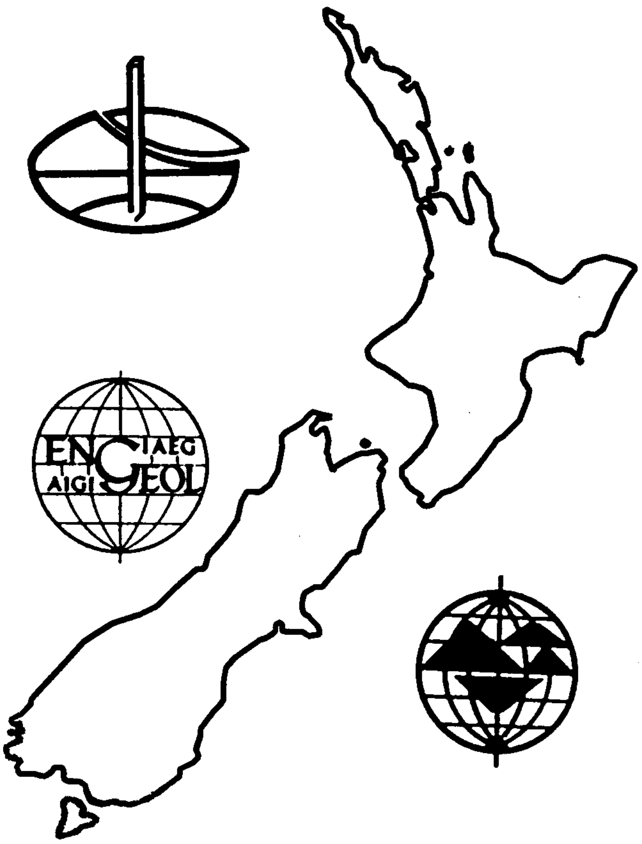
ISSN 0111-6851

# N.Z. GEOMECHANICS NEWS

## No. 52

## DECEMBER 1996




*A NEWSLETTER OF THE N.Z. GEOTECHNICAL SOCIETY*

# NZ GEOMECHANICS NEWS

## NO.52 DECEMBER 1996

## A NEWSLETTER OF THE NZ GEOTECHNICAL SOCIETY

## CONTENTS

## NOTES FOR CONTRIBUTORS

### EDITORIAL POLICY

*NZ Geomechanics News* is a newsletter for which we seek contributions of any sort for future editions. The following comments are offered to assist 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 the international journals and conferences
  - technical notes
  - comments on papers published in 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

Submission of text material in camera-ready format is not necessary. However, typed copy is encouraged particularly via e-mail (to the editor) or on floppy disk. Diagrams and tables should be of size and quality for direct reproduction. Photographs should be good contrast black and white gloss prints and of a suitable size for mounting to magazine format. *NZ Geomechanics News* is a magazine for Society members and papers are not necessarily refereed. Authors and other contributors must be responsible for the integrity of their material and for permission to publish.

Stephen Crawford
EDITOR

**THIS IS A REGISTERED PUBLICATION**

*NZ Geomechanics News* is a newsletter issued to members of the NZ Geotechnical Society. It is designed to keep members in touch with recent developments. Authors must be consulted before papers are cited in other publications.

Persons interested in applying for **membership of the Society** are invited to complete the application form at the back of the newsletter. The basic subscription rates are given on the information pages at the rear of this issue. These rates are supplemented according to which of the international societies, (namely Soil Mechanics, Rock Mechanics or Engineering Geology) the member wishes to be affiliated. Members of the Society are required to affiliate to at least one International Society.


**Editor:** SA Crawford
PO Box 5271
AUCKLAND

Phone: (09) 355 6000
Fax: (09) 307 0265
E-mail: sac@tontay.co.nz

**Sub-Editor:** J. Burr
PO Box 100253
North Shore Mail Centre
AUCKLAND
Phone: (09) 489 7872
Fax: (09) 489 7873

**Advertising:** A. Murashev
PO Box 3942
WELLINGTON
Tel: (04) 473 7551
Fax: (04) 473 7911
E-mail: TOM@beca.co.nz

**PRACTICE COLLEGE**

The establishment of a Practice College for geotechnical specialists was proposed at the Hamilton symposiumin February this year. No submissions have been received on this topic. The reported initial enthusiasmfor this proposal seems to have faded. Could it be too expensive ? - annual member fees are estimated at close to $1000 per year. Will it be too tough for many to gain entrance ? Will there be enough specialists to form this college? Should we consider an *Australasian* college, similar to some medical disciplines (e.g. the Royal Australasian College of Psychiatrists ? Colin discusses the topic a little further later in this issue.

**SOCIETY BRANCH MEETINGS / NINTH NZ GEOMECHANICS LECTURE**

The attendance at branch meetings around the country seems to vary . There have however been some interesting topics discussed (both technical and practical) as well as some respected speakers making their time available. The recent tour by Mick Pender to present the 9$^{th}$ Geomechanics Lecture was met with enthusiasm around the country with record attendances occuring at some centres. The paper for this lecture is presented in this issue along with the spoils from other meetings.

**7$^{TH}$ ANZ (ADELAIDE ) CONFERENCE**

Another sucess by all accounts. Reflections of the conference are presented along with the list of papers and NZ abstracts. The full proceedings at about 50mm thick can be purchased and make for excellent reading.

Four more conferences are to be held in Australia by the end of 2000. In particular, the GeoEng2000 Melbourne conference will bring together the three international societies, IAEG , ISRM & ISSMFE.

Steve Crawford
EDITOR

# GRIFFITHS DRILLING (NZ) LTD

MEMBER OF THE NEW ZEALAND
DRILLERS FEDERATION

## SPECIALISTS in GEOTECHNICAL & ENVIRONMENTAL DRILLING also WATER WELL,SEISMEC,PILING, & GROUND ANCHORS

The Company has been operating for many years with the guidance and experience of nearly 50 years, drilling on most NZ dam sites, marine drilling off barges and jack-up platforms, investigation drilling for commercial high-rises, motorways, bridges etc, and in this last decade a substantial amount of Environmental and Methane gas drilling.

With the increasing need for **Static Cone Penetration Testing** GRIFFITHS DRILLING (NZ) LTD is keeping up with the Civil Engineering needs in NEW ZEALAND.

**CONTACT: Melvyn or Gordon Griffiths**
**Mobile: 021 433 137 or 04 527 7346**
**PH/FAX 04 526 9943**

**PO Box 40 422 UPPER HUTT**

**GRIFFITHS DRILLING (NZ) LTD:** *Geotechnical, Ground Anchoring, Water Well Drilling, Contractors*

---

P.O. Box 40-422, Upper Hutt. Telephone (04) 526-9943 Office/Workshop (04) 527-7346

## WELCOME

Another successful year is essentially completed with the Society having held a symposium in February, the four yearly ANZ conference in Adelaide and Professor Pender presenting the ninth Geomechanics Lecture. Local branches have similarly been active with a variety of invited speakers covering a range of topical issues.

## FOUNDATION FOR RESEARCH SCIENCE AND TECHNOLOGY

It was pleasing to attend a Branch meeting where John Hawley presented the results of his research to develop a computer program for consolidation modelling. The model started its life as his PhD thesis some 25 years ago running on a colossal mainframe computer taking several days per run. It now resides on a laptop PC with a run time measured in seconds. The work was undertaken with the aid of research grant from The Foundation for Research Science and Technology.

The important aspect for Society members is that there is an independent source of finance for such research projects and it is not limited to just research organisations. Any members with a desire and a suitable project are encouraged to explore this avenue.

Similarly, FRST regularly requires reviewers to vet proposals. Members are encouraged to register with the Foundation to ensure that proposals for geotechnical research receive informed comment and review. Research in our field has been limited over the last few years with changing Government funding, but this opportunity needs to be pursued.

## MANAGEMENT COMMITTEE

The structure of the Management Committee has been in its current form for a significant period and it now seems appropriate to review its structure. A number of other technical committees are structured on somewhat different lines with members having two year terms and a more focussed approach.

Currently the committee has eight members and provides financial support to New Zealand International Society Vice Presidents and support to co-opted individuals. The major expenditure of the Society is the management meetings. The concept of practice colleges have also been raised recently and the roles of the Vice Chairman of the International Societies have lightened in recent years along with the secretariat work load.

In the light of these observations, I consider that it is appropriate to review the committee structure and its roles. I therefore welcome feedback from the membership on issues relating to the committee and its structure.

While I am advocating a review, I do not consider it appropriate that the primary function of the society as a "learned society" needs to change.

## IPENZ

Brabha attended the combined IPENZ Board and Technical Group Secretaries and Chairman's meeting at IPENZ in October on behalf of the Society. The meeting comprised an update of the activities from the Technical Groups represented, an update on the Institution Plan and discussions with National Office staff.

It was announced at the meeting that the Chief Executive had resigned and will complete his term at the annual conference.

The next IPENZ Conference is to be held in Wellington with the theme of "Engineering our Nations Future". At the conference, the Society will hold its AGM. I hope to see a good turn out of members at the AGM to be held at the IPENZ conference in early February 1997.

**ISSMFE AUSTRALIAN VICE PRESIDENT NOMINATION**

With the Australian Geomechanics Society hosting the *Geo2000 Conference* in Melbourne at the end of the millennium, it was considered appropriate that the Australians nominate one of their own members to fulfil this key role. The role will require considerable travel, marketing the conference to various overseas societies and groups to ensure its success.

The nominated successor to Max Ervin is Mark Randolph who will take up the role in September following the XIVth ISSMFE Conference to be held in Hamburg, Germany.

**THANKS TO JOHN EADE (IPENZ-NZGS LIAISON)**

It was recently announced that John Eade will be stepping down from his position at IPENZ. John has been an invaluable liasion person between the Society and IPENZ over the years and we take this opportunity to say a special thank you for your assistance. We wish you all the best with your future endeavours.

Colin Newton
NZGS CHAIRMAN

**STABILITY GUIDELINES**

A subcommittee of the Management Committee, chaired by myself, is working on preparing a draft of the guidelines. Progress is slow and the Management Committee is addressing ways of hastening the process. Any members with a strong interest in helping develop a set of guidelines for stability assessments in land development should contact me.

**NEW MEMBERS**

It is pleasing to report that 22 new members joined the Society since the last issue of Geomechanics News. They are :

| | | | |
|---|---|---|---|
| J Sickling | B Cameron | A McMenamin | A Ahmed-Zeki |
| D Rayudu | P Millington | D Coleman | N Al-Saoudi |
| A Sutherland | C Bauld | M Buckley | N Thomas |
| T Logan | T Adhikary | M Robertson | T Browne |
| N Logan | J Dennett | T Davies | L Cheenikal |
| G Jamieson | R Young | | |

**OVERDUE SUBSCRIPTIONS**

In the last issue it was pointed out that outstanding fees totalled $3,000 with half of this amount arising from the previous year. While most of this outstanding amount has been resolved, a significant amount has had to be written off.

Members are reminded that the Society rules provide for membership to be withdrawn when subscriptions are two years in arrears. Invoices for the new subscription year (October to September) will be sent shortly.

Please note that the Society honours your subscriptions for the International Society affiliations as selected by each member. This is often done in advance of receiving late subscriptions. Members are requested to advise the Society as early as possible if they wish to resign or are not intending to renew their subscriptions.

**1996 GEOMECHANICS AWARD**

The Geomechanics Award is awarded approximately every three years for the paper that best advances the objectives of the Society. The period considered for this award was 1 August 1992 to 31 July 1995.

The paper selected for the 1996 Geomechanics Award is :

"Ewen Bridge Replacement Foundation Construction" by Dr Graham Ramsey of Beca Carter Hollings & Ferner Ltd, Wellington.

It was presented at the 1995 IPENZ Annual Conference, and published in IPENZ Transactions, Vol 22, No.1/CE, Nov. 1995 and reprinted in Geomechanics News, No 49, June 1995. This paper also won IPENZ's 1994 Fulton Downer Award.

The award will be presented at the Society's AGM to be held at the 1997 IPENZ Annual Conference in Wellington, on 9 February 1997.

Geoffrey Farquhar
MANAGEMENT SECRETARY

## ISSMFE AUSTRALASIAN VICE-PRESIDENT VISITS NEW ZEALAND

The ISSMFE Vice-President for Australasia, Mr Max Ervin, attended our NZGS Management Committee Meeting on 3rd October 1996, and briefed us on developments in the ISSMFE front. An edited version of his report follows.

### *INTRODUCTION*

The Board of the ISSMFE met on 14 and 15 October, 1996 in Santiago, Chile. I am pleased to present a summary of the key issues discussed at that meeting, as my report on the recent activities of the Society.

### *MEMBERSHIP*

Membership of the Society is about 16,500 and is relatively static. The number of Member Societies now stands at 70, but with only 54 paid up to end of 1995 and 32 for 1996. New Member Societies are Azerbarjan and Kasahkstan.

### *COMMUNICATIONS*

- The ***Database of Geodatabases*** is now available at US$50 for members of ISSMFE, US$75 for others, through the Geotechnical Engineering - Information Resource Centre at AIT. Brochures available. Libraries are likely to have greatest interest. *(See article following this report - Ed.)*

- The proposal to develop a low cost ***Information Retrieval System*** appears unlikely to succeed, following a disappointing response from the Swedish Geotechnical Institute (SGI). Dick Parry and I met with them in May, to find a commitment to the Internet (but not at very low access cost) and little interest in CD Rom. When pursued, SGI agreed to CD Rom, but not at a sale price of less than US$700. I am to pursue further.

  This is an important opportunity to provide a strong international database which will be as good on a local or regional level as local groups want to make it.

- A ***Home Page*** on the Internet is to be established for ISSMFE. This should be up in its initial form by the end of 1996, but will be more fully developed by September 1997.

### *ISSMFE XIVTH INTERNATIONAL CONFERENCE, HAMBURG, SEPT. 6-12, 1997*

Two papers have been put forward to the conference from New Zealand. At least eight papers have been submitted from Australasia. However not all papers have been submitted yet.

### *INTERNATIONAL CONFERENCES ON ENVIRONMENTAL GEOTECHNICS (ICEG)*

The 3rd ICEG is to be held in Lisbon, Portugal, in September 1998.

### *GEO2000 CONFERENCE, MELBOURNE, 23-27 OCTOBER 2000*

A special conference jointly sponsored by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE), the International Society for Rock Mechanics (ISRM) and the International Association for Engineering Geology (IAEG) is planned to be held in Melbourne to mark the new century in the Year 2000.

### *OTHER NEWS*

***Education***: The Technical Committee chaired by Harry Poulos is to prepare what I am sure will be a comprehensive report for presentation at the Hamburg Conference.

- ***ISSMFE List of Members:*** To be updated ASAP. Needed by 31 January 1997, at latest. To be in electronic form for separate use by Secretariat. Balkema will publish in soft cover. Approx. 20% of membership to be revised for distribution.

- ***Name of Society:*** The proposal for name change of ISSMFE to "*International Society for Soil Mechanics and Geotechnical Engineering*" will be put to the council meeting in Hamburg in September 1997.

***Heritage Museum for Soil Mechanics:*** Idea supported. Possibly in Vienna.

- ***Secretariat*** Dick Parry to retire. Current Board to seek expressions of interest from Member Societies.

- ***ISSMFE President Nomination:*** Professor Harry Poulos was nominated for the position of ISSMFE President at the Santiago board meeting. This nomination is supported by the NZ Geotechnical Society Management. The vote for this position is to be held at the Hamburg meeting in September 1997.

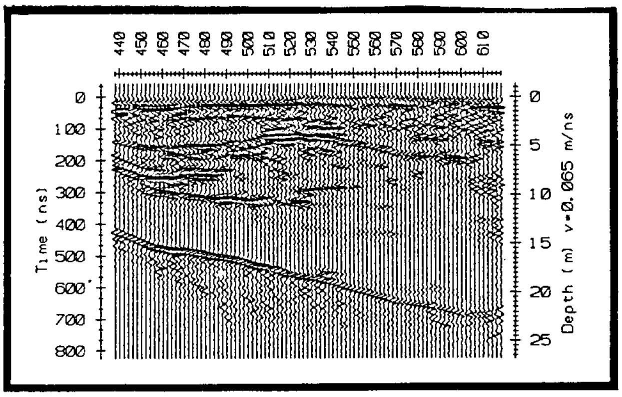
P Brabhaharan
VICE-CHAIRPERSON ISSMFE

S. Crawford
EDITOR

## **Do you know what's there before you dig ?**
## **Do you want to save money ?**

With the best intentions in the world and the records available there is still a **high risk in all subsurface work.**

The **use of Ground Radar removes** most of **these unknowns** and is a *cost effective* tool for eliminating disruptions and improving economics on the job. It allows you to know what you are dealing with before you start.




**Ground Radar** is fast, reliable, and proven technology with the ability to work up to 35 metres deep or more.

Applications include:

- **Quick location of Pipelines and Cables with improved certainty over other older methods.**
- **Detect Cavities from surface, no other remote sensing method will do this.**
- **Establish reasons for surface subsidence without expensive excavation.**
- **Non Destructive Road Pavement Surveys - Cover large areas and better understand subgrade and pavement structures without any digging.**
- **Know location of Buried Items, tanks before you excavate, thus improving safety when excavating**
- **Map deep structures, like buried channels, without having to drill holes (saves money and helps better target drillholes before you dig).**
- **Non destructive testing of roads, bridges and other structures. This lets you see pavement structure, rebar position without taking the structure to pieces.**

For a **free** presentation and no obligation discussions on how Ground Radar can serve your needs please call Grant Roberts or Matt Watson at Groundsearch on (9) 826 0700 or fax on (9) 826 0900 or complete and either fax or post the coupon below.

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

Please arrange to see me in the month of ____________ for a no obligation **FREE** briefing to show me how this new technology can benefit my business. ☐

Please contact me immediately regarding this new technology ☐

Name........................................ Company........................................

Address ........................................................................................

Phone ........................................ Fax ........................................

Groundsearch, Freepost 85446, PO Box 15-038 New Lynn Auckland.
Or Fax 9-826-0900 or Email to Radar@groundsearch.co.nz

The following is an edited report on the meetings of the Executive Committee and Council of the International Association of Engineering Geology, 3-4 August 1996, held in Beijing, at the 30th International Geological Congress.

**ADOPTION OF THE NEW BY-LAWS**

The new by-laws, which have been well circulated and discussed amongst the committees of our respective national groups (AGS and NZGS) were adopted without change. The important voting clause went in favour of 1 vote per country, by an overwhelming majority. This is in accord with the wishes of our region, and evidently nearly all other regions too. The new by-laws should appear in the newsletter of the IAEG.

**AWARDS**

The prestigious ***Hans Cloos medal,*** was awarded to ***Prof. Ricardo Oliveira*** of Portugal. Ricardo is a prominent engineering geologist, well known internationally (especially in Europe and Latin America) and a friend and colleague of many of us in Australasia. I am sure members will be delighted to learn of his successful nomination for the award, in competition with other strong contenders.

The ***Richard Wolters Prize*** for young achievers in the IAEG was awarded to ***Dr C.J. van Western*** of the Netherlands. Cees van Western, of the ITC, Enschede, Netherlands is known for his recent work on the application of geographic information systems to landslide hazards mapping and engineering geomorphology.

A very close decision separated Dr Van Western from Prof Huang Runqiu of the Chengdu Institute of Technology, China. His work has centred upon slope stability studies for large construction projects in areas of high slopes and has included numerical simulation of slope processes. So close were the votes for Dr van Western and Prof Huang Runqiu that a special certificate or "Honorary Mention" was formally presented to Prof Runqiu.

**AWARDS 1998: CALL FOR NOMINATIONS**

The ***Hans Cloos Medal*** and ***Richard Wolters Prize*** are awarded every two years. I urge national groups, through their various branches to start seeking nominations for these awards now. They will be presented at the IAEG Congress in Vancouver, 1998. (See announcements following this report).

**NEW NATIONAL GROUPS**

Nepal and Malaysia are two new national groups which were welcomed into the Association at our Council Meeting. I would like to pay tribute to the efforts of our previous Australasian Vice President, John Braybrooke, in help to bring about the formation of the Malaysian National Group. Yugoslavia, now representing a newly defined territory, was welcomed back as a national group.

**COMMISSIONS** (See IAEG Newsletter No.23)

- ***Waste Disposal (Commission No.14)*** From 1995 this commission was chaired by Michael Langer and was reported on in the Bulletin of the IAEG, No.51, April 1995 pp 5-29. (Criteria for site selection, characterisation and evaluation, including principles of safety assessment and special purpose mapping).

- ***Landslide and Other Mass Movements***: Under the chairmanship of Edmund Krauter (Germany; Vice President IAEG Europe) this commission is now making a feature of mapping and description of landslides, in co-operation with the commission on engineering geological mapping.

- ***Education***: This commission is to be chaired by Dr Michael de Freitas, Imperial College London.

  ***Fees***: It was agreed that there shall be no fees increase this year. The situation will be reviewed in June 1997.

- ***Aggregates:*** There is a proposal for a commission on aggregates, suggested by the Nordic countries and in co-operation with the UK. Anyone interested should contact Prof. Brian Hawkinis, IAEG Vice President for Europe.

## THE IAEG BULLETIN

The IAEG Bulletin has become increasingly popular as a journal in which to publish and the delay time is increasing. It will, in due course, move to a full quarterly journal. Our Secretary-General, Louis Primel, is also Editor-in-Chief of the Bulletin. He has indicated that the two roles need to be separated.

## PERMANENT CO-ORDINATING SECRETARIAT OF THE IAEG, ISSMFE AND ISRM

This really no longer exists and contacts between the three societies are proceeding, less formally, in any case. A first meeting between the three Presidents and Secretaries in Cambridge resulted in the decision to hold the joint ***Geo Engineering Conference in the year 2000***. The confirmation of the Australian bid to stage this conference in Melbourne was a major success for our region.

## FORTHCOMING EVENTS

1997, Athens. June 23-27. *Engineering Geology and the Environment* . This is the official IAEG Symposium for 1997.

1998, Vancouver. September 21-25. *Engineering Geology: A global view from the Pacific Rim* . This is the 8th Conference of the IAEG. It will mark the end of the term of the current President and Vice Presidents.

2000, Melbourne. October-November. The first joint Congress/Conference on GeoEngineering to be sponsored by the 3 societies - IAEG, ISSMFE, ISRM.

Warwick Prebble
AUSTRALASIAN VICE PRESIDENT, IAEG.

**RICHARD WOLTERS PRIZE**

This prize will be awarded in 1998, at the 8th Congress of the IAEG, in Vancouver, 21-25 September 1998.

NZ Candidates should have their applications submitted by the ***NZ Geotechnical Society*** to the Secretary General of the IAEG before April 20, 1997.

The prize is a suitably engraved medal and certificate awarded every two years to recognise the "meritorious scientific achievement by a younger member of the engineering geology profession" and is awarded to honour Dr Richard Wolters' many contributions to the IAEG, and to the profession in general. Candidates should be members of the IAEG and less than 40 years of age on the first of January 1998.

The nominator shall provide:

- A copy of the nominees curriculum vitae
- A list of publications, identifying the three most important papers
- A statement of support for the nominee (less than two A4 pages)

**HANS CLOOS MEDAL**

This will be awarded in 1998 at the 8th Congress of the IAEG, in Vancouver, 21-25 September 1998.

NZ candidates should have their applications submitted by the ***NZ Geotechnical Society*** to the Secretary-General of the IAEG before April 20 1997.

If you wish to nominate someone, or be considered, please contact your local convenor as soon as possible. I will be very happy to support fully any application by the NZ Geotechnical Society or the Australian Geomechanics Society.

The medal is suitably engraved and is accompanied by a certificate honouring the contributions of the recipient to engineering geology. Candidates should be members of the IAEG.

The Hans Cloos Medal is the senior award presented by the IAEG, given to an engineering geologist of outstanding merit, in commemoration of the "founder of geomechanics". The recipient should therefore be a person of international repute who has made a major contribution to engineering geology in his/her written papers or to the development of engineering geology and/or the IAEG in their own area. We need not confine our nominations to our two local national groups.

The nominator (national group) should provide:

- A copy of the nominee's curriculum vitae
- A list of publications
- A statement of support for the nominee (less than two A4 pages

---

PLEASE CONSIDER nominating one of your professional colleagues or, seek nomination YOURSELF.

I look forward to the NZGS receiving nominations via the NZ Geotechnical Society before 1st February 1997.

Warwick Prebble
AUSTRALASIAN VICE PRESIDENT, IAEG

## 1. INTRODUCTION

This report to the NZGS & AGS will provide an overview of ISRM matters over the period of April to October 1996, in particular it will focus on the Board Meeting and Council Meeting held in Turin on 31st August and 1st September respectively.

## 2. BOARD MEETING

- o The ***ISRM Directory 1996*** has recently been published by Balkema and distributed at an approximate cost of $US26000. A few national groups did not produce a list of members, NZ was the only such group to offer a convincing reason (ie the Privacy Act). The ISRM hopes that NZ can overcome these problems for the next edition.
- o There are five applications for the 10th International Congress for Rock Mechanics in 2003: Beijing PRC, New Delhi India, Slovakia, Sun City RSA, somewhere to be named in the USA.
- o A VP has been appointed to each commission to provide some strong control and provide an informal reporting mechanism to the Board (the Presidents have the formal reporting role).
- o ISRM News is going well, it would welcome any short newsy articles on matters or projects of interest to the rock engineering community. As usual, advertising would be greatly appreciated.
- o There are a whole sway of conferences endorsed by the ISRM, most of these are in Europe. The Board enthusiastically endorsed the GeoEng2000 conference.

## 3. COUNCIL MEETING

- o This meeting was attended by representatives of 33ish National Groups and the Presidents of the ISSMFE (and Secretary General), ICOLD, IAEG, ITA and IUGS. This is a fairly impressive turnout.
- o The president has reappointed six commissions: Education (Prof I Johnston); Fragmentation by Blasting (Mr John Grant and Dr Cameron McKenzie - I think); Rockbursts in Hardrock Situations; Squeezing Rock in Tunnels; Swelling Rock; and Testing Methods.
- o The **ROCHA MEDAL** for 1997 was announced, the winner was **Dr Martin Brudy** for a thesis entitled ***"Determination of insitu stress magnitude and orientation to 9 km depth at the KTB site"***.
- o Nominations are called for the 1998 Rocha Medal and must be submitted to the regional VP by 31st December with supporting documentation.
- o The ISRM is somewhat upset with the name change of the ISSMFE and there is a proposal for a name change to the International Society for Rock Mechanics and Rock Engineering.
- o There was some discussion of developing some form of differential membership subscriptions to enable less developed countries to join - this was left to the Board to come up with a recommendation.
- o Nominations for the next President need to be in by 29th December 1996 to the Secretary General.
- o The 1998 International Conference was decided to be NARMS'98 at Cancun, Mexico, and this will host that year's board meeting. Note next year is in New York, 1999 is in Paris, and the Board has agreed that the 2000 one will be in Melbourne at GeoEng2000.

## 4. FUTURE CONFERENCES

| | | | |
|---|---|---|---|
| o | 36th US Sym Rock Mechanics | New York, USA | 29 June - 2 July, 1997 |
| o | SARES97 - the 1st Southern African Rock Engineering Symposium | Johannesburg | 15-16 September 1997 |
| o | International Symposium on Rock Stress | Kumamoto University, Japan | 8-10 October 1997 |
| o | 1st Asian Rock Mechanics Symposium on Environmental and Safety Concerns in Underground Constructon | Seoul | 13-15 October 1997 |
| o | NARMS'98 | Cancun, Mexico | 3 - 5 June 1998 |
| o | 9th Int Congress of ISRM | Paris, France | 1999 |
| o | GeoEng2000 | Melbourne | 2000 |

Garry Mostyn
**AUSTRALASIAN VICE PRESIDENT, ISRM**

## AUCKLAND BRANCH

I have taken over the task of the Auckland Branch co-ordinator from Clive Anderson who has been tempted away to Australia. Since the last report in June we have organised several interesting lectures on a variety of topics:

June 4 ***PILE SPECIFICATIONS - WHAT USE ARE THEY?*** A panel discussion involving members of the contracting and consulting communities raised some of issues and practical difficulties encountered with pile specifications. The panel comprised *Steve Scott (Brian Perry Ltd), John Yonge (Gilberd Hadfield Ltd) and Tim Sinclair (Tonkin & Taylor Ltd).* Further details of the discussion are presented elsewhere in this edition of *Geomechanics News.*

July ***GEOTECHNICAL RISK ANALYSIS*** *by R. Semple (Woodward Clyde Ltd).* Bob presented an interesting talk on the use of risk assessment in geotechnical engineering. The method has been used extensively in dam safety assessments and has the ability to be utilised in many other areas of geotechnical engineering to provide a better definition of "safety" than the regularly used Factor of Safety concept.

August 7 ***9th NZ GEOMECHANICS LECTURE*** *by Professor M.J. Pender.* Mick gave an informative presentation on "Aspects of the Geotechnical Behaviour of Some New Zealand Soils" based on his personal experiences. The lecture covered material from cohesive and cohesionless soils to unweathered hard rock. This lecture was particularly well attended by the Auckland geotechnical community with 150-200 people present. *The paper is printed later in this issue of Geomechanics News.*

October 16 ***PREDICTING SETTLEMENT RATES OF CLAYEY SOILS*** *by Dr John Hawley.* John presented an updated version of his Ph.D research using a computer program that calculates both settlement rates and magnitudes. His approach is able to overcome some of the simplifying assumptions that Terzaghi was required to make in his consolidation theory, while the program has been written to provide a user friendly interface. The paper is reprinted later in this issue of *Geomechanics News.*

Thanks to all of our speakers for the considerable time and effort spent preparing and giving their presentations. We look forward to more lectures in 1997. Any bright ideas for future lectures, panel discussions or site visits would be gratefully received. Merry Christmas!

James Burr
<u>AUCKLAND BRANCH CO-ORDINATOR</u>

## WELLINGTON BRANCH ACTIVITIES

The Wellington Branch has been relatively quiet over the past six months. Two technical meetings were held at the IPENZ meeting rooms in Molesworth Street, Wellington. The meeting highlights are summarised below:

19 June 1996 ***QUATERNARY SEDIMENTS AND DEFORMATION IN THE WELLINGTON AREA***
*John Begg, Institute of Geological and Nuclear Sciences, Lower Hutt*

John updated us on the recent findings on the quaternary geology of Wellington. This geology was mapped for the new 1:25,000 scale geology map to be published shortly. He described the deposition and tectonic deformation of the sediments in Wellington. For example, it was interesting to hear how the Hutt Valley sediments have undergone subsidence and uplift due to historical earthquakes in the region, and how this has influenced the geology of the Quaternary sediments. About 20 people attended and enjoyed the presentation.

14 August 1996 ***1996 GEOMECHANICS LECTURE: ASPECTS OF THE GEOTECHNICAL BEHAVIOUR OF SOME NEW ZEALAND MATERIALS***
*Prof. M.J. Pender*

The lecture was first presented at the ANZ Conference in Adelaide in July 1996. It was interesting to see how Prof. Pender approached some common geotechnical e.g. retaining wall failures and the adverse effects of swelling soils problems. In particular, the Wellington gathering was interested to hear of the behaviour of Wellington Greywackes - both in the weathered state and as a closely jointed rock mass. The audience were reminded of the need to think about the uncommon soils and rocks in New Zealand which we have to deal with, and develop a good understanding of their behaviour. The meeting was attended by a record turnout of about 35 people.

P. Brabhaharan
WELLINGTON BRANCH CO-ORDINATOR

## CHRISTCHURCH BRANCH

The following local branch meetings have been held during this year:

26 July 1996 — ***AKAROA LANDSLIP MONITORING AND REMEDIAL WORK:***
*Mr Mark Yetton, Geotech Consulting and*
*Dr Jagath Ekanayake, Landcare Research Ltd*

21 August 1996 — ***1996 GEOMECHANICS LECTURE: Aspects of the Geotechnical Behaviour of Some NZ Materials.*** *Professor Mick Pender, University of Auckland.*

6 September 1996 — ***SOUTHERN ZONE NZ GEOTECHNICAL SOCIETY STUDENT PRIZE:***
Four presentations were given by the following Christchurch students.

*SEISMIC RESPONSE OF DRILLED SHAFT FOUNDATIONS*
*-Alastair Chambers, Department of Civil Engineering, University of Canterbury*

*USE OF ROCK MASS CLASSIFICATION METHODS FOR RIPPABILITY RATING AT THE PROPOSED GLOBE PROGRESS OPEN PIT GOLD MINE, REEFTON*
*-Philip Clark, Department of Geological Sciences, University of Canterbury*

*A COMPARISON OF THREE DIFFERENT METHODS OF SOFT GROUND TUNNELLING USING COMPUTER SIMULATIONS*
*-Prasad Rayudu, Department of Natural Resource Engineering, Lincoln University.*

*LANDSLIDE DAMBREAK HAZARD ASSESSMENT, CALLERY RIVER, WESTLAND*
*-Ben Scott, Department of Natural Resources Engineering, Lincoln University.*

1 November 1996 — ***LANDSLIDE HAZARDS IN ALPINE TERRAIN, WITH PARTICULAR REFERENCE TO CASE HISTORIES IN EUROPE AND WESTERN CANADA:***
*Nigel Skermer, EBA Engineering Consultants Ltd., Vancouver, Canada and*
*Graham Rawlings, Graham Rawlings Consulting Ltd., Vancouver, Canada.*

Guy Grocott
CHRISTCHURCH BRANCH CO-ORDINATOR

## OTAGO/SOUTHLAND BRANCH

Activity of the Otago Branch of the New Zealand Geotechnical Society has been very limited this year. In July, two visiting French Students gave a seminar on the Wide Area Slope Stability Server (WASSS) a slope stability information database. They have been entering New Zealand landside data into the database. This service is available on the internet at http://wasss.entpe.fr. Unfortunately this seminar was very poorly attended.

While Ian Walsh of Works Consultancy Services has offered to give a talk on the design and problems encountered with the McArthurs Bend realignment of State Highway One. This is yet to go ahead. He has also suggested a local workshop on the newly adopted roading materials standards.

The annual conference of the Geological Society of New Zealand was held in Dunedin from the 26-28 November 1996 and we were involved in preparing engineering geological field trips and an engineering geological papers session. The conference was very well attended this year.

I would like take this opportunity to remind all members that I am open to ideas about any meeting or events they have in mind and that some assistance with organising these events would be more than appreciated.

Phil Glassey
OTAGO/SOUTHLAND BRANCH COORDINATOR

# Engineered Anchoring By Ancor-Loc NZ

Think about it. How many screw anchors and deadmen have been installed without a clue as to their holding capacities? Ancor-Loc New Zealand is proud to announce the arrival in this country of the Manta Ray engineered earth anchor - the solution to this problem. Used extensively around the world and now throughout New Zealand, these anchors are well proven and recognised in the field of engineering as a cost effective alternative to traditional anchoring methods.

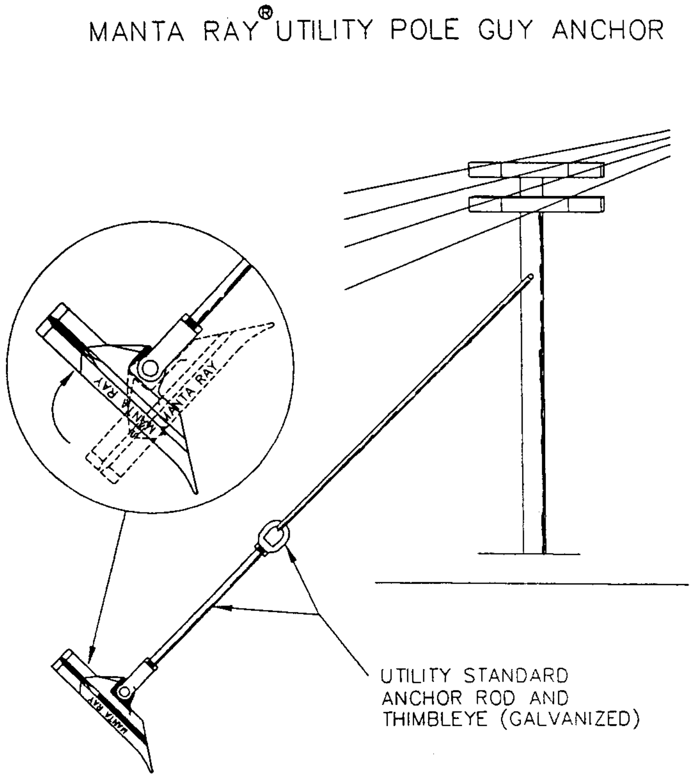
Manta Ray anchors are driven into the ground with conventional hydraulic/pneumatic equipment. Once driven to the proper depth - the rod-tendon attached to the anchor is pulled to rotate the anchor into undisturbed soil - like a toggle bolt. This is called 'anchor locking'. The Anchor is pulled upon to reach a specified holding requirement, which is measured by a gauge on the anchor locker. Each anchor is immediately proof-loaded to the exact capacity required in simultaneous testing and installation. No other anchor offers this feature.

Manta Ray anchors can cut installation costs by up to 75 percent over other systems. Made from galvanised ductile iron, these anchors can be installed in difficult situations inaccessible to digger derrick trucks. No digging, no mess, no damage to the soil. Ancor-Loc New Zealand can also offer completely grouted systems.

Ancor-Loc anchors can be used successfully in the following applications: Embankment repair, erosion control, foundation stabilisation, retaining walls, gabions, scree walls, sheet piles, geo grid walls, sea walls, moorings, floating docks, installation and repair of underwater pipes

Ancor-Loc New Zealand provide a complete sales and installation service throughout New Zealand.

To contact your local area installer call 09-426-5798



# 7TH ANZ CONFERENCE ON GEOMECHANICS: ADELAIDE : *"GEOMECHANICS IN A CHANGING WORLD - REFLECTIONS*

The 7th ANZ Conference was held in Adelaide during the first week of July this year. It was attended by some 200 participants with about 15 from New Zealand. The venue was the Adelaide Conference Centre which was centrally located with a variety of accommodation available in the immediate vicinity. Central Adelaide was only a couple of blocks away with plenty of restaurants and cafes on offer.

As with conferences in the past, the Australians proved to be excellent hosts with a good mix of technical and social activities. In particular the field trip organised by David Stapledon and Alan Moon proved to be extremely educational with David taking participants through his engineering geology field exercises developed for his courses at the university. After the trip, it was clear that Australia has had a seismically active history which has helped shape the landscape.

The conference dinner later that evening was noted for the entertainment provided by green frogs and a frog fanatic. Guests were entertained with a variety of frog related jokes and related points of interest. Green frogs provided a dance spectacular.

No trip to South Australia would be complete without a generous sampling of local red wines. The conference provided ample opportunity for participants to sample a variety of first class local wines. The program contained a balance between technical and special sessions, and theme presentations which worked extremely well. The program was well organised with participants spending around an hour and a half per session followed by breaks for either morning or afternoon tea or lunch.

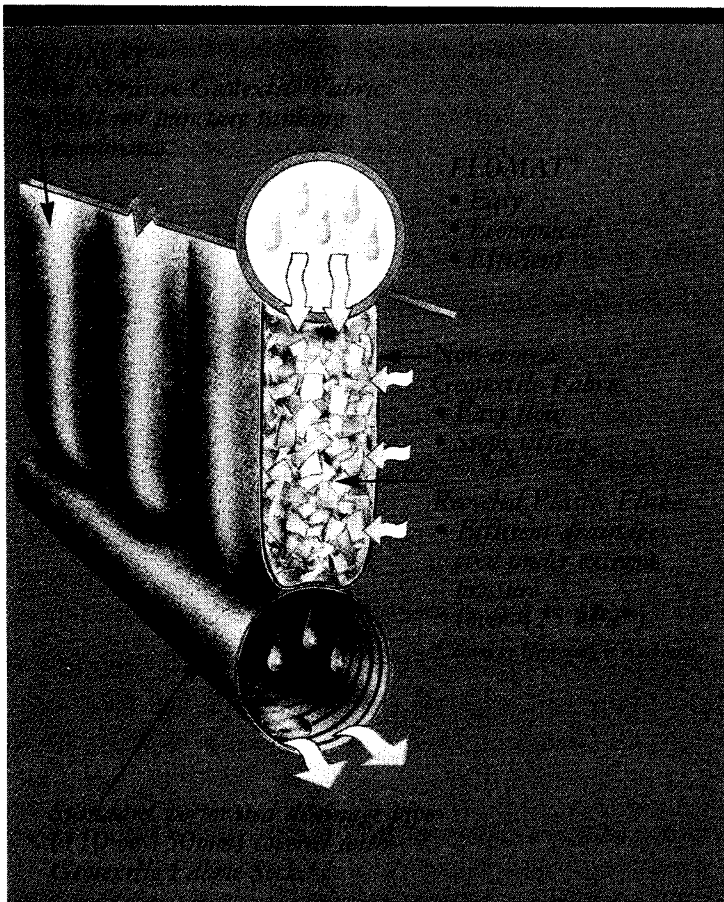
The keynote lecture was presented by Mike Jamiolkowski on stress-strain behaviour of sands far from failure , David Stapledon presented his John Jaeger memorial address and Mick Pender presented the NZGS Geomechanics Lecture. All three presentations were well attended and provided the opportunity to discuss a variety of issues.

Two speciality sessions provided an opportunity for reflective thought and allowed some discussion on the wider issues affecting the profession. The first was "Where is Geotechnical Practice Heading" and the second on "Momentous Occasions". Both sessions provided a chance for open discussion on where we had been, what factors have shaped our profession and where we should head in the future. Presentations on momentous occasions ranged from pure luck (both good and bad) to achievements through sheer hard work and energy. Those who attended, I am sure, would have left both sessions with new perspectives to consider.

Of particular note was John Carter's presentation on Analytical and Numerical methods. Using a laptop computer and presentation software he was able to clearly demonstrate the advances in numerical modelling tools available to practitioners which could be used for both design and technical presentations. These tools are still largely confined to the Universities but will become an increasingly important in the future for geotechnical design practitioners.

*The contents of theproceedings and the abstracts* of the *NZ papers presented are reproduced later in this issue of NZ Geomechanics News.*

Colin Newtown
NZGS CHAIRMAN

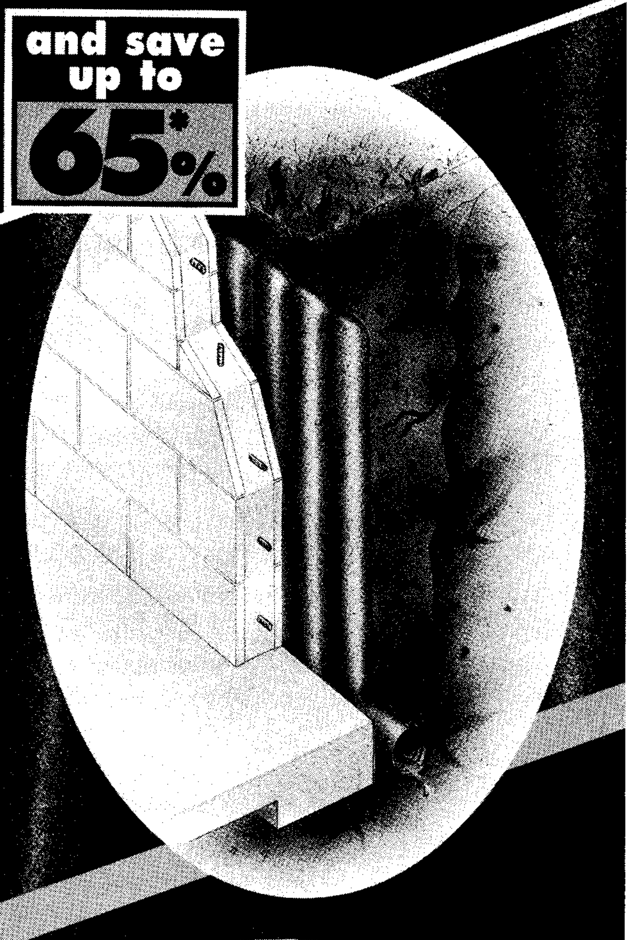





FLOMAT LIMITED
PO Box 15 978 New Lynn, Auckland.
Phone and Fax 827 7172

# FLOMAT™

## Easily the most effective way to drain



## ULTIMATE LIMIT STATE DESIGN OF FOUNDATIONS

The Building Industry Authority (BIA) will shortly release a revision of B1/VM4 FOUNDATIONS for comment.

This revision is expressed in limit state format. It represents the first attempt to formalise the recommendations that were presented and discussed at the 1994 joint workshops of the NZ Geotechnical Society and SESOC (Structural Engineering Society).

It is very important that this document be widely discussed and comments and suggestions for change be sent to the BIA.

Perhaps each local group of the Geotechnical Society needs to convene a group to examine the recommendations. This might be a joint activity with the local SESOC group.

The draft for comment will be available early in the New Year.

*[Also refer to Ultimate Limit State Design of Slopes included in the* ***Technical Articles*** *section elsewhere in this edition of NZ Geotechnical News - Ed.)*

# SQUARE TIMBER PILES

*By Joe ten Broeke (BRANZ senior technical adviser)*

The use of square sawn timber piles for light timber frame construction is now a well-established trend but their use has some restrictions.

Most light timber frame buildings use NZS 3604 as an acceptable solution to satisfy the requirements of the New Zealand Building Code clauses B1 Structure and B2 Durability.

In practice, questions arise where designers and builders wish to depart from the requirements of NZS 3604 in respect of pile cross section and level of presevative treatment.

Some designers have asked: "Can I use 100 x 100 mm H4-treated piles for house foundations?"

The answer is "no" if NZS 3604 is to be the acceptable solution. Otherwise it would require specific design to show that the strength and durability of the piles are adequate to meet the requirements of the N Z Building Code.

**Requirements**

The minimum cross-section of square sawn timber piles is specified in clause 4.3.5.4 as:

- Piles shall comply with NZS 3605
- Treatment shall be H5 Group B of MP 3604
- The clause also refers to treatment of cut surfaces.

Pile quality – Refer to NZS 3605 *Timber piles and poles for use in building.*

Section 4 of NZS 3605 deals with "Round or Square House Piles." Clause 4.3 "Strength" and Table 1 are important. This sets out the bending capacity for piles of various lengths and the clauses that indicate how compliance with the required bending capacity can be achieved.

The minimum pile cross-section is set at 125 x 125 mm.

1 Square sawn piles up to 900 mm long – the required bending capacity is 1.8 kNm. If the pile meets the defects limits for No 2 framing grade it is assumed that it has the required bending capacity.

2 Square sawn piles over 900 mm but not more than 1.2 m long – the required bending capacity is 3.6 kNm. The pile is acceptable if it meets the defects limits for No 1 framing grade.

3 Square sawn piles over 1.2 m and up to 1.8 m long – the required bending capacity is 7.2 kNm. One of the following can be used to prove acceptable quality:

   - the pile meets the requirements for No 1 framing grade and, in addition, the central 600 mm of its length is free of knots greater than 20 mm in diameter or,
   - all piles are proof-tested to a bending moment of 6.0 kNm or,
   - batches of 100 piles are proof-tested annually to a bending moment of 7.2 kNm or,
   - piles have a 150 x 150 mm minimum cross-section and meet the requirements for No 1 framing grade.

4 Square sawn piles over 1.8 m long – the required bending capacity is 3.6 kNm. One of the following can be used to prove acceptable quality:
   - all piles are proof-tested to a bending moment of 3.0 kNm or,
   - batches of 100 piles are proof-tested annually to a bending moment of 3.6 kNm.

All house piles over 1.5 m long shall be branded with a letter A, signifying that they meet the strength requirements of NZS 3605. All square sawn house piles, regardless of length, must also show other branding to indicate treatment plant number, pile producer and treatment level.

From the above requirements of NZS 3605 it is clear that not all 125 x 125 mm treated timber is necessarily suitable for house piles.

The requirements for bending capacity are to ensure that the timber piles are capable of carrying horizontal loads that may be transferred into them during storms or earthquakes. It is highly unlikely that piles of 100 x 100 mm cross section will be able to meet the strength requirements.

## TESTING OF SOILS - REVISION

A POSITIVE approach by Standards Australia Technical Committee CE/9 and its working groups will soon see the publication of a new set of up-to-date test methods for soil classification.

The committee has been working on a major revision of AS 1289 – 1991 *Methods of testing soils for engineering purposes.*

While a portion of the test methods relating to soil classification, strength and consolidation and reactivity tests are revised and published, the remainder are now being revised, including some test methods relating to soil moisture content and compaction and density tests.

The committee's working groups have considered public comments and revision of test method 5.8.4.

Also, two new test methods proposed by the committee are now under consideration by Standards Australia. These methods will enable calibrating authorities of nuclear surface moisture density gauges to establish assigned density values for Type B Standard density blocks.

The main committee has agreed to convene a small working group to prepare soil sampling test methods since AS 1289.1 refers to AS 1726, which has not included sampling methodology since 1993.

To address this issue and to fulfil the needs of relevant industry personnel, the committee is preparing test methods to include sampling from disturbed and undisturbed samples, and will also include test methods for selection of sampling, or test sites using random or stratified random number methods.

The revision of the full AS 1289 series of test methods should be available by the end of 1997.

*The chairman of CE/9 is Dr Jack Morgan and the Projects Manager is Neil Jayasekera, Standards Australia.*

## EARTH RETAINING STRUCTURES STANDARD

STANDARDS AUSTRALIA has prepared a draft standard for earth retaining structures (including reinforced soils).

The document – DR 96405 – proposes requirements and recommendations relating to design and construction of structures required to retain soil, rock and other materials at slopes steeper than that which the soil, rock or other material would naturally assume.

It also proposes requirements and recommendations for the reinforcement of soil and rock materials so that the materials, without a separate retaining structure, can be retained at slopes steeper than they would naturally assume.

The draft includes sections dealing with investigation and testing, design requirements, design loads, material design factors, construction and performance monitoring. The appendices provide guidelines on classification of structures, material selection and durability, drainage, fill materials and load combinations, amongst other topics.

DR 96405 is administered by Standards Australia Technical Committee CE/32 Reinforced Soils and Retaining Structures, which first met in 1992 to discuss a draft based on a British document. That proposal was rejected by the committee under the light of comments received and a simpler more general standard was proposed, resulting in DR 96405.

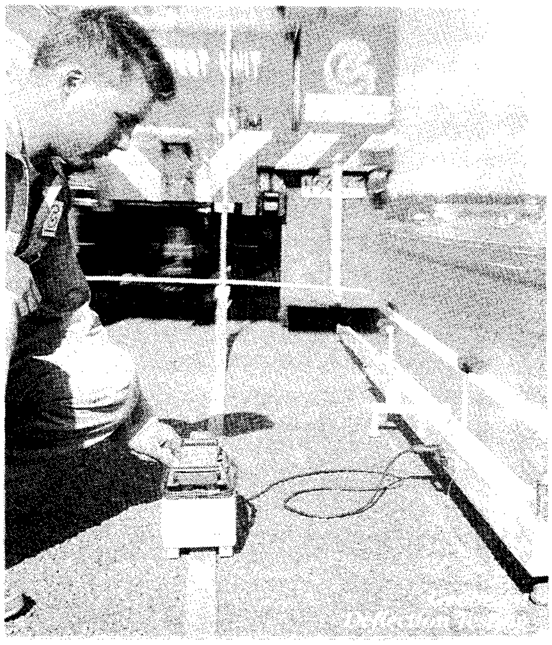
*The chairman of CE/32 is Associate Professor Manfred Hausmann, University of Technology, Sydney and the Projects Manager is Ruben Naccarelli, Standards Australia.*

# GEOTECHNICS LTD
# ROAD TESTING UNIT

*Geotechnics offers a comprehensive road testing service which incorporates a wide range of testing applications from single lane unsealed rural accessways to multi-lane highways and motorways.The Road Testing Unit is purpose built for a range of TELARC registered services including:*

## DEFLECTION TESTING (BENKLEMAN BEAM)

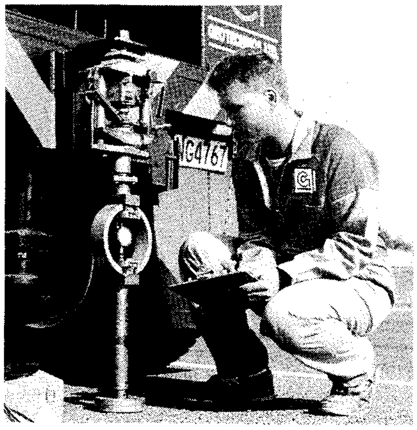
This service utilises a standard Benkleman Beam where pavement deflections are measured and recorded with preliminary results issued on site, followed up by a formal test report.



## DEFLECTION TESTING (GEOBEAM)

Using our patented Geobeam, deflection measurements are made via an electromagnetic proximity transducer located at the point of test. This system provides for both standard deflection information and detailed bowl shape at every test point if required. The information is automatically recorded and stored on a hand held site computor and can be used to determine subgrade moduli and analysis of pavement component performance.
This sevice has particular application on existing pavements where subsurface information is required for design purposes.

Standard test loads of 7.3 tonnes and 8.2 tonnes are available for deflection testing.

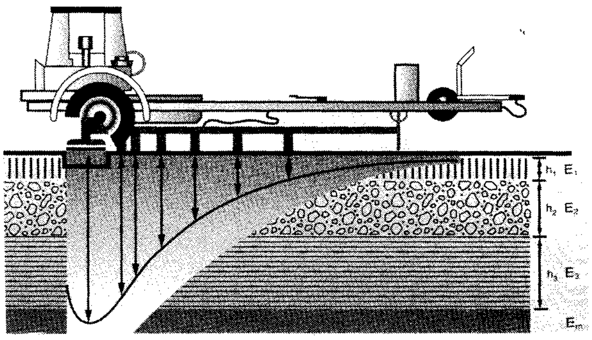


## FIELD CBR AND PLATE BEARING TESTING

The unit has also been designed to perform Californian Bearing Ratio and Plate Bearing Tests and has built in facilities and equipment for the perfomance of these tests.

## FULL TIME TEAM

The Road Testing Unit is operated by a two man team who are committed full time to its operation and maintenance. We aim to provide a timely, cost competitive service which meets the demands of the civil engineering and construction industries.



## THE FALLING WEIGHT DEFLECTOMETER

Using the Falling Weight Deflectometer (FWD) Systems and associated analysis software, it is possible to quickly and accurately determine the structural condition of the pavement system. The required overlay or other rehabilitation alternatives are calculated from analytically based structural design methods, at a cost which is negligible compared to the cost of an incorrect rehabilitation strategy.

GEOTECHNICS LTD
19 MORGAN ST. NEWMARKET, AUCKLAND.
TELEPHONE (09) 3793067 FAX (09) 3070265 MOBILE (025) 747693

# A GEOTECHNICAL PRACTICE COLLEGE

It was somewhat disappointing not receive any feedback in response to the practice college concept discussed in our June 1996 edition. At the February 1996 symposium, there was overwhelming support from the participants and there is also considerable support from IPENZ.

The committee has discussed the issue at length at its meetings and there are a number of very positive benefits to be gained including:

- increased recognition for the Society and members
- an increased level of technical awareness
- a more focussed perspective on technical challenges.

Potentially more importantly, society at large will be in a better position to make decisions regarding the solution of geotechnical problems.

I appreciate that the benefits for the Society are often intangible and more tangible benefits will be gained mainly by members of the college. Also the Society will have a significant increase in work load with its involvement in the establishment and also the continuing operation of the college which could be viewed as detrimental to the Society as a whole.

The major reservation I have with the college is the number of participants it will be able to attract of the appropriate calibre and whether the critical mass level will be achieved. Experience with IPENZ technical groups indicates that a number in excess of 300 is required to achieve this level. It is unlikely that the college would have a third of this number, although the college would have a considerably different function to the technical groups and the critical mass level may be considerable lower.

I am reluctant to pursue the practice college concept unless there is a strong mandate from the membership. I intend to have matter placed on the agenda for the AGM in February 1997 for discussion. Any feedback before the AGM would be warmly appreciated.

Colin Newton
NZGS CHAIRMAN



**_see pages membership pages at rear of this issue of NZ Geomechanics News for details_**

# PILING SPECIFICATIONS - WHAT USE ARE THEY?

The following is a report on the oral presentations made at the Auckland Branch meeting of the NZ Geotechnical Society on 4 June 1996. This meeting involved a panel discussion, the members of which comprised:

| | |
|---|---|
| Steve Scott | (Brian Perry Ltd, Piling Contractor) |
| John Yonge | (Gilberd Hadfield Pile Co. Ltd, Piling Contractor) |
| Tim Sinclair | (Tonkin & Taylor Ltd, Geotechnical Consultant) |

## COMMENTS BY STEVE SCOTT (PILING CONTRACTOR)

### *INTRODUCTION*

It is fairly easy to define what a piling document is suppose to achieve. The objective is no different to any other construction contract: to deliver the works fit for their intended purpose, at least cost to the owner, and need it be said - in the shortest possible time.

Where piling works differ (from other construction works) is that each site is unique, especially given the diverse geologic conditions we have in Auckland, and the many and varied applications for which piles are used.

Add to this that more construction problems are caused by underground conditions than any other factor, it is perhaps not surprising that piling documentation will vary according to individual experience.

There is nothing dramatically wrong with the way piling works are presently specified or constructed. However, there is room for common ground, so to speak, in piling documentation and I would like to offer a few observations from a Contractor's viewpoint using these headings as a framework:

- GEOTECHNICAL UNDERSTANDING
- DESIGN
- RISK MANAGEMENT AND TENDER DOCUMENTATION
- CONSTRUCTION PROCEDURES

### GEOTECHNICAL UNDERSTANDING

Because each piling site is unique, the starting point is the geotechnical understanding. By this I mean understanding the project requirements as well as the site conditions. This information is as important to the Contractor as it is to the designer. This is the information, together with his experience, on which the Contractor will make his tender assumptions. Yet, in just about any tender document we receive, there is a "Nature of Ground" clause or similar which in essence says to the Contractor:

> "We've done some investigation, but we can't rely on it, so it is not included in the contract, and be it on your own head if you use it".

A number of these clauses go on to say:

> "PS - the fact that you submit a tender means you acknowledge all the risk is yours."

> "PPS - if you want to see the geotechnical information, please make an appointment to come to our office."

I recently tendered a job where I was given great hope by the following clause in the tender document:

> "The results of soils investigations are appended and form part of the contract".

However, when I went to Appendix A, there was no information. Accordingly, I rang the Engineer, and he apologised and said that clause was a mistake, and Notice to Tenderers No.1 was coming. This Notice said that the results of soils investigations on this project undertaken were attached but they did not form part of the Contract documents. The fact that five (5) sheets of borelogs were attached was due to my protestation when he wanted me to go to his office to view them.

For later discussion, I'd appreciate an explanation of the contractual difference between these (latter) two clauses.

Quite simply, there should be full disclosure of all the geotechnical information to the contractor. As an absolute minimum, all the factual information should be provided - this includes:

- borelogs (but not without a site plan)
- ground surface levels (for the top of the borehole)
- any laboratory test results
- groundwater levels
- other relevant information

In the event of an unforeseen condition which neither you - as an experienced geotechnical Engineer - nor he - as an experienced Contractor - could have reasonably foreseen, then like it or not, the geotechnical information will be central to any contractual claim.

You should also be aware of the requirements of the Health & Safety and Employment Act 1992, and more particularly the approved Code of Practice for Safety in Excavations and Shafts for Foundations issued by September 1995. This code requires proper site investigations be made before the construction work commences. The code requires the results of this investigation to be made available to the Employer - that is (in this case), the Contractor - who will carry out the work. The Contractor must assess the general hazards which may arise during the construction. Such hazards can include the presence of dangerous gases, contaminated ground or high groundwater pressures.

I suggest to you that if you are not disclosing all the available geotechnical information, you may not be taking all practicable steps to eliminate a hazard as required under the Act.

## *DESIGN*

I won't comment on design (as Tim Sinclair will do this later), other than to say it may very well be time to take a hard look at allowable bearing pressures for bored piles in the Waitemata Group.

## *RISK MANAGEMENT AND TENDER DOCUMENTATION*

Risk management is the process of deciding how best to manage the particular risks of the project, including contractual arrangements, such as design and build, tender or negotiated works.

Since nearly all piling work is tendered, we have limited our discussion accordingly.

The tender documentation should translate the geotechnical understanding, the risk management and design requirements through the Specification and scheduling of the Works. Tender documents and a technical specification should be project specific. Standard specifications or piling specifications prepared on a pigeon-hole type basis (or word processor being the modern-day equivalent) without due regard to the particular requirements of that site or project, will lead either to oversights or unnecessary requirements that simply increase the cost to the owner. Such standard specifications can also produce documents which either contradict recommendations in the geotechnical report or don't act on those recommendations.

This is not to say that there shouldn't be standardisation of specifications. On the contrary, it would be very helpful there was some general agreement and acceptance of industry practices. Examples are the free-falling of concrete in bored piles, limiting vibratory compaction to the top of piles and some consensus on tolerances and inspection procedures.

Scheduling of piling contracts range from a detailed building type schedule where the quantity surveyor is obviously being paid for his work, to lump sum items prepared by engineers who may not be getting paid for their work, to lump sum prices requiring a take-off by the contractor who definitely doesn't get paid for doing this whether he wins the job or not.

A properly thought-out schedule is part of the risk management and placing all the risk on the contractor does not necessarily provide the lowest cost job for the owner.

### *CONSTRUCTION PROCEDURES*

Monitoring construction procedures and providing the requisite quality assurance checks and balances is a vital part of piling to ensure that the works are in fact fit for their intended purpose and John Yonge will add to this.

## COMMENTS BY JOHN YONGE (PILING CONTRACTOR)

### *TENDER DOCUMENTATION*

Specifications must be objective and flexible - objective to give the Client the product he is hopefully paying for and flexible so that they can be varied to suit changed conditions.

As a Contractor, we find all too often that the Specification was seemingly pulled out of the computer at the last minute with little thought or understanding (given to the specific project):

- e.g. a ***drilled pile specification containing driven*** pile clauses

We, as a Contractor, or (more) particularly, as a Subcontractor, often do not even see a specification!

Another problem is the copied specification not being fully relevant:

- e.g. a specification copied from a sample overseas spec for driven minipiles carefully specifying the set for a pneumatic hammer, but not the hammer or even the pile load!

A recent Auckland job quoted two out-of-date specifications being CP2004 and NZS 4205P and both were unable to cope in detail with the site problems as they existed.

### *CONSTRUCTION PROCEDURE*

The specifications should reflect the job size or complexity, and the engineering supervision should acknowledge the Contractor's experience and plant.

Nowadays, we all too often see small excavator/auger machines doing bored pile work they cannot properly cope with due to changed conditions or a misunderstood bid.

We have observed small contractors planning to pour concrete through water blindly unaware of the consequences, without pumps available, no specification and no supervision.

We have observed small contractors unable to penetrate sandstone, unable to achieve the necessary depths (e.g. short kelly) unable to pump or bale the shafts and the like, all without an apparent specification or adequate supervision. There seems to be a wide variation on expected standards of pile (base) cleanliness.

We have experienced rock items removed from the documents to bring the project under budget, but no apparent inclusion of a contingency for rock when reporting to the Client. The Client, and the Consultants therefore unreasonably resist proper payment when rock is found.

We are in favour of alternative disputes resolution or mediation as a means of solving disputes as opposed to arbitration or the courts.

At the end of the day, it all comes back to money:

- the cost of preparing and ensuring specification relevance
- the cost of specification compliance and supervision

In the final event, it is the Client who pays and his interest would be best served with good documentation, adequate, flexible and experienced supervision, and responsible well equipped Contractors to achieve in harmony a satisfactory end product.

**COMMENTS BY TIM SINCLAIR - (GEOTECHNICAL ENGINEER)**

The task bestowed upon Tim was to provide some form of rebuttal to comments made earlier tonight. While not excusing poor practices in piling documentation, Tim chose, rather, to focus his few minutes of limited presentation to the purpose and philosophy of pile specifications. The following is an outline of Tim's comments:

The purpose of a pile specification includes:

- to ensure good construction practice
- to confirm design assumptions

There are essentially two philosophies for pile specifications, namely:

- A Method Specification - dictating the type of pile and the method of construction
- A Performance Specification - the Contractor's responsibility is to demonstrate the pile(s) have the design capacity

The NZ experience for pile engineering is essentially that of the *Method Specification.* There is a reluctance in NZ to undertake pile load tests (whether they be full loading tests or involve the use of a pile design analyser (PDA). With the Method Specification, the designer carries the main responsibility for the pile performance. Typically, NZ pile designs are based on:

- Theoretical and Empirical Methods (which require experience)

- Precedence (e.g. piles in the Waitemata weak rocks are often designed for up to 6 MPa ultimate end bearing, with an ultimate side shear limit which can vary widely (for sites or designers)

By way of example, Tim displayed an overhead which allowed a designer a wide choice of "$N_q$" parameters for pile design for varying material strengths.

The experience gained overseas (e.g. South-East Asia) is that it is the norm for designers to adopt *Performance Specifications.* Such projects often involve many pile load tests (which are virtually obligatory). The Contractor, in this case carries the responsibility of the pile performance. The design of the pile is essentially done by the Contractor using his experience and the precedence set on other projects.

## DISCUSSION

A lively discussion followed which included some of the following comments/suggestions:

- Piling schedules should include estimates for supply and driving depths for driven piles
- More intensive site investigation is required for greater confidence in determining driving depths or schedules - this should result in a saving to the client although there would be higher investigation costs
- Council experience is that all-up costs are greater for piling where more risk (i.e. limited investigation) is taken
- One contractor's experience in Thailand and Asia has been that piling construction under a performance specification proved very difficult
- The origin of 6 MPa ultimate end bearing in the Waitemata weak rocks was queried and the (tacit) consensus was that some pile tests were done previously although no one present could recall specifically. However, it was a generally accepted precedent
- Often the number of piles constructed on a NZ project, or the scale, did not warrant the cost of pile load test(s)
- There was often not sufficient or readily available equipment to allow load testing of piles
- That piling contractors prepare a list of common conditions for piling specifications and that clause 10.4 of the Occupational Safety & Health (OSH) requirements for site investigation be included in these. This list could then be considered/developed further by the Geotechnical Society to provide more uniform design standards/specifications

## AUCKLAND UNIVERSITY

Employers of geotechnical staff have long regarded a graduate qualification as necessary. We now have two programmes of study that require one academic year - 9 months of full time study, or longer if done part time - for completion. These are the Diploma in Engineering (DipEng) and Master of Engineering Studies (MEngSt).

In general we require an engineering degree before enrolment in the MEngSt. In the case of the DipEng, though, with four points of preliminary study (Engineering Mechanics, and Geomechanics I and II), this qualification could be obtained by someone who has done no previous study in engineering. One academic year is equivalent to passing papers to the value of 14 points. Papers are available in:

- Soil and rock mechanics
- Engineering geology
- Foundation engineering
- Slope and excavation engineering
- Numerical methods
- Laboratory methods

In addition some of the 14 points can be gained from projects. Topics available involve laboratory work, numerical analysis, engineering geology, and investigations of design methods. It is also possible, and indeed encouraged, for participants to bring a project topic from their current employment. Analysis of field data, assessing soil test data from a particular region or soil type, consideration of foundation monitoring data, investigation of geotechnical design methods, and surveying the literature on a geotechnical process, are all examples of possible projects. These are only examples, we would be only to pleased to hear what you might suggest.

Further enquiries to: Auckland University School of Engineering, Tel: (09) 3737 599; Fax: (09) 3737 462

| | | | |
|---|---|---|---|
| Mick Pender | ext 7919 | Tam Larkin | ext 8183 |
| Laurie Wesley | ext 7920 | John St George | ext 8195 |
| Warwick Prebble | ext 7591 | (The fax number for Warwick is: (09) 3737 435) | |

## CANTERBURY UNIVERSITY

The following is a list of geotechnically-related M.E. courses for 1997. These may be taken individually by part-timers (leading to a Certificate of Proficiency) or as part of a Masters programme.

- Engineering Seismology
- Risk Assessment
- Groundwater Flow
- Advanced Pavement Design
- Engineering Geology and Construction Practices
- Geological Hazards

The main event on the geotechnical side in 1997 is the introduction of a second option in geomechanics, entitled 'Earthquake Geotechnical Engineering'. It will cover basic engineering seismology, the cyclic behaviour of soils, the modelling of site effects and the seismic behaviour of soil structures, seismic design loads and design of machine foundations.

Current geotechnical research includes the following topics:

- seismically induced landslides
- determination of seismic soil strain data from down-hole records
- site-specific prediction of liquefaction
- full-scale cyclic testing of piles in gravel
- shaking-table tests of model piles in sand
- the effect of cavitation on undrained shear strength
- seismic bearing capacity of foundations
- liquefaction-induced lateral loads on piles
- seismic hazard analysis

The geomechanics group comprises Rob Davis, Kevin McManus and John Berrill with frequent help and advice from David Bell, Jarg Pettinga and Mark Yetton in Geology. Further enquiries to:

John Berrill
Dept of Civil Engineering
University of Canterbury
Tel: (03) 364 2250
Fax: (03) 364 2758

# TECHNICAL PAPERS

NINTH NZ GEOMECHANICS LECTURE (1996):

ASPECTS OF THE GEOTECHNICAL BEHAVIOUR OF SOME NZ MATERIALS

–Prof. M.J. Pender

PREDICTING SETTLEMENT RATES OF CLAYEY SOILS

–Dr J.G. Hawley

ULTIMATE LIMIT STATE DESIGN OF SLOPES

–Prof. M.J. Pender

7TH ANZ CONFERENCE ON GEOMECHANICS (Adelaide 1996)

Table of Contents (Proceedings)

Abstracts of NZ papers presented

# Aspects of the Geotechnical Behaviour of Some NZ Materials

**M J Pender**

B.E. (Hons) PhD, FIPENZ, MASCE

Professor of Geotechnical Engineering, Department of Civil & Resource Engineering, University of Auckland

**Summary** This paper contains the text of the ninth NZ Geomechanics lecture. Properties of NZ soil and rock masses ranging from sand and clay to hard unweathered (but closely jointed) rock are reviewed. The aim of the lecture is to remind members of the NZ Geotechnical Society that although we deal with some very interesting and unique materials we still have some distance to travel towards the goal of adequate characterisation of these materials. A secondary aim of the lecture is to illustrate a variety of methods that have been used to determine property values for NZ geotechnical materials.

## 1. INTRODUCTION

This lecture aims to remind the members of the NZ Geotechnical Society about the following aspects of the materials which we encounter:

- very little systematic data is available about the soil and rock masses we deal with everyday in our practice of geotechnical engineering;
- many of the materials we deal with are unusual and not covered in the traditional soil and rock mechanics literature;
- as our soils are sufficiently different from those found elsewhere we need to exercise caution when importing offshore correlations between soil properties;
- there is an extensive range of methods that can be used to determine values for soil and rock mass parameters.

The approach adopted in the lecture is to present information about some NZ soil and rock masses with which I have personal experience. In NZ there is not a sharp distinction between soil and rock, rather there is a continuous spectrum of materials. As this reflects the range of materials I have worked with the examples given in the lecture range from cohesive and cohesionless soils to unweathered (but closely jointed) hard rock. Extensive information about particular materials is not presented but rather aspects of the behaviour of various materials are used to illustrate several interesting features about our soil and rock masses. Topics that require further work, possibly in a co-operative manner involving the wider membership of the Society, are mentioned.

The background to the lecture is the view I hold that the determination of appropriate values for soil and rock mass shear strength and stiffness parameters is possibly the most pressing current need faced by the geotechnical profession. We have at hand a very extensive series of models for soil and rock mass behaviour, well equipped laboratories and field testing rigs, access to computational facilities with breathtaking power, and yet, despite all these riches, it seems that we still find problematical the determination of soil and rock mass parameters for many applications. When I was first involved in geotechnical engineering, at a practical rather than research level about twenty five years ago, one often heard, at least in NZ, the comment that our computational ability far exceeded our ability to model soil behaviour or obtain the appropriate input. This situation has probably got worse rather than better in the intervening years, that is our computational ability has moved ahead faster than improvements in understanding soil and rock mass behaviour and even faster again than developments in obtaining values for material parameters. This difficulty becomes even more pressing when practical geotechnical problems have to be solved within the constraints of money and time which usually limit what can be done for a given project.

A further development which focuses our attention on the estimation of soil parameters is the advent of limit state design methods. These tend to be quite specific about load factors and strength reduction factors, but say little about the process by which parameter values are to be chosen.

1 Bolton Street overbridge
2 Aurora Terrace overbridge
3 Public Trust Office
4 Herbert Gardens
5 Southern Portal, Terrace Tunnel

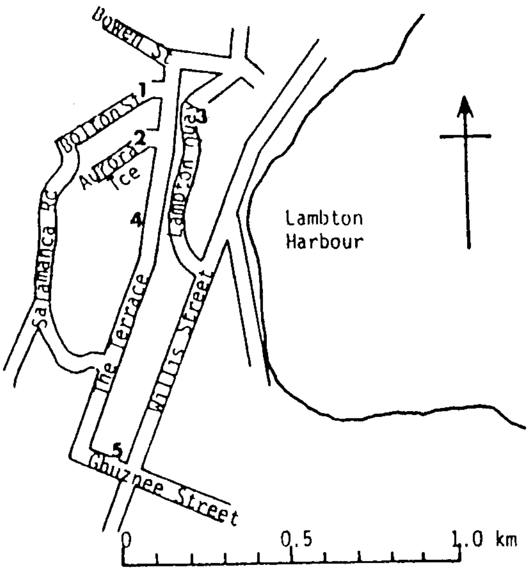



Figure 1. Sites from which weathered greywacke was obtained for triaxial testing.

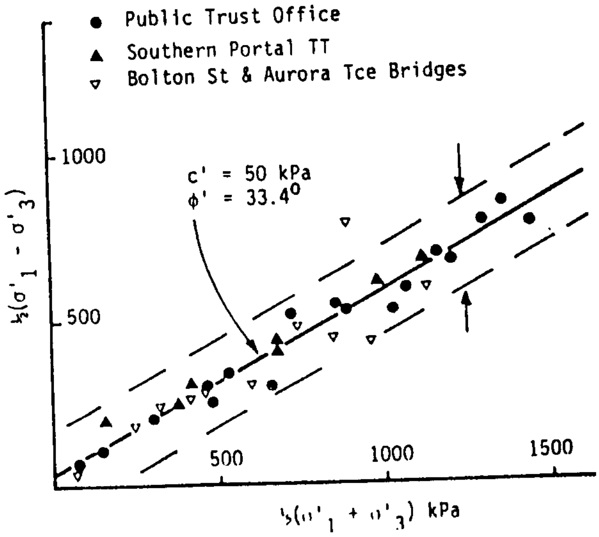



Figure 2. Triaxial test results on completely weathered greywacke specimens with void ratios between 0.50 and 0.60.

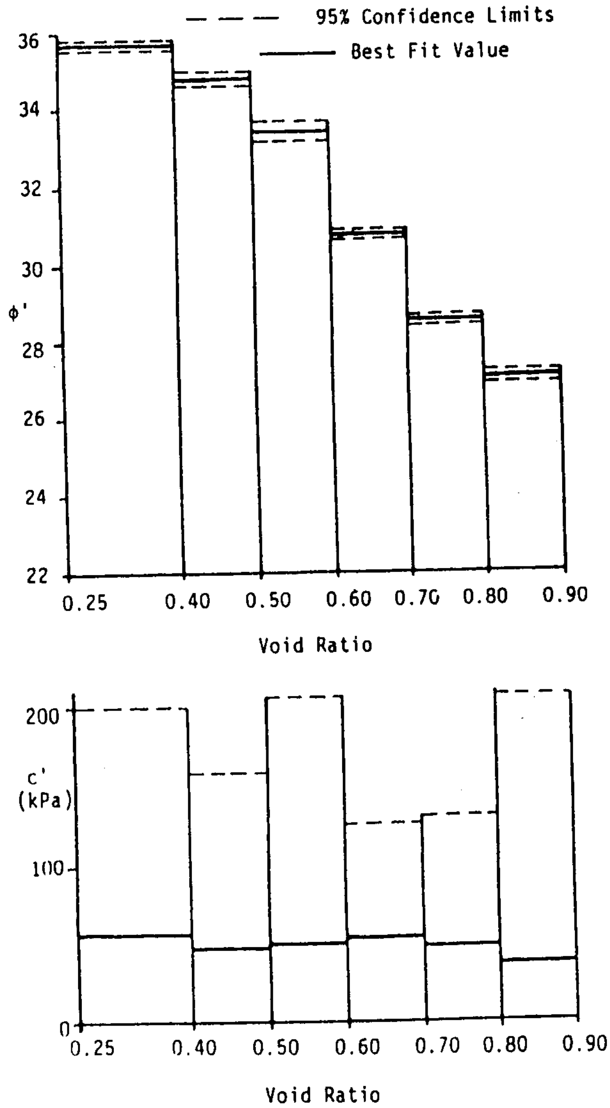



Figure 3. Shear strength parameters for completely weathered greywacke. Top: friction angle. Bottom: cohesion.

## 2. EXAMPLES

### 2.1 Weathered Wellington greywacke

The greywacke which is the basement rock of much of NZ is completely weathered in parts of Wellington. This means that the sandstone, which in the unweathered state is a very hard rock with an unconfined compression strength of the order of 50 to 100 MPa, is weathered to a soil that can be crumbled under finger pressure to sand and silt sizes. I first encountered this material in investigations for the Wellington Urban Motorway and buildings around Wellington in 1969. Over a period of a couple of years working for the then Ministry of Works and Development Central Laboratories I handled investigations at a number of sites, located as shown in Fig. 1, around the city. Part of the laboratory work involved triaxial testing on specimens taken from the 100 mm continuous core recovered with a triple tube rotary core barrel specially adapted for sampling this material. A few years subsequent to the investigation work I decided to examine all the triaxial data to see if there was any useful information that could be gained from the results. As the sites were relatively close, the sampling had been done with similar equipment, and the laboratory testing done with the same equipment by the same technicians it seemed not unreasonable to pool all the data. This provided about 193 consolidated undrained triaxial test results. Previous work on the weathered Wellington greywacke, Pender (1971), had shown that void ratio was a useful parameter for categorising the material. Consequently the triaxial results were grouped according to void ratio and regression analyses done on the strength test results. The results of one such analysis are shown in Fig. 2 which has 39 data points. The main finding from this examination of the pooled data was that the friction angle for the weathered greywacke correlated very well with the void ratio whereas the cohesion was very poorly defined for all void ratio ranges and showed little systematic trend with void ratio. This information is reproduced in Fig. 3. The conclusion from this is very clear: given the void ratio or density of the weathered greywacke one can predict the frictional component of the shear strength with some confidence but not the cohesive component.

It is of note that this work was done not by conducting a special purpose research programme but simply by reviewing data obtained from site investigations which had involved careful triaxial testing as a routine procedure. It so happens that this is the only such set of data for a NZ material, presumably one would expect a similar conclusion if data was available for other materials.

### 2.2 Residual soils from Waitemata Group soft rocks

Auckland soils are basically of three types: volcanic ash, Pleistocene deposits, and residual cohesive soils derived from in situ weathering of the Waitemata Group siltstones and sandstones. Two research students, Indrawan (1986) and Meyer (1996), have done extensive triaxial testing on residual Waitemata clays. Block samples were taken by excavating the sites to a depth of a few metres and pushing steel sampling tubes 203 mm inside diameter, wall thickness of 8 mm, and length of 200 mm, fitted with a removable low angle sharp cutting shoe. After jacking into the soil the tubes are excavated by hand. The sample ends were trimmed flush and then sealed with rubber sheets and restraining plates. From each of these sample tubes four triaxial specimens 75 mm in diameter and 150 mm in length can be trimmed. One of the objectives of these two projects was to examine the behaviour of these Auckland soils in terms of the concepts of critical state soil mechanics. An essential parameter in the critical state framework is void ratio (or specific volume), this being one of the three axes ($q = \sigma'_1 - \sigma'_3$, $p' = (\sigma'_1 + 2\sigma'_3)/3$, e - void ratio) that are used to plot soil behaviour.

Figure 4 gives the results obtained by Indrawan (1986) for the critical state line. The projection of the critical state line onto the q - p' (not presented herein) is well defined but onto the e - log p' plane,

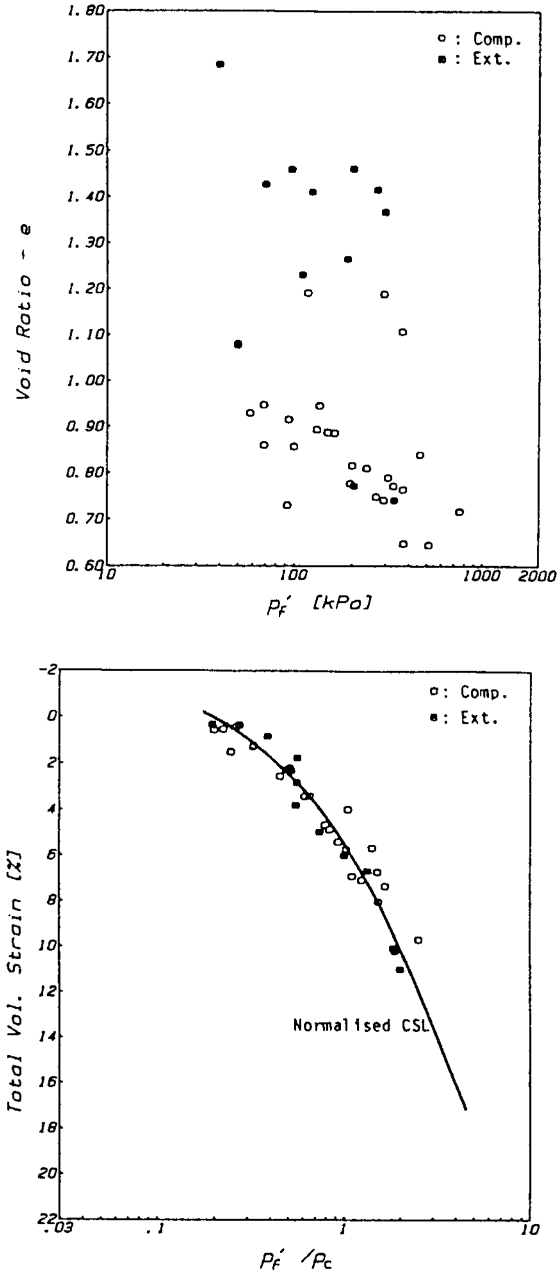



Figure 4. Indrawan's triaxial test data. Top: plotted with void ratio as the vertical axis. Bottom: plotted with total volumetric strain as the vertical axis.

shown in Fig. 4, there is an unacceptable amount of scatter. However we found that if the total volumetric strain, that is the sum of the volumetric strain during consolidation as well as that during shearing, is used instead of the void ratio then the plot against log p' exhibits much less scatter, Fig. 4. Meyer (1996) reached essentially the same conclusion as shown in Figs. 5. (There is a slight difference between Figs. 4 and 5 which does not affect the conclusion reached, namely that Indrawan normalised p' with respect to the preconsolidation pressure for the soil whereas Meyer did not do this.)

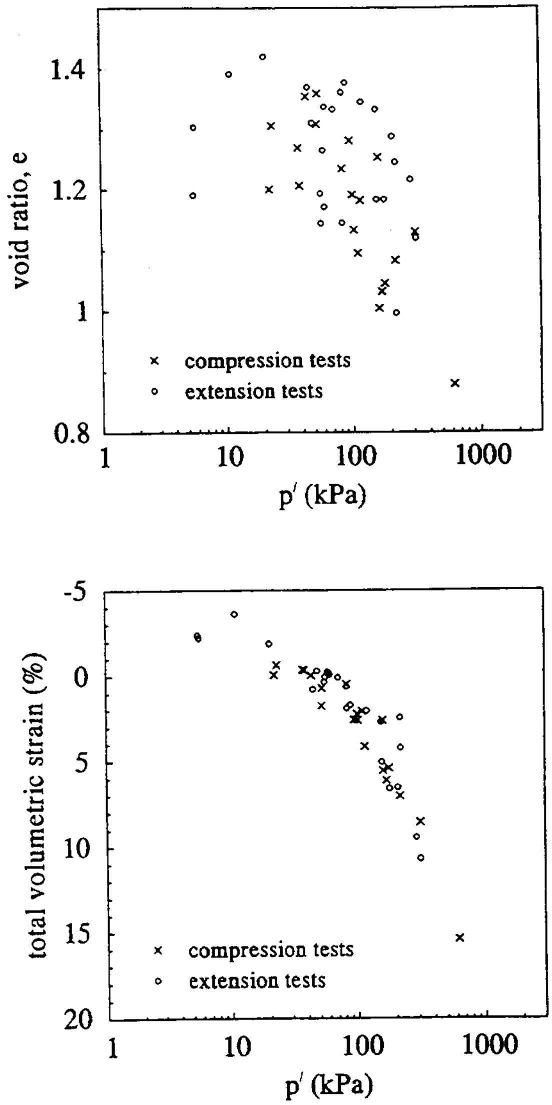



Figure 5. Meyer's triaxial test data. Top: plotted with void ratio as the vertical axis. Bottom: plotted with total volumetric strain as the vertical axis.

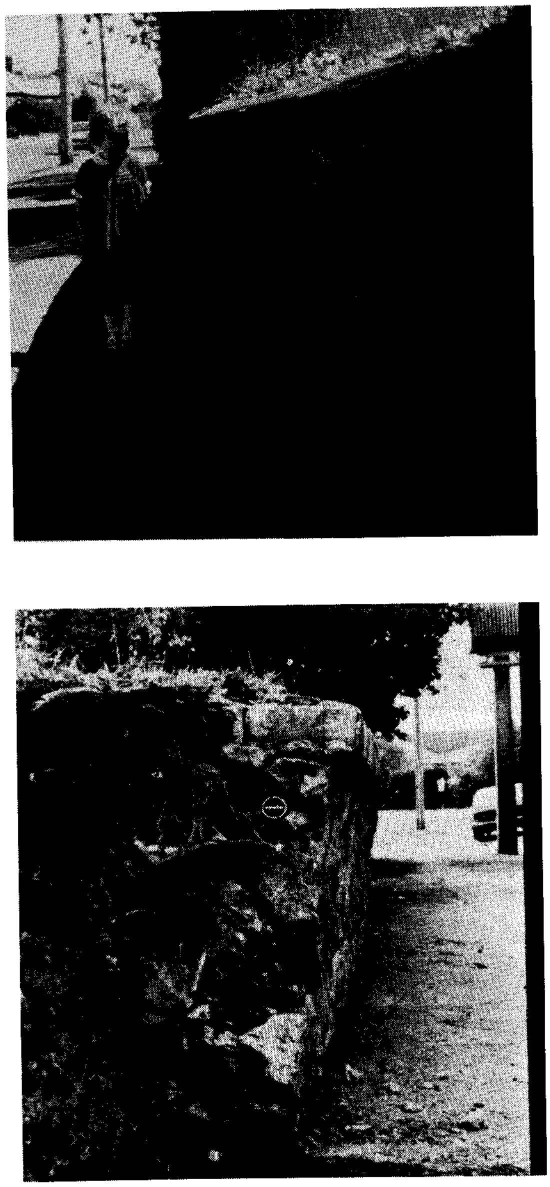


Figure 6. Pronounced lean on a domestic boundary wall retaining residual clay. Top: the wall prior to demolition. Bottom: the clay retained.

These findings suggest that the behaviour of the residual Waitemata clays is not governed simply by void ratio. Figures 4 and 5 reveal that the total volumetric strain is a more satisfactory parameter, this leaves unclear the mechanism that controls the stiffness of the soil skeleton for this particular residual soil.

### 2.3 Swelling pressures for Auckland residual clays

In the parts of Auckland with residual Waitemata clays older residential properties are often bounded by retaining walls up to a one metre or so in height. Many of these walls dating from the 1920's and 1930's now have a pronounced lean. An example of one such wall is shown in Fig. 6 along with an impression of the clay and lack of drainage behind the wall which was revealed when the wall was demolished prior to reconstruction.

One might initially conclude that the wall was inadequately constructed in the first place and that earth pressures have over a period of time led to a gradual tilting of the wall. As these clays have undrained shear strengths up to and exceeding 100 kPa no explanation for the state of the walls to be obtained from conventional active earth pressure considerations, even though the construction of these walls seems to have been done without drainage provisions and no special foundation. Generally they are built by placing with minimal mortar blocks of locally available basalt. This makes it very unlikely that water pressures are the source of the problem as the face of the walls is not

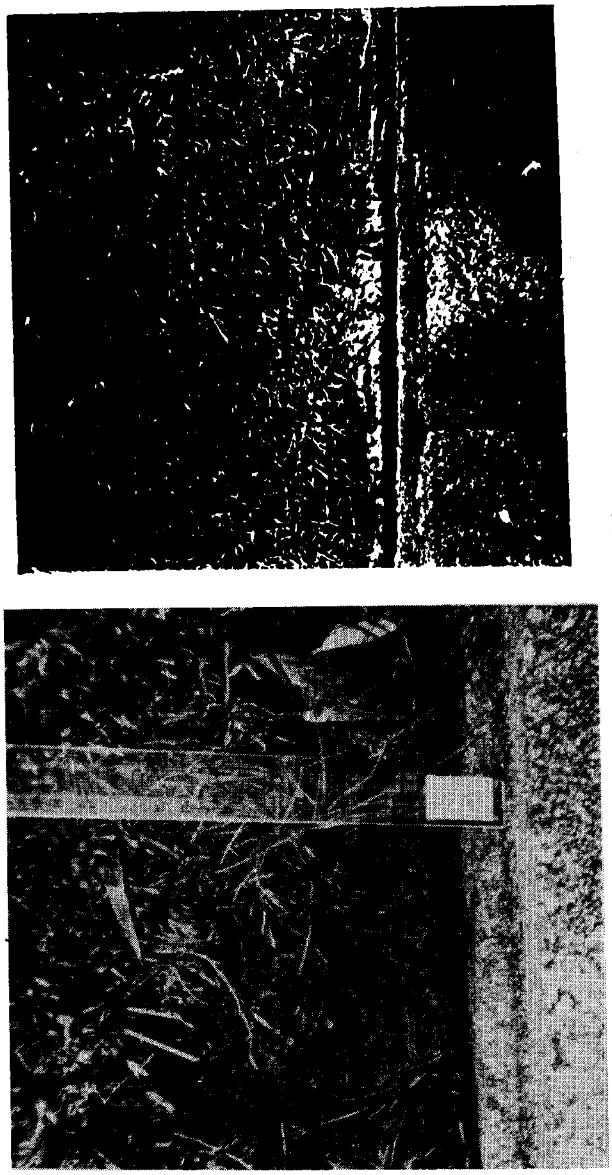


Figure 7. View of the top of the soil - wall interface for a 1.2 m high domestic retaining wall. Top: the crack visible in summer. Bottom: the interface in winter. (Photographs: V. M. Meyer.)

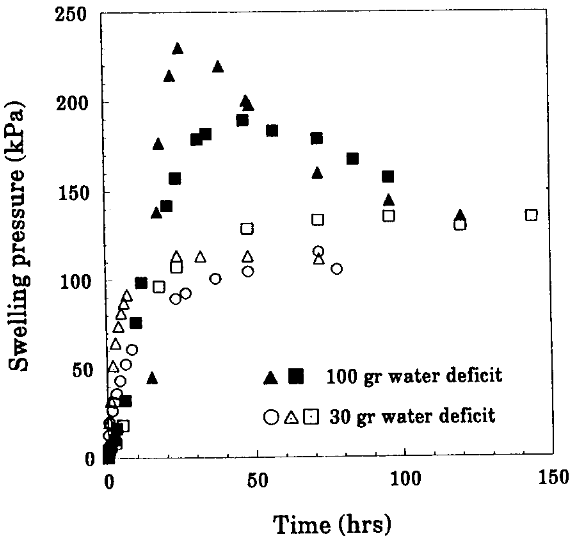



Figure 8. Lateral swelling pressures generated during one dimensional swelling of Auckland residual clay.

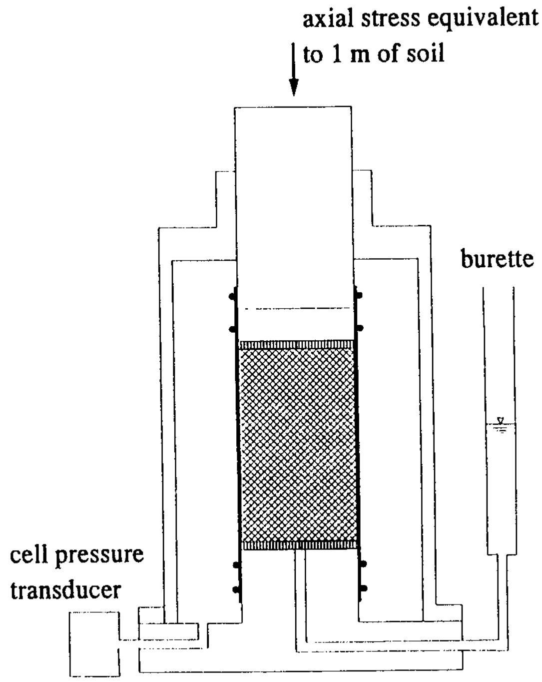



Figure 9. Triaxial cell used for one dimensional swelling tests.

likely to be waterproof. Thus the explanation for the state of these small domestic retaining walls must lie elsewhere.

Tschebotarioff (1973) suggests a possible mechanism which is repeated by Fredlund and Rohardjo (1993). They suggest that the annual shrink - swell cycle of clays between summer and winter might be responsible and they envisage that the clay shrinks and cracks in the summer and swells in the wet season. Around Auckland the cracking generally occurs to a about a depth of half to one metre. A summer and winter view of the top of a 1.2 m high wall retaining clay is shown in Fig. 7. It is clear that the clay shrinks away from the wall in summer but it is in contact during the winter. During the summer the cracks formed will collect some debris. When the cracks are filled with water and the clay swells to close the cracks which are now wedged with debris. As a consequence quite large swelling pressures will be exerted against the wall which requires a small outward movement to occur to relieve the pressure. Over the years this outward movement is cumulative, hence that state of the walls shown in Fig. 6.

Figure 8 has the swelling pressures generated during one dimensional swelling of unsaturated specimens of the residual clay from a site adjacent to the wall shown in Fig. 6. The specimens were 75 mm in diameter and 150 mm in length. After trimming from a near saturated state the specimens were allowed to dry in the laboratory until they had lost 30 grammes mass (about 10% of the water in the sample) and 100 grammes (minor surface cracking was then visible). They were then mounted in a $K_o$ triaxial cell having a very stiff cell wall. Filter paper side drains and a conventional rubber membrane were used. The cell was filled with water and care taken to flush out as much air as possible. A pressure transducer was attached to the cell pressure line and the cell fluid isolated by closing the valve. An axial load equivalent to the vertical stress from a one metre depth of soil was applied to the specimen and the clay given access to water from a burette through the bottom drainage disk. This set-up, illustrated in Fig. 9, was intended to model the situation in the field when water enters the soil from the cracks but lateral swelling is restrained because of the adjacent wall.

After the access to water the cell pressure rises and there is an increase in length of the specimen. For the specimen starting from a water deficit of 30 gr the cell pressure builds up to 100 to 140 kPa. This test was repeated a number of times on the single specimen, that is after the test the specimen was removed from the cell and allowed to dry in the laboratory until the water deficit was again 30 gr and the test repeated. Each time a similar cell pressure was recorded. The specimens with a starting deficit of 100 grammes were only tested once because for these the cell pressure rises to a maximum value in the 180 to 230 kPa range and then falls to about 150 kPa. On stripping of the cell these specimens were found to have undergone extension failure at the bottom where water had been drawn in.

These one dimensional swelling tests are more restrictive than occurs in situ as the $K_o$ triaxial cell prevents any lateral increase in diameter of the specimen (presuming all the air has been flushed from the cell) whereas if the cracks behind the wall are not completely filled with debris some lateral swelling may be possible. Nevertheless the pressures recorded by this soil with only moderate water deficit, certainly not enough to take the soil drier than the shrinkage limit, are sufficiently large to lead to the conclusion that the critical retaining wall loading comes not from active earth pressure but from the swelling mechanism. Clearly the maximum lateral pressure is controlled by the passive strength of the soil. Pressures of this magnitude could easily explain the titling of the small retaining walls. At this stage we have not determined how much lateral deformation is required to relieve the swelling pressure. The mechanism proposed by Tschebotarioff requires that this be small so to explain why many years are required before the tilt of the wall becomes noticeable.

### 2.4 Pumiceous sands

Central North Island volcanoes have produced considerable quantities of pumice which gives rise widespread occurrence of pumiceous sands. The distinguishing features of these sands is the ease with which the individual pumice particles can be crushed, the vesicular nature of the particles, and the texture of the particle surface. A micrograph of a pumice particle is shown in Fig. 10.

Because of the vesicular nature of the particles the specific gravity depends on the particle size. It was found that by taking the fraction retained on various sieves the apparent specific gravity increases as the particle size decreases; for material retained on the 1.18 mm sieve the SG was 1.60 whilst for pumice particles ground down to 63μm the specific gravity was 2.48. Even with this approach there are difficulties with the proper determination of void ratio as the standard method of determination of specific gravity requires immersion in water. The SG so determined will reflect penetration of water into the interior of the particles. If this occurs the SG value determined is not appropriate for determining void ratio which is intended to reflect the voids between the particles and not the voids within the particles. Pending a resolution of this problem the results herein were derived using a specific gravity of 2.27 which is a weighted average reflecting the particle size distribution and the separate values for the fraction retained on the various sieves.

The results from a series of drained triaxial tests on dry pumiceous sand are plotted in Fig. 11. The specimens were prepared by raining dry sand and the tests done with free ends and a height to diameter ratio of unity. It was found that strains in excess of 20 % were required for the sand to approach the critical state condition. It is clear that the critical state line is well defined both in the q - p′ plane and e - log p′ plane. Of considerable interest in Fig. 11 is the value of 1.7 for the critical state friction parameter, M. This corresponds to a friction angle in triaxial compression of 41.5°, a particularly high value probably reflecting the surface texture of the individual particles illustrated in Fig. 10.

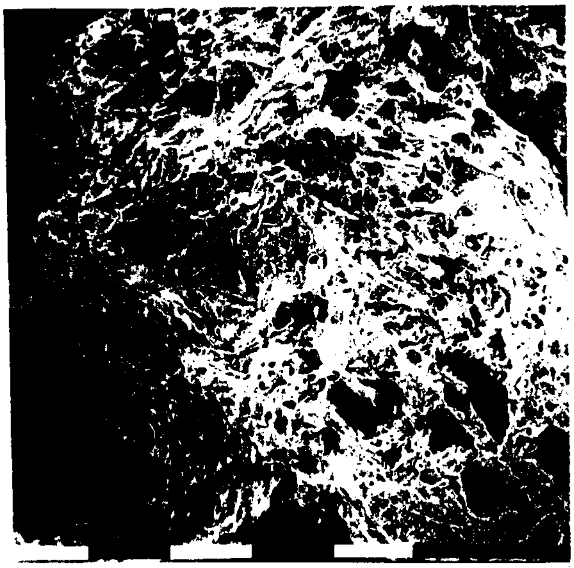


Figure 10. Surface texture of a pumice particle. (Scale: 0.1 mm per division)

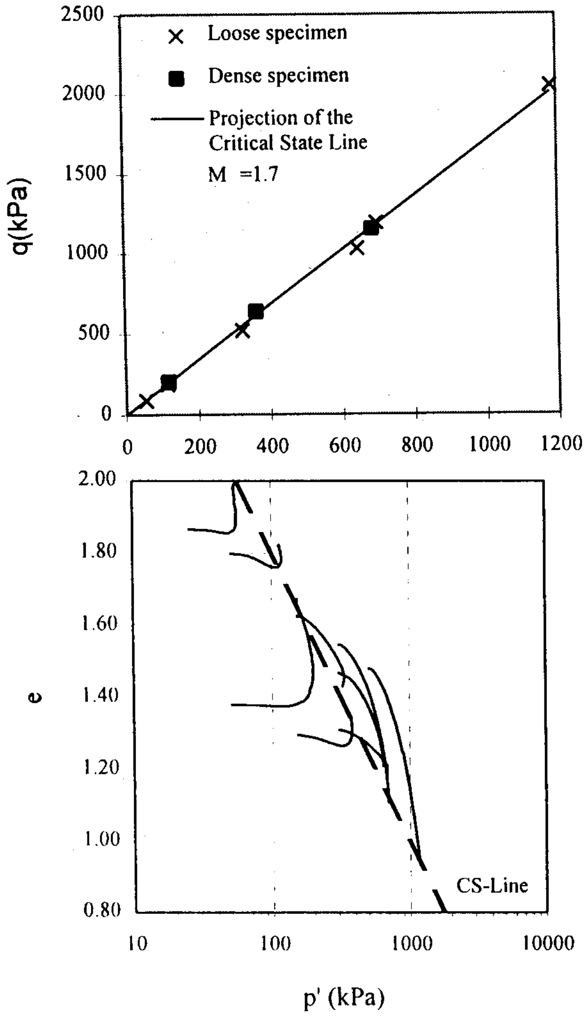



Figure 11. Critical state line for the pumiceous sand. Top: projection onto the q - p' plane. Bottom: projection onto the e - log p' plane (e determined using an SG of 2.27).

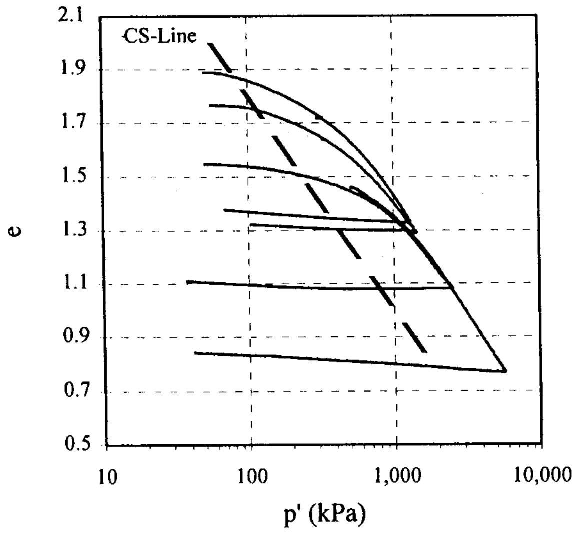



Figure 12. One dimensional compression of pumiceous sand (e determined using an SG of 2.27).

Since the pumice particles are so compressible it is of interest to investigate the pumiceous sand at high stresses such as occur during cone penetration. This was done by constructing a $K_o$ triaxial cell that could test specimens 75 mm in diameter and 150 mm tall. These results are presented in Fig. 12. Comparable lines for quartz sands are much flatter so the presence of the pumice gives a compressibility more like that of a clay than a sand. It is also of note that the slope of the critical state line and the $K_o$ compression line at high pressure are roughly parallel in the e - log p' plane, which is a feature of the critical state models of soil behaviour.

### 2.5 Cone and vane resistance in sensitive volcanic ash soils

Soils of volcanic origin are characterised by extreme variability. In such materials the cone penetrometer is an excellent investigation device because it gives a continuous record of the soil resistance and hence an indication of variability. The upper part of Fig. 13 gives the cone penetration resistance and friction ratio for a volcanic ash site at Ramarama near the Auckland Southern Motorway. Using the relative values of the cone resistance and sleeve friction the ash appears in the silt or silty clay part of the usual classification diagram.

In addition a profile of vane shear strength, with measurements taken at 200 mm intervals, and the sensitivity (ratio of the peak vane resistance to that after 2 complete revolutions of the vane) is plotted in the bottom part of Fig. 13. The vane is of robust construction and 100 mm in height and 50 mm in diameter.

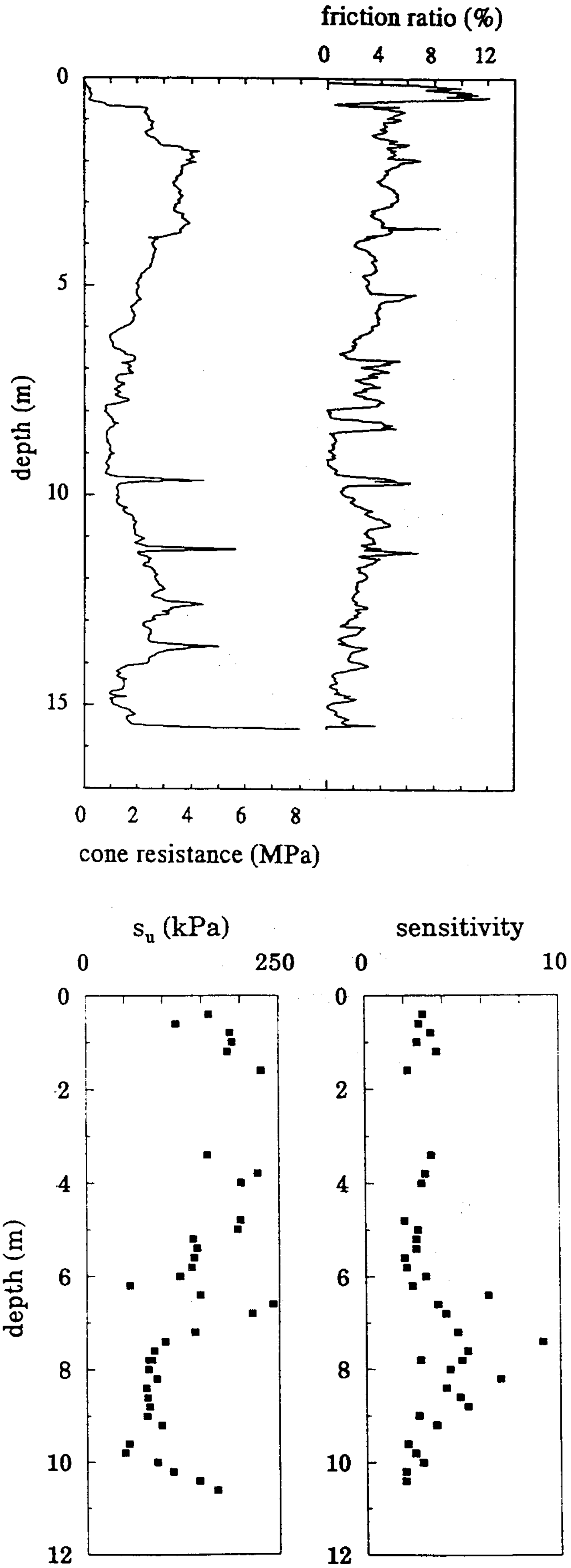



Figure 13. Cone and vane profiles in the volcanic soil deposit near Ramarama. Top: cone profile. Bottom: vane profile.

It is of interest to look at the relation between the cone resistance, $q_c$, and the undrained shear strength, $s_u$, from the vane, commonly expressed as $q_c = N_k s_u$. The variability of the Ramarama profile means that determination of $N_k$ is not straightforward even though the cone and vane profiles are adjacent. The cone record indicates a number of quite thin but very stiff layers and the remainder of the record exhibits significant fluctuation. For those parts of the profile where it is possible relate the vane and cone values $N_k$ ranges between 10 and 17. Deep bearing capacity theory gives a value for the ratio of penetration resistance to vane shear strength of 9, however when cone resistance and vane strength profiles are compared, this ratio is frequently found to be greater. It has been suggested that for cohesive soils values of $N_k$ larger than 9 are associated with larger plasticity indices.

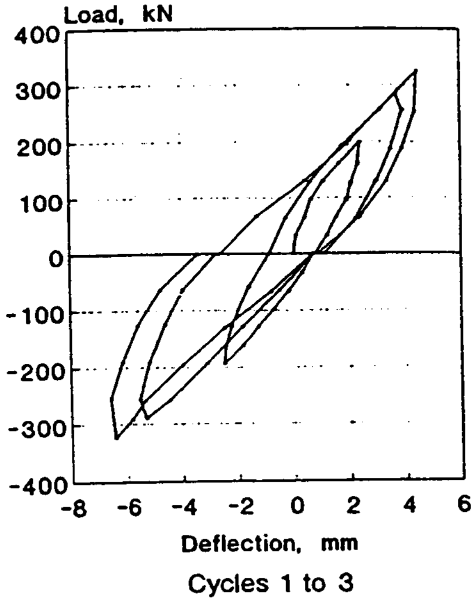
Alternative possibilities are the sensitivity of the ash and drainage during the vane test which is done at a much slower rate than the cone. The deeper ash in the profile given in Fig. 13 is very sensitive as evidenced by handling material from an adjacent exposure, yet apart from three positions having sensitivities in excess of six, the plotted values in Fig. 13 do not indicate high sensitivity. The pore pressure records registered large positive pore pressures while the cone was being advanced, but showed a significant drop during the pause of a few minutes required for adding a rod. The later part of the vane tests during which the sensitivity is measured also took a few minutes. This suggests that the vane tests may not be undrained and particularly that the undrained remoulded strength is not obtained after the two full revolutions, consequently the sensitivity is not determined correctly. This suggestion is consistent with local knowledge that volcanic ash soils tend to be reasonably permeable.

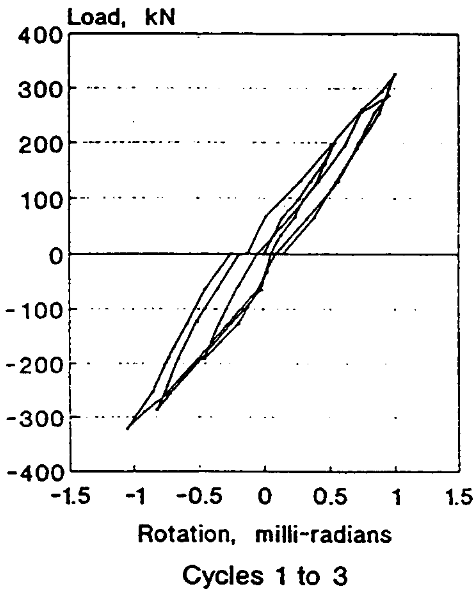
Yet another factor that might contribute to difficulty in comparing the vane and cone readings are the abrupt changes that occur in the cone profile. Vreugdenhil et al (1994) explain how the interpretation of cone records in soils is complicated in places where there are rapid changes in the soil resistance.

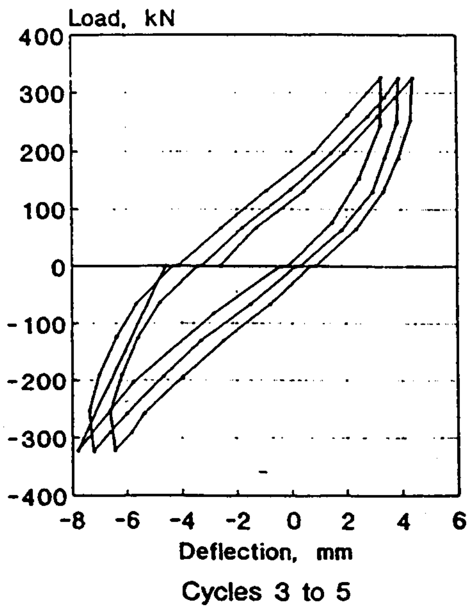
The conclusion from this discussion is that although both the vane and cone are extremely useful investigation devices, the complexity of volcanic soil deposits makes the interpretation difficult, particularly in situations where there is a need to convert from cone resistance to soil strength or vice versa.

### 2.6 Lateral stiffness of bridge piles in river gravels

NZ bridges are frequently constructed over rivers with gravel beds. Gravels with particle size distribution extending beyond 150 mm are not uncommon. Estimation of stiffness and strength values for these deposits presents difficulties as it is clearly not possible to recover undisturbed samples for laboratory testing. To provide some data on the stiffness properties of gravels, foundations for four bridges were subjected to lateral load testing prior to the installation of the deck. The foundations consisted of cylinders with diameters ranging between 1.2 to 1.8 m. The testing was done when the substructure had been completed but before the deck structures were placed. The detailed results are presented by Wood and Phillips (1987, 1989a, 1989b, 1991) and the total programme is summarised by Wood and Pender (1994). The test set-up, which makes possible two way cyclic loading on the centre piers of the bridges, applies shear and moment to the foundation by loading cables at deck level which react against adjacent piers. Figure 14 gives the lateral displacement and rotation for five cycles of loading for pier C of the Maitai bridge. The foundations for this bridge consist of single 1.8 m diameter cylinders embedded 12 m into the river bed, the load was applied 8.2 m above the groundline. From this data, and that for the other three bridge foundations tested, the stiffness of the gravels was determined using expressions for the lateral stiffness of piles embedded in an elastic medium which are summarised by Pender (1993).



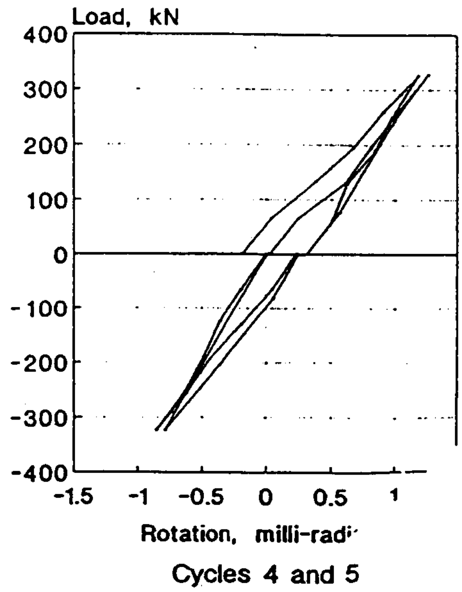




Figure 14. Maitai Bridge foundation stiffness testing. Right: Top - Deflection for cycles 1 to 3; middle - rotation for cycles 1 to 3; bottom - rotation for cycles 4 and 5. Bottom left: Deflection for cycles 3 to 5.

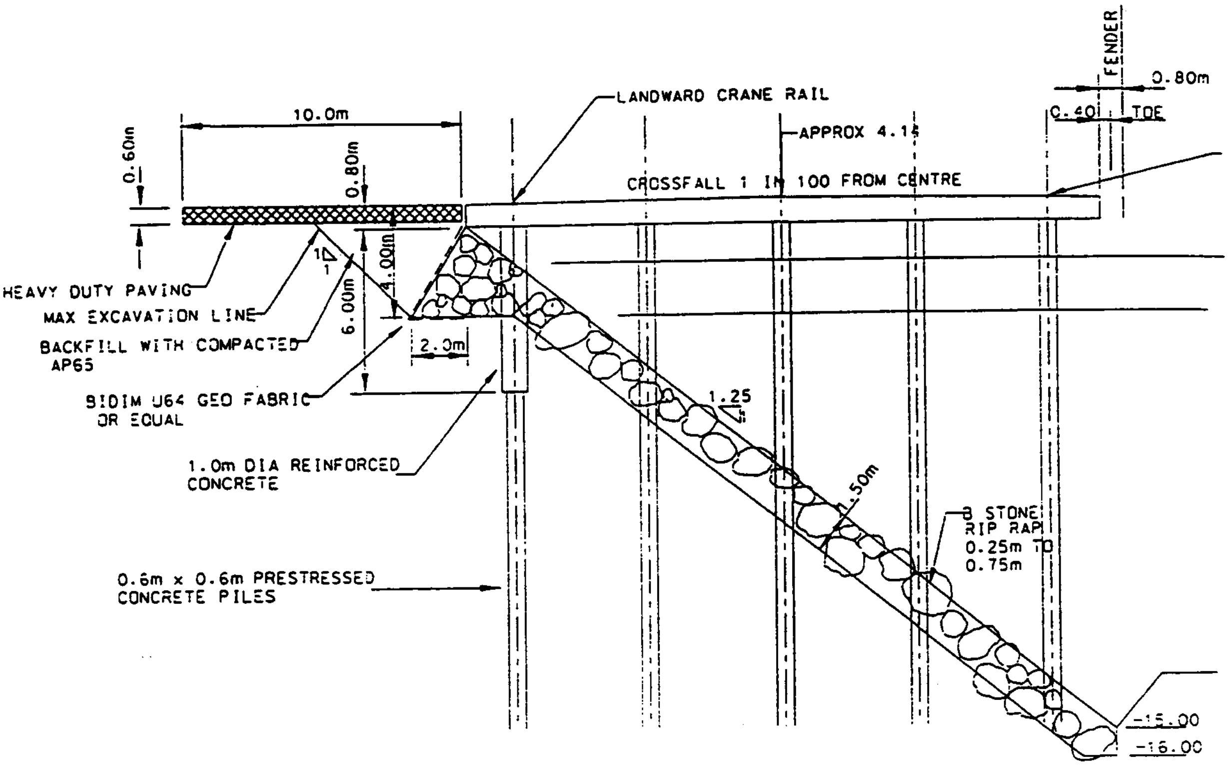



Figure 15: Cross-section through the Cashin Quay 4 development at the Port of Lyttelton.

The modulus determined for the saturated gravels at the four bridge sites was comparable to that of a dense saturated sand. This suggests that the gravel behaves in a manner similar to sandy soils and that the sandy matrix, rather than the gravel fraction, determines the behaviour. As the magnitude of loads was well below the capacity of the foundations the response was reasonably linear.

### 2.7 Pile driving resistance in rockfill

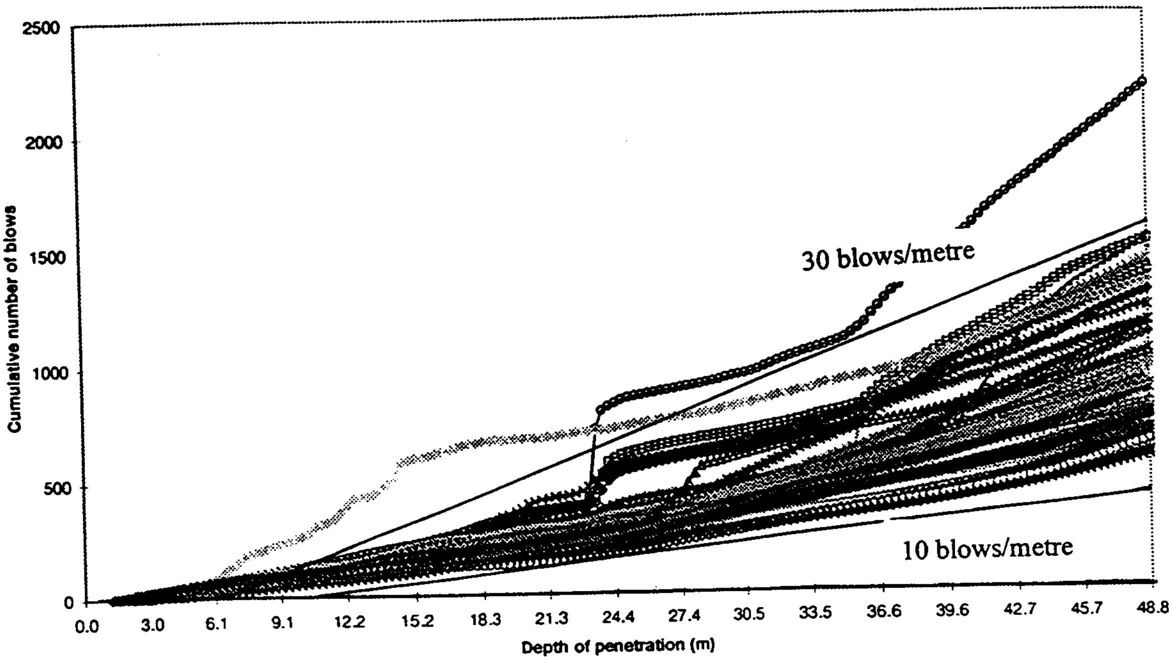
The Cashin Quay development for the Port of Lyttlelton has proceeded in a number of stages. Originally the reclamation was made in the 1960's using material obtained from a local quarry. The fill was placed for the full length of the eventual quay but the construction of the deck took place in stages. Timber piles were driven for the first stage in the mid 1960's, then in the early 1970's concrete piles - 0.45 m in diameter - were driven. The final part of the development, Cashin Quay 4, was completed in the early 1990's this time using 0.6 m x 0.6 m driven prestressed concrete piles. A cross-section through the most recently constructed part of the quay is given in Fig. 15.

Of interest here is the possibility of the fill material changing properties with the passage of time so that the driving resistance of the later piles is different from that of the earlier piles. Figure 16 gives the driving records for the landward row of concrete piles driven in the early 1970's and those for the piles driven in the 1990's. The pile sizes differ as do the driving hammers. Working from the approximate upper and lower bounds on the slope of the driving records, shown in Fig. 16, one can estimate the energy required to advance the piles one metre. Since the pile sizes are different this energy has been converted to the energy per unit tip area of the piles. The details are given in Table 1. Assuming that the hammer losses are the same for each driving rig one reaches the conclusion that the 1990's piles require about the same unit energy as the 1970's piles so the properties of the reclamation

**Table 1: Bounds on energy per unit tip area to advance the Cashin Quay piles 1 metre**

| | Hammer weight (kN) | Drop height (m) | Energy per blow (kNm) | Pile section area ($m^2$) | Energy per unit tip area ($kNm/m^2$) | Blows per metre | Upper and lower bounds on the energy per unit tip area to advance the pile 1m ($kNm/m^2/m$) |
|---|---|---|---|---|---|---|---|
| Cashin Quay 3 (1970's) | 46.6 | 1.22 | 56.8 | 0.16 | 355 | 10, 30 | 3550, 10650 |
| Cashin Quay 4 (1990's) | 118.0 | 1.0 | 118.0 | 0.36 | 328 | 12, 27 | 3936, 8856 |

seem to have changed little in the 20 year period. Examining the data from the timber piles driven in the first stage of construction in the late 1960's about the same unit energy is required to drive these piles. However the timber piles are tapered and although the circumference of the bottom end is recorded on the driving sheets the amount of taper is not, so unit energy values for these are not included in Table I.



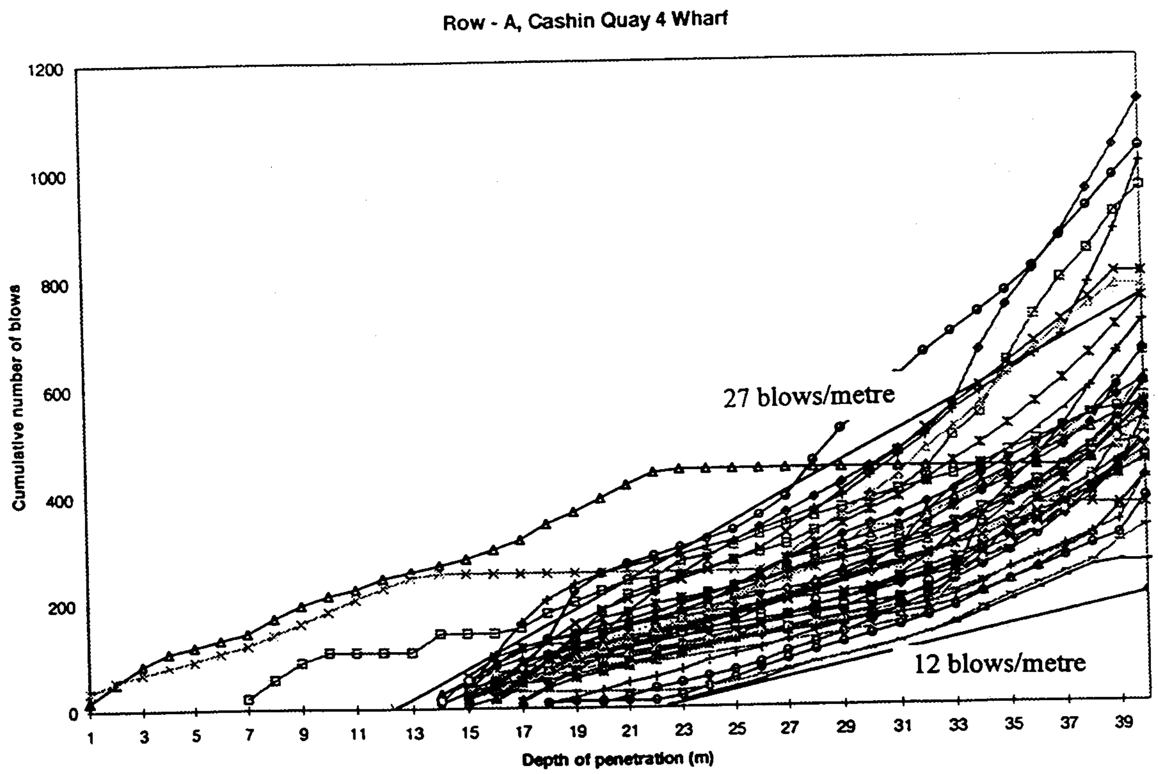




Figure 16. Driving records for the Cashin Quay piles. Top: Cashin Quay 3, 0.45 m diameter piles driven in the 1970's. Bottom: Cashin Quay 4, 0.6 m x 0.6 m piles driven n the early 1990's. Upper and lower "bounds" on the penetration resistance are shown on each plot.

## 2.8 Stiffness values for soft rock

Much of the Central North Island of NZ is cloaked in a soft rock of tertiary age known locally as "papa". This material often has sufficient strength to stand in near vertical slopes several tens of metres in height. When cuttings are formed for road construction there is a characteristic slabbing failure, which does not usually close the highway, but is an annoying maintenance problem. The Structures Committee of the Road Research Unit of the former National Roads Board funded a number of investigations into the properties of this material. One opportunity arose during the daylighting of a tunnel when the North Island Main Trunk Railway line was electrified. Some multiposition extensometers were installed into the rock surrounding the tunnel and the movements monitored during the daylighting process. The dimensions of the cut formed by the daylighting are shown in Fig. 17 and the positions of the extensometers in Fig. 19, further details are given by Read et al (1988). More information about the work discussed in this section is given by Cheenikal (1996).

The data obtained has been used to get an indication of Young's modulus for the rock mass. The finite element mesh before any excavation is shown in Fig. 17 and in detail around the tunnel in Fig. 18. The finite element programme used was capable of incremental removal of elements and hence able to model the excavation process. The behaviour of the rock mass and tunnel lining was assumed to be elastic and various values chosen for the modulus of the rock until a reasonable match was obtained between the observed and computed deformations. The modulus of the lining was taken as that of

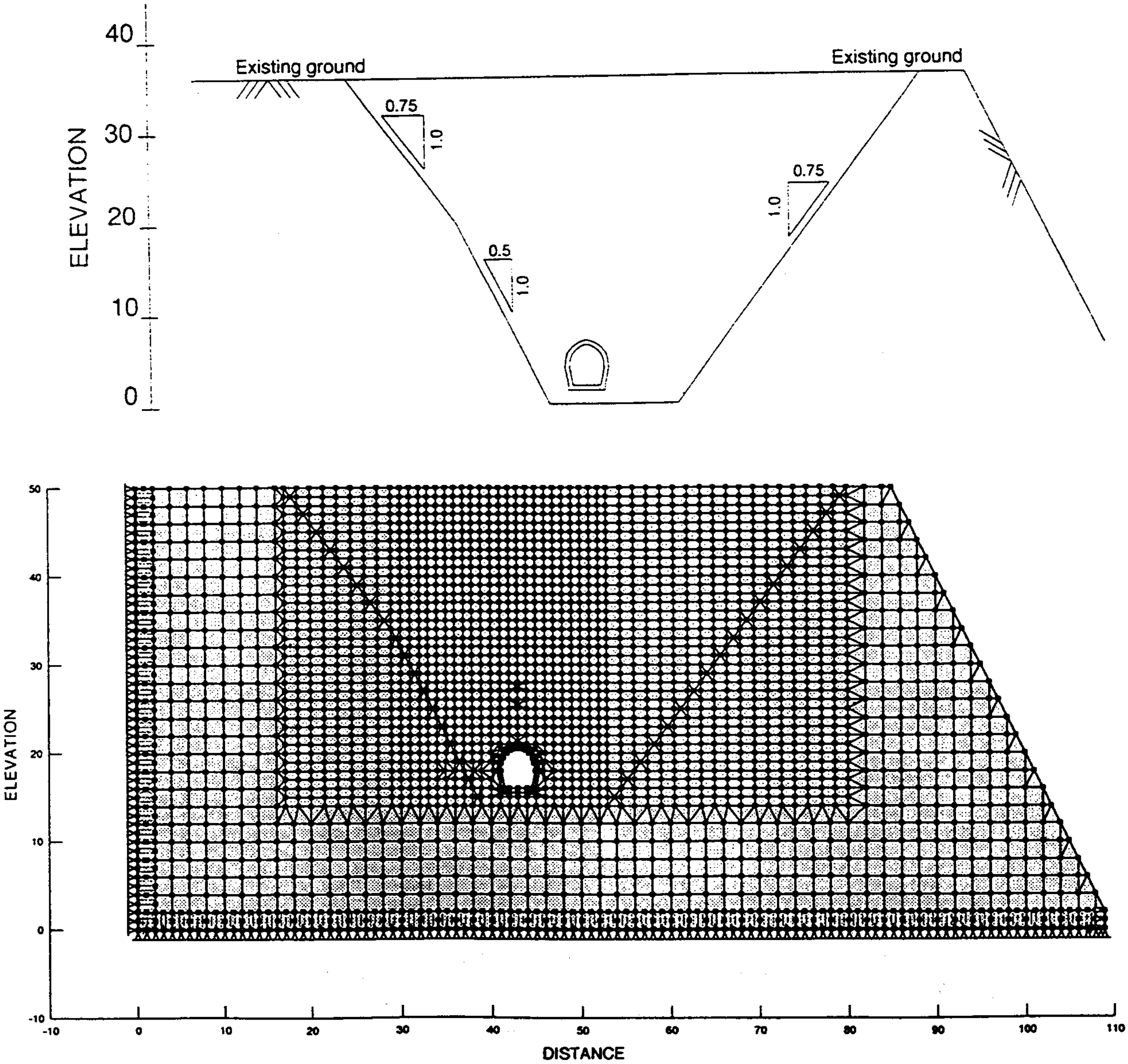



Figure 17. Profile of the excavation for the daylighting of Makohine 9 Tunnel and the finite element mesh used for the numerical modelling of the process.

concrete at 25 GPa. The in situ stresses in the rock were modelled using a value of Poisson's ratio that gave the initial horizontal stresses about half the vertical. This was considered to be likely as the ridge through which the tunnel passed did not have great lateral extent.

Figure 19 compares the measured and computed displacements and demonstrates a reasonable agreement. In achieving this agreement it was

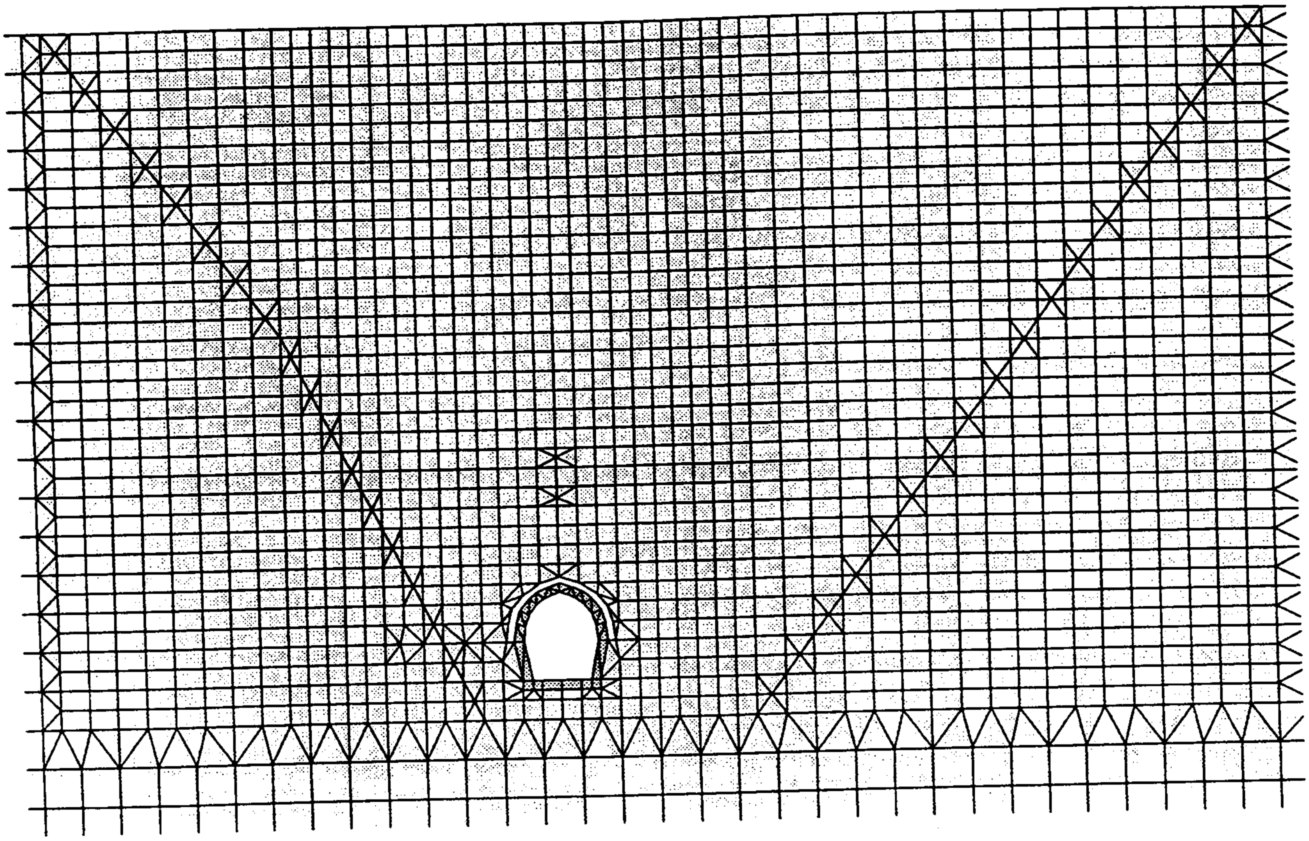


Figure 18. Detail of the finite element mesh surrounding the tunnel showing the modelling of the gap above the crown.

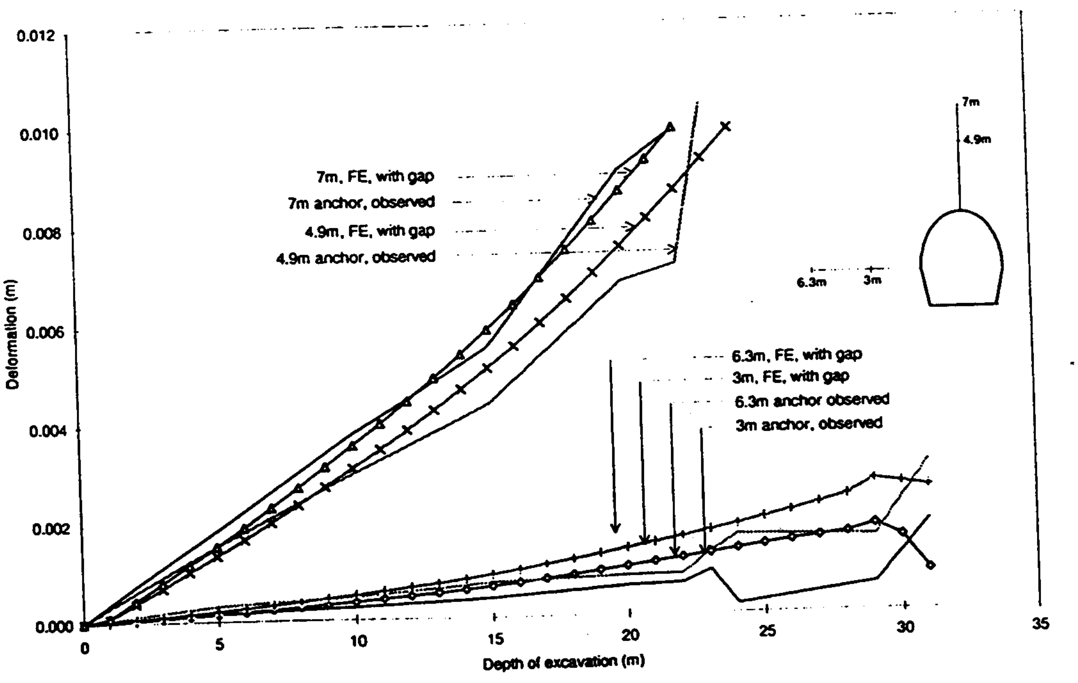



Figure 19. Comparison between observed and calculated displacements for the tunnel excavation. A Young's modulus value of 550 MPa was used for the calculations. The positions of the extensometer anchors

found to be important to represent the gap between the tunnel lining and rock at the top of the tunnel. The modulus determined for the rock of about 550 MPa was greater by a factor of five from the average modulus determined from unconfined compression testing of Nx size cores (Young's modulus 27 to 167 MPa), and rather greater than that determined in triaxial tests on the soft rock at confining pressures corresponding to the overburden presssure at the depth of the tunnel (Young's modulus 125 to 320 MPa). This differenece between the triaxial stiffness and the inferred in situ stiffness may reflect the properties of the particular core tested, rather than a deficiency in the process of taking cores of the soft rock and performing laboratory testing.

## 2.9 In situ stresses in a coal seam

Modern rock mechanics places much reliance on the determination of in situ stresses in the design of underground openings. The earliest methods were developed for hard rocks and are unsuitable for application in soft rocks. In the 1970's the CSIRO pioneered a method that gives good results in soft rocks but is still not suitable for even softer materials such as coal. In the course of a project at the Huntly West mine in the North Island of NZ, a device was developed for the measurement of in situ stresses in coal. The instrument consists of a very flexible cylindrical membrane into which have been cast three rosette strain gauges, the details are given by Mills and Pender (1986) and Mills et al (1986). The steps in the measurement process are as follows: the pilot hole is drilled and cleaned, the outer surface of the probe is coated with epoxy and inserted into the pilot hole, the membrane is inflated with a modest pressure to bring the epoxy and strain gauges into contact with the wall of the borehole, this pressure is maintained whilst the epoxy cement cures, a "pressuremeter" test is then done to (i) confirm the cotrect operation of the strain gauges and (ii) provide information from which the modulus of the coal to be overcored is determined, the overcoring is done and the change in the strain readings noted, and finally the data is processed to give the in situ stress field. Apart from the very flexible membrane, which ensures that the epoxy cement is not put into tension during the overcoring process, the main innovation of this device is the ability for it to act as a small pressuremeter. This enables the modulus of the coal to be obtained without subsequent laboratory tests on the overcored piece of coal.

The instrument was used to measure the stresses in a panel of coal through which an experimental

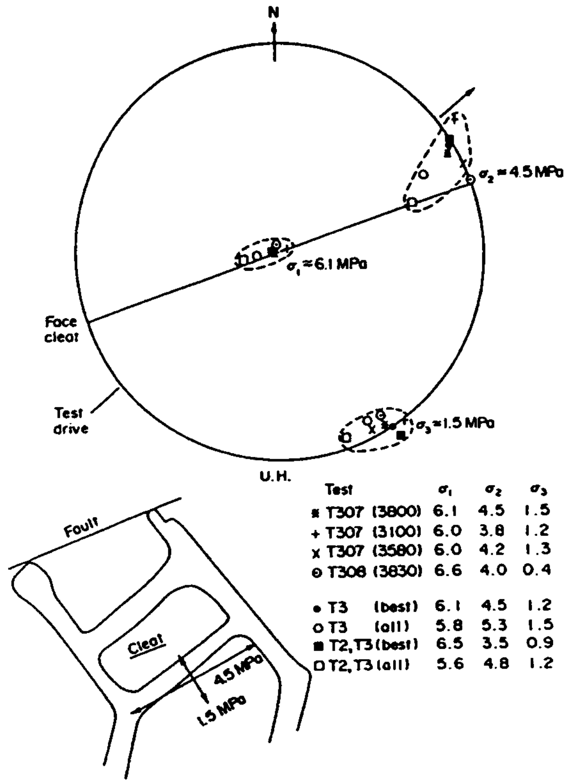



Figure 20. Measured in situ stress field in the coal seam at the Huntly West Mine.

roadway was later driven, the measured stress field is shown in Fig. 20. The measurements were made at a depth of 250 m beneath the ground surface. It is of interest to note that these were such that the measured vertical stress was the major principal stress, the intermediate principal stress was approximately horizontal and oriented in the direction of the experimental roadway excavated later, and the minor principal stress was also horizontal oriented across the direction of the roadway. The minor principal stress was about one quarter of the major principal stress so the coal sustains considerable permanent shear stress.

Other instruments were installed so that displacements and stress changes could be monitored when the roadway was driven. The layout of the experimental roadway and instrumentation is shown in Fig. 21. Subsequent finite element analysis (mesh also shown in Fig. 21) of the deformations and stress changes based on the measured in situ stress field, confirmed that the instrument gave a correct indication of the in situ stresses in the coal seam. A comparison of the measured and calculated displacements are shown in Fig. 21. More details in Pender and Mills (1993).

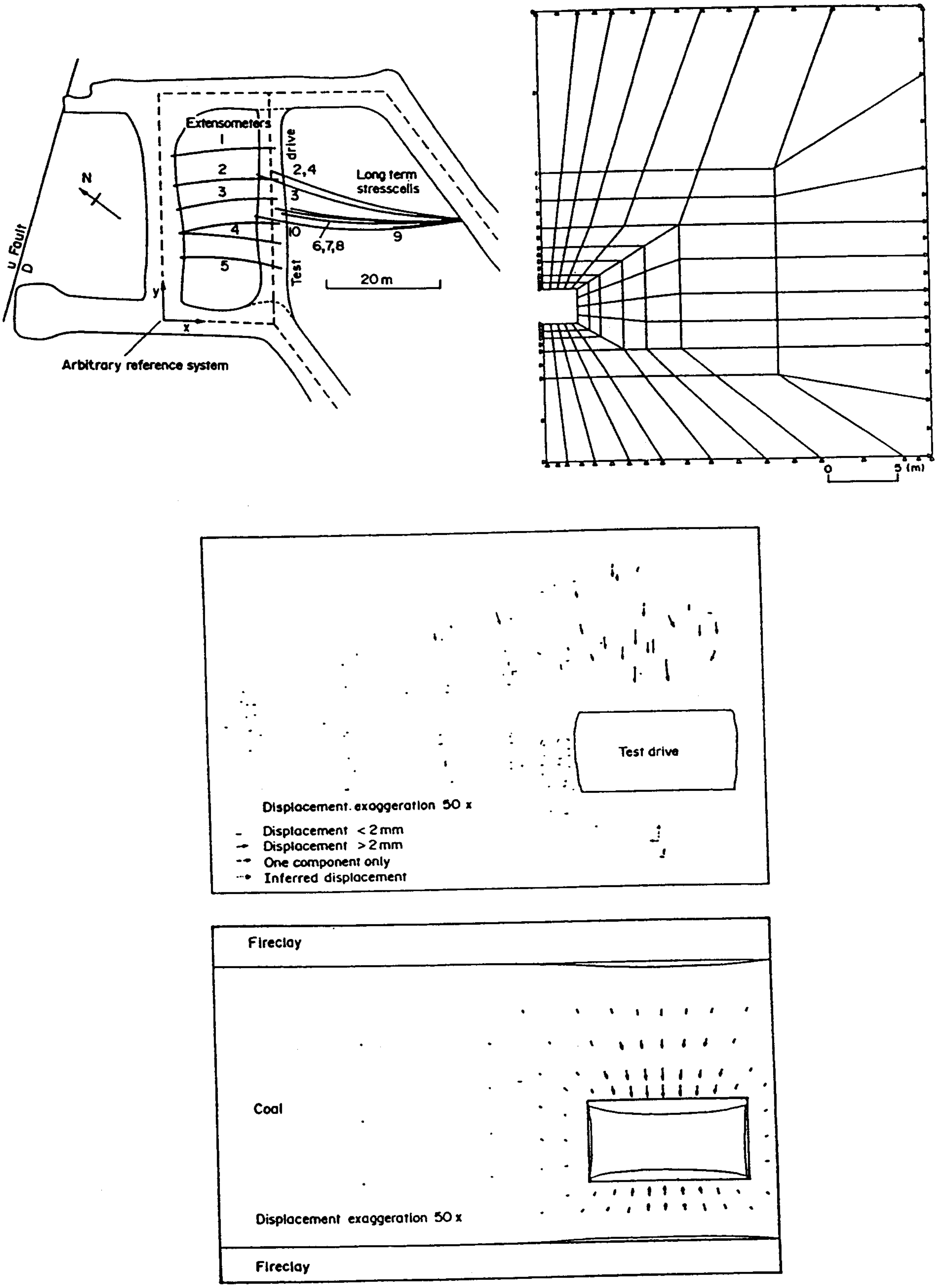



Figure 21. Huntly West Mine experimental roadway. Upper left: layout of instrumentation. Upper right: finite element mesh. Middle: displacements observed when the roadway was excavated. Bottom: displacement field calculated by the finite element analysis using the measured in situ stress field as part of the input.

## 2.10 Strength parameters for closely jointed rock masses

To finish we will return to Wellington, this time to discuss shear strength parameters for closely jointed unweathered greywacke rock masses. The older rocks in NZ are generally very closely jointed, an example of an excavated slope in unweathered greywacke in Wellington is shown in Fig. 22. The great problem in dealing with this material is the estimation of the strength parameters for the rock mass. The rock is unweathered and the intact material is very strong and although closely jointed, the joints are very tight. One piece of information that is available is a plot of slope heights and slope angles for the Wellington slopes, which is reproduced in Fig. 23. It is possible to take the steeper slopes and ask what mobilised shear strength is required to satisfy equilibrium in these slopes. In fact, if one assumes that the rock mass is dry, one obtains the lower limit on the strength for the rock mass. Work along these lines is reported by Pender and Free (1993) and the mobilised strength envelope so determined is reproduced in Fig. 24. Since this is a lower bound, one is inclined to wonder how far above this the real failure envelope for the rock mass lies. An alternative is to compare this mobilised shear strength envelope with the modified Hoek-Brown failure envelope for a closely jointed rock mass, Hoek (1994a). This is also plotted in Fig. 24 which suggests that there might be a considerable reserve of shear strength available if the Hoek-Brown envelope is valid for this material (in this regard recent comments by Hoek (1994b) about the widespread adoption of a criterion which was offered more as a suggestion than a definitive statement are relevant). One possible approach to getting a better feeling for the available strength of this material is to consider the seismic history of the Wellington. The slopes plotted in Fig. 23 have been subjected to earthquake loading in the past. It is no doubt possible to get from the seismological community some idea of past maximum peak ground accelerations. The back analysis of the slope could then be repeated with these accelerations present to get a new mobilised shear strength envelope. It would be of interest to know how large an acceleration is needed to push the mobilised strength out to the Hoek-Brown envelope in Fig. 24.

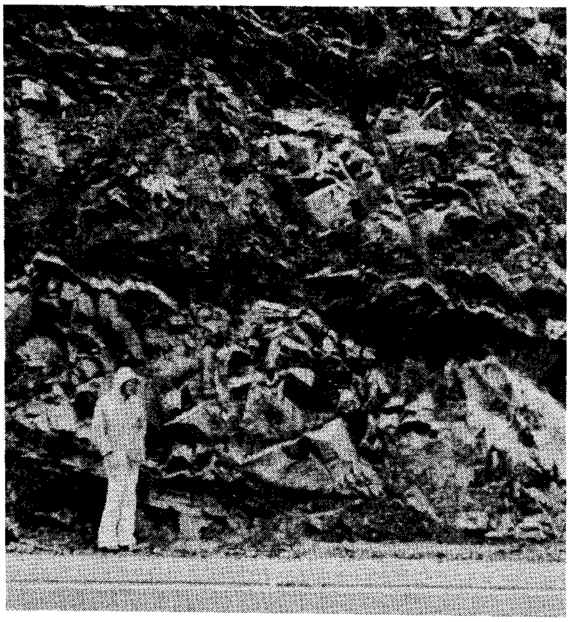



Figure 22. Rock slope excavated in closely jointed unweathered greywacke in the Ngauranga gorge in Wellington.

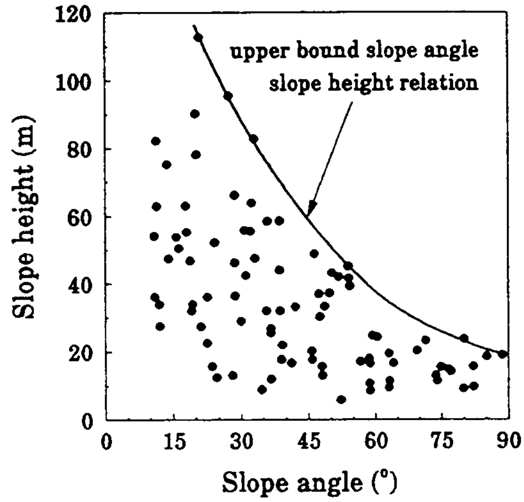



Figure 23. Greywacke slope height slope angle data.

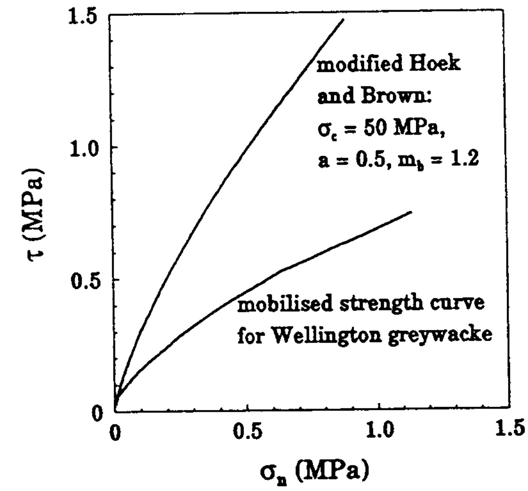



Figure 24. Mobilised strength envelope for the upper bound of the Wellington greywacke slopes and the failure envelope derived from the modified Hoek - Brown failure envelope.

## 3. DISCUSSION

Returning to the introductory comments about the difficulty of determining parameter values, it is of interest to review the above ten examples as illustrations of various techniques that can be used.

*Laboratory testing* - this is the classic means of investigating soil and rock behaviour. In this paper the information about the behaviour of pumiceous sands and residual Auckland clay was gained this way.

*Getting the most from data obtained in routine site investigation* - in the case of the completely weathered Wellington greywacke, it was possible to gain useful insight by re-examining the results of routine laboratory testing on a given material. This approach is particularly helpful if data from more than one site investigation are combined.

*Interpretation of in situ test results* - as the stress conditions in field tests are not as easily controlled as many laboratory tests, the need for interpretation arises. Sometimes it will be necessary to rely on more than one test method to gain a fuller understanding. In the above discussion, the correlation of cone penetration and vane data for volcanic ash was found to be difficult because of the variability of the soil.

*Are conventional theories always valid?* There may be situations for which the standard ways of thinking about soil behaviour are not valid and other points of view are required. The example herein is the manner in which void ratio does not seem to be an effective state variable for describing the behaviour of residual soils derived from in situ weathering of Auckland clays and for pumiceous sand.

*Use of finite element (or other numerical method) analysis to interpret data obtained from monitoring of field behaviour* - the examples discussed herein are the tunnel daylighting and the coal seam. The ability to handle complex boundary conditions was illustrated in the tunnel example with the gap over the top of the lining.

*Recognition that new techniques may need to be developed for particular cases* - the example herein is the measurement of stresses in coal seams.

*Reinterpreting old field data and construction records* - the investigation of the pile driving at the Port of Lyttelton is the example where this was done. This example also highlighted the usefulness of good quality construction records.

*Looking at structural behaviour and asking what aspect of soil behaviour could explain what is observed* - the example given in the paper is the behaviour of small retaining walls.

*Observing in situ conditions and asking if this can tell us about the properties of a particular material* - the closely jointed rock slopes in Wellington provided an example of this approach.

*Prototype scale testing* - the stiffness evaluations of the bridge foundations illustrated this method.

## 4. CONCLUSIONS

The membership of the NZ Geotechnical Society are familiar with the interesting materials that we encounter. This point has been illustrated again in the above sections of this lecture in which aspects of the behaviour of NZ materials have been emphasised. What has also been illustrated is a range of techniques for investigating material behaviour and properties are also varied. One can take samples and do laboratory testing, undertake field testing, use finite element and other numerical techniques to interpret field observation data, re-evaluate data collected some time ago, simply look at a field situation and do simple numerical calculations to gain a better understanding of what may be happening there, extract data from past project files. Applications of all these techniques have been illustrated in this lecture. No doubt there are others not mentioned. The most striking conclusion from the material presented above is that much useful data is already available, what is required is the effort to extract it and review it.

## 5. ACKNOWLEDGEMENTS

The invitation to give this lecture is one way the NZ Geotechnical Society has of recognising contributions to geotechnical engineering in NZ; my sincere thanks to the Society for honouring me in this way. Personally I have to admit that any contribution I have made has received input from many others. Thus I wish at the conclusion of this lecture to acknowledge the various members of the Society and others in NZ who have contributed to the development of my view of geotechnical engineering. Similarly I would like to mention the various organisations in the county which have played a part.

Firstly the organisations. The University of Canterbury for fostering an outstanding learning environment at both undergraduate and graduate levels and for excellent library facilities. The former NZ University Grants Committee for the Post Graduate scholarship that enabled me to study for a PhD and subsequently a Post Doctoral fellowship which made it possible for me to spend time with the soil mechanics group at the University of Cambridge. The former Ministry of Works and Development Central Laboratories for forcing me to come to grips with the reality of geotechnical engineering as distinct from the idealised world one inhabits as a research student. The University of Auckland for providing excellent geotechnical laboratories. The various groups in the country who have invited me to become involved with their work as a consultant. The former Energy Research and Development Committee which funded the work on the in situ properties of coal. The Structures Committee of the Road Research Unit of the former National Roads Board which funded the work in closely jointed rock slopes. State Coal of NZ at Huntly for access to the Huntly West Mine. The Lyttelton Port Company for pile driving records. The Foundation for Research Science and Technology for supporting the work on pumiceous sands.

Next the people. Colleagues and former colleagues at the University of Auckland: Peter Taylor, Laurie Wesley, Tam Larkin, Ian Collins, Graeme Duske, Warwick Prebble, John St George, Geoff Martin, Max Irvine, and John Hughes. Present and former graduate students who have worked on properties of NZ materials: Bill Gray, Chris Graham, Ken Mills, Zacheus Indrawan, David Carter, Matthew Free, Ross Peploe, Nigel Fitch, Lani Cheenikal, Satyawan Pranjoto, and Vaughan Meyer. Former teachers and colleagues at the University of Canterbury: Pip Alley, Tom Dodd, David Elms, John Berrill, Rob Davis, John Blakeley, and Dave Bell. Those with whom I worked at the Ministry of Works and Development: John Robinson, John Galloway, John Rutledge, Dave Jennings, Ian Parton, Andrew Olsen, Dave Convery, Jeff Bryant, Glynn East, and Henry Kennedy. Staff of the former Department of Scientific and Industrial Research: Roy Northey, John Hawley, Ian Brown, Bruce Riddolls, and Stuart Read. From Tonkin and Taylor: Don Taylor, Tim Sinclair, Peter Millar, and Graham Salt. Finally Trevor Matuschka of Engineering Geology, Mary Fama and Bill Munden formerly of the former State Coal Mines of NZ, and John Wood of Phillips and Wood.

## 6. REFERENCES

Cheenikal, L. (1996). *Back analysis of the Daylighting of NIMT Tunnel 9 at Makohine*, Project D report the Master of Engineering, Department of Civil and Resource Engineering, University of Auckland.

Fredlund, D. G. and Rahardjo, H. (1993). *Soil Mechanics for Unsaturated Soils*, Wiley, p. 313.

Hoek, E. (1994a). Strength of rock and rock masses *ISRM News Journal*, Volume 2 no2, pp. 4- 16.

Hoek, E. (1994b). The challenge of input data for rock engineering, *ISRM News Journal*, Volume 2 no2, pp. 23 24.

Indrawan, Z (1986). *Stress-strain and strength characteristics of an Auckland soil*, PhD thesis Department of Civil Engineering University of Auckland.

Meyer, V. M. (1996). *Low stress behaviour of Waitemata clay*, PhD thesis, Department of Civil and Resource Engineering, *University of Auckland*, in preparation.

Mills, K.W. and Pender, M.J. (1986). A soft inclusion for in situ stress measurement in coal, Proc. *Int. Symp. Rock Stress and Rock Stress Measurement*, edited by O. Stephansson, Stockholm, pp. 247 - 251. Centek, Lulea.

Mills, K.W., Pender, M.J. and Depledge, D. (1986). "Measurement of in situ stress in coal", Proc. *Int. Symp. Rock Stress and Rock Stress Measurement*, edited by O. Stephansson, Stockholm, pp. 543 - 549. Centek, Lulea.

Pender, M.J. (1971). Some Properties of Weathered Greywacke, Proc. *1st Aust.-N.Z. Conference on Geomechanics*, Melbourne, Vol. 1, pp 423-429, Vol. II, pp 569-574.

Pender, M.J. (1980). Friction and Cohesion Parameters for Highly and Completely Weathered Wellington Greywacke, Proc. *3rd Australia-New Zealand Conference on Geomechanics*, Wellington, Vol. 1, pp 171-175.

Pender, M. J. and Mills, K. W. (1993) In situ testing and monitoring of a test drive in an underground coal mine, In: *Comprehensive Rock Engineering*, Vol. 4, Chapter 27, pp. 731-750, Pergamon Press.

Pender, M. J., (1993) "Aseismic pile foundation design analysis", Bulletin of the NZ National Society for Earthquake Engineering, Vol. 26 No. 1, pp. 49-160.

Pender, M. J. and Free, M. W. (1993) "Stability assessment of slopes in closely jointed rock masses", Proc. *Eurock'93*, Lisbon, Vol. I., pp. 863-870.

Read, S. A. L, Sutherland, A. and Millar, P. J. (1988). Performance of instrumented cut slope in tertiary age soft rocks - daylighting of the NIMT tunnel 9 (Makohine). *Unpublished New Zealand Geological Survey report*, NZGS EG418.

Tschebotarioff, G. P. (1973). *Foundations, Retaining and Earth Structures*, McGraw Hill, 2nd edition p. 386.

Vreugdenhil, R. Davis, R. O. Berrill, J. B. (1994). Interpretation of Cone Penetration Results in Multilayered Soils, *Int. Jnl. Num. Anal. Methods in Geomechanics*, Vol. 18, No. 9, 585-599.

Wood, J. H. and Pender, M. J. (1994). Lateral stiffness of large diameter bridge pile foundations, Proc. *2nd International Workshop on Seismic Design of Bridges*, Queenstown, R. Park editor, Civil Engineering Department University of Canterbury, Vol. 1, pp. 205 - 228.

Wood, J. H and Phillips, M. H. (1987). Lateral stiffness of bridge pile foundations: Load tests on Newmans bridge, *Report ST 87/2, Mills and Wood Ltd.*, Lower Hutt.

Wood, J. H and Phillips, M. H. (1989a). Lateral stiffness of bridge pile foundations: Load tests on Maitai River Bridge, *Report ST 88/1, Mills and Wood Ltd.*, Lower Hutt.

Wood, J. H and Phillips, M. H. (1989b). Lateral stiffness of bridge pile foundations: Load tests on Wai-iti River Bridge, *Report ST 89/1, Phillips and Wood Ltd.*, Lower Hutt.

Wood, J. H and Phillips, M. H. (1991). Lateral stiffness of bridge pile foundations: Load tests on Charwell River Bridge, *Report ST 90/2, Phillips and Wood Ltd.*, Lower Hutt.

# PREDICTING SETTLEMENT RATES OF CLAYEY SOILS

**Auckland Branch Meeting Presentation, 16 October 1996**

Dr John Hawley spoke on ***"Predicting Settlement Rates of Clayey Soils"***. This was a report on a FORST contract to put his late 1960's Cambridge PhD consolidation theory onto a PC, to make it user-friendly and to incorporate *stress relaxation.*

The numerical (computer) approach removes the need for several of Terzaghi's simplifying assumptions. Most importantly, the linear relationship between effective stress and void ratio alone can be replaced by a "surface" in "effective stress/void ratio/strain rate" space. This has the effect of uniting the primary and secondary stages under the control of six relationships:

- continuity
- Darcy's Law
- equilibrium
- the effective stress equation
- a void ratio/permeability relationship
- the "effective stress/void ratio/strain rate" relationship

Laboratory behaviour is then more accurately modelled in that:

(a) laboratory settlement continues at large times after the "primary" phase is over (see "Computation 1")
(b) in reduced Local Increment Ratio (LIR )tests (see "Computation 2") - the ratio of secondary to primary settlement is increased (Ref 1)
(c) in such tests excess pore pressures dissipate more rapidly than in standard (LIR = 1) tests (Ref 2).

Because at a field scale, strain rates are generally much lower than in lab tests, and because LIR decreases with depth as self-weight forces become significant, the claim (by Dr Hawley) was that the new method is likely to give more accurate extrapolations of scale than the "$t/H^2$" rule given by Terzaghi's theory.

Other improvements on Terzaghi theory are:

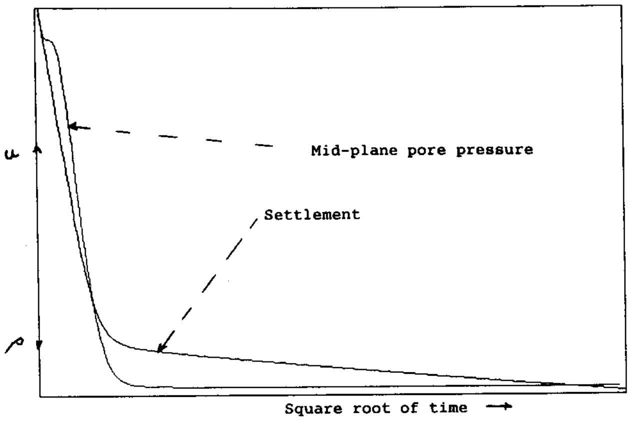
- *self-weight effects are included*:- while neglecting self-weight is seen to make little difference at lab scale, at field scale that will generally not be the case
- *a permeability/void ratio relationship is incorporated*:- this is in preference to the assumption that permeability remains constant during each increment

The computer program also includes the following facilities:

- the option of drainage for the consolidating layer at *top only, bottom only or both*
- the facility to carry on from one increment to the next with the programme picking up void ratios and pore pressures from the previous increment, and opportunity to change the slope of the void ratio/log effective stress alignment of the stress/void ratio/strain rate "surface"
- a "commercial front end" with limits on input data which prevent users feeding in obviously wrong numbers (such as solids densities less than 2.2 or greater than 3)
- "help" statements:- to explain what each input line refers to and what its units should be.

Extensions of the program could make it carry out "automatic" iterations, refining values of the constants defining particular soils to achieve more accurate correspondence with laboratory results. Once a good fit was achieved, predictions of field behaviour could be made by changing stratum thickness alone.

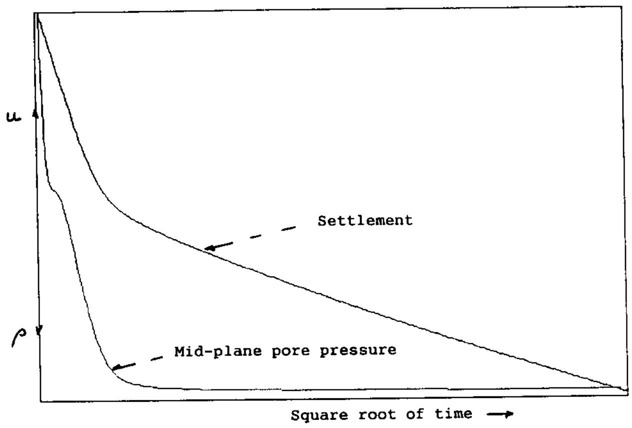
The method highlights how little information about the low strain rate part of the "effective stress/void ratio/strain rate" surface is revealed by the standard 24hr, LIR = 1 test. The inclusion of a small load increment (say LIR = 0.2) could help with this problem.




**Computation 1** Step loading from 30 to 60 kPa Load Increment Ratio (LIR = 1) on a sample of thickness 0.02 m.

Method of computation models observed secondary as well as primary settlement.

Conventional assumption of zero pore pressure during secondary stage is a good approximation at this scale. However, when thickness is increased 10x (Computation 3 below) the continued dissipation during the secondary stage is apparent. This becomes more marked at even greater thicknesses.




**Computation 2** As for Computation 1 but with LIR reduced to 0.2.

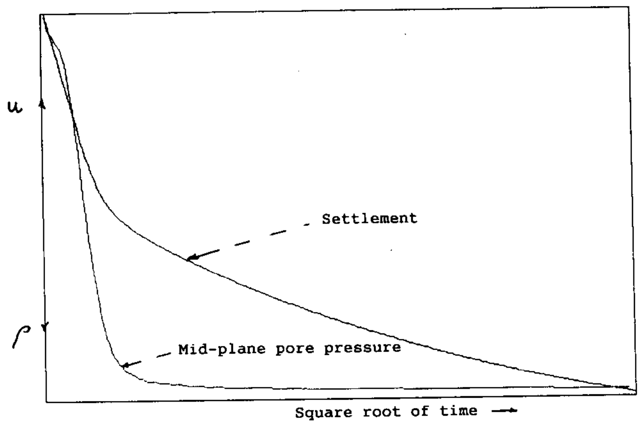
Increased ratio of secondary to primary settlement as observed by Newland Allely (1960).

Earlier dissipatioin of pore pressures as observed by Leonards and Girault (1961).

**Computation 3** As for Computation 1 but thickness increased 10x to 0.2m.

The time scale has been increased according to the $t/h^2$ rule i.e. 100x. The Terzaghi theory would give graphs identical to those for Computation 1 (but with no secondary settlement in either case).

Settlement is less clearly divided into primary and secondary stages, even through LIR=1. Though pore pressure dissipation is comparatively unaffected in this case, this is generally true.




## References

1. Newland, P.L.; and Allely, B.H.; (1960): "A Study of the Consolidation Characteristics of Clay" Geotechnique, 10:2:62 - 74.
2. Leonards, G A; and Girault, P; (1961): "A Study of the One-dimensional Consolidation Test" Proc.5th Int.Conf, SMFE Vol.1.

# Ultimate limit state design of slopes

M J Pender

The question is should we design slopes using a limit state approach? Why bother, you say; our present factor of safety methods are quite satisfactory. Limit state design of foundations is based on applied actions (forces and moments) coupled with an assessment of the ultimate capacity. Slope stability analysis on the other hand uses a well understood approach which seems to be quite different. This is certainly a valid response if one is considering a slope which has no foundation loads applied, but what do we do if the slope supports a foundation. The foundation loads will have been factored using the load combinations in the loading standard such that a limit state design of the foundation would be expected. Thus it is worth considering if slope design is possible in limit state format. A key aspect of the discussion is the factoring of the unit weights of the soil and pore water. Very good reasons why these are not factored are discussed below. Given this the slope stability factor of safety is found to be the inverse of the strength reduction factor.

## Factoring soil dead weight and pore water pressures

Reasons for not factoring soil unit weight are given by Orr (1993) and Simpson (1992). The points they make are that of the soil parameters required for stability analysis the unit weight is less variable than the strength parameters. Secondly some load factoring schemes use different values for loads that enhance stability and for those that drive instability. For instance NZS4203:1992 uses a 0.9 for dead load which enhance stability. If one considers a slip circle analysis with the rotation from left to right, then those slices to the right of the centre aid stability and would be factored with the 0.9 and those to the left drive stability and so would have a different load factor. However, if one searches for the worst circle then various positions are tried for the circle centre. This means that an element of the soil volume could be to the left of the circle centre in one calculation and the right in another. Thus the load factor applied same volume of soil would change depending on the particular slip circle involved. One concludes from this that greater consistency is obtained if the only load factor applied to soil unit weight and pore water pressures is unity. This provides a basis for expressing the slope stability factor of safety in terms of a strength reduction factor.

## Slope stability factor of safety and strength reduction factors

The slope stability definition of the factor of safety is based on how much, on average, of the shear strength of the soil is mobilised:

$$F_{\text{slope stability}} = \frac{\text{average shear strength along the failure surface}}{\text{average shear stress along the failure surface}}$$

For a soil with both frictional and cohesive strength components we assume that the same proportion of c' and $\tan\phi'$ are mobilised, thus along a failure surface with a factor of safety, F, we have:

$$\text{Shear stress} = \frac{\text{Shear strength}}{F} = \frac{c'}{F} + \frac{\sigma_n' \tan\phi'}{F}$$

For a slip circle with n slices and radius r the moment about the circle centre of the slice weights (the action which drives the possible failure) is:

$$M_D = r\sum_{i=1}^{n} W_i \sin\theta_i$$

where $\theta_i$ are the angles to the vertical the circle radius makes with the centre of the slice bases.

The moment of the available resistance is:

$$M_R = r\sum_{i=1}^{n} \{c_i \Delta A_i + N_i \tan\phi_i\}$$

where $N_i$ are the normal forces at the slice bases and $\Delta A_i$ are the areas of the slice bases. The expression for the factor of safety which is quite consistent with the above definition, is then:

$$F = \frac{M_R}{M_D} = \frac{\sum_{i=1}^{n} \{c_i \Delta A_i + N_i \tan\phi_i\}}{\sum_{i=1}^{n} W_i \sin\theta_i}$$

Depending on the particular method of slices some assumption is made to estimate the normal forces and hence calculate F, but, as explained by Lambe and Whitman (1969), the above equation is exact. We can rearrange it to give

$$F\sum_{i=1}^{n} W_i \sin\theta_i = \sum_{i=1}^{n} \{c_i \Delta A_i + N_i \tan\phi_i\}$$

This gives us the factor of safety times the driving moment is equal to the moment of the available shear resistance. A simple further rearrangement gives:

$$\sum_{i=1}^{n} W_i \sin\theta_i = \Phi\sum_{i=1}^{n} \{c_i \Delta A_i + N_i \tan\phi_i\}$$

where $\Phi$ is the strength reduction factor (note the upper case, the usual notation for the strength reduction factor is a lower case phi, but, since we use $\phi$ for friction angle, the upper case is used herein for the strength reduction factor). Comparison of the above two equations reveals that:

$$\Phi = \frac{1}{F}$$

Note that this in only possible if the load factor on the unit weight is unity, the reason being that the unit weight of the soil is involved on both sides of the equation; on the left to determine the slice weights and on the right to estimate the normal forces on the base of the slices.

The above shows that it is possible to consider slope stability analysis within the framework of ultimate limit state design. A value of $\Phi$ of 0.8 for the strength reduction factor corresponds to a factor of safety of 1.25, 0.67 to 1.5, and 0.5 to 2.0. Foundation loads applied to the slope can also be incorporated easily as they will provide additional components of the driving moment on the left hand side of the above equation and to the normal forces on the right hand side.

**References**

Lambe, T. W. and Whitman, R. V. (1969 & 1979) "*Soil Mechanics*", Wiley

Orr, T. L. L (1993) "Partial safety factors in geotechnical design", Paper presented to the Geotechnical Society of Ireland, 9th November 1993.

Simpson, B. (1992) "Retaining structures: displacement and design", Geotechnique, Vol. XLVII No. 4, pp. 539-576.

## CONTENTS

## Session 2: Excavations, Tunnelling and Mining



## Session 3: Seismicity and Stability

## Session 4: Expansive Soils



## Session 5: Geotechnical Modelling

## Specialty Session 1: Where is Geotechnical Practice Heading?



## Session 6: Foundations and Pavements

## Session 7: Environmental Geomechanics



## Session 8: Field Testing

## Session 9: Professional Issues



## Specialty Session 2: Momentous Occasions

# 7th Australia New Zealand Conference on Geomechanics

## Geomechanics in a Changing World

## Adelaide, South Australia

## 1 - 5 July 1996

## Abstracts

**Edited by M.B. Jaksa, W.S. Kaggwa and D.A. Cameron**

(with assistance from G. Chari)

Organised by the Australian Geomechanics Society in cooperation with the New Zealand Geotechnical Society and the Australasian Institute of Mining and Metallurgy. The conference is a Regional Conference of the International Society for Soil Mechanics and Foundation Engineering (ISSMFE) and is endorsed by the International Association of Engineering Geology (IAEG) and the International Society for Rock Mechanics (ISRM).

# Building on Marginal Land - Some New Zealand Experiences

**D.H. Bell**
B.Sc (Hons) M.Aus.IMM
Senior Lecturer, Department of Geological Sciences, University of Canterbury, NZ

**Abstract** Marginal land is here defined as a building site that is affected by one or more geotechnical hazards with a severity or frequency such that during its design life damage may occur to the structure. Marginal land may be suitable for residential use provided that adequate investigations are undertaken to define the geotechnical constraints, that appropriate remedial or protection works are implemented, and that the owner accepts a degree of risk to the property. Examples of successful building on marginal land include dormant landslide complexes, coastal areas, and flood-prone sites; whilst land subject to rockfall or erosion hazards may similarly be built on if appropriate protection measures are implemented. Professional advisers have important obligations to clients in such situations, and administrative authorities are encouraged to make greater use of s36(2) of the Building Act 1991 when approving such developments.

**Keywords** Geotechnical hazards, erosion problems, rockfall hazards, construction on landslides, coastal hazards, stability assessment, professional issues, administration matters.

**Reference** Bell, D.H. (1996). Building on Marginal Land - Some New Zealand Experiences. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 273-281

# Near-field Seismic Design Motions: A Case Study From Wellington, New Zealand

**J.B. Berrill**
Reader, University of Canterbury, New Zealand

**Abstract** The special character of ground shaking close to the fault together with the difficulty of theoretical predictions requires that near-field design motions be estimated empirically. However, the set of near-field strong motion records is far from complete, and scaling must be employed in most cases. Simple rules for scaling near-field records are reviewed and illustrated with an example from Wellington, New Zealand.

**Keywords** Earthquake resistance, earthquakes, seismic waves, seismology, structural design.

**Reference** Berrill, J.B. (1996). Near-Field Seismic Design Motions: A Case Study from Wellington, New Zealand. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 282-287.

# An Observational Approach to Optimise Risks and Costs of Road Cuttings in Highly Fractured Rocks

**P. Brabhaharan**
B.Sc.Eng. (Hons), M.Sc.Eng., M.I.P.E.N.Z., R.Eng., M.I.E.Aust., C.P.Eng., M.I.C.E., C.Eng.
Senior Geotechnical Consultant, Works Consultancy Services Limited, New Zealand
**M.J. Fleming**
B.Sc. (Hons), N.Z.C.E.
Senior Engineering Geologist, Works Consultancy Services, New Zealand

**Abstract** The design and construction of road cuttings in highly fractured and fault disturbed rocks, and the associated uncertainties pose a challenge to geotechnical engineers. An observational approach can be applied to the design and construction of cuttings to optimise costs and risks. This involves design of road cuttings based on the available limited information, followed by routine engineering geological mapping of exposures, observation of performance, geotechnical assessment and review of the design during construction. The incorporation of trial excavations into construction contracts to facilitate this approach can also be valuable in this process. Two recent projects in central New Zealand, illustrate the appropriateness of this philosophy to highways requiring road cuttings through highly fractured, fault disturbed rocks.

**Keywords** Highway engineering, slope stability, rock, risks, value engineering, engineering geology, cut slopes, faults, greywacke, observational methods.

**Reference** Brabhaharan, P. and Fleming, M.J. (1996). An Observational Approach to Optimise Risks and Costs of Road Cuttings in Highly Fractured Rocks. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 171-178.

## Laboratory Testing - General Report

**G.B. Farquhar**
B.E., B.D., M.Sc(Lond)., D.I.C., C.Eng., MIPENZ, MICE
Senior Geotechnical Engineer, Worley Consultants Ltd, New Zealand

**Abstract** This General Report reviews 22 papers allocated to the session on Laboratory Testing. The papers cover areas in soil and rock testing, ie fundamental behaviour, geofabrics, simulation of field conditions, calibration of field apparatus, and properties of particular materials.

**Keywords** Soil mechanics, rock mechanics, material testing.

**Reference** Farquhar, G.B. (1996). Laboratory Testing - General Report. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 43-47.

## Settlement of a Building on Coral and its Underpinning with Proof Loaded Piles

**G.B. Farquhar**
B.E., B.D., M.Sc(Lond)., D.I.C., C.Eng., MIPENZ, MICE
Senior Geotechnical Engineer, Worley Consultants Ltd, New Zealand
**A.J. Olsen**
B.E.(Hons), M.Sc(Lond)., D.I.C., MIPENZ
Manager Infrastructure Group, Worley Consultants Ltd, New Zealand

**Abstract** A four storey reinforced concrete building supported by shallow strip footings founded on a coral reef, settled by 125 mm overnight while under construction. The building on Majuro Atoll in the Marshall Islands continued to settle, and by the time it had been underpinned with driven 150 mm diameter steel end bearing micropiles and jacked back to level, 13 months later, a bowl shaped settlement pattern had developed which was 450 mm at the centre. The cause of subsidence appears to have been the collapse of lightly cemented coral gravel, infilling a former surge channel through the reef which had been bridged over by beach rock (cemented coral). Piling in the coral proved difficult and a procedure was developed where eventually 72% of the 485 piles were proof load tested to determine their capacity.

**Keywords** Settlement of structures, reefs, piles, load testing.

**Reference** Farquhar, G.B. and Olsen, A.J. (1996). Settlement of a Building on Coral and its Underpinning with Proof Loaded Piles. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 614-619.

## Planning and Design of the Second Manapouri Tailrace Tunnel Project, NZ

**M.D. Gillon**
B.E., M.E., MIPENZ, Reg. Eng.
Hydraulic Structures Manager, Electricity Corporation of New Zealand, NZ
**R.J. Essex**
B.S., M.S., M.E, P.E., MASCE, MITA
Vice President and Project Manager, Woodward-Clyde, USA

**Abstract** The Manapouri Power Station is a hydroelectric facility located on the South Island of New Zealand. Constructed in the 1960's, it includes an underground power station and a 9.8 km, 9.2 m diameter tailrace tunnel. The output of the power station is currently limited due to excessive head losses in the tailrace tunnel. To remedy this situation, the Electricity Corporation of New Zealand (ECNZ) intends to construct a second tailrace tunnel. ECNZ selected Woodward-Clyde and DesignPower to confirm the feasibility of the project and to prepare Tender Documents for construction. The Project will involve the construction of a 9.8 km, 10 m diameter, TBM-mined tunnel and appurtenant facilities. This paper summarises key planning and design issues addressed during the design, outlines innovative disputes avoidance provisions incorporated in the Contract, and overviews the Interactive Tender Process (ITP) to be implemented.

**Keywords** Hydroelectric power, hydropower, tunnelling, tunnel boring machine, tailrace tunnels, rock mechanics, engineering geology, underground construction, contracting.

**Reference** Gillon, M. and Essex, R.J. (1996). Planning and Design of the Second Manapouri Tailrace Tunnel Project, NZ. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 179-184.

# Application of Biopolymer Technology in Silty Soil Matrices to Form Impervious Barriers

**G.R. Martin**
Ph.D
Professor, Department of Civil Engineering, University of Southern California
**Teh Fu Yen**
Ph.D
Professor, Department of Civil Engineering, University of Southern California
**S. Karimi**
Graduate student, Department of Civil Engineering, University of Southern California

**Abstract** The Potential application of biopolymer technology for the construction of impervious barriers using silty soils is investigated. Laboratory experiments are presented demonstrating that the permeability of silty soils can be reduced by a factor of 100 or greater by either mixing commercially available biopolymers such as Xanthan gum or sodium alginate to the soil matrix or by mixing slime-forming micro-organisms with the soil matrix to produce biopolymers. Experimental results indicate that the soil shear strength is also increased by 50 percent.

**Keywords** Silts, permeability, biopolymers, bio-barriers, xanthan gum, sodium alginate, strength, bioremediation.

**Reference** Martin, G.R., Yen, T.F. and Karimi, S. (1996). Application of Biopolymer Technology in Silty Soil Matrices to Form Impervious Barriers. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 814-819.

# Seismicity and Stability - General Report

**T. Matuschka**
B.E.(Hons.), Ph.D., MIPENZ
Engineering Geology Ltd., New Zealand

**Keywords** Seismicity, slope stability.

**Reference** Matuschka, T. (1996). Seismicity and Stability - General Report. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 267-272.

# Shear Strength of Dense Sands During Rapid Loading

**K.J. McManus**
PhD
Senior Lecturer, Dept. of Civil Engineering, University of Canterbury, New Zealand
**R.O. Davis**
PhD, FIPENZ
Reader, Dept. of Civil Engineering, University of Canterbury, New Zealand

**Abstract** Dilation during undrained shear in saturated triaxial samples of sand leads to cavitation of the pore fluid. The onset of cavitation is observed by direct measurement of pore pressure, by measurement of sample volume change, and by an abrupt change in both deviatoric stress-strain response and stress path behaviour. The implications of cavitation are significant in situations where rapid loading of dense saturated soils may occur. A simple method for predicting shear strength with cavitation is presented.

**Keywords** Cavitation, dilation, shear strength, sand, triaxial test, rapid loading.

**Reference** McManus, K.J. and Davis, R.O. (1996). Shear Strength of Dense Sands During Rapid Loading. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 114-117.

# Elastic Soil Properties From Bender Element Tests

**V.M. Meyer**
B.E. (Hons), Grad.IPENZ
Department of Civil and Resource Engineering, The University of Auckland, New Zealand
**M.J. Pender**
B.E. (Hons), PhD, FIPENZ, MASCE
Department of Civil and Resource Engineering, The University of Auckland, New Zealand
**A. Nishihara**
Dr. Eng., MJSCE, MJSSMFE
Department of Civil Engineering, Fukuyama University, Japan
**G.C. Duske**
NZCE (Civil)
Department of Civil and Resource Engineering, The University of Auckland, New Zealand

**Abstract** This paper presents results from laboratory research into the use of bender elements to determine the small strain shear modulus, $G_{max}$, of a soil. Using bender elements mounted in either end platen of a conventional strain-controlled triaxial cell and undisturbed samples of sand, silt and clay, bender element tests enabled both P- and S-wave velocities to be measured. Using the theory of elastic wave propagation, the dynamic elastic parameters $G_{max}$, E, and $\nu$ for the soil samples were evaluated. These parameters showed general agreement with soil type. Variation of these elastic parameters with test conditions, undrained shear strength and confining pressure is presented. A brief summary of the bender element testing methodology is given along with some of the difficulties associated with this testing.

**Keywords** Clays, dynamics, laboratory tests, bender elements, elasticity, stiffness.

**Reference** Meyer, V.M., Pender, M.J., Nishihara, A. and Duske, G.C. (1996). Elastic Soil Properties from Bender Element Tests. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 123-128.

# Modelling of Stress-Strain Behaviour of Normally Consolidated Aged Clays

**A.K. Murashev**
M.Eng.Sc., Ph.D.
Geotechnical Engineer, Beca Carter Hollings & Ferner Ltd., New Zealand

**Abstract** Many clays and silts expected to be normally consolidated are shown by laboratory test results or more often by field settlement monitoring data to be apparently preconsolidated due to ageing. Although conventional laboratory tests on these clays often fail to determine a preconsolidation pressure, the settlements and deformations of these clays, monitored in the field prove that the material is preconsolidated. As a result of large scale investigations a new system for triaxial testing of soils was designed and constructed. Vertical and horizontal strain measurements were carried out in the central undisturbed part of the soil sample by electronic strain transducers. The test data obtained showed distinct preconsolidation of most tested aged clays. A new soil model was formulated on the basis of the test data. This model was used in computer modelling of the behaviour of soil under rigid circular foundations. The results of the calculations were compared with the field data which included monitored settlements at several depths beneath the centre, edges and outside of foundations.

**Keywords** Clay, settlement of structures, soil testing, triaxial testing, oedometer, preconsolidation, ageing.

**Reference** Murashev, A.K. (1996). Modelling of Stress-Strain Behaviour of Normally Consolidated Aged Clays. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 538-543.

## Aspects of the Geotechnical Behaviour of Some NZ Materials

**M.J. Pender**
B.E. (Hons), Ph.D., FIPENZ, MASCE
Professor of Geotechnical Engineering, Department of Civil and Resource Engineering, University of Auckland

**Abstract** This paper contains the text of the ninth NZ Geomechanics lecture. Properties of NZ soil and rock masses ranging from sand and clay to hard unweathered (but closely jointed) rock are reviewed. The aim of the lecture is to remind members of the NZ Geotechnical Society that although we deal with some interesting and unique materials we still have some distance to travel towards the goal of adequate characterisation of these materials. Particular information is provided about NZ residual soils, swelling pressures against retaining walls, pumiceous sands, volcanic ash, tunnel daylighting in soft rock, stability of slopes in , in situ stresses in coal, and pile driving resistance in rock fill.

**Keywords** Residual soil, volcanic ash, pumiceous sand, rockfill, closely jointed rock masses, soft rock, in situ stress measurement.

**Reference** Pender, M.J. (1996). Aspects of Geotechnical Behaviour of Some NZ Materials. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 21-39.

## A Tale of Sludge

**L.D. Wesley**
M.E., M.Sc. (Eng.), Ph.D., MIPENZ
Senior Lecturer, The University of Auckland, New Zealand

**Abstract** A lagoon was created for the disposal of paper mill sludge by constructing an earth embankment to enclose a wide flat area. The lagoon was intended to operate in a manner similar to a conventional tailings lagoon; in practice, however, its mode of operation turned out to be quite unconventional. Instead of settling out, the sludge "floated out" and formed a large floating mass right across the lagoon. It was still effective in separating out the solids, but failed to provide an impervious, deformable blanket on the upstream face of the earth embankment, and after some years of operation leakage problems developed in the embankment. These were overcome by using the sludge itself to build a secondary embankment.

**Keywords** Tailings lagoon, earth embankment.

**Reference** Wesley, L.D. (1996). A Tale of Sludge. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 991-994.

## Aspects of Seepage into Sheet Piled and Open Excavations

**L.D. Wesley**
M.E., M.Sc. (Eng.), Ph.D., MIPENZ
Senior Lecturer, The University of Auckland, New Zealand
**K. Ampualam, K.H. Fung and V. Ragunathan**
Former M.E. Students, The University of Auckland, New Zealand

**Abstract** This paper looks at aspects of seepage flow into ground excavations. The first part is concerned with seepage flow into sheet piled excavations and examines the influence of three dimensional flow and soil anisotropy on the exit hydraulic gradient at the base of such excavations. The second part is concerned with open excavations and examines seepage rates for fully penetrating and partially penetrating excavations. It compares estimates from theoretical or empirical formulae with estimates from computer analysis. The analysis is carried out using a computer programme called GeoFlow. This is a finite element programme with the ability to handle both two-dimensional (2-D) and axisymmetric flow (Ax-S) flow in either isotropic or anisotropic materials.

**Keywords** Seepage, excavations, axisymmetric, anisotropic, finite element method.

**Reference** Wesley, L.D., Ampualam, K., Fung, K.H. and Ragunathan, V. (1996). Aspects of Seepage into Sheet Piled and Open Excavations. Proceedings 7th Australia New Zealand Conference on Geomechanics, Adelaide, pp. 569-574.

# GeoEng 2000

# THE INTERNATIONAL MILLENNIUM CONGRESS ON GeoENGINEERING

## MELBOURNE, AUSTRALIA

PROPOSED FORMAT

- Propose a Keynote lecture and six (6) Theme Keynote lectures as follows:
  - Geotechnical Earthquake Engineering
  - Underground Works, Mining and Planning
  - Stability of Natural and Excavated Slopes
  - Environmental Goetechnics
  - Earth and Rockfill Embankments
  - Deep Foundations and Deep Excavations
- 18 Issues lectures, to be given, generally on issues related to the above 6 themes
- 3 Heritage lectures, presenting some insight into the past activities of our professions
- A session devoted to Education in Geo Engineering
- A Debate on where we might be heading
- A lecture at the end to pull together the mood of the Theme lecturers
- 12 Discussion Sessions
- A significant case history relating to each these
- Poster Sessions
- A Momentous Occasions Session
- Presentation of an award for best three papers submitted to Congress
- A "Roll Call", or "Hall of Fame"
- A continuous video and film showing
- Technical tours to be on the Saturday after the Congress
- An excellent social programme, with travel into Australian countryside, Sunday afternoon on the Goulburn River
- An accompanying persons programme, encompassing tourist venues around Melbourne
- Pre and post Congress tours, combining technical and scenic interests

We have given some thought to various issues topics, but would welcome further input and suggestions as to possible speakers/presenters for all Themes, Issues and Discussion sessions.

Max Ervin , Organiser

Contact Address : c/o Golder Associates Pty Ltd
PO Box 6079
Victoria 3122
AUSTRALIA
Tel. (613) 9819 4044
Fax (613) 9818 7990
E-mail mervin@golder.com

# GEOENVIRONMENT 97
# 1st AUSTRALIA NEW ZEALAND CONFERENCE ON ENVIRONMENTAL GEOTECHNICS

The Victorian Branch of the Australian Geomechanics Society is organising a conference on environmental geotechnics to be held at the Hilton Hotel, Melbourne, between 26 and 28 November 1997. This conference follows the very successful conference on "Geotechnical Management of Waste and Contamination" held in Sydney in 1993.

GeoEnvironment 97 is intended to provide a forum for practitioners to meet and exchange ideas in the rapidly growing area of environmental geotechnics. The conference will extend over three days and will include an international and an Australasian key note speakers. Theme papers are to be prepared by invited authors from Australia and New Zealand on the following topics:

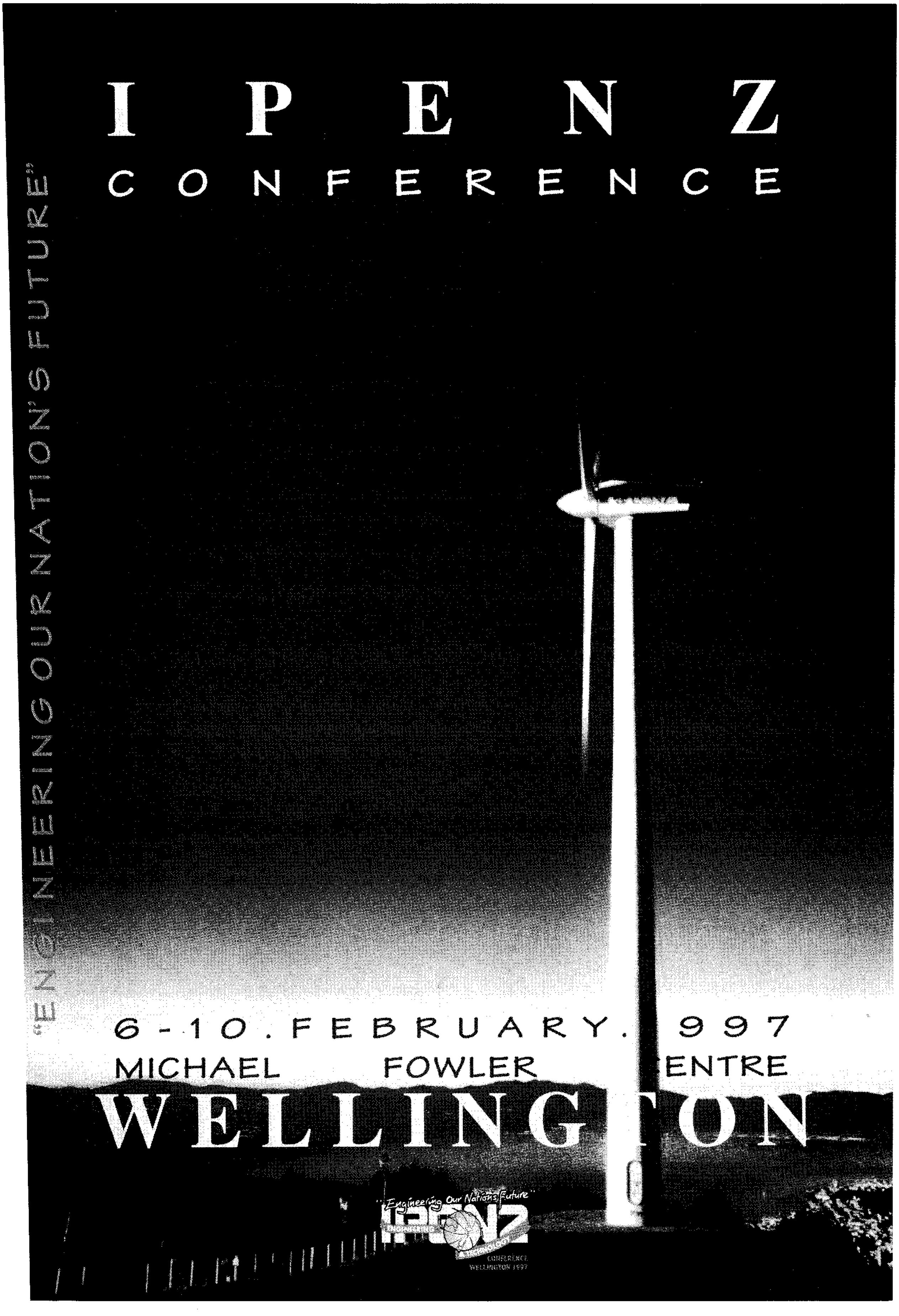
- Environmental Site Investigation and Risk Assessment
- Contaminated Land Remediation
- Waste Containment Design
- Geotechnics of Mining Wastes and Tailings Dams
- Construction on Derelict Land
- Contaminant Transport
- Future Directions in Regulation and Planning.

A call for papers is to be circulated in the near future with abstracts to be submitted by 15 December 1996.

It is proposed that the conference will include half day workshops and an exhibition.

Additional information can be obtained from the Conference Organisers:

'Geo Environment 97'
C/- ICMS Pty Ltd, 84 Queensbridge Street, Southbank Victoria 3006 Australia
Telephone: 03 9682 0244
Facsimile: 03 9682 0288
e-mail: geoenvironment.97@icms.com.au


I P E N Z
C O N F E R E N C E
"ENGINEERING OUR NATION'S FUTURE"
6-10. FEBRUARY. 997
MICHAEL FOWLER ENTRE
WELLINGTON

# CONFERENCE HIGHLIGHTS

## 'Engineering our nation's future'

Following on from the theme of the '96 Conference ('*the foundations of society*'), in '97 we turn to the future and examine where we as a nation are heading and the role that we, as Engineers and Technologists, take in our developing society. Both from national and global perspectives, what are our roles in this rapidly developing economy and how effective are we in achieving them ? How should we lend our skills to the way in which this country develops as a community and as an emerging force in a rapidly developing region ?

### THURSDAY 6 FEBRUARY

**ESR Conference**

**Conference Ice Breaker**

Mayoral reception and trade display opening. A chance to complete early registration, enjoy some cocktails and meet Wellington's Mayor Mark Blumsky.

**NZSO Concert - Wellington Harbour**

A spectacular concert from the world class New Zealand Symphony Orchestra playing from the back of the frigate Waikato. A great summer event for the whole family.

### FRIDAY 7 FEBRUARY

**Keynote Plenary Sessions**

**Conference Opening**

with the Governor General, the Prime Minister and the Mayor of Wellington.

**Newnham Lecture**

Sir Edmund Hillary

**Keynote Sessions**

Brian Easton, Tom Munsey, Sir Michael Fowler, Dr Ian Mair, Helen Hughes, Rear Admiral Jack Welch.

**Social Hour**

View the poster papers and discuss the day's issues and events over refreshments. Entertainment from the Royal New Zealand Navy Band.

**President's Reception**

Hosted by IPENZ President Dr Francis Small. Cocktails, the President's address, and dessert + coffee to follow.

### SATURDAY 8 FEBRUARY

**More Feature Sessions**

Adventure Tourism, Treaty of Waitangi, Fire Engineering, Museum of NZ, Operations Research

**Technical Streams begin**

**Lunchtime Visits**

Museum of NZ, HMNZS Waikato.

**Young Engineer of the Year Papers**

**Best 3 Papers - Conference Theme**

**Social Hour**

**Tranz Rail 1997 Engineering Excellence Awards**

A spectacular gala event, including dinner held at Wellington's gracious Town Hall - compere Ian Fraser, guests including the Prime Minister and industry leaders.

A number of IPENZ Awards together with the new Engineering Excellence Awards will be presented during a pacy, high technology evening - this is the premier event of the Conference.

"Engineering Our Nation's Future"

ENGINEERING & TECHNOLOGY

### SUNDAY 9 FEBRUARY

**Women Engineers' Forum**

**Young Engineers' Forum**

**More Technical Streams**

**Lunchtime Visits**

Refurbished Parliament Buildings

Moa Point Sewerage Treatment Plant

Wellington's Wind Turbine

**IPENZ Annual General Meeting**

**Special IPENZ Board Topic**

**IPENZ Learned Society Dinner**

Award of the IPENZ Learned Society Prizes over dinner with your colleagues.

### MONDAY 10 FEBRUARY

**Full and Half Day Visits together with the remaining technical sessions**

Catering for all engineering tastes, a variety of Technical Visits and Papers to wind up the Conference

**Visits**

Wairarapa Wind and Wine

Industrial Hutt

Engineering Heritage

Electrical Interest

**Don't miss the companions' programme - make a weekend of it in Wellington with the family!**

# THIRD ANZ YOUNG GEOTECHNICAL PROFESSIONALS CONFERENCE MELBOURNE 1998

The third ANZ Young Geotechnical Professionals Conference will be held in February 1998 in Melbourne. The conference will build on the success of the previous two conferences held in Sydney in 1994 and Auckland in 1995. Geotechnical organisations are encouraged to use this conference as an opportunity to both promote themselves and support their most promising young geotechnical staff.

## Conference Aims

- to promote the professional development of delegates through sharing experience and ideas, and by presenting a paper to senior professionals and peers;
- to provide a forum at which delegates can benefit from the insight of acknowledged authorities within the profession;
- to expand and strengthen the lines of communication between young professionals in the field of geomechanics;
- to promote an enhanced perspective of the varied roles, responsibilities and opportunities encompassed by the geotechnical profession;
- to foster an active interest in the geotechnical affairs of the region.

## Who Should Participate?

All Australian Geomechanics Society and New Zealand Geotechnical Society member organisations will be invited to nominate their young professionals to participate in the conference. Around thirty delegates will participate in the conference, representing a range of consulting, contracting and research organisations. The conference is designed to be of maximum benefit to young professionals with up to 10 years experience.

## Conference Format

The conference will be held over three days in February 1998 during which each delegate will present a 10 minute presentation of their paper. Papers will be reviewed by senior geotechnical professionals and published in conference proceedings.

Keynote speakers will be invited to give a one hour lecture on a topic within their field of expertise. The keynote speakers will be internationally acknowledged authorities in their field. The speakers along with other experienced local professionals will be present to act as mentors and to stimulate topical debate.

## Interested?

Organisations or individuals interested in participating in the conference should contact either the conference organisers or the NZGS liaison person for the conference at the addresses below. It is envisaged that organisations will sponsor their delegates to the conference. In addition the New Zealand Geotechnical Society may be able to obtain some sponsorship to help with the travel costs. Conference costs which include accommodation, meals and a copy of the proceedings are expected to be around AUS$420.

| Critical dates are as follows: | | |
|---|---|---|
| | Call for Delegates and Abstracts | February 1997 |
| | Acceptance of Candidates | May 1997 |
| | Submission of Papers | August 1997 |
| | Conference | February 1998 |

**Contacts :**

Ben Collingwood
Geomechanics Group
Dept of Civil Engineering, Monash University
CLAYTON VIC 3168
AUSTRALIA
Tel. (613) 9905 5581
Fax (613) 9905 4944
email: Collingwood@eng2.eng.Monash.ed.au

James Burr
Riley Consultants Ltd
P O Box 100-253
North Shore MailCentre
Auckland, NZ
Tel (09) 489 7872
Fax (09) 489 7873

1. The New Zealand Geotechnical Society wishes to recognise and encourage student participation in the fields of soil mechanics, rock mechanics, and engineering geology. It has therefore agreed to present annually two merit awards, each for a book of the value of $250* which shall be known as the "**New Zealand Geotechnical Society Student Prize**". (* the value of the prize is subject to review at the next NZGS annual general meeting).

2. The award shall be made to the bona-fide full-time student of a recognised Tertiary Institute in New Zealand who makes the adjudged best presentation on any aspect or topic in the field of geomechanics to the designated Local Group Meeting in either Auckland or Christchurch. The award is open to both undergraduate and postgraduate students, but the same student is not eligible for more than one award.

3. In May of each year students shall be invited to submit a Synopsis of their topic to the Local Group convenor in either Auckland or Christchurch, and the due date for receipt of synopses will be 30 June of that year. The Synopses shall not exceed 1,000 words or two A4 pages typed.

4. Students whose synopses are accepted shall be invited to present their topic verbally at a Local Group meeting specially designated for that purpose, and this will usually be held in the following September. The Local Group convenor shall be responsible for the format and timing of the meeting, but students should normally be required to speak for 20 minutes followed by 5 minutes of questions.

5. The Prize shall be awarded to the student who is judged to have made the best presentation in terms of clarity, and who is considered to have dealt with questions most competently. The composition of the judging panel is a matter for the Local Group convenor, and the judges' decision shall be final.

6. The Local Convenors in Auckland and Christchurch are expected to liaise through the National Activities Officer regarding the timing, format and venue for the annual Student Prize Meeting in each centre. They are also to ensure that the awards are made each year under generally similar conditions, and that invitations to participate are extended to students at institutions outside Auckland and Christchurch.

THE DEADLINE FOR SYNOPSES IS 30 JUNE 1997 *NOTE: Students wishing to submit a paper for the 1997 NZGS Student Prize should contact:*

Alexei Murashev
c/o Beca Carter Hollings & Ferner Ltd
P O Box 3942
Wellington

Phone: (04) 473 7551
Fax: (04) 471 5501

## NZGS is pleased to announce the winner of the 1996 Student Prize is:

**ALASTAIR CHAMBERS**

for his paper entitled

***Seismic Response of Drilled Shaft Foundations***

# 1997

**FEBRUARY 7-9, 1997**
Wellington, NZ
IPENZ CONFERENCE: ENGINEERING OUR NATION'S FUTURE (See article elsewhere in *Geomechanics News*)

**FEBRUARY 9-12, 1997**
St Petersburg, Florida, USA
INTERNATIONAL CONFERENCE ON CONTAINMENT TECHNOLOGY CALL FOR PAPERS
Topics: Barriers-Walls, Floors, Caps, Construction QA, Contaminant Transport Modelling, Permeable Walls, Long Term Performance Monitoring, Barrier Materials.

**MARCH 13-14 (PROV.) 1997**
London, UK
INTERNATIONAL CONFERENCE ON GROUND ANCHORAGES AND ANCHORED STRUCTURES.
Topics: Site Investigation, Anchor Design and Materials Corrosion, Construction techniques, Monitoring, Field Testing, Laboratory Studies, New Development, Standards.

**MAY 6-8, 1997**
Macau
IC ON GROUND IMPROVEMENT TECHNIQUES.
Topics: Soil stabilisation; Accelerating consolidation; Soil reinforcement; Grouting; Densification; Innovative techniques.

**MAY 12-13, 1997**
Singapore
IC ON FOUNDATION FAILURES.
Topics: Contractual and legal aspects; Design and construction-related failures; Full-scale tests to failure; Case histories; Failure investigation and remedial actions.

**JUNE 3-5, 1997**
London, UK
BGS/CFMS CONFERENCE ON GROUND IMPROVEMENT BY DENSIFICATION AND REINFORCEMENT.
Topics: Densification of granular soils; Reinforced soil construction; Reinforcement by nailing; Densification of fine grained soils; Novel techniques for improvement of soils.
Languages: English and French.

**JUNE 22-25, 1997**
Lillehammer, Norway
IS ON ROCK SUPPORT
Topics: Theory, general; Projects for public use; Sewage and water; Nuclear waste, Mining and temporary excavation.

**JUNE 23-27, 1997**
Athens, Greece
INTERNATIONAL SYMPOSIUM ON ENGINEERING GEOLOGY AND THE ENVIRONMENT
Topics: Engineering geology and geomorphological processes; Natural and man-made hazards, Geological environment in urban and regional planning; Waste disposal; Impact from the exploitation of mines and quarries; Environmental aspects of the design and construction of large engineering works and schemes; Protection of historical and architectural heritage; Strategies and legislation related to geological conditions and processes affecting; Environmental courses in geological and geotechnical education.
Languages: English and French, Greek

**SEPTEMBER 4, 1997**
London, UK
GEOTECHNIQUE SYMPOSIUM IN PRINT: PRE-FAILURE DEFORMATION OF GEOMATERIALS.
Theme: Characterising the pre-deformation behaviour of geomaterials, particularly in relation to predicting ground deformation and the displacement of structures.
Topics: Laboratory and field studies involving new experimental techniques; Novel interpretative approaches; Geomaterials which differ significantly from the current experimental database; Theoretical studies; Case histories; Parametric studies; Re-analysis of existing data.
Paper: The papers will be printed in the September 1997 issue of Géotechnique.

**SEPTEMBER 6-12, 1997**
Hamburg, Germany
XIV INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING
Themes:
Plenary Sessions:

- Soil Testing & Ground Property Characterisation
- Recent Developments in Foundation Techniques
- Retaining Structures and Excavated Slopes
- Underground Works in Urban Environment
- Soil Improvement & Reinforcement
- Waste Disposal and Contaminated Sites

Parallel Sessions:
- Recent Developments in Laboratory

Stress-Strain Testing in Geomaterials
- Ground Property Characterisation by Means of Insitu Tests
- Interplay between Physical and Numerical Models as Applied in Engineering Practice
- Soil Structure Infraction for Shallow Foundations under Static Dynamic Loadings
- Design and Performance of Piled Rafts
- Limit States Concept in Design of Shallow and Deep Foundations
- Design Construction and Performance of Anchored Walls and Strutted Excavations
- Large Excavations with Dewatering in Urban Environment
- Subsidence as Related to Various Tunnelling Techniques
- Performance and Monitoring of Underground Works
- Soil Improvements for Tunnel Works
- Deep in Place Mixing Methods including Jet-Grouting
- Use of Geosynthetics and Geotextiles in Geotechnical Engineering
- Pollutants Containment via Passive Barriers
- Active Pollutants Control and Remediation of Contaminated Sites
- Dredging Sludge and Tailings Impoundments
- Teaching and Education in Geotechnical Engineering

Manuscripts by 31 Dec 1996

**SEPTEMBER 15-16, 1997**
Johannesburg, South Africa
ISRM REGIONAL SYMPOSIUM
Theme: Implementing Rock Knowledge
Topics:
- Applied and practical strategies to reduce rockbursts and seismicity on mines
- Coal mining strata control
- Stability and design of underground openings
- Tunnels and tunnelling
- Laboratory and field instrumentation and measurements
- Underground storage and sealing
- Reservoir engineering
- Foudnations on rocks
- Large caverns
- Fracture system and discontinuities
- Constitutive and numerical modelling

**SEPTEMBER 29 - OCTOBER 3**
Montreal, Canada
7$^{TH}$ IC ON UNDERGROUND SPACE - INDOOR CITIES OF TOMORROW

**OCTOBER 4-7, 1997**
Nagoya, Japan
IS ON DEFORMATION AND PROGRESSIVE FAILURE IN GEOMECHANICS (Is' NAGOYA).
Topics: Theory and practice on deformation and progressive failure in Geotechnical Engineering.

**OCTOBER 13-15, 1997**
Seoul, Korea
ISRM REGION SYMPOSIUM - 1ST ASIAN ROCK MECHANICS SYMPOSIUM:
Environmental & Safety concerns in underground construction.

**NOVEMBER 2-7, 1997**
Wuhan, China
9th INTERNATIONAL CONFERENCE IACMAG (INTL. ASSOCIATION FOR COMPUTER METHODS AND ADVANCES IN GEOMECHANICS)
Themes: Computer Modelling; Computer Aided Engineering; Geoenvironmental Engineering; Underground Works; Infrastructure Rehabilitation; Static and Dynamic Soil-Structure Interaction; Ground Improvement; Natural and Man-Made Hazards; 21st Century Geomechanics.

**NOVEMBER 26-27, 1997**
Melbourne, Australia
1$^{st}$ ANZ CONFERENCE ON ENVIRONMENTAL GEOTECHNICS

# 1998

**FEBRUARY, 1998**
Melbourne, Australia
3$^{rd}$ YONNG GEOTECHNICAL PROFESSIONALS CONFERENCE.

**MARCH 8-15, 1998**
St Louis, USA
4$^{th}$ IC ON CASE HISTORIES IN GEOTECHNICAL ENGINEERING.

**MARCH 25-29, 1998**
Atlanta, Georgia, USA
6TH INTERNATIONAL CONFERENCE ON GEOSYNTHETICS CALL FOR PAPERS

**JUNE 19-22, 1998**
Atlanta, Georgia, USA
1ST INTERNATIONAL CONFERENCE ON SITE CHARACTERISATION - CALL FOR PAPERS
Topics: Planning Site Investigations, Specifications, Standards, Drilling and Testing, Geophysical Testing, Case Histories.

**JULY 14-17, 1998**
Wollongong, Australia
IC ON GEOMECHANICS/GROUND CONTROL IN MINING AND UNDERGROUND CONSTRUCTION - *(See article elsewhere in Geomechanics News).*

**SEPTEMBER 21-25, 1998**
Vancouver, Canada
8TH CONGRESS IAEG
Topic: A Global View from the Pacific Rim.
*(See article elsewhere in Geomechanics News).*

**SEPTEMBER (Prov.) 1998**
Naples, Italy
2ND IS GEOTECHNICAL ENGINEERING OF HARD SOILS - SOFT ROCKS.
Theme: To outline the characteristics of hard soils and soft rocks and to verify if the main frames of Classical Soil & Rock Mechanics are still valid for their behaviour. Sponsored by ISSMFE Technical Committee TC22.
Abstractors deadline: 30 June 1997.

**OCTOBER 1998**
Sendai, Japan
IS ON PROBLEMATIC SOILS (IS TOHOKU '98)
Themes: Basic and engineering properties; Engineering classification; Foundation engineering and earthworks; Countermeasures or solutions from case histories.
Topics: Peat and organic soils; Volcanic soils; Expansive and collapsible soils; Decomposed soils; Others.

## 1999

**FEBRUARY, 1999**
Hobart, Australia
8TH ANZ CONFERENCE

## 2000

**JUNE 26-30, 1998**
Cardiff, UK
8TH IS ON LANDSLIDES
BRITISH GEOTECHNICAL SOCIETY

**OCTOBER 23-27**
Melbourne, Australia
GEO ENG 2000. INTERNATIONAL CONGRESS SPONSORED JOINTLY BY ISSMFE, IAEG AND ISRM- (See article elsewhere in *Geomechanics News*)

**Footnote**: For further details on contacts or brochures for any of the above conferences or symposia please contact the Assistant Editor of NZ Geotechnical News.

ENGINEERING GEOLOGY and the ENVIRONMENT

ΤΕΧΝΙΚΗ ΓΕΩΛΟΓΙΑ και ΠΕΡΙΒΑΛΛΟΝ

LA GEOLOGIE DE L'INGENIEUR et L'ENVIRONNEMENT

ENGINEERING GEOLOGY COMMITTEE OF THE GEOLOGICAL SOCIETY OF GREECE (GREEK NATIONAL GROUP OF IAEG)

INTERNATIONAL SYMPOSIUM
sponsored by
the International Association of Engineering Geology (IAEG)

Co - sponsored by
the International Association of Hydrogeologists (IAH)

ATHENS, GREECE June 23-27, 1997

# CIRCULAR FOR THE ATHENS' 97 IAEG SYMPOSIUM

## WELCOME

The Greek National Group of the International Association of Engineering Geology takes pleasure in inviting all interested scientists to attend the Athens 1997 IAEG Symposium on the Environment.

**Athens**, the country' s capital has all the makings of a major city whose heart beats untiringly all round the clock. Busy and creative from morning till night, carefree and lively from evening till dawn. Such is today's pulse of the city which has spread itself out alongside a 3300-year past which came so close to perfection in culture and in art, leaving its glow to shine down from the Acropolis.

## THE SUBJECT

With the explosion of development in the last decades, the expansion of cities, the excessive land use and the problem of disposal of waste material, the environmental protection has become a matter of first order priority. Engineering Geology, by knowledge and experience, is aware of the behavior of the earth, therefore is in an excellent position to contribute in a dynamic way; not only by protecting, but also by supporting development without harming at the same time the environment.

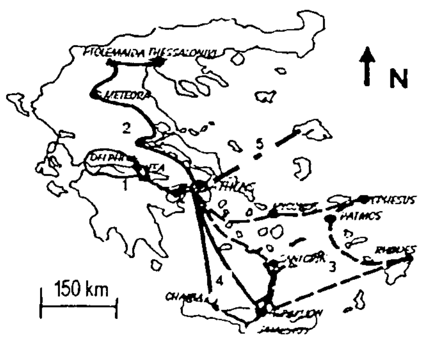
## AUSPICES

- Welcome address by the President of the Republic
- INTERN. ASSOC. OF ENGINEERING GEOLOGY (IAEG)
- INTERN. ASSOC. OF HYDROGEOLOGISTS (IAH)
- COGEOENVIRONMENT (IUGS)
- PARTICIPATION OF ISSMFE AND ISRM SPECIALISTS
- UNESCO
- MINISTRY OF ENVIRONMENT, PLANNING AND PUBLIC WORKS
- THE CITY OF ATHENS-Official reception by the Mayor of Athens
- HELLENIC NATIONAL TOURISM ORGANIZATION
- NATIONAL TECHNICAL UNIVERSITY OF ATHENS
- UNIVERSITY OF PATRAS
- DEMOCRITUS UNIVERSITY OF THRACE

## PLACE AND DATE

The Sypmosium will be held in Athens from June 23 to 27, 1997. It will last for five days and will be followed by excursions to sites of geological, geotechnical and environmental interest in Greece, associated with archaeological visits.

Registration and social events will start from Sunday 22, 1997. The scientific sessions will be held at the **Athens Hilton Hotel.**




## THEMES

1. Engineering geology and geomorphological processes.
2. Natural and man-made hazards.
3. Geological environment in urban and regional planning and management.
4. Engineering Geology and Hydrogeology for environmental health - Waste disposal.
5. Impact from the exploitation of mines and quarries.
6. Environmental aspects of the design and construction of large engin. works and schemes.
7. Protection of geological and geographical heritage.
8. Protection of historical and architectural heritage
9. Strategies and legislation related to geological conditions, processes and hazards affecting the environment.
10. Environmental courses in geological and geotechnical education.

## SITUATION BY END OF JULY 1996-PAPERS

The Bulletin No1 has been distributed, all over the world, between June 1994 and Dec. 1995. By the end of May 1996, the state of pre-registration was :

Delegates : 1206

Accompanying persons : 333

Countries : 79

768 Abstracts have been selected (286 of them with suggestions or remarks to the authors),

Affiliations IAEG : 265, IAH : 93
ISRM : 75 ISSMFE : 98

Full papers will be submitted to the Organizing Committee for review by September 30, 1996 according to instructions provided to authors

## SCIENTIFIC PROGRAM

The opening ceremony and the welcoming addresses will be followed by a technical visit to the Acropolis of Athens and the Temple of Parthenon (Pericles Age, 5th century B.C.).

**28 scientific sessions** will be held at the Athens Hilton from Monday 23 afternoon to Friday 27. On Wednesday a full day boat trip from Athens to Itea, a bauxite area in Central Greece, crossing the famous Corinth canal, and then to the archaeological site of Delphi, will take place.

Most of the sessions will be opened by an **invited lecturer**.

**General reporters** will review groups of papers. **Selected papers** will also be presented orally.

An open discussion will close each session. In the closing session reporters and panelists will summarize and conclude from the contributions and the debates of sessions.

A provision will be made for **poster display** too.

Technical visits with a special emphasis on environmental aspects are planned to be made during the symposium (Metro, landslides, landfills).

## OFFICIAL LANGUAGES

The languages of the Symposium will be English and French, the official languages of IAEG.

A simultaneous translation will be provided.

## PROCEEDINGS

The 4 volumes of Proceedings will be distributed to participants **upon their registration.**

'A.A.BALKEMA' will be the publisher. Selected papers will also be published in a special issue of the *International Journal of Engineering Geology.*

## POST SYMPOSIUM TOURS

Four Post Symposium tours are currently planned to sites with a special geological, geotechnical, hydrogeological, environmental, historical and archaeological interest.

Tour 1 : Central Greece (3 days)
Tour 2 : Central and Northern Greece (5 days)
Tour 3 : The islands of the Aegean World (3 days cruise)
Tour 4 : The island of Crete and the volcano of Santorini island(4 days)
Tour 5 : The island of Lesvos and the fossilised forest

## REGISTRATION FEES

The registration fees for participants will be about 500$ for early registration. Significantly reduced fees are foreseen for participants under special conditions.

Registration fees cover :

- one set of proceeding volumes
- access to all technical sessions of the symposium
- opening ceremony
- welcome reception
- light lunches during the Symposium
- visit to the Acropolis of Athens
- technical visits (Metro works, etc.)
- cultural performance and visits to museums
- one full day excursion (boat trip to Corinth canal and Delphi)
- coffee and refreshments during the breaks

**Accompanying persons** benefit all the above mentioned social events plus an accompanying persons' program.

## BULLETIN No. 2

The Bulletin No. 2 will be distributed before September 1996 to all those who have already preregistered and to those who will sent the form below :

For more information please return to :
Greek National Group of IAEG (Prof. P. Marinos)
P.O. Box 19140, GR-117 10,
Athens, Greece. Fax : ++301 9242570, 7723435

Last name : ..............................

First name : ..............................

Address : ..............................
..............................

Affiliation :

# UNIVERSITY OF WOLLONGONG
# INTERNATIONAL CONFERENCE IN GEOMECHANICS / GROUND CONTROL IN MINING AND UNDERGROUND CONSTRUCTION

## July 14 -17, 1998

**WOLLONGONG, New South Wales, AUSTRALIA**

## CALL FOR PAPERS

250-300 word abstracts are invited along the following themes:

Geology and geosciences
Site explorations
Fundamental rock mechanics
Pillar design
Roadway stability
Underground support systems
Longwall mining
Subsidence and control
Joint & fracture mechanics
Instrumentation & monitoring
Dynamic phenomena (gas and rock outbursts)
Water inflow and dewatering
Tunnelling/Excavation Technology
Slope stability
Computer applications

### IMPORTANT DEADLINES

| | |
|---|---|
| Abstract submission date | 31 October 1996 |
| Notification of acceptance | 31 March 1997 |
| Paper submission date | 30 November 1997 |
| Acceptance of the paper | 28 February 1998 |
| Conference date | 14-17 July 1998 |

Please forward **ABSTRACTS** to:

Dr B. Indraratna
(Conference Convener)
Dept. of Civil & Mining Engineering
University of Wollongong
Wollongong, NSW 2522,
Australia
Tel: (61) 42 213046
Fax: (61) 42 213238
e-mail: b.indraratna@uow.edu.au

**REGISTRATION FEE:**

Before June 15, 1998: A$ 600
After June 15, 1998: A$ 650
Day Registration: A$ 200
Full-time Students: A$ 150

Trade Exhibition: Display booths of dimensions 2m x 3m are available for interested parties at a cost of A$ 800.

## PLACE AND DATE

The Symposium will be held in Athens, from June 23 to 27, 1997. It will last five days and will be followed by excursions to sites with a geological, hydrogeological, geotechnical and environmental interest. The venue will be also combined with visits to archaeological and historical areas in the Greek territory. During that time the weather in Greece is very pleasant and the tourist period is active. The average daily temperature is 25 degrees and average precipitation 12mm (2.5 days frequency).

## THEMES

1. **Engineering geology and geomorphological processes.** Engineering geological view of sedimentation, weathering, erosion and desertification processes; active tectonics; sea level changes and coastal protection; fluvial and deltaic environment; karst and soluble rock terrain; problematic soils (sensitive clays, swelling and expansive soils, loess, permafrost).
2. **Natural and man-made hazards.** Landslides and other slope movements; subsidence of all types and vanishing lands, compaction, groundwater oil and gas extraction, karst sinkholes etc; hazards resulting from seismisity, volcanic activity, floods; geotechnical control, civil and environmental protection; design and construction in hostile geological environment.
3. **Geological environment in urban and regional planning and management.** Site investigation; engineering geological mapping for urban and regional development; site suitability and vulnerability assessment.
4. **Engineering Geology and Hydrogeology for environmental health - Waste disposal.** Site investigation; site selection; geological, hydrogeological and geotechnical criteria; landfills, design and construction; confinement of toxic and radioactive wastes, physical barriers, geological repositories; soil and water pollution, decontamination and clean up; operation, monitoring and reclamation of sites; re-use of industrial wastes for geotechnical purposes.
5. **Impact from the exploitation of mines and quarries.** Land disturbance, landscape changes, refuge disposal and associated hazards; tailing dams; reclamation of waste tips and excavations; changes in groundwater regime.
6. **Environmental aspects of the design and construction of large engineering works and schemes.** Geomorphic and environmental changes during the construction and operation of various projects; case histories (dams and reservoirs; transportation infrastructure: roads, tunnels, crossings, metropolitan railways, etc.).
7. **Protection of geological and geographical heritage.** Natural parks and eco-systems; wetlands; geological monuments, caves; case histories.
8. **Protection of historical and architectural heritage.** Environmental restrictions; stability of foundations; protection from natural and man-made hazards; decay of building stones; case histories.
9. **Strategies and legislation related to geological conditions, processes and hazards affecting the environment.** Specifications; codes of practice; warning and mitigation; existing legislation; engineering geologists in the public administration.
10. **Environmental courses in geological and geotechnical education.** Teaching and training; professional practice.

## PROGRAMME

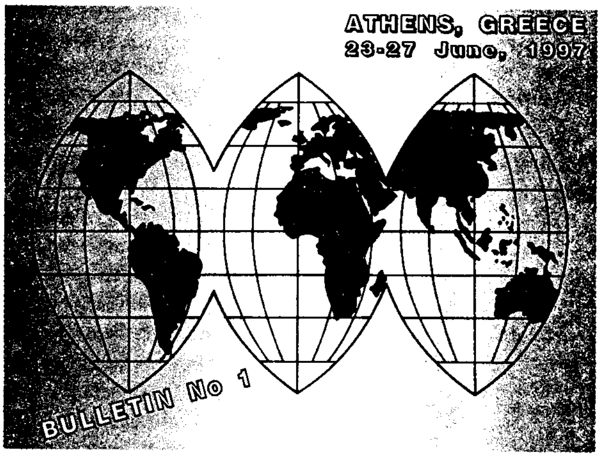
It is planned that Monday, Tuesday, Thursday and Friday will be devoted to scientific sessions. Invited speakers will present state of the art reviews and special lectures will be given by well known experts. Speciality sessions will provide opportunity for participants to present accepted papers. Wednesday is devoted for a full day trip in Northern Peloponnese.

*The tour will include the environmental implications and geotechnical aspects of the Athens - Corinth highway, the famous Corinth Canal with its special geological and geotechnical features, ancient cities affected by sea-level changes, the ancient city of Corinth (6th century*

International Association
of Engineering Geology

**INTERNATIONAL SYMPOSIUM ON**

# ENGINEERING GEOLOGY and the ENVIRONMENT




ENGINEERING GEOLOGY COMMITTEE
OF THE GEOLOGICAL SOCIETY OF GREECE
(GREEK NATIONAL GROUP OF IAEG)

**CO - SPONSORS**

- INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (IAH)
- COGEOENVIRONMENT (IUGS)

**UNDER THE AUSPICES OF**

- UNESCO
- MINISTRY OF ENVIRONMENT, PHYSICAL PLANNING AND PUBLIC WORKS
- THE CITY OF ATHENS
- NATIONAL TECHNICAL UNIVERSITY OF ATHENS
- UNIVERSITY OF PATRAS

# PUBLICATIONS OF THE SOCIETY

***The following publications of the Society are available from the Secretary, IPENZ, P.O. Box 12241, Wellington North. Some publications have been reduced in price to members to clear excess stocks. All prices exclude postage and GST.***

| | LIST PRICE | |
|---|---|---|
| | MEMBERS | NON MEMBERS |
| Proceedings of the 7th Australia-New Zealand Conference on Geomechanics, Adelaide, July 1996 | Aus$160.00 approx. | |
| Proceedings of the Second Australia-New Zealand Young Geotechnical Professionals Conferences, Auckland, December 1995 | $ 25.00 | $ 40.00 |
| **Australia-NZ Conferences on Geomechanics** Proceedings of the Sixth Australia-NZ Conference on Geomechanics, Christchurch, February 1992 | $50.00 | $100.00 |
| Proceedings of the Third Australia-NZ Conference on Geomechanics, Wellington, May 1980 | $ 10.00 | $ 30.00 |
| Proceedings of the Second Australia-NZ Conference on Geomechanics, Brisbane, July 1975 | $ 25.00 | $ 25.00 |
| **NZ Geomechanics Society Symposiums** Geotechnical Issues in Land Development. Proceedings of Technical Groups. Vol.22, Issue 1G, Hamilton, 1996 | $ 20.00 | $ 35.00 |
| Proceedings of the Auckland Symposium "Groundwater and Seepage", May 1990 | $ 10.00 | $ 45.00 |
| Proceedings of the Hamilton Symposium "Piled Foundations", September 1986 | $ 10.00 | $ 25.00 |
| Proceedings of the Alexandra Symposium "Engineering for Dams and Canals", November 1983 (a joint Symposia with NZSOLD) | $ 10.00 | $ 50.00 |
| Proceedings of the Palmerston North Symposium "Geomechanics in Urban Planning", May 1981 | $ 20.00 | $ 20.00 |
| Proceedings of the Wanganui Symposium "Using Geomechanics in Foundation Engineering", September 1972 (xerox copy) | $ 8.00 | $ 10.00 |
| **Other Publications** Guidelines for the Field Description of Soils and Rocks in Engineering Use | $ 10.00 | $ 13.00 |
| "Stability of House Sites and Foundations - Advice to Prospective House and Section Owners" | $ 1.00 | $ 1.00 |
| IEA Guidelines for Provision of Geotechnical Information, etc. | $ 10.00 | $ 10.00 |
| Back dated issues of Geomechanics News | $ 0.50 | $ 0.50 |

## OBJECTS

(a) To advance the study and application of soil mechanics, rock mechanics and engineering geology among engineers and scientists.

(b) To advance the practice and application of these disciplines in engineering.

(c) To implement the statutes of the respective international societies in so far as they are applicable in New Zealand.

## MEMBERSHIP

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

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

## ANNUAL SUBSCRIPTION

Annual subscriptions, which include the newsletter are (for 1997)

| | | |
|---|---|---|
| *Members* | *(IPENZ members)* | *$35.00* |
| | *(others)* | *$50.00* |
| *Students* | *(IPENZ members)* | *$17.50* |
| | *(others)* | *$25.00* |

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

| | | |
|---|---|---|
| *International Society for Soil Mechanics and Foundation Engineering* | *(ISSMFE)* | *$20.00* |
| *International Society for Rock Mechanics* | *(ISRM)* | *$20.00* |
| *International Association of Engineering Geology* | *(IAEG)* | *$15.00* |
| | *(with bulletin)* | *$42.50* |

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

*NZ Geotechnical Society*
*P O Box 12 241*
*WELLINGTON*

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

## NEW ZEALAND GEOTECHNICAL SOCIETY
## APPLICATION FOR MEMBERSHIP

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

**FULL NAME** (Underline Family Name): ..........................................................................................

**POSTAL ADDRESS:** ..........................................................................................................

..........................................................................................................

Phone No:. . . . . . . . . . . . . . Fax No.: . . . . . . . . . . . . . .E-MAIL: . . . . . . . . . . . . . . . . .

**ACADEMIC QUALIFICATIONS:** ..........................................................................................

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

**PRESENT EMPLOYER:** ..........................................................................................

**OCCUPATION:** ..........................................................................................

**EXPERIENCE IN GEOMECHANICS:** ..........................................................................................

..........................................................................................................

..........................................................................................................

**STUDENT MEMBERS:**

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

**SUPERVISORS SIGNATURE:** ..........................................................................................

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

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

I wish to affiliate to:

| | | |
|---|---|---|
| **International Society for Soil Mechanics and Foundation Engineering** | (ISSMFE) | Yes/No |
| **International Society for Rock Mechanics** | (ISRM) | Yes/No |
| **International Association of Engineering Geology** | (IAEG) | Yes/No |
| **(with Bulletin)** | | Yes/No |

---

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

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

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

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

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

---

(for office use only)

Received by the Society ..........................................................................................

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

Approved by the Council of the Institution ..........................................................................

# ADVERTISING IN NZ GEOMECHANICS NEWS

*NZ Geomechanics News* is published at least twice a year and distributed to the Society's 400 members throughout New Zealand.

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

| **Advertisement Location** | **Single Issue** |
|---|---|
| Back Cover | $250*2 |
| Inside Cover (Front or Back) | $200*2 |
| Full Page Internal | $180 |
| Half Page Internal | $125 |
| *Note: 1 All rates are excluding GST<br>2 Subject to availability | |

The deadline for advertising copy for the next issue is 9 May 1997. Arranging artwork for your adverts can be carried out at a reasonable additional cost if requested. However, advance notice is required for this additional service.

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

The Publications Officer
Alexei Murashev
c/o Beca Carter Hollings & Ferner Ltd
P.O. Box 3942
WELLINGTON

Tel: (04) 473 7551
Fax: (04) 473 7911
E-mail: tom@beca.co.nz

The Editor
Stephen Crawford
c/o Tonkin & Taylor Ltd
P.O. Box 5271
AUCKLAND

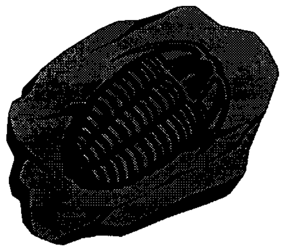
Tel: (09) 355 6054
Fax: (09) 307 0265
E-mail: sac@tontay.co.nz

# <u>WANTED</u>

# QUALIFIED GEOLOGIST WITH 8-10 YEARS GEOTECHNICAL EXPERIENCE

*REQUIRED FOR SHORT TERM FREELANCE OVERSEAS CONTRACT IN THE MIDDLE EAST*

*PROBABLE START - MID TO LATE JANUARY 1997*



*PLEASE CONTACT:* *GEOFF HANSEN*

*Ph: (07) 576 6101*

# GEOTECHNICAL ENGINEER
## CONSULTING/MANAGEMENT

Our client is a well respected and progressive Consultancy specialising in the Civil sector. To further develop and expand their range of client services they now seek to appoint a qualified and skilled professional to a senior position within their organisation.

Based in their Auckland office and as part of the management team reporting directly to the General Manager the successful candidate will primarily be responsible for the further expansion of the Geotechnical services including; client development, project management and staff supervision.

This is a career opportunity and it is envisaged preferred applicants will be highly self motivated, well organised and possess an appropriate degree in Civil engineering with extensive experience within the Geotechnical sector. Previous supervisory experience is also required along with excellent written and verbal communication skills, the ability to foster strong client relationships and identify and develop commercial opportunities.

To attract candidates of the highest calibre an attractive salary package including vehicle, bonus and future shareholding will be offered.

For a confidential enquiry please phone **Garth Raines (04) 472-6558** or send your CV in application to:

**Technical Recruitment Solutions Limited**
**PO Box 5439, Wellington**

technical Recruitment SOLUTIONS

# GEOTECHNICAL VACANCIES

In addition to the above advertised position, we have a number of clients currently seeking qualified and experienced Engineers and Technicians for vacancies throughout New Zealand.

The positions range from junior/intermediate Technician to Senior Engineering Management, covering locations such as Christchurch, Nelson, Wellington, Hamilton, Tauranga and Auckland, with smaller private companies through to large international consultancies.

Whether seeking your next career move, wishing to broaden your experience, improve your position or just a change in location, we may be able to assist.

For a strictly private and confidential enquiry please phone **Garth Raines (04) 472-6558**:

**Technical Recruitment Solutions Limited**
**PO Box 5439, Wellington**

technical Recruitment SOLUTIONS