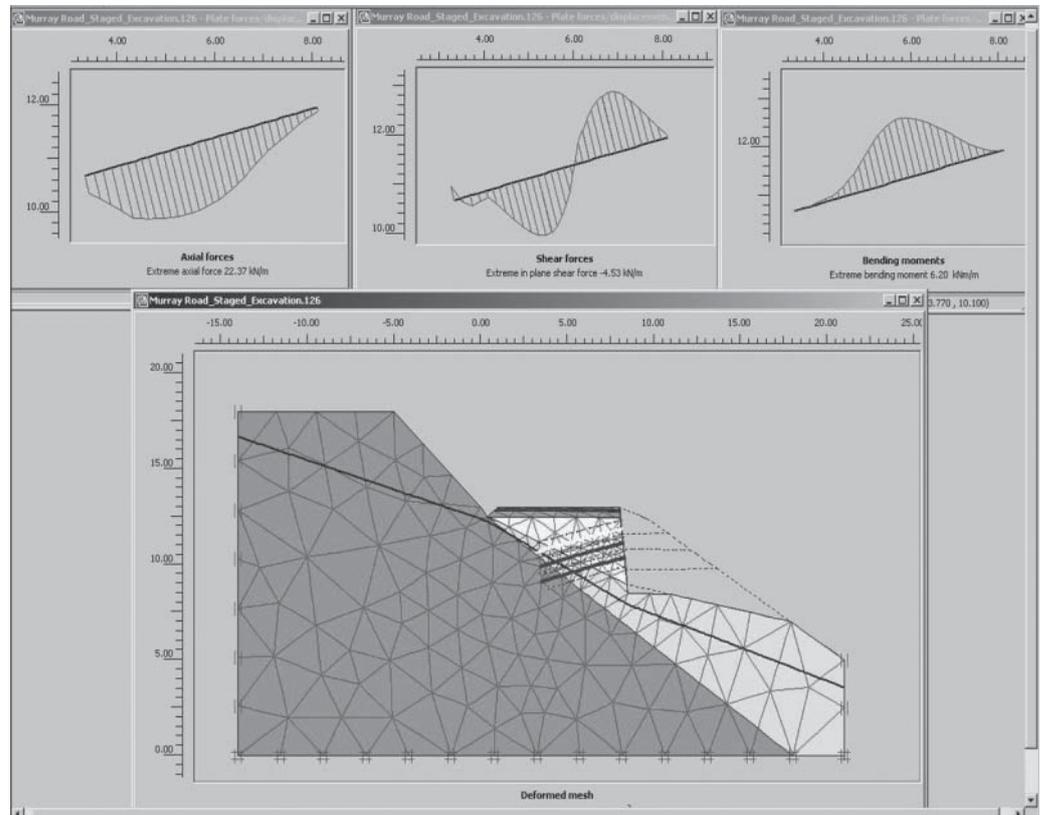


Figure 7.

nails and the excavation to final formation level for the GRS buttress.

The authors believe that at each of these key intermediate stages the three plots of axial, shear and bending moment provide a graphical representation of how the top row

of nails could be acting to re-distribute the soil stresses and help maintain stability. The FE analysis suggests that the Factor of Safety on strength for the final stage of the temporary excavation is greater than 1.2. The construction and completed works are shown on Figures 8 & 9. Since



Figure 8.

the works were implemented safely the authors are of the opinion that this result is probably more reasonable than $F_s = 0.7$ predicted by the limit equilibrium approach.

Reliability?

The authors would be the first to admit that there maybe some flaws, inaccuracies and uncertainty in the “design” approach being advocated. To be seriously considered as a sensible and pragmatic approach, the FE design philosophy and process has to consistently deliver results that match actual physical conditions and experience. The design process has to be repeatable, and it has to be recognised that given the complexity of the tools we probably still have a lot to learn before any two analysts using them will consistently replicate their respective results.

Particular issues we have tried to grapple with include justification of a two dimensional plane strain analysis for a problem that is essentially 3-D in nature. The inclusions or soil reinforcement are discrete nails installed at a spacing of 20-30 times the diameter and the software model treats them as an equivalent structural plate!

Another concern is how to ensure or verify that the predicted results obtained from the models with respect to the load take-up in the nails is realistic?

An answer to both these questions that shows some promise lies in an exercise recently undertaken to compare output from FE models with the results obtained from an instrumented centrifuge test carried out by the University of Hong Kong in 2006 (Zhou et al 2006).

The summary of comparative results is presented in Figure 10 and show a surprisingly good correlation. It



Figure 9.

is interesting to note that within acceptable margins of error the predictions of axial load mobilised along the soil nails in both 2-D and 3-D models is remarkably similar suggesting that the analytical assumptions within the simpler and quicker 2-D models might be reasonable.

In undertaking this comparative analysis the authors have also tried to test the assumption that “pull-out” capacity is an important design / performance criteria. The summary results also show the impact of introducing into the computer model a friction limiting factor to the nail / soil interface elements. The analysis shows that even factoring the ability of the soil to transfer axial load to the nails by 0.5 made little impact on the theoretically mobilised capacity. In both cases the comparison with

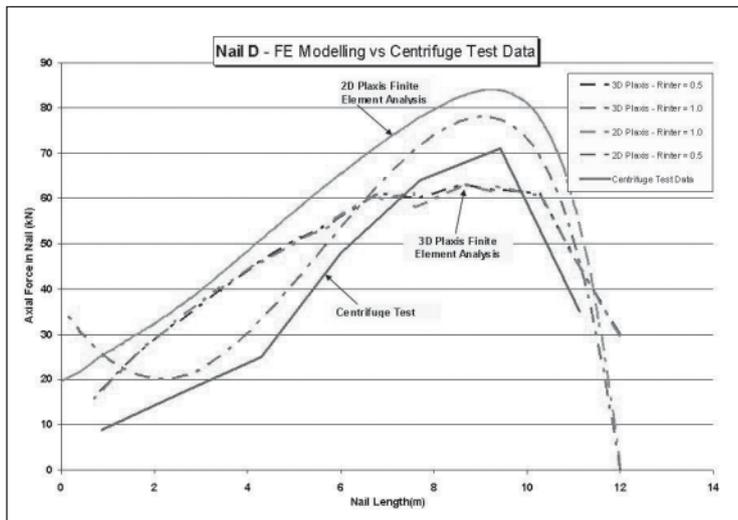


Figure 10.

actual mobilised capacity in the centrifuge test was reasonable.

This result would seem to support the intuitively correct assertion that these soil structures, reinforced with structural inclusions that modify the mechanical behaviour or characteristics of the system should not be treated in the same way as “anchored” structures where the inclusion is required to perform a specific action.

Conclusions and Discussion Points

- Conventional Limit Equilibrium analysis of soil nail systems does not allow for the stabilising contribution of all the inclusions physical attributes or the aggregate of group effects.
- FE analysis offers the designer a better opportunity of understanding the interaction of complex mechanisms in these systems.
- A simple design and construct case study has been presented of a road stabilisation project that was

successfully completed that might not have been attempted relying on a routine or conventional design approach.

- There is sufficient practical and theoretical experience and expertise available to generate some confidence in the sorts of innovative solutions and design approach advocated.
- However, significantly more work is required on checking and validating the analytical theory.
- The authors believe this can be achieved through centrifuge testing, full scale instrumented field trials and verifiable FE modelling.

Reference

Zhou, R.Z.B., Ng, C.W.W., Zhang, M., Pun, W.K., Shiu, Y.K., Chang, G.W.K. (2006). *The effects of soil nails in a dense steep slope subjected to rising groundwater. Physical Modelling in Geotechnics – 6th ICPMG 2006.*



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1. "Compaction trial" **Jacqui Coleman** – Beca Infrastructure. 2. "Drilling company leads the way with speed to discover pot of gold" **Paul Currie** - Boart Longyear (NZ) Ltd. 3. "Best in the dirt" **Paul Currie** - Boart Longyear (NZ) Ltd. 4. "Maybe if I lean against this 'vertical' borehole the boss won't realise that I'm drunk" **Mason Reed** - Fraser Thomas Ltd. 5. Just another Northland slip..." **Harry Follas** - Opus International Consultants Ltd. 6. "Murphy's Law: Rule 13 – You will strike the only conduit within a 1km radius severing all four cables" **Mason Reed** - Fraser Thomas Ltd. 7. "Now where is that Pesky U-boat hiding?" **Jaime Bevin** - Arup Consulting Engineers. Ireland

FOREIGN CORRESPONDENT

Kirsti Murahidy
San Francisco, USA

Kirsti Murahidy
Senior Staff Engineer
Treadwell and Rollo Inc



Above: more skiing – Mt Bachelor in Oregon

Most Kiwis sometime in their careers will look to stretch their wings and head for a spell in the UK or across the ditch to Oz. I'd spent quite a bit of my childhood overseas so I hadn't originally planned on doing an OE. My husband and I had moved to Auckland from Christchurch straight after graduation from Canterbury and after three years in the City of Sails we were pretty well settled – good jobs, great flat and a lifestyle that saw us bouncing about the country during the weekends. But then the opportunity to work in San Francisco came our way and it was something that we had to jump at. We knew it would be a huge leap heading overseas. The sense of adventure and anticipation of what lay ahead was overwhelming at times. But it's been worth it.

San Francisco is an amazing city. It's one of those places in the world which is distinguished by the notion that everyone is from somewhere else. And with almost seven million people living in the Bay Area, you'd expect some outsiders. It is a beautiful city. Almost every block is different. It has taken us some time to get used to that.

Our introduction to the City was probably not what the average tourist would experience. Most international visitors are likely to check into one of the major hotels close to Union Square or in the Financial District. Not us. We somehow managed to book ourselves into a hostel bang smack in the middle of the dodgiest part of San Francisco – a quarter know as the Tenderloin. It's a pretty rough couple of blocks but we were told that if you aren't looking for trouble (read out late at night) it won't come looking for you.

Within days of arriving in the city, I had done the usual interview circuit of a new arrival and I was fortunate

to land a job with one of the major Environmental and Geotechnical Engineering firms servicing the Bay Area, Treadwell and Rollo (T&R). Unfortunately, there were problems securing what is called 'Employment Authorization'. So, even though I had a job offer, I had to wait for the okay from the Department of Homeland Security. It sounds bad – off to a foreign country and put in a holding pattern while the paperwork gets done - but in a way, I was lucky. I'd heard horror stories of people waiting almost half a year for this essential piece of plastic to turn up in the mail.

My card turned up around New Year so I was only in a holding pattern for about two months. And it was great. With an enforced holiday, I put on my running shoes and explored our new home. My husband, Alex, was able to start working straight away at the office of Holmes Culley (a subsidiary of Holmes Consulting Group (NZ)). With Alex out working, it was my job to find us a home. This wasn't as simple as it sounds. San Francisco is going through a period of change here. In stark contrast to the housing boom in NZ, prices for houses in the Bay Area have been falling. A lot of people have been stung by interest rates and low rate development schemes; foreclosures are at a historical high. There has been a huge shift away from home ownership with many people resorting to rental accommodation. Of course, that pushes up demand. And here we were – new arrivals looking to find a place to sleep competing with locals. It was a bit of work but eventually we found a place right in the heart of town.

So, come the New Year, I eventually got to start work. Treadwell & Rollo has about 100 staff who are based in five offices scattered about the San Francisco

Bay Area, Sacramento and in Montana. Being in a highly seismic area (called Zone 4 and similar to Wellington), the company does a lot of earthquake engineering work. In the Geotechnical Group, projects range from single storey buildings to high-rise office towers. The Group also works on major infrastructure projects such as port development, road, rail and transit systems and in urban development. Being based in the most litigious state in the whole of the US many of our senior staff are called upon to give expert testimony.

The projects I'm involved with are similar to the projects I was working with Tonkin & Taylor in New Zealand. There are, of course, the usual geotechnical investigations for houses and multi-story buildings. I've performed investigations and preliminary studies for a bridge and a hospital and managed projects through construction which included installation of both conventional shallow foundations and deep foundations such as torque down piles for a multi-story family housing development, installation of shoring systems and preparation of pavement subgrades. I've also worked on a number of litigation cases for projects in Hawaii, New Mexico and California. These cases, where T&R is providing expert witness services, have involved landslides, settlement and subgrade failure issues.

One of the most interesting projects I have been involved in is the restoration of tidal wetlands in Redwood City, on the San Francisco Peninsula. Redwood Shores is a 110 acre section of privately owned land which, in the late 1800's, was a high tidal marsh. The land was drained and used for farmland and salt production. Currently, only a small area of the project site contains wetlands and this area has degraded from its original state. The plans include restoring approximately 90% of the property to a tidal wetland, constructing a school and using the remaining 9 acres for residential development. A new levee system is planned to protect the school and housing development. The construction of the levee system presents some geotechnical challenges- up to 18 metres of soft compressible clay locally referred to as Bay Mud underlie the site. This material has SPT-N blow counts of 0, and 0 psi gauge readings when pushing Shelby tubes!

Earlier this year, I assisted in the geotechnical investigation for a new acute-care hospital on the campus of the San Francisco General Hospital. The proposed hospital, which has a basement floor plan area of 7,000 square metres, will be about 30 metres high and incorporate a base isolation system at the foundation level. It required a detailed field investigation, including insitu testing of the soil and bedrock, laboratory testing, and engineering analyses to meet the requirements of the California Geological Survey and the Office of Statewide Health

Planning and Development (OSHPD).

Yep, there's plenty going on here in SF. Despite a looming housing crisis, condominiums still keep going up so the outlook appears to be good for people involved in engineering and construction. However, just as NZ, it is a struggle getting enough people into the industry. Everyone here knows that the situation is unsustainable and many organizations, like the American Society of Civil Engineering and the Structural Engineering Association of California are doing what they can to try and correct the imbalance.

So, the work is great but our lifestyle is pretty good too. Living here is pricy but when you get past turning everything you pay for into NZ dollars (which lasts about a month), it isn't too bad. We never imagined that we could live in America without a car but it's been surprisingly easy. The public transport system here in San Francisco is excellent, despite what the locals trumpet. By living in the middle of the city we are within walking distance of our offices so there's no commute. The big car rental companies are all nearby and we're part of one of the car sharing schemes set up for city dwellers which means we can get around in anything from a brand new Mini to a van.

We've managed to escape the City every second or third weekend – you have to because there's not a lot of green in the middle of town and Kiwis need green. Many of my colleagues are amazed at the territory we have covered in the short time we have been here. I guess if you intend to live permanently in a particular country you always expect that at some time you'll get around to seeing the places everybody talks about. The distances here are vast and occasionally a little deceptive with everything in miles rather than kilometres. Still, we've visited nine of the western states, touched the north and south borders and even zipped over into Canada for a spell. Christmas in the Grand Canyon will be looked back on fondly and gems like Yellowstone, the Grand Tetons, the Rocky Mountains and Yosemite will never be forgotten. They are all simply amazing and everybody should see them.

Our plans from here? Well, with a few more years left on our work visas and only 43 states left to cover and you can bet we're going to do our best to knock over most of them. There is just so much to do and see. Working here in San Francisco has been life changing. It has meant we have been able to explore this huge country and get to know the United States and its people close up.

MEMBER PROFILES



Warwick Prebble

Occupation

Engineering Geologist
Senior Lecturer, The University of Auckland

The beginning – getting hooked on Geology

My passion for the outdoors was nurtured from an early age. The mountains and coastlines of Wellington were a daily inspiration. Growing up in Eastbourne provided the ideal environment for outdoor pursuits and a wonderful base for frequent expeditions into the wilderness. I quickly developed an affinity for the Rimutakas, Tararuas and as far north as the Kaimanawas and Tongariro. Little did I realise then just how much those volcanoes and mountains would challenge me in later years.

Family holidays to the mainland added a rich mix of trans-alpine tramping and mountaineering amongst the valleys, peaks, passes and coastlines of that amazing region which is middle New Zealand. I am ever grateful to my parents who provided these exciting and memorable adventures.

Greywacke, granite, schist, andesite, cirques, crevasses, moraine, lava flows, lahars and many more names became a commonplace part of our language.

It is no surprise that I studied Geology at Victoria University, with the express desire to perpetuate the outdoor lifestyle as a career.

Formative years at VUW

My mentors and peers at Vic had a profound influence, giving another purpose to the adventures and another layer of understanding. As students we were guided and inspired by academics of exceptional intellect and international stature such as Harold Wellman. He and other inspirational teachers like Bob Clarke, John Bradley, Paul Vella and Ross Lauder gave us an amazing start and fantastic opportunities. I was one of a fortunate group of students who took part in VUW expeditions to Antarctica. My first journey to the ice free areas of the Trans Antarctic Mountains was as an undergraduate student and then as a graduate and expedition leader over two more successive summer field seasons. Our junior contribution to the cutting edge research of Harold Wellman and Alec Wilson was an exceptional scientific opportunity. It provided us all with a platform from which to launch our careers in the earth sciences. We returned with an unforgettable collection of memories of the pristine beauty and spectacular landscape of Victoria Land, lucky

to have been part of the exploration era of New Zealand's Antarctic history. As a lesson in teamwork it was excellent preparation for work as an engineering geologist.

Work experience on big projects

Tokaanu tunnel and power station provided practical experience like nothing else that I have worked on since. Those years with the Ministry of Works on the Tongariro Power Development, as part of the Geological Survey engineering geology section were an extremely valuable experience and amazing training. There were no courses in engineering geology in Australia or New Zealand when I graduated so I was sent to gain experience on the Snowy Mountains Scheme in the Great Dividing Ranges of eastern Australia. Here the discipline and knowledge of Dan Moye, David Stapledon and their many colleagues gave a wonderful blend of theory and practice. I went for 4 weeks and stayed for 6 months. It was invaluable preparation for the somewhat daunting tasks at Tongariro. The work I returned to there was challenging, diverse and very satisfying. It was perhaps the best possible training and set a trend of project-based work by the Geological Survey. I have enduring memories of tunnelling in hot swelling clay, investigation boreholes discharging as geysers, and disappearing foundations.

Turangi, the project town, afforded a superb location for outdoor pursuits. Many of us took full advantage of the chance to tramp, ski, hunt, angle and water-ski. Some of us even learned to fly and glide.

Big project work continued when I joined Beca Carter Hollings and Ferner as their first geologist. Those years in private sector consulting, based in Auckland, were a very valuable balance to the previous decade and brought a completely new collection of geological settings in NZ and SE Asia. I continued the connection with Beca and other consultants throughout the rest of my career.

The move into teaching and research

After 11 years of practical experience the strong desire to teach what I had learned from it was reinforced by a stint at Auckland Institute of Technology (now AUT) and Epsom Secondary Teachers College. A year later I was appointed to the Geology Department of The University of Auckland to introduce and develop courses



and research in engineering geology, a position I have held for the last 32 years. Arriving here with a BSc Honours degree, I quickly completed an MSc by thesis only and then a PhD. On top of a full time teaching programme and active research supervision, this was stimulating to say the least. In fact it was really enjoyable, rewarding and a critical phase of professional development. The time here at Auckland Uni. has been fantastic. I consider it a privilege to have assisted and guided so many talented young people and to help them establish a professional career path in the wider field of geotechnical endeavour. It has been constantly rewarding to bring geology and engineering students together and encourage them to work on problems of mutual interest. The courses in which they do that are the largest in their year groups in geology. A mixture of real case histories, professional field and lab tasks and a series of graduate mapping exercises have met with approval from employers and students alike.

The emphasis is on finding and identifying problems, asking the right questions, finding the weakest links and establishing a robust terrain model.

These courses dissolve the boundaries between departments, faculties and disciplines – as indeed they must for an effective geotechnical team approach. I believe a sound and comprehensive degree in geology is an essential platform for engineering geology. Courses in field geology are a vital part of the preparation. I would like to see them increased and strengthened.

Research with graduates and colleagues into volcanic

terrain, landslides, weak rock and toppling has been part of the on-going attraction of an academic position. No year is ever quite the same even with perpetuating courses and programmes. Different qualities and attributes are brought by the different students. Courses and projects evolve and students develop their knowledge and capabilities in different ways at different times. It is all immensely rewarding.

Opportunities and privileges in the Profession

An important and very satisfying aspect has been involvement with the profession through our NZ Geotechnical Society. We enjoy an excellent combination of related disciplines in our NZ and Australian societies, both of which foster the team approach. I have enjoyed excellent support from the NZGS. Active participation in the IAEG executive has been another privilege for which I am grateful. There is much to learn from the vast pool of international expertise and we have some different experiences to offer in return. There is always a lesson waiting for us in the wisdom of others. There will always be new messages in the fold of the land if we can but see them.

For me the 42 years of work in engineering geology and education has been a series of high points. There have been challenges for sure but when tackled they too yield their rewards. It has also been a time of fun, friendship and memorable occasions.



Lucy Coe

Occupation

Geotechnical Engineer
Beca Infrastructure Ltd, Auckland

How it all Started

After developing a strong interest in science and math at school I headed down to the University of Canterbury to study Civil Engineering. I graduated with a BE (Hons) Civil, a fairly broad engineering degree with several Geotechnical electives. I chose geotechnical engineering as it was both fascinating and technically challenging.

Working as a Geotechnical Engineer

After completing my degree I moved up to Auckland and joined Beca as a Geotechnical Engineer. Nearly five years on I am still learning and enjoying the large variety of projects, opportunities and challenges on offer.

I have worked on a number of large roading infrastructure projects and gained a wide range of experience and skills from scoping geotechnical investigations, field logging, geotechnical design to construction supervision. I have had the privilege of working in great multi-disciplinary and inter-company teams. The variety of work is more than I ever expected and every site has its own challenges.

Geotechnical Design

I have worked as part of the design team on several projects, developing skills and applying soil mechanics theory to real life situations. Types of design include slope stability for a causeway widening, retaining wall design, bridge foundations, abutment design, liquefaction analyses, static and seismic settlements and not to mention the FLAC analyses (using the DOS version) for a double sheet pile wharf extension.

Seeing what you have designed being built is very rewarding. A number of the design projects I have worked on have been Design Build Projects and I have had the opportunity to provide site supervision and to observe construction challenges. These contacts allow hands-on practical input from the beginning on construction methodologies and techniques.

Field Work – Getting Down and Dirty

My first field experience was trudging through very soft estuarine sediments to test the strength of soils underlying the Upper Harbour Causeway Widening in Auckland. Loosing a few gumboots, putting on waders and being rescued when stuck in the mud luckily did not put me off field work.

I had the opportunity to develop my logging skills

on the Tauranga Harbour Bridge Duplication Project including night shifts for the offshore barge drilling. Highlights included watching the sunrise over the harbour after a night of logging sand, more sand and if you were lucky some interbedded sand.

My most recent stint of field work and the most exotic place I have been is Yap, part of the Federated States of Micronesia. I agreed before I had googled the location, how could I say no! Four flights and several days later I arrived on Yap to try and find an excavator to undertake test pits.

The Northshore Busway

Over the last two years I have spent the majority of my time working on the Northshore Busway Project as part of the O~B~CW (Opus~Beca~Connell Wagner) MSQA team, with Fletcher Construction as the Contractor. My role included site construction supervision, design support (soil conditions and ground profiles are not always as expected), methodology review, contract administration, several hundred Contract Instructions and more pile inspections than I can remember.

Geotechnical highlights on this project include staged embankment construction with wick drains over a 20m thickness of marine sediments, MSE walls, soil nail walls, reinforced slopes, piled walls, the Northcote cut and cover tunnel, concrete bored bridge piles and raked bottom driven tube piles.

I have gained invaluable experience working on site including learning the importance of planning, people skills and listening to others. Unexpected problems do occur and usually conflict with construction time and money pressures. You quickly become aware that the way you approach a problem is often the key to finding a resolution. There have definitely been some stressful times, particularly when things could not be constructed using proposed methodologies or when defects are identified, however these are the times you learn the most and are rewarded when looking back following the adoption of a pragmatic solution.

What Now?

I have just started a design role on the New Lynn Rail Box as part of an alliance team (and struggling to sit at a computer all day after the freedom? of a site role but enjoying having my weekends free).

I am also on the organising committee for the Young Geotechnical Professionals Conference in Wellington next year and am working towards CPENG registration.

Thoughts

It is important to listen to other people but always think for yourself. Also, never be afraid to ask why if you don't understand something.

NEW ZEALAND GEOTECHNICAL SOCIETY INC. PUBLICATIONS 2007

Publication Name	List Price Members	List Price Non-Members
New Zealand Geomechanics Society Conferences: Proceedings of Technical Groups, Vol 22, Issue 1G <i>Geotechnical Issues in Land Development</i> Hamilton 1996	\$20	\$35
Proceedings of the New Zealand Geotechnical Society Symposium – <i>Roading Geotechnics 98</i> Auckland 1998	\$40	\$70
Proceedings of the New Zealand Geotechnical Society Symposium – <i>Engineering and Development in Hazardous Terrain</i> Christchurch 2001	\$50	\$70
Proceedings of the New Zealand Geotechnical Society Symposium – <i>Geotechnics on the Volcanic Edge</i> Tauranga 2003	\$50	\$70
Proceedings of the New Zealand Geotechnical Society Symposium – <i>Earthquakes and Urban Development</i> Nelson 2006	\$50	\$70
Australia – New Zealand Conferences on Geomechanics: <i>Proceedings of the 3rd Australia – NZ Conference on Geomechanics</i> Wellington, May 1980 (Vols 1, 2 & 3 per set)	\$10	\$30
<i>Proceedings of the 2nd Australia – NZ Young Geotechnical Professionals Conference</i> , Auckland, December 1995	\$25	\$40
<i>Proceedings of the 5th Australia – NZ Young Geotechnical Professionals Conference</i> , Rotorua, March 2002 (spiral bound reprint)	\$75	\$85
<i>Proceedings of the 6th Australia – NZ Conference on Geomechanics</i> Christchurch, February 1992	\$50	\$100
<i>Proceedings of the 9th Australia – NZ Conference</i> February 2004 – 'To the enz of the Earth'	\$150	\$200
Other Publications: NZ Geomechanics News Collection 1970–2003 Volumes 1–66 (CDRom)	\$25	\$40
<i>Shear Vane Guidelines</i>	\$15	\$20
<i>2005 Guideline for the Field Classification & Description of Soil & Rock</i>	\$25	\$50
<i>Stability of House Sites and Foundations – Advice to Prospective House and Section Owners</i>	\$1	\$1
Back Issues of NZ Geomechanics News	\$5	\$5

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Orders to: Imrana Azimullah, Management Secretary. Email: nzgs@paradise.net.nz

COMPANY PROFILE

GNS Science

GNS Science is New Zealand's Government-owned earth sciences organisation that has evolved primarily from the New Zealand Geological Survey and the Geophysics Division of DSIR, with a 130 year history of mapping New Zealand's hazards and resources. GNS Science has 320 staff based at three locations; Wairakei, Lower Hutt and Dunedin and is New Zealand's leading supplier of earth science research and consultancy services. Our multidisciplinary natural hazard research, combined with an extensive background of geology, engineering geology, geomorphology and geotechnical engineering, underpins our ability to provide geotechnical consultancy services, advice, peer review and research on engineering projects, particularly related to geological hazards and their impacts.

GNS Science undertakes projects overseas as well as throughout New Zealand. We are involved in a range of projects from geotechnical investigations for the proposed Transmission Gully route in Wellington, dam safety studies for Contact, Meridian and Mighty River power, and landslide monitoring for OnTrack, for example.

Investigations for dams

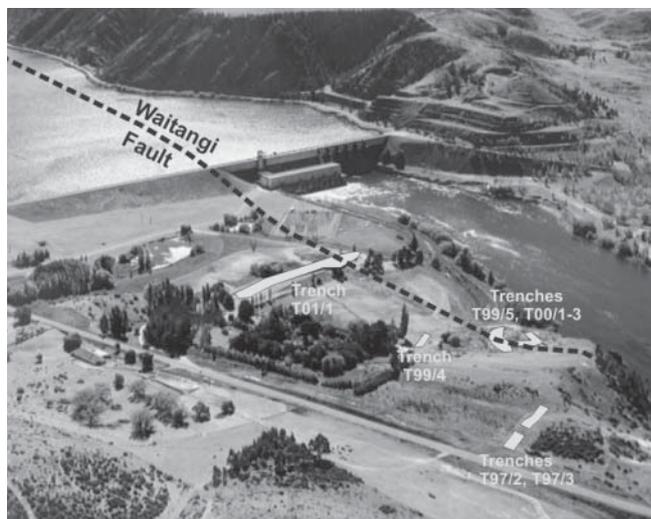
GNS Science and its predecessor organisations have been involved in most hydroelectric power schemes in New Zealand. GNS Science brings together geology, earthquake hazards (fault rupture and ground shaking), landslide hazards, and the properties of rock and soil materials to evaluate dam foundations and the risk from potential geological hazards. We have performed feasibility and safety evaluations of dam sites, provided engineering seismological input for dam design, carried out studies defining: surface rupture history of faults, including evaluation of fault displacement, characteristic shaking inputs for seismic stability assessment, landslide processes, and slope stability assessments for dams and reservoirs.

Aviemore Dam seismic safety evaluation, New Zealand

GNS Science contributed significantly to the assessment of seismic loads on dams in the Waitaki Valley. This involved a detailed assessment at Aviemore Dam including definition of the surface rupture history of faults, surface mapping, trenching, evaluation of fault displacement and characteristic shaking inputs to underpin the seismic stability assessment of the dam and its reservoir.

Monitoring New Zealand's Natural hazards

The New Zealand GeoNet Project provides real-time



Above: Aerial view of the Aviemore Dam, the approximate location of the Waitangi Fault and the investigation trenches

monitoring of landslide, earthquake, volcano and tsunami hazards in New Zealand, contributing to their detection, research and emergency response. It receives funding from the New Zealand Earthquake Commission (EQC) and is operated by GNS Science.

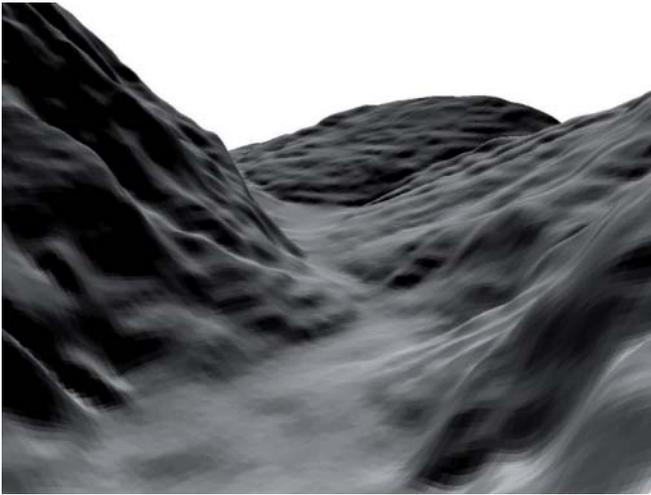
Landslides

GeoNet maintains a rapid response and monitoring capability for landslides in New Zealand. This incorporates:

- A national register of multi-agency landslide experts.
- A rapid response team, which can be mobilised within 24 hours of a major landslide.
- In the near future, web access to a catalogue of significant New Zealand landslides.
- Monitoring of major landslides.

Monitoring Landslide Movement and Triggering Factors in near-real time – Taihape

GNS Science is currently using a new technique to monitor a large landslide in Taihape. The deep-seated, slow-moving landslide covers approximately 45 hectares and contains over 200 households and a primary school. As a result of recent accelerated movement, GNS Science has installed a near real-time monitoring system on the landslide. The project has involved field mapping and sub-surface investigations as well as near real-time monitoring of surface movement, groundwater levels and rainfall within the landslide. A key component of the monitoring



Above left and right:
Before and after terrain
models of the Young River
valley and landslide dam

Left: The young river
landslide dam lake taken
from the automatic
camera installation